AN EVALUATION OF PROBLEM BASED LEARNING IN ARCHITECTURAL EDUCATION

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Abstract

This thesis is a case study that explores the implementation of Problem Based Learning in architectural education. It aims to evaluate the appropriateness of Problem Based Learning for the pedagogical improvement and development of architectural education. The relevant literature from architectural education and the Problem Based Learning pedagogical approach, were used to identify the critiques and problems encountered in contemporary architectural education and to analyse the potential of Problem Based Learning in architectural education. The research questions look at why the implementation of Problem Based Learning in the Faculty of Architecture, the Delft University of Technology, the Netherlands, could not be considered as a complete success. This proposition required further analysis that led to the formation of research procedures focusing on three issues: identifying the research strategies, selecting interviewees and documentation review as data collection methods, and choosing content analysis as the main analysis method. The results of the analysis confirmed that the implementation of Problem Based Learning at TUDelft was not a success, due to resistance from academic staff and their misunderstanding of the true philosophy of the educational approach. From this analysis, the thesis then discussed how to adapt Problem Based Learning for use in architectural education, and which direction architectural research should go next, to improve the pedagogy of architectural education as a whole.

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

Problem Based Learning (PBL) has become increasingly popular in the tertiary education levels of many professional disciplines (Boud & Felletti, 1997). It is claimed to have maximum effectiveness in producing professional competencies among graduates, but its effectiveness in architectural education has never been thoroughly scrutinised. 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). For that reason, this research attempts to fill the gap in architectural educational research, by investigating the implementation of Problem Based Learning in architectural education, with the aim of providing ways to improve architectural education in general.

The main approach of the research involves discussion of the problems and criticism of the conventional architectural education, comparative analysis of the components and characteristics of general PBL pedagogical approaches, and a critical analysis of PBL implementation in architectural education itself.

Since education is the least popular research topic in schools of architecture and "strikingly research on architectural education has not been of concern to many academics" (Salama, 2004), architectural education itself is severely criticised for not providing competent architects to the architectural profession (Stansfield-Smith, et. al., 1999). This criticism is generated from the problems encountered within architectural education itself, where the lack of a formal theoretical framework leads to a disaggregated body of architectural knowledge (Maitland, 1997; De Graaff, 1993; Stansfield-Smith, et. al., 1999; Nicol & Pilling, 2000). There is also a tendency to focus on artistic values (Cuff, 1989; Salama, 1995; Brown, 2002), and an inability to cope with the current rate of change (Moore, 2001; Koch, et. al., 2002). As such, the architectural education system is desperately in need of solutions to tackle such problems encountered.

As Problem Based Learning has been known to provide competent graduates in many other professional disciplines, there have been attempts to utilise the same pedagogical approach in architectural education as well. Here, PBL is seen as a potential solution to the problems encountered in architectural education. This is particularly the case with its pedagogical mechanism that is believed to provide students with lifelong learning skills essential for future competency in professional practice. Therefore, before investigating PBL implementation in architectural education, this research undertakes a comparative analysis of the components and characteristics of general PBL pedagogical approaches.

There is only a limited literature available on the relevancy and effectiveness of the PBL implementation in architectural education, although there are two institutions which are known to have used Problem Based Learning as their pedagogical approach. Some scholars present their description of the implementation of PBL in architectural education (De Graaff, 1993; Maitland, 1997), but those descriptions are often limited to presenting the curriculum structure and the learning theory of an architectural version of the PBL pedagogical approach. Generally, 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 outcome." 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. Therefore, this research is intended to take a critical look at the experience of implementing PBL, especially in an institution that discontinued its PBL implementation whilst claiming its success.

1.1 Aim of the Thesis

The thesis examines the experience of the implementation of PBL in architectural education, with specific reference to a case study of The Faculty of Architecture at the Delft University of Technology (TUDelft), the Netherlands. Although some information on the subjects have been obtained from the review of documentation, research question of which factors contributed to the termination of PBL in the Faculty have yet to be investigated. Within the scope of this investigation, the writer established specific research objectives as a guide in formatting the research design.

The Faculty of Architecture at TUDelft started implementing PBL in September 1990 (Jochems, 1993), after 3 years of planning. The implementation of PBL in the Faculty was the proposed solution to the problems of deterioration in its educational systems. As the leading institution initiating and exploring the potential of PBL in architectural education in Europe, the Faculty of Architecture at TUDelft claimed to be successful in incorporating PBL in their strategic approaches to educational innovation (De Graaff & Cowdroy, 1997). Nevertheless, the PBL implementation in the Faculty was discontinued, despite claiming its success, and there was no architectural school known to follow the lead of the Faculty of Architecture at TUDelft in using PBL as its main educational approach.

Prior to the implementation of Problem Based Learning, the Faculty of Architecture at TUDelft implemented the Conventional architectural Teaching Approach. However, a "national review committee" from the Dutch Ministry of Education, considered the way architecture was thought in the faculty was not of comprehensive technological and scientific foundations (Verkenningscommissie Bouwkunde, Eindrapportage, 1988). TUDelft was generally regarded as university which focused on "science and practice" (Bekkering, et. al., 2004) and strived to maintain its reputation and "academic status" (Bekkering, et. al., 2003) as the leading technical university in Europe (Delft University of Technology, 1993). As such, the sheer existence of the Faculty of Architecture in TUDelft had been "regarded as the odd man out" (Bekkering, et. al., 2004). Since there were as many as 30 art academies in the Netherlands that trained students in architecture in the former decades, the existence of the Faculty of Architecture at TUDelft seemed to be redundant. In addition, unlike those academies, the Faculty of Architecture in TUDelft depended on Dutch government bodies and international institutions for financial funding to have "extra facilities" and maintain its "higher standards" (Bekkering, et. al., 2004; Joint Quality Initiative, 1999). These two factors led to the threat received from the ministry: the faculty would have to be closed down if improvement measures were not done. The threat resulted in the venture of implementing PBL, with the general purpose of improving the performance of the architectural programme and to establish the programme as of scientific nature (De Graaff and Cowdroy, 1997). A decision to undergo a large scale educational restructuring was initiated by the Faculty Board in 1989 (Woord & De Graaff, 1993).

Since a documentation review of the Faculty's PBL implementation did not provide a conclusive idea of why and how the decision to end the use of PBL occurred, evaluation would have to be done by seeking insights into perceptions of the implementation. The successful implementation of PBL in the Faculty of Architecture at the University of Newcastle (UniNC), New South Wales, Australia, was used as a comparison or a benchmark. This reference to another case of PBL implementation was made to further explain the strength and the weakness of the PBL implementation carried out in the Faculty of Architecture at TUDelft.

1.2 Objectives of the Research

In order to understand the circumstances influencing the termination of PBL implementation in the Faculty of Architecture at TUDelft, an investigation was carried out using the followings research objectives:

- To investigate if the PBL pedagogical approach gave a workable theoretical framework to architectural education.
- To examine the process of adaptation and implementation of PBL in the Faculty, as compared to other architectural institutions and other disciplines of studies.
- To identify the changes influenced by the introduction of PBL in the Faculty of Architecture at TUDelft.
- To investigate the acceptance of PBL among people involved in the implementation.
- To suggest appropriate ways to improve the implementation of PBL in architectural education.

1.3 Research Methodology

This research was designed using the phenomenological approach of case study research. It was organised around six major topics; the study region, the paradigm and methodology, research method and procedures, analysis of interview data, some ethical considerations and conclusion. This type of interpretative single case study research was selected because it allowed the use of a deduction mode of using the knowledge and information to understand something and form an opinion.

Firstly, review of the main study field was done in order to understand the background for the thesis. Chapter 2 discusses the critiques and problems in architectural education, and the mechanism of Problem Based Learning pedagogical approach. Chapter 3 describes PBL implementation in the Faculty of Architecture at TUDelft, based on the documentation review. It also describes PBL implementation in the Faculty of Architecture at the University of Newcastle (UniNC) so that the comparison of ideas could allow an understanding of the significance of different representations. These two chapters led to the identification of gaps in the description of PBL implementation in architectural education, which suggested **a proposition** that the PBL implementation in the Faculty of Architecture at TUDelft was discontinued because it was not really a success. Therefore, further investigation into the implementation was required, in order to have a more conclusive understanding as to why the PBL implementation in the Faculty of Architecture at TUDelft was discontinued.

The overall research design for this thesis is described in Chapter 4. Here, the aim and the objectives formulated for this research show how they resulted in the selection of the qualitative research format, which was the interpretive case study. The procedures focused on three issues: identifying the research strategies, selecting data collection methods, and choosing data analysis methods. Research strategies were identified to meet the research objectives. Data was sought from documentation of the PBL implementation, and first hand accounts were sought from educational and architectural specialists, with experience of PBL implementation in the Faculty of Architecture at TUDelft. Since the former was carried out as part of the literature review to form the framework of the analysis, the latter was conducted using focused face-to-face interviews to fill the gaps found in the earlier investigation. The interviewees were chosen based on their involvement in the PBL implementation at TUDelft. Consequently, analysis of interview data was carried out by using content analysis method.

Chapter 5 displays the collected data in retrievable format of matrices and tables for easy understanding, so that discussion on the data presented could be carried out without continual cross-referencing to the interview transcripts. Chapter 6 discusses the analysis of the data which compared the ideas, and verification of perceptions. This chapter led to the drawing of general conclusions from this research.

Concluding chapter 7 gives some ideas about the whole research project. It presents an overview of the research, the contribution of the research, the potential for future research, the research limitations and some recommendations for improvement of PBL in architectural education (see Figure 1).

The evaluation of the implementation of PBL in architectural education confirmed that what was proposed was in fact established. The **proposition,** that the PBL implementation in the Faculty of Architecture at TUDelft was discontinued because it was not really a success, was demonstrated to be true. Nevertheless, this research provided useful reflection so that a measure of improvement could be established to overcome the current shortcomings and challenges faced by architectural education in general. Specifically, an understanding of the experience of PBL implementation in architectural education opened the horizon for developing the PBL pedagogical approach to suit architectural disciplines. By recommending new methods of architectural education practice, this research could benefit architectural students, architectural academicians and architectural practice as a whole.

This research was an example of multi-disciplinary research that combined the fields of architecture and education. More research of this nature should be conducted to further understand how architectural education works in the framework of pedagogical context. As such, the writer suggested that research related to PBL should be carried out in the areas of staff development; the integrational quality of the PBL pedagogical approach in architectural education; the performance of architectural graduates undertaking PBL; and the impact of the implementation of PBL in architectural education, to architectural profession.

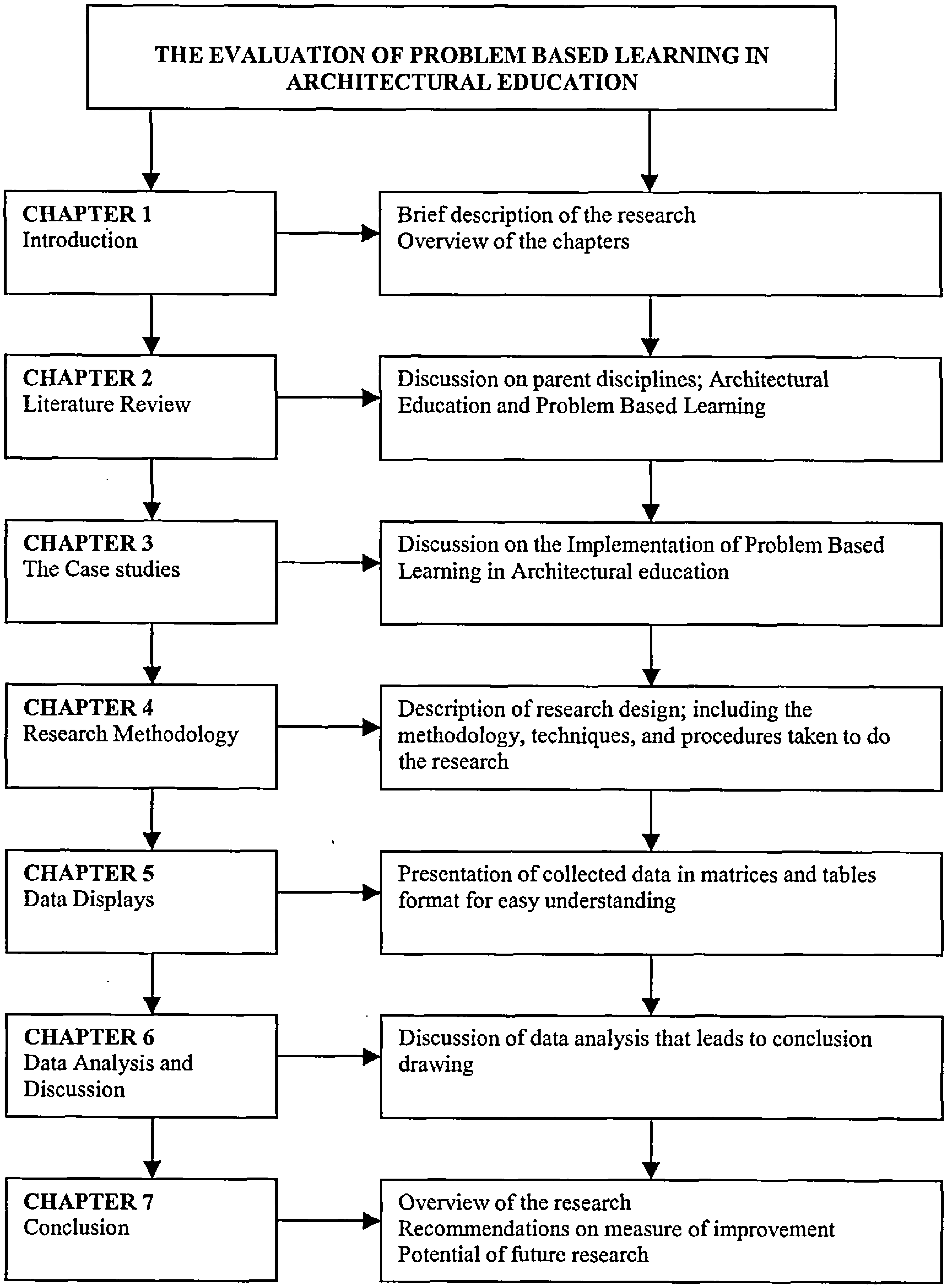

Figure 1: ***The structure of the thesis chapters and their contents.***

CHAPTER 2

LITERATURE REVIEW

2.0 LITERATURE REVIEW

Chapter 2 will establish the context of the research studies, by reviewing the literature of Architectural Education, and Problem Based Learning (PBL) in general tertiary education. By analysing these two parent areas of studies in this chapter, the research can focus on the immediate multidisciplinary study of Problem Based Learning (PBL) in Architectural Education. An analytical framework for the intermediate research of PBL in Architectural education can also be developed in this chapter, to formulate the research design later.

Section 2.1 of chapter 2 discusses contemporary phenomena in architectural education, presenting the problems and criticism encountered for decades in the application of conventional teaching methods in architectural education. This analysis of the first parent study leads to a discussion of PBL in section 2.2, examining the mechanisms of the popular educational approach of PBL. This analysis of PBL is intended to see if it may offer any solutions to problems encountered in architectural education, and to focus on its potential for implementation in architectural education.

There is a good deal of literature on the development of PBL pedagogical approaches implemented in tertiary education. The PBL educational approach is known to have maximum effectiveness in producing professional competencies among graduates in many professional disciplines. However, there is limited discussion about PBL pedagogical approaches implemented in architectural education. This approach has not been established as a major pedagogical method in schools of architecture around the world. Although there are a few schools of architecture that use the innovation of PBL in their curriculum system, the applicability of PBL in architectural education has yet to be examined. Therefore, chapter 3 will further analyse and evaluate the PBL approach where it has been implemented in architectural education.

2.1 Architectural Education

2.1.1 Introduction

This first section of the text will discuss general architectural education, particularly focussing upon its history and conventions, the conventional methods of architectural educational approach, the influence of architectural professional practice upon it, issues of students' competencies, and challenges faced by architectural education. The comprehensive discussion on these subjects will lead to the critical analysis of Problem Based Learning (PBL) as an innovative pedagogical approach widely used in contemporary tertiary education, and the applicability of PBL in architectural education.

2.1.2 History and Convention

Architectural education is one of the most distinctive branches of education that requires creative capabilities (Salama, 1995). As such, the establishment of architectural education in any educational institution is significantly different, compared to other disciplines. It is mainly underpinned by the development of the architectural profession. As the requirements of the architectural profession change, so does architectural education.

Today's architectural education history and convention have their roots mainly in the French Ecole Beaux Arts Approach and the German Bauhaus Movement (Salama, 1995). Throughout the decades, these two architectural training approaches evolved, resulting in many architectural education models, but still keeping the main essence of the French Ecole and German Bauhaus approaches, commonly called the Design Studio. The influences of these two architectural educational developments are apparent in most architectural schools around the globe and, in combination, it is commonly known as the conventional or traditional architectural approach.

2.1.2.1 The French Ecole Beaux Art Approach

Prior to the mid 19th century, there was no formal institution that trained architects (Koch, et. al., 2002). Even though colleges and universities were becoming established as the places for professional training in many disciplines, architecture as a unique branch of education was content to be different. Informally, architectural education at that time existed as "an apprentice system" where aspiring architects would serve under the guidance of an experienced architect (Koch, et. al., 2002).

Only in the 1850's was a formal architectural education model developed in Paris and commonly known as the Ecole des Beaux Arts. Introducing "a new way of thinking" (De Graaff, 2004) in architectural training, the Ecole (French word for school) attracted many young designers to Paris from all over the world. The philosophies of the Ecole des Beaux Arts later influenced architectural schools in the United States, as that its graduates were among the founders of architectural schools there, such as at MIT and Columbia University. "By the turn of the 20th century, most schools had Beaux Arts-trained professors, and the pedagogies of the Ecole were dominant" (Koch, et. al., 2002). Meanwhile, most countries in the world, except in Europe, had not yet established architectural schools in their formal educational institutions.

According to The Grove Dictionary of Art, the Beaux-Arts style is a term applied to a style of classical architecture found particularly in France and the United States (Bertelli, 1996), and it is characterized by its formal planning and rich decoration. During the revolution in the architectural movement in the 19th and the early 20th centuries, the principles of the Beaux-Arts were used as the basis of the academic teaching at the Ecole des Beaux-Arts in Paris, and later introduced to and applied in numerous schools of architecture in the United States of America.

However, the issue of style in the Ecole of Beaux-Arts was in general secondary to "the more permanent tenets of the doctrine" put forward by the Ecole (Bertelli, 1996): rationalism. The French rationalism held the idea that "through the analysis of precedent and the application of reason" a consensus about the truth in a given situation could be arrived at (Koch, et. al., 2002). This rationalism underlay the teaching methods of most architectural schools in the United States for more than 150 years, specifically in studio culture pedagogy. What was called the atelier-based training in France, was adapted in the United States to become the "architectural studio". The studio pedagogy, offered architectural education a teaching model for a design discipline in which the functional, structural, social and technical aspects of design could be adapted (Kuhn, 2001).

Many features of the teaching methods of the Ecole survived in today's architectural studios, such as the unquestioned authority of the critic, the long hours trainees spend working on architectural design, the focus on schematic solutions, and the rare discussion of users or clients (Koch, et. al., 2002). The idea in the Ecole teaching methods, of being great architects, resulted in individualistic phenomena, in which architects regarded their design solution as intuitive and relied heavily on their "experience, judgement, and talent" (Salama, 1995).

2.1.2.2 The influence of the Bauhaus Movement

The early 19th century experienced the industrial revolution, where matters of tradition were substituted by innovations in many aspects of life. Consequently in architecture, the period between 1920 and 1955 witnessed a transition in which most schools of architecture changed from a curriculum modelled on the Ecole des Beaux-Arts "to one of several modernist models" (Silberberg, 1996). The Bauhaus, a German architecture school, had a particularly dominant impact in the modernism of architectural education in the United States of America because most of its instructors had migrated there from Nazi Germany (Koch, et. al., 2002). Although the original Bauhaus School, which was located in Dessau, German, lasted only from 1919 until 1933, the influence of its teaching methods spread in the United States because it offered alternative modern styles of architecture which loosened the dominance of classical style institutionalised by the French Ecole in Europe.

Walter Gropius and Mies van der Rohe were among the most notable German architectural design instructors whose idealistic styles profoundly influenced modern architectural design, which was later known as the international style. The former served as the head of the Architecture School at Harvard University and the latter became the head of the Architecture School at the Illinois Institute of Technology (Koch, et. al., 2002).

Providing a modern method in architectural education, the Bauhaus program intended to develop creative minds for architecture and industry, and promoted the scientific development of design training through a vocational approach (Gordeeva, 2004). Having such influences, graduates would then be able to produce "artistically, technically, and practically balanced utensils" in architectural design (Gordeeva, 2004). The Bauhaus approach to architectural education was also considered as a socially-oriented program, where "an artist must be conscious of his social responsibility to the community," and "the community has to accept the artist and support him" (Gordeeva, 2004). Having this socialised idealistic idea, the attention and focus of architectural education were directed to star designers and their modern individualistic styles. The Bauhaus program also promoted "the striving for freedom from constraints, the historicist nature of architectural theory," and the polarization of education and practice (Koch, et al, 2002).

Overlaying the Ecole teaching method, the emergent idea of the Bauhaus teaching concept in the States was of the unity of artistic and practical tuition. The Bauhaus "replaced the stylistic content" of the Ecole teaching with a new content, that was more "industrial and technological" (Salama, 1995). The Americans further adapted the Bauhaus teaching methods by increasing the focus on natural human science and more sophisticated training in mechanical techniques (Gordeeva, 2004). While the Beaux Arts teaching methods focused on the atelier system (Salama, 1995), where students work on design while a teacher walks around for critiques, the Bauhaus established independent classes to provide students with theoretical knowledge of architecture, without superseding the French atelier culture. Indeed, the atelier had a strong emphasis on training architectural students with variety of architectural skills required for architectural practice, whilst the Bauhaus's addition of independent classes educated students with accumulation of necessary architectural knowledge to enhance the training of skills. The concept of atelier is commonly known today as the apprenticeship in design studio, but in combination, both Beaux Arts and Bauhaus approaches made up what is called today the Conventional Architectural Education.

2.1.2.3 The Transition of Architectural Education

The phenomena of adapting the teaching philosophies of the French Ecole des Beaux Arts and the Bauhaus were particularly prevalent in the United States, yet the emergent American version of architectural education was later adapted in schools of architecture all over the world. Many scholars from the Asian and Middle Eastern countries who had graduated from the American schools of architecture introduced the concept of the Beaux Arts movement in their own countries (Salama, 1995). As a result, in the first half of the 20th century, the establishment of architectural schools had taken place in most developing countries, using what was then known as the conventional architectural approach.

The conventional architectural educational approach continuously experienced transition, throughout the 20th and 21st centuries, depending on the different conditions and cultural factors influencing the evolution of each architecture program (Koch, et. al., 2002). This transition has often been characterized as a paradigm shift from one knowledge system and pedagogical system to another (Silberberg, 1996). However, the main essence of the French Ecole's "atelier" and of the German Bauhaus' workshop have been maintained as the focus of conventional architectural education today, in the form of the Design Studio.

Salama discussed the features of transitions in architectural education throughout the 20th century in his book, <u>The New Trend in Architectural Education</u>. Table 1 summarises the evolution of "Conventional Architectural Education".

Table 1: ***A summary of the evolution of "Conventional Architectural Education" (adapted from Salama, 1995).***

Time/ Duration	Educational Approach	Features
1900's	The French Ecole des Beaux-Arts	The influence of classical style in architecture Intra mural version of studio Large drawing represented architectural composition Using apprentice/mentor based approach
1930 to 1950	The German Bauhaus	The modern movement of architecture Studio teaching embarked on, with realistic problems Still using apprentice-based approach
1940 to 1960	The Combination of the Ecole and Bauhaus, known as the conventional architectural approach	Design studio with support courses, such as theory and history of architecture.
Early 1960's	The conventional approach	Design studio with introduction of planning issues, such as city planning, urban design, and historic district upgrading Transition derived by population growth The emergence of the international style
Late 1960's	The conventional approach	Design studio Introduction of human and social science in design Concept of cultural and regionalism Participation of users in design process
1970 to 1990	The conventional approach	Design studio Introduction of specialisations, such as design methods and theories, community preservation, participatory architecture, environment and behaviour, and cultural intervention Architectural education had a slow response to general trend and style developed
1990 to 2000's	The conventional approach	Design studio with design instruction and techniques followed the Bauhaus approach. Introduction of free clinic of urban and architectural design Establishment of community design centre Response to social revolution of the 1960's.

2.1.3 The Conventional Architectural Educational Approach

Although the current architectural educational approach has been established for decades, it continues to be known as the 'Conventional Method' of architectural education. This conventional pedagogical method is unique and specially designed for the teaching of architectural education. The distinctive features of architectural education, as compared to other disciplines, lie in its contents, its curriculum structure, and its teaching methods. Architectural educational features emphasise not only the development of students' design and professional skills, but also the training of students in vocational aspects and a vast range of architectural knowledge.

2.1.3.1 The Content

The content of architectural education usually consists of core subjects, general subjects and elective subjects. There are many variations of core subjects required by schools of architecture, depending on the niches of the schools. Schools "can choose the emphasis they wish to give to the curricula; some will undoubtedly narrow the focus to the vocational rather than seeking a multiplicity of pathways" (Stansfield-Smith, et. al., 1999).

The core subjects of architectural education are usually divided into several categories (Table 2, IIUM, 2001). Some of the subjects are categorised in more than one category, based on the nature of the subjects. For example, the subject of History of Architecture might be included in either history or philosophy categories, simply because the subject incorporates the knowledge of architectural history, as well as the knowledge of architectural philosophy in many different aspects.

Table 2: ***Example of categorisation of contents, and names of subjects in typical conventional architectural educational programmes***

NO	CATEGORISATION OF CONTENT	EXAMPLE OF SUBJECTS
1	Artistic & Design skills	Architectural design Civic/Urban Planning and Design
2	Technical Aspects	Architectural drafting/Drawing Building Material and Construction Building Services Environmental studies Landscape Structure
3	Professional Practice and Management	Building Contracts Building Economics Project Management Professional Practice Specifications
4	History and Theory of Architecture	History of Architecture Theory of Design
5	Philosophy	Ethics Theory of Design History of Architecture

Besides the core subjects, most schools of architecture also require their students to learn some general and elective subjects. In the United States, for example, general subjects, such as the history of The United States, are compulsory for all students in tertiary education. Meanwhile, elective subjects are usually required for students who choose certain specialisations in architectural studies. For example, those students who decide to specialise in Computer Aided Design (CAD) may enrol in a number of CAD classes, while those who are interested in business administration may enrol in classes related to that field of studies, either offered by the architectural faculty itself or by the business faculty.

The choice of having general and elective courses in contemporary architectural education corresponds with the claim that architecture is actually a multi-disciplinary field of studies. The RIBA Review of Architectural Education (Stansfield-Smith, et. al., 1999) suggested that architecture is the "measure of quality" in the built environment, which aspires to "an all-embracing ideal which is all-inclusive and multi-disciplinary." Indeed, the inclusion of a variety disciplines in architectural core, general, and elective subjects is considered mandatory in architectural curricula, so that seems "to be crammed to the gills with requirements, all of which any good faculty can justify" (Dill, 1997).

2.1.3.2 The Curriculum Structure

In most schools of architecture, architecture as a field of study in tertiary education is taught in a framework of four to six years of undergraduate degree. This framework varies, depending on the level of architectural qualification sought by students, or qualification offered by architectural institutions. In the United States of America, 4 years of architectural study may lead to the award of a general architectural degree, which would not qualify graduates to be called professional architects. However, those graduates who have this degree could pursue the accreditation for professional status by undertaking a further two years study for the Architectural Masters Degree. Many American institutions offer five years courses of study in architectural field, leading to the conferment of a professional architectural degree accredited by the National Architectural Accrediting Board (NAAB, 1998; NAAB, 2004).

Similarly in the United Kingdom, architecture is taught in a framework of a five-year undergraduate degree course with an intermediate qualification (Stansfield-Smith, et. al., 1999). Students get their RIBA (the Royal Institute of British Architects) Part 1 qualification after successfully completion of 4 years of architectural study, and then the RIBA Part 2 qualification after they complete the 5 years architectural study framework. In other countries, there are considerable differences in the process of educating architects but the general curriculum structure is remarkably similar.

Within the average 5 years study in architecture, the architectural curriculum structure is generally arranged in sequences of semesters, or study sessions, with each successive session having an increase in its complexity. In each session, the curriculum structure of architectural education is generally formed by two tier activities: students are taught to acquire architectural knowledge, and students are trained to develop various architectural skills. As both knowledge and skills of architectural studies are equally important to produce competent graduates in architecture, they are incorporated in unique curriculum structure as shown in figure 2.

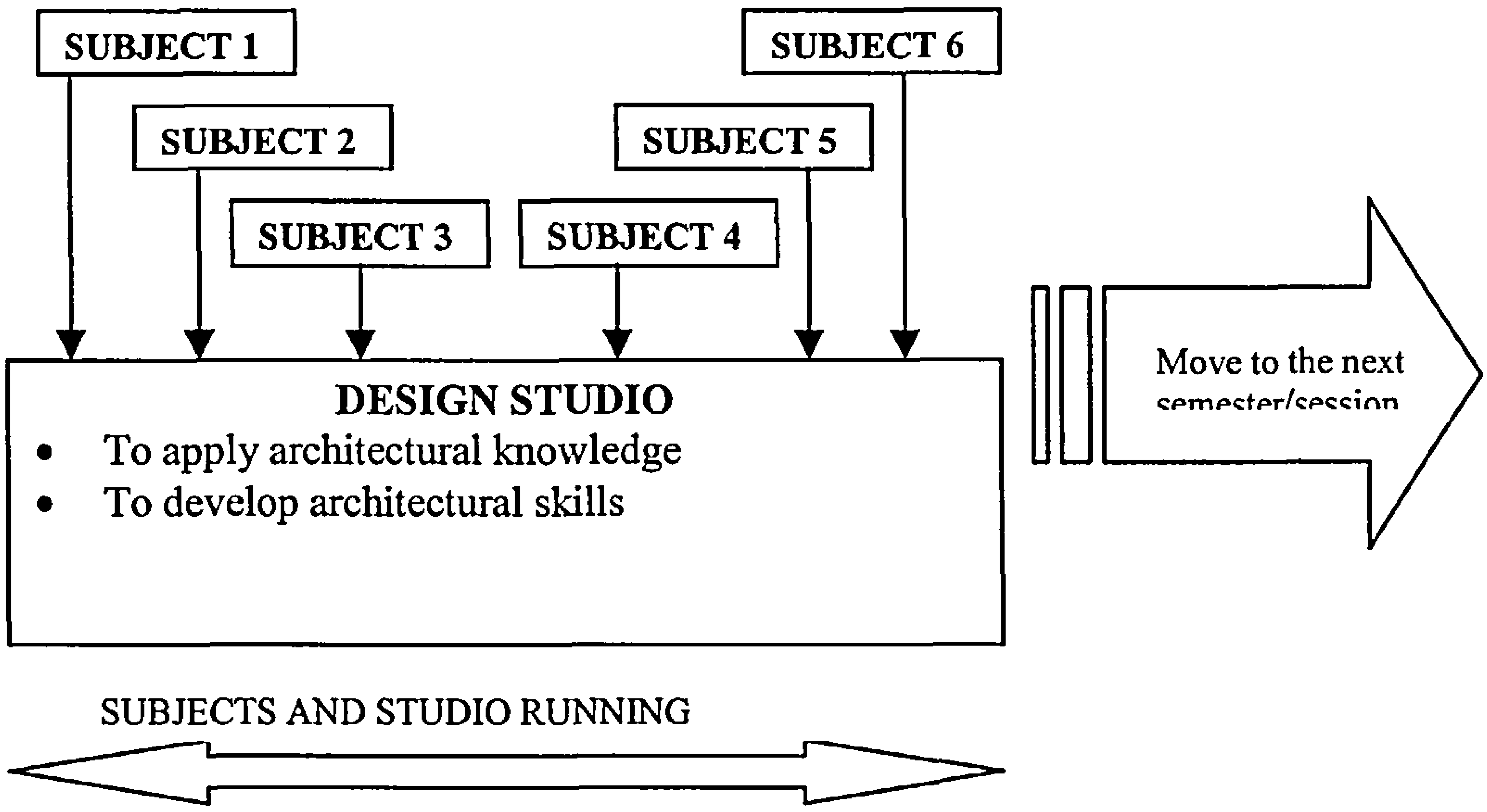

Figure 2: *The curriculum structure in one session of architectural study, in the conventional architectural teaching approach.*

The knowledge part of architectural study is usually disseminated in separate lecture classes, whilst the application of subjects learnt in those classes is expected to take place in the design studio. Subjects learnt in traditional lecture classes are based on the categories in Table 2, with the level of complexity and appropriateness of subjects relating to the years of study. For example, the first year students would focus on learning basic concepts of architectural theory, to develop their understanding in architectural philosophy, whilst most courses related to Professional Practice and Management category would be taught to students in the upper years only.

Design studio work progresses concurrently with the various subject classes or course work within a session, providing a "testing ground for all other knowledge gained to make a building function and stand up" (Salama, 1995). The importance of design studio work in architectural education is apparent as it is "intended as the point of integration for all other coursework and educational experiences" (Koch, et. al., 2002), and is considered to be the link across the curriculum at most architectural schools (Petry, 1999). As the backbone of architectural education, more than half of students' learning time is spent in the design studio, where the main forum of "creative exploration, interaction and assimilation" takes place (Salama, 1995). It commands "the most credit hours, the largest workloads, and the most intensive time commitment from educators and students" (Koch, et. al., 2002).

2.1.3.3 The Teaching Methods

The two tier activities within the conventional architectural curriculum structure produce the two divisions of its teaching methods; traditional teacher-centred approach and design studio teaching. Using the traditional teacher-centred approach, knowledge of architectural subjects is disseminated via lectures in architectural coursework classes. Teachers periodically give lectures and by the end of a study session, assessment of students' performance is made, mainly based on examination. Although the current architectural education system has seen the emergence of variations in modes of performance assessment of architectural coursework, this is usually limited to report submission and presentation, which do not depart from the teacher-centred approach.

On the other hand, the design studio teaching in architectural education has its unique distinctive teaching methods which are often called tutorial-based teaching, apprentice-based teaching, or mentor-based teaching (De Graaff & Cowdroy, 1997). The differences in terminology used to describe studio teaching actually depend on the different roles educators prefer to undertake while disseminating design knowledge, or on the policy of the educational institutions. Since those so-called teaching methods are generally governed by similar components of architectural teaching mechanisms, this section of the thesis will only describe the teaching method known as Apprentice-Based Teaching.

Apprentice-based teaching is the most common pedagogy in use in architectural design education (Webster, 2002). It originated from the practice of apprenticeship in architectural training in the early 19^{th} century, where architects-to-be would be apprenticed to architects in an architectural office practice. The late 19^{th} century experienced a shift of apprenticeship from the office practice to higher education establishments (Cuff, 1998), where design instructors play the role of knowledgeable masters or mentors in the design studio. The mentors in apprenticeship models promote "scaffolding and coaching knowledge, heuristic, and strategies, while students carry out authentic tasks" of design projects (Collins, Brown, & Newman, 1989; cited in Tam, 2000).

However, the resonant constructivist idea, that the teacher is a guide instead of an expert (Tam 2000), modernizes apprentice-based teaching in architectural education from being a teacher-centred pedagogical approach to a student-centred method. Having this paradigm shift, teachers serve as guides, who show students how to reflect on their evolving knowledge and provide direction when the students are having difficulty in working on their design tasks. Participation of both parties in the architectural design process promotes the sharing of learning and responsibilities for the instruction (Tam 2000).

Accordingly, some scholars prefer to use the label of Project-based Learning (De Graaff & Cowdroy, 1997; Kolmos, 2003; Webster, 2002), rather than apprentice-based teaching to describe the studio teaching method, because of its emphasis on the architectural design project. More importantly, the change from the use of the word "teaching" to "learning" emphasises the importance of students' own roles and participation in the design process.

Ironically, despite the paradigm shift of apprenticeship-based teaching, the exclusiveness of design teaching method in architectural education has often been misused by instructors whose ideology of being experts extends to "archetypes" (Cuff, 1998). Cuff (1998) describes archetypes as guides on whom students are expected to model themselves, in terms of "behaviour, values, design strategies, and thought processes". Archetypes anticipate transferring their "entire modes of acting, thinking and being" to students, whilst students have to cleanse themselves of their previous held beliefs. This personal model teaching style of having values transferred between teacher and students in "mystical and transcendental" manners

(Cuff, 1998), led De Graaff and Cowdroy (1997) to describe architectural education as lacking a theoretical framework in its pedagogical approach.

Typically in architectural design studio, students' works are organised into semester length projects, where they respond to "complex and open-ended" architectural assignments, before ultimately producing design solutions. The architectural assignments, which are commonly called projects, are expected to be tackled with "heterogeneous issues", ranging from aesthetic, structural, feasibilities to social impact of the design (Kuhn, 2001). During the design process, students undergo a series of informal and formal critiques, multiple and rapid proliferation of proposed design solutions, and interim design presentations. With the help of design instructors, students undergo an intensive design workout that requires them to have the ability to work quickly and impose appropriate constraints on their design process in order to find a satisfactory design solution (Kuhn, 2001). By the end of the semester, the final design solution should be presented with appropriate use of diverse design media.

Corresponding with the complexity of design studio teaching method, the assessment mode of students' performance in the design studio is also wide-ranging; from submission of design models, critique sessions, drawing presentations, verbal presentations, and reports submission to portfolio. Although considerable value is placed on the design process, by requiring the students to submit progressive portfolios and having periodical design critiques, some scholars argue that there is too much emphasis on the final design product in the design studio (Salama, 1995). The final design schemes produced by students are commonly used as the basis of assessing the students' performance at the end of a semester. Contradictory to this idea, some scholars claim that the design studio actually teaches students to develop critical thinking by encouraging students to critically question all things in order to create better designs, and use design-thinking as the base for exploration (Schon, 1991; Koch, et. al., 2002).

2.1.4 *Critiques of the Conventional Architectural Approach*

Although the conventional architectural educational approach has been used by most schools of architecture for more than a hundred years, and recognised by scholars as being a "good" experiential learning method (Schon, 1985), it is also criticised as having a weakness and its irrelevancy to the current architectural education is being harrowing. Through decades of its evolution, architectural education has been confronted with many wide-ranging critiques, discussed in such occasions as architectural conferences, architectural accreditation meetings, in printed media such as journals and reports, and formal and informal faculty discussions. Among the critiques are: some that state that architectural education does not have a proper pedagogical theoretical framework (Dutton, 1991; Teymur, 2001; Moore, 2001; and Hubka, 2003), has problems of disintegrated knowledge (Maitland, 1997; De Graaff, 1993a; Stansfield-Smith, et. al, 1999; and Nicol & Pilling, 2000), focuses too much on design and artistic value (Cuff, 1989; Salama, 1995; Brown, 2002), and is not prepared to cope with the speed of changes (Moore, 2001; Koch, et. al., 2002). These critical comments are expressed as responses to the disappointment arising from many parties involved in the construction industry that architectural graduates do not perform as expected of them. In fact, the architectural profession was shocked by the intensity of the critical comment it received from client focus groups, "the strongest message of which was the dissatisfaction and serious inadequacies of architects' performance" (Stansfield-Smith, et. al., 1999).

2.1.4.1 No Theoretical Framework

Architectural Education is accused of lacking a proper theoretical framework in its architectural curriculum, which leads to the indigenous creation of a "hidden curriculum." De Graaff and Cowdroy (1997) claimed that, although the conventional architectural education approach has been established and implemented for decades, it is lacking in a proper theoretical framework in terms of pedagogical science. This latter requires any educational approach to have designed objectives, strategies, and goals. Instead, what is found in architectural educational today is the hidden curriculum, a term referring to "un-stated values, attitudes, and norms that stem from the social relations of the school and classroom, as well as the content of the course" (Dutton, 1991).

Teymur (2001), in his article, *Learning from Architectural Education*, questions if there is any theoretical basis in architectural education, and if so, he question if it is guided by architectural design theories. Teymur suggested that architectural education does not have a pedagogic objective that is "definable, testable or even properly presented" to be easily researched (Teymur, 2001). Meanwhile, specifically referring to design studio teaching, De Graaff claimed that the architectural education teaching approach does not have the necessary theoretical framework, since it lacks objectives, strategies, and goals (De Graaff and Cowdroy, 1997). Although both of them seem to be in agreement on the lack of a theoretical framework in architectural education, they do not go into further detail in their statements.

In accord with the critique, Hubka (2003) emphasises the importance of having a pedagogic theory and strategy for teaching that can lead to learning. He claims that the theoretical framework of teaching and learning should provide a "raison d'etre" and guidelines for its practices, where the content functions as object knowledge, and the methods as process knowledge. Meanwhile, in order to generate a theoretical framework that explains learning, Driscoll (1994) states that three basic components of learning are required: the result, the means, and the input.

> "Result refers to the changes of performance to be explained by the theory, the means are the process by which the results are brought about, and inputs are the resources or experience that triggers the process of learning" (Driscoll, 1994).

This concurs with De Graaff's "objectives, strategies, and goals,' which could be defined as the following: objectives are the input, strategies are the means, and goals are the result. Thus, "learning theory comprises a set of construct linking observed changes in performances with what is thought to bring about the changes" (Driscoll, 1994).

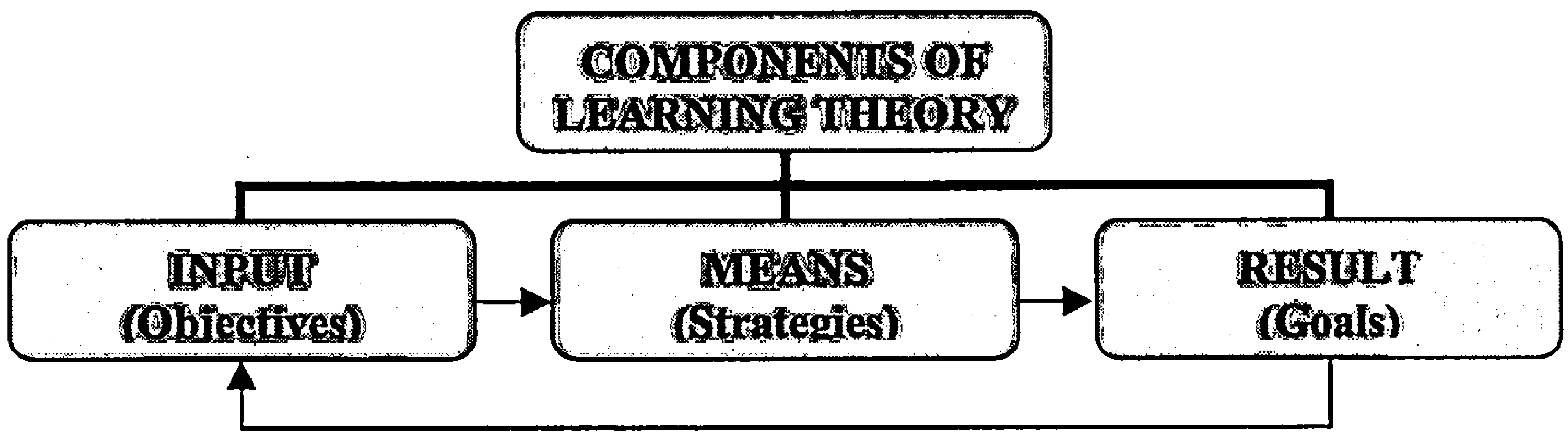

Figure 3: ***Driscoll's systematic and recursive process for building a theory in learning (adapted from Driscoll, 1994).***

The "absence" of theory in architectural education reflects the uncommon pedagogical discussion in schools of architecture (Moore, 2001). To prove the point, Webster (2002) states that there was a forty one year gap between the first 1958 British architectural education conference in Oxford, and the Architectural Education Exchange (AEE) Conference held in 1999. Furthermore, although the British education system has dedicated itself to research into education, there is no British journal specifically dedicated to architectural education. The same lack of interest in theory and pedagogical discussion of architectural education is also apparent in the American counterpart: that only a small percentage of articles in The Journal of Architectural Education (JAE) discuss architectural education. It was analysed that only 14% of JAE articles published between 1984 to 1994 were concerned with teaching architectural design (Salama, 1995).

There are three main factors contributing to the lack of interest in the subject of architectural education:

- Firstly, the current "understaffing" typical at most schools of architecture does not allow time for self-reflective action to be done on the architectural curriculum (Cryler, 1995).
- Secondly, the lack of proper training for teachers in schools of architecture leads to the "unsubstantiated belief that skilled professionals or researchers make good teachers" (Webster, 2002). As such, many schools of architecture

employ a high percentage of professional architects to work as teachers on a part-time basis, resulting in difficulty in having discussions on policy of architectural education among the employees. For example, in the year 2000, the Faculty of Architecture in the Delft University of Technology (TUDelft) had 200 out of its 270 "scientific staff" working as part time members, and discussion on the "school politic" was done only among the staff members who were permanently employed (Toft, 2000). The difficulty of participation in discussions of theoretical frameworks in architectural education leaves the subject unattended.

- Thirdly, there is fear within the architectural field that theorising about the design process might lead to a kind of "empirical reductivism." Consequently, tutors in architectural education have little explicit knowledge of educational theory, and its impact on the quality of student learning. Instead, they hold the idea that the implicit paradigm, as practiced in architectural education, drawn partly from their personal experiences, continues to offer quality learning (Webster, 2002). As Klaus states that, "both method and theory emerge from the phenomenon of the subject" (Hubka, 2003); therefore, the tacit teaching practice in architectural education constitutes the term "hidden curriculum" (Dutton, 1991).

As mentioned previously, the hidden curriculum is defined as the "unstated values, attitudes, and norms" (Dutton, 1991) that have been practiced and accepted in the teaching and learning of an architectural educational curriculum. As the formal curriculum has explicit emphasis on knowledge, the hidden curriculum has the underlying concept that "knowledge is not neutral, and is informed by ideological considerations" (Brown, 2002). In the architectural education context, the hidden curriculum is referring to the habit, culture and pattern of pedagogy in the design studio, that has been developed and built upon by generations of students, educators, and practitioners (Koch, et al., 2002). It is passed on through the years, even decades, without having a proper theoretical framework of pedagogical theory. This "value-laden assumptions" of the architectural educational process created more than a century ago has become increasingly ingrained with each passing generation

(Moore, 2001), even though the world view and order are currently experiencing rapid changes. As a consequence, studio culture, with its hidden curriculum, persists in the same form throughout the education of generations of architects (Koch, et al., 2002).

The rock solid culture in the hidden curriculum of architectural education is well illustrated when Moore (2001) notes that most instructors in design studio teach in the same manner in which they themselves were taught, in "a self-perpetuating proposition." As such, they rely on their former experience as architecture students to guide their own teaching methods (Anthony, 1991), espousing the inherited hidden values and beliefs, regardless of whether the techniques used are bad or good, from a pedagogical point of view. In this nebulous learning process, students cannot understand what designing means and find "the artistry of thinking and doing like an architect to be elusive, obscure, alien, and mysterious." Ironically, the instructors could not explain fundamental concepts of designing because it can only be grasped by students in the context of the doing (Koch, et al., 2002). By experiencing the design process, students intuitively learn and become acquainted with a set of unstated values inherited from their instructors (Brown, 2002). Donald Schon called this phenomenon the "paradox and predicament of learning to design," where both the students and the instructors ultimately achieve "a kind of convergence of meaning" after the pervasive confusion and mystery in the early part of the design process (Schon, 1987). Meanwhile, Stansfield-Smith described architectural discourse as being esoteric by nature and therefore of limited use for communication purposes (Stansfield-Smith, et. al., 1999).

Consequently, the practice of the hidden curriculum has dangers in "what it can impose upon the students" (Brown, 2002), and what it fosters on educational structure and methodology (Dutton, 1991). Through the prevailing paradigm delivered, instructors' values and experiences are given an authority which students are required to follow and, ultimately, the reinforcement of existing patterns of thinking in such pedagogy cultivates "a sense of dependency" upon their design instructors in the students (Brown & Moreau, 2002). Furthermore, since different instructors might have different values and experiences, depending on their own backgrounds and educations and, since they often employ "implicit transmission techniques" (Webster, 2002) in their one-to-one tutorial with students, they may deliver "uninformed consent to the dominant culture" (Dutton, 1991). Continuous generations of uninformed consents will result in a wider variation of uncertainty in architectural education.

Thus, this phenomenon hidden teaching methods, without proper a pedagogic theoretical framework as the conceptual base from which goals, objectives, and strategies naturally proceed, should be unpacked and understood in order to avoid "counter productive fashion, leading to deficient educational experience" (Moore, 2001). Concern about this lack of theoretical framework in architectural education is raised and examined in this thesis to give background and perhaps improve the educational systems of the discipline. As architecture and its education has always suffered from being the "odd-one-out" in disciplinary and university contexts, a research project on architectural education is not a straight-forward task (Teymur, 2001).

2.1.4.2 No Integration of Knowledge

The problem of integration of knowledge is one of the most popular discussions around architectural education. There is a

> "long-standing view in architectural education that knowledge and application are learned separately; knowledge occurs in the formal lecture class, and application occurs in the design studio" (Bernart, 1981, cited in Salama, 1995).

This view is supported by De Graaff (1993), who states that the majority of architectural education is characterised by "dis"integrated teaching, in individual subjects with little connection and cohesion between them.

Although some scholars acknowledge the natural allocation of integrative value of design studio in architectural education (Schon, 1985), disintegrated knowledge has become significantly dominant, with increasing specialisations in architectural education (De Graaff, 1993a). By nature and tradition, the design studio as the central feature of architectural education holds vast potential as a model for the integration and application of learning (Boyer and Mitgang, 1996). However, most subjects learned in the traditional structure of lecture classes are neglected and forgotten when students embark on design tasks in the studio. The lack of connection and cohesion between subjects makes it extremely difficult for students to make the links between design and specialised subjects, especially without proper guidelines on how to do so within the curriculum structure. As such, instead of offering an arena for application of all important architectural knowledge, the design studio has become the place that limits the integration (Koch, et. al., 2002) between the creative and academic parts of architectural education.

Teymur (2001) comments that it is not possible to integrate separate elements of studio teaching and subjects specialisations without understanding them in the first place. He emphasises that, to be integrated, the "key components" should be transformed prior to the process of integration. To understand both features in architectural education requires all parties involved to grasp the theoretical framework of the design process, which is itself absent in the hidden curriculum. As such, an attempt to understanding the whole integrative nature of studio culture is merely unfeasible.

Another important reason for the disintegration of knowledge in architectural studies is due to the increasing creation of specialisms. The 20th century has seen architecture becoming a "more fractured totality", as more and more disciplines, such as urban design, health and safety, conservation, and sustainability, become part of the whole responsibility of the architecture discipline. As these specialisms each have their own "discrete culture and knowledge base," each specialised course of study "promotes a distorted emphasis in the context of the whole and the integration of the sum of the parts becomes more difficult" (Stansfield-Smith, et. al., 1999). As such, the classic question of how these parts of architectural education can be reconciled and integrated remains unanswered.

The consequences of disintegration in architectural education are apparent by the fact that students fail to apply subjects learned in lecture classes into architectural design. Maitland (1997) notes that instructors perpetually complaint that students, who have successfully passed exams in structural frame design, for example, "go into the studio and design a frame building as if they have no ideas of the principles involved." Conversely, he stresses that lectures courses seem to have been devised in isolation from the studio projects, resulting in an incoherent and unrelated way of presenting information. In terms of professional competency, the inability to synthesize knowledge as a whole may jeopardise the students' potential to perform well in their future professions.

In view of the bad consequences stated above, a way of reconciling lecture classes and design studios is really needed in architectural education. The curriculum policy needs to encourage the incorporation of knowledge in different learning settings (Salama, 2004). A couple of scholars suggest ways of reconciling and integrating knowledge in architecture education. First, Salama (2004) perceives that design should be based on theories that should be tested with respect to the problem at hand. Secondly, the curriculum must facilitate the relationship between general education and specialised study (Petry, 1999). These proposed endeavours are seen to enable students to have better judgement in the studio to produce good design, and further prepare students to meet the complex demands of the architectural profession.

2.1.4.3 Tendency to Focus on Artistic Values

Beside the problems of integration and theoretical framework, critiques on architectural education also concern about the strong tendency to focus on artistic value that create imbalance in students' professional competency development. The teaching of architectural studies was criticized for its major emphasis on design and artistic value, leaving the development of other architectural and professional skills at the perimeter. Boyer and Mitgang (1996), report that at virtually all schools of architecture, design "has taken on limited connotations, focusing more on the aesthetic and theoretical dimensions of design than on the integrative nature of the process itself." As the result, many important areas of architectural studies such as the technical, social, environmental, and management aspects have been left unattended. The evidence that architectural education has too much emphasis on the artistic aspect of design is apparent in the use of final design products as the measure of assessing students' performance.

Typically there are three factors influencing the unnecessary emphasis on artistic aspect of design education. Firstly, both students and instructors in design studios follow the trend of architectural practice, in which "star architects are immersing themselves in a matter of self exploration and self expression," emphasizing the "individual's beliefs rather than human needs and social concerns" (Salama, 1995). Weaver (2001) reports that the RIBA's President Marco Goldschmied promoted this perspective by saying, "it's got to be beautiful first and efficient later."

Secondly, architectural education has placed similar emphasis upon aesthetics values, since its establishment through the Beaux Arts that stressed formal style and proportion (Hellmann, 1987; cited in Brown, 2002). Since contemporary architectural education follows principles and rules developed in the past, the same philosophy continues to be applied today. Lastly, special emphasis on aesthetic values in architectural practice and history leads to the enforcement of the same values as the major criteria for assessment in design education. With this philosophy in mind, design instructors tend to impose specific artistic requirement on students' design works. Architectural students are instilled with the idea that self-expression is the major concern in their education to be great architects (Cuff, 1989).

The emphasis on artistic value in architectural education has resulted to the "exclusion of other values within the existing paradigm" (Brown, 2002), and acts as a constraint on innovation (Salama, 1995). As architectural design actually contains aspects of both artistic behaviour and science application (Hubka, 2003), it is time to end the monopoly of aesthetic emphasis in architectural education. By doing so, students could develop in all aspects of architectural competency for both their private benefit and public good.

2.1.4.4 Inability to Cope with the Speed of Changes

Architectural education has often been questioned as to its capability to cope with rapid and continual changes in the world, specifically in architectural disciplines and practices. There are numerous instances of these issues being pompously presented in discussions of architectural education. Among them are the widening gap between practice and education, increasing scope of services in architectural practice, rising complexity of working collaboration, and growing competency requirement upon architectural graduates. This accelerating rate of change in architectural disciplines and practices is directly influenced by the fact that the "world is becoming more complex, boundaries are eroding, information is flowing faster, and globalization is a part of our everyday vocabulary" (Koch, et. al., 2002).

Gap Between Practice and Education.

The widening gap between architectural practice and education has been one of the major reasons why coping with changes is extremely difficult for architectural education. Architectural practice has changed rapidly, especially in terms of the roles and services required from architects, while architectural education remains statically teaching students the knowledge and skills developed in the last 150 years. Furthermore, architectural education suffers from this static development because to cope with the changes in practice requires proper planning, implementation, and evaluation that not many schools of architecture are willing to undertake for fear of failure and being different.

Salama (1995), notes that architectural education suffers from several problems pertaining to "the gap between what is taught and what society needs; and the failure to employ methods of teaching" that develops students' critical thinking. Undoubtedly, several schools of architecture have made attempts to narrow the gap by introducing more and more specialisms in their curriculum, but the attempts thus far have only either cramped the syllabus (Moore, 2001), or given the architectural educational institution a niche in their curriculum. They do not really prepare the architectural graduates with the skills required for rounded architects who can succeed in the current and future practice environment. Thus, the architectural profession demand for a highly technical, practical, and intellectually liberating education is far from being fulfilled.

Increasing Scope of Architectural Services

Architectural education today has not been updated to respond to, nor to expose students to, the increasing scope of architectural services. Besides traditionally delivering design and administrating construction, architectural practices currently respond to clients' demands by delivering extra services, such as "business consulting, strategic planning, real estate development, web site design, and facility management". This increasing scope of services demanded by clients is actually the result of the transformation in technologies, and construction industry. Technology offers new ways of designing spaces, producing construction documents, and fabricating buildings, whilst the construction industry offers new ways of delivering projects, such as the design-and-build agreement (Koch, et. al., 2002).

All the transformations in architectural services have had a large impact on the roles of architects, but most schools of architecture persistently resist the changes by continuing with the conventional architectural teaching approach, especially in the design studio. As such, it is as if confirming the comments of client focus groups that architects' performance has serious inadequacies in delivering their services (Stansfield-Smith, et. al., 1999).

Rising Complexity of Working Collaboration

Architectural education is also severely criticised for its inability to prepare students who can work collaboratively. Although schools of architecture sometimes offer a team working environment in the design studio, mostly collaboration is done informally among architectural students, without any involvement from students or staff from other disciplines. The traditionally accepted way of working in the design studio does not address collaborative efforts required by the architectural profession. In fact, architectural education encourages the "primacy of the autonomous designer by focusing all its attention on the student's experience as an individual" (Cuff, 1991). This phenomenon nothing like the real situation in an architectural practice environment where architects are supposed to collaborate with structural, electrical and mechanical consultants, landscape and interior designers, contractors, clients, end-users etc.

The need to instil collaborative capability among architectural students is essential because the success of architects is dependent upon the application of knowledge from multiple disciplines and perspectives. Architectural education should include encouraging collaboration and communication within the scope of the design studio. This concern for collaborative issues is acknowledged by The 1999 RIBA Review of Architectural Education, stating that "more team play" is needed to avoid architectural education from continuing being "too referential and self-indulgent" (Stansfield-Smith, et. al., 1999). Boyer and Mitgang (1996) previously suggested that making connections between architecture and other disciplines on campus might serve as a challenge confronting architectural education.

Growing Competency Requirement

From the discussion above of the three issues relating to change in architectural education, emerges the criticism that architectural education does not prepare graduates with the growing competency requirement. Although various bodies have identified types of competency required for future architects, they do not address the issues of how schools of architecture should approach the problems and how to evaluate students' competency level. In fact, many professionals feel as though "graduating students have neither the knowledge nor process skills necessary for architectural practice" (Boyer and Mitgang, 1996). This critique of architectural graduates is made worse by the fact that even in practice, the architectural profession experiences "an eroding client base, loss of professional turf, and a waning sense of professionalism" (Fisher, 1994).

Based on the critiques discussed, it is evident that the relevancy of architectural conventional teaching approaches in architectural education is largely in question. These critiques would continuously echo within architectural education unless measures of improvement are undertaken, corresponding to the massive changes in architectural practice. Attempts at improvement can take various forms, such as adjusting architectural curricula, reconfiguring the structure of the educational process, testing ideas and probing future visions (Salama, 2004). In doing so, architectural education has the choice of examining what the architectural professional practice has to offer.

2.1.5 The Influence of Architectural Professional Bodies

2.1.5.1 Accreditation and Prescription in the U.K.

The Architects Registration Board (ARB) is the statutory regulator of architects in the UK. Established by an Act of Parliament, The Architects Act, in 1997, ARB has a dual mandate to protect the consumer and to safeguard the reputation of architects.

ARB is different to the Royal Institute of British Architects (RIBA) in that it is not a membership organisation, nor does it promote architects or architecture. Membership of the RIBA is optional (and not all architects are members of the RIBA), whereas registering with ARB is mandatory for those wishing to practise using the title "architect".

ARB regulates the profession by ensuring that prescribed qualifications meet threshold standards for entry to the UK Register of Architects, for which ARB is responsible. ARB also ensures that standards of conduct and competence are maintained

The U.K. Government has also designated the Architects Registration Board (ARB) as the competent authority in the UK for all matters relating to the implementation and administration of the provisions of the Architects' Directive (1985/384/EEC – the "Directive") which provides the basis for mutual recognition of architectural qualifications within the Member States of the European Union (EU). Its purpose is to assist with the establishment of architects and the provision of architectural services throughout the Community by removing artificial national barriers to professional recognition.

In the UK, courses of architecture leading to the award of recognised qualifications are conducted in two stages. Currently, over thirty universities and other tertiary institutions offer approved courses and examinations, which are of five years ' duration or the equivalent in part time study. The ARB Criteria for Prescription are held in common with the RIBA which applies the same criteria in its own independent validation of courses.

The qualifications awarded at completion of each stage of an approved course of study are individually and separately recognised by the ARB for registration purposes.

A list of all the Part 1, Part 2 and Part 3 qualifications is available on the ARB website [www.arb.org.uk] or from the ARB.

The Part 1 and Part 2 qualifications prescribed by the Board for registration as an architect in the U.K, are the UK qualifications nominated under the terms of the Architects Directive in Europe.

2.1.5.2 Professional Structure in Australia

The accreditation and prescription system in Australia is very similar to that in the U.K. Professional architecture courses in Australia are subject to an accreditation and recognition procedure which is jointly run by the Architecture Registration Boards in each State and Territory and The Royal Australian Institute of Architects (RAIA).

In each State and Territory of Australia it is a legal requirement that any person using the title 'architect' or offering services to the public as an architect, must be registered with the Architects' Board in that jurisdiction.

Each State and Territory of Australia has its own Architects' Board. Generally, the following three steps outline the requirements for registration as an architect in a State or Territory of Australia.

A candidate must:

1. have a recognised academic qualification in architecture *or* a pass in the National Program of Assessment (NPrA), *or* a pass in the relevant Registration Board Prescribed Examinations where offered;
2. have a period of training through experience followed by successful completion of the AACA Architectural Practice Examination (APE); and apply for registration to the Architects' Board in the State or Territory in which registration is sought.

2.1.5.3 Accreditation and Prescription in the Netherlands

In The Netherlands the title of architect has had legal protection since 1988. Only architects, whether Dutch or foreign, registered in the legal register may call themselves architects. Registered Architects are not subjected to a code of conduct, nor is any practical experience required.

The Netherlands has two legal bodies involved in the accreditation process of architectural schools at the national level, both under the auspices of the Ministry of Education, Culture and Sciences; the Accreditation Organisation of the Netherlands and Flanders (NVAO) and Quality Assurance Netherlands Universities (QANU). Courses approved by these organisations are allowed to award the academic title "Bouwkundig Ingenieur" (Engineer of Architecture), Both NVAO and QANU do not specifically accredit architectural education only, but also accredit many higher educational programmes in the Netherlands.

For the purposes of the Architects Directive, the Stichting Bureau Architectenregister (Architects' Register Foundation) is authorised to receive and to issue diplomas, certificates and other formal qualifications according to the article 28 of the Directive 85/384EEC.

The professional association for Dutch architects is the Bond van Nederlandse Architecten (Royal Institute of Architects of The Netherlands). The aims of the BNA are the development of architecture and the promotion of the professional practice of its members.

2.1.5.4 Requirements for Prescription

ARB has published guidelines as standards of requirements for schools of architecture to monitor their curricula. This thesis will focus on ARB and RIBA (as most commonwealth countries derived their standards from ARB/RIBA standards). Meanwhile, architectural schools in the Netherlands basically follow guidelines outlined by NVAO and QANU for accreditation, at the same time refer to EU Architects Directive for mutual recognition of architectural qualifications at international level.

The ARB Prescription and the RIBA Review

ARB is the legal architectural body in the United Kingdom to prescribe qualifications required by graduates of architectural studies. With cooperation from the Royal Institute of British Architects (RIBA), ARB takes the responsibility to validate the process of architectural education. Both architectural bodies seek "to maintain and enhance the quality of architectural education and to encourage experiment, innovation, and contemporary relevance in course delivery and teaching methods" (Jones, 2002).

In 1999, the RIBA produced a review report on architectural education entitled: The Architectural Education for the 21st. Century, in which a strategic review of architectural education is described as "diversity, specialisation, and integration" (Stansfield-Smith, et. al., 1999). This review superseded the previous report published in 1992, chaired by Richard Burton.

Consequently, the RIBA successfully published The Criteria for Validation in May 2002. This subsequent publication was intended to "set out the minimum levels of awareness, knowledge, understanding, and ability" that architectural students would need to acquire in the process of qualifying as architects (RIBA, 2002). There are 5 key areas listed in the ARB publication: Design, Technology and Environment, Cultural Context, Communication, and Management Practice and Law.

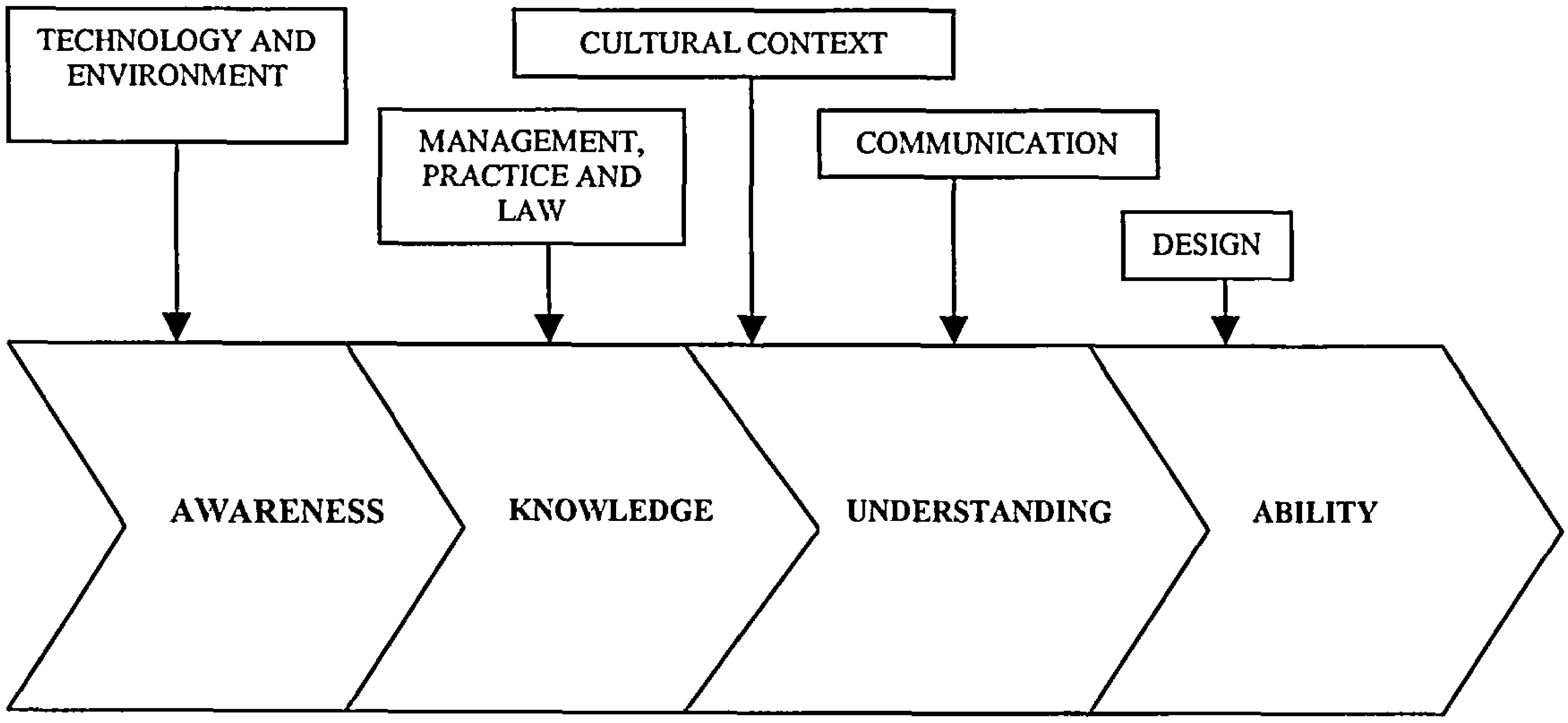

Figure 4: ***Summary of RIBA guidelines for criteria for validation.***

The RIBA recognises that architectural education is the most powerful lever in managing the changes needed in the architectural profession (Stansfield-Smith, et. al., 1999). Vice versa, the profession has great influence on recommending what architectural education should have in terms of its content, structure, the length of the course, and funding mechanism, simply because the needs of the architectural profession are considered as the "driving issues that would determine the shape of architectural education" (Burton, 1992; cited in Stansfield-Smith, et. al., 1999). One of the recommendations in the RIBA 1999 review was that architectural education should come under "further" scrutiny for the reason that the findings "demonstrated growing anomalies between architectural education as translated by universities, and the training and education of architectural students as a vocation" (Stansfield-Smith, et. al., 1999).

Although the 1999 review was claimed to "encourage experiment, innovation, and contemporary relevance in course delivery and teaching methods", it did not provide any particular suggestion or solution as to how schools of architecture should tackle the issues. Instead, it continued to praise the "pedagogic model of project based iterative focus" in design as had been utilised for decades in British architectural institutions and approved by the 1958 Oxford conference. Puzzlingly, Stansfield-Smith (1999) actually criticised the 1958 Oxford conference for giving schools of architecture "the authority to teach without prescription," that lead to the anomalies mentioned by him in the 1999 review. As such, the RIBA should have recognised that the anomalies within architectural education are actually the effects of the long used of a pedagogic model which has a project-based iterative focus. The RIBA 1999 review did not focus on that particular teaching model as a specific subject of scrutiny.

Conclusively, critiques of architectural education partly come from the RIBA. It has become a loop where the link between architectural education and the architectural professional body makes them both accountable for the problems arising in architectural education. As such, there is a need to scrutinise the teaching method in architectural education, perhaps by using references from current pedagogical models designed by education specialists. The theoretical frameworks of available pedagogical models might offer solutions for architectural education, and consequently a relief to professional architectural body whose members are usually not familiar with current pedagogical models used in other disciplines. As suggested by the review, architectural education needs to "support an educational framework that has flexible routes and opportunities, and help sustain a powerful and relevant educational force to make a future for the profession" (Stansfield-Smith, et. al., 1999).

The NVAO Accreditation and the QANU Assessment

In the Netherlands, NVAO is responsible to issue accreditation of architectural programme. However, the actual quality assessments of architectural programmes in higher educational institutions are carried out by QANU, which appoints a committee of independent experts for the purpose. Prior to QANU external assessment, architectural schools in the Netherlands are required to carry out "self-evaluation" and then produce reports as the ground of the QANU assessment process (Delft University of Technology, 2006).

Self evaluation is considered essential for architectural schools to prepare for QANU committee's visit and inspection. Using standards and criteria called The QANU Protocol, schools of architecture in the Netherlands carry out self evaluation to address specific topic of quality assurance, "studiability" and yields (Delft University of Technology, 2006). Generally, the QANU Protocol offers:

- Guidelines and support for the writing of the self evaluation report
- Peer review by an authoritative assessment panel
- Preparation and organisation of the site visit
- Support in the formulation and submission of the application for (renewal of the) accreditation
- Special services tailored to the need of universities (Wamelink, F.J.M, 2004).

The QANU Protocol also specifies that the internal quality assurance of a particular architectural institution must guarantees the teaching quality of each degree programme it offers, high students success rate, and the right orientation of the teaching activities towards professional field for which students are prepared (QANU, 2004).

QANU assessment is carried out based on application of universities, normally a year before the expiry of the current accreditation. This system of reviewing the quality of architectural educational programme is done on the basis of a six-year cycle. An architectural school must submit a compilation of self-evaluation report as a prerequisite before a review committee of independent external expert pay a visit to the architectural institution (Delft University of Technology (1993). The QANU assessment committee is consisted of independent panels of academics, who are regarded as authoritative in their field and selected for their professional expertise and reputation (QANU (2004). They are expected to produce an assessment report of the site visit which, together with self-evaluation report produced by the "course provider", form crucial parts of the assessment procedures required for the application of accreditation to NVAO (Wamelink, F.J.M, 2004).

Subsequently, the NVAO uses the assessment report as a basis for its decision as to whether or not to grant the programme accreditation. Their accreditation decision simply states whether or not the programme in question meets the relevant basic quality standards, but do not provide "an improvement function" (QANU (2004). Since the NVAO assesses degree programmes on the basis of educational aspects (objectives of the degree course, programme, deployment of staff, facilities and provisions, and internal quality assurance), architectural schools have to check for compliance with certain quality criteria set up in EU Architects Directive to get mutual recognition at international level.

EU Architects Directive is initiated by the Council of the European Communities with the aim to provide "progressive alignment of education and training leading to the pursuit of activities under the professional title of architects". This aim requires the standardization of "mutual recognition of diplomas, certificates and other evidence of formal qualification" for architectural graduates to pursue legally in architectural activities throughout Europe, without "concomitant coordination of national provisions relating to education and training" (ARB, 1985).

Based on the EU Architects Directive, architectural education and training leading to the award of formal architectural qualification shall have balance between the theoretical and practical aspects of architectural training. Architectural programmes should also ensure the acquisition of the following criteria among graduates:

1. an ability to create architectural designs that satisfy both aesthetic and technical requirements.
2. an adequate knowledge of the history and theories of architecture and the related arts, technologies and human sciences.
3. a knowledge of the fine arts as an influence on the quality of architectural design.
4. an adequate knowledge of urban design, planning and the skills involved in the planning process
5. an understanding of the relationship between people and buildings, and between buildings and their environment, and of the need to relate buildings and the spaces between them to human needs and scale.
6. an understanding of the profession of architecture and the role of the architect in society, in particular in preparing briefs that take account of social factors.
7. an understanding of the methods of investigation and preparation of the brief for a design project
8. an understanding of the structural design, constructional and engineering problems associated with building design
9. an adequate knowledge of physical problems and technologies and of the function of buildings so as to provide them with internal conditions of comfort and protection against the climate
10. the necessary design skills to meet building users' requirements within the constraints imposed by cost factors and building regulations
11. an adequate knowledge of the industries, organizations, regulations and procedures involved in translating design concepts into buildings and integrating plans into overall planning (ARB, 1985).

Within the Netherlands, the Council of the European Communities only recognises architectural schools that have been accredited by the local accreditation agency, the NVAO. Therefore, to be eligible practicing architects, graduates must be registered members of BNA, and previously obtain the training of architectural profession from either the followings:

1. fulltime education in a five years' courses at the Technical University of Delft or Eindhoven,
2. Or part-time education at an Academy of Architecture of Amsterdam, Rotterdam, Tilburg, Arnhem, Groningen or Maastricht, providing that students are employed in an architect's office or similar practice during the daytime (Visser-Kuipers, 2003).

Just like NVAO, the EU Architects Directive does not prescribe specific methods of teaching architecture although it has strong influences in shaping the architectural programmes in the Netherlands and other European countries. This discussion of the influence of architectural professional bodies in architectural education shows that NVAO and RIBA do not really provide ways to accomplish recommendations outlined, but leave the schools of architecture to improvise their own ways to meet the requirements set by the accreditation bodies. It is acceptable that architectural accreditation bodies only help to provide a framework for guidance, but "it is the responsibility of the intuition, the administration and faculty to develop, implement, assess, and improve" architectural education (Petry, 2002). Therefore, in order to devise methods of improving architectural education, schools of architecture should not only follow the standards, but also to examine the current and future challenges they face.

2.1.6 Current and Future Challenges in Architecture Education

Architectural education faces many challenges in ensuring that architectural graduates have the competency required by current and future professional architectural practice. Based on the critiques of architectural education discussed earlier, there are four main challenges that need to be examined and tackled in order to improve architectural education:

- To innovate a pedagogical theoretical framework for learning,
- To integrate parts of the architectural curriculum,
- To abolish the unnecessary emphasis on artistic value, and
- To improvise method of coping with the rapid speed of changes.

Figure 5 shows the summary of the problems in architectural education faced by schools of architecture, and list of strategies to improve the situation.

2.1.6.1 To Innovate a Pedagogical Theoretical Framework for Learning

Concern about the absence of a theoretical framework in architectural education raises the need to have an innovative pedagogic theory that may serve as a basis for improvement. Although the RIBA does not propose any established pedagogical framework for architectural education to follow, it does recommend characteristics of innovation which schools of architecture could use to improve the situation. Having a review commissioned by the RIBA, Stansfield-Smith (1999) suggests that schools of architecture should increase their curriculum strength by having strategic reviews of their architectural programme with diversity, specialisation and integration. Meanwhile, Boyer and Mitgang (1996) recommended that evaluation of students' work and performance in architectural education should be organised around modes of thinking: the discovery, application, integration, and sharing of knowledge. This proposed modes of thinking can foster a better learning habit among architectural students, as compared to the conventional methods of teaching and learning practiced thus far, which are organised around blocks of knowledge (Petry, 1996), and worst, around the hidden curriculum.

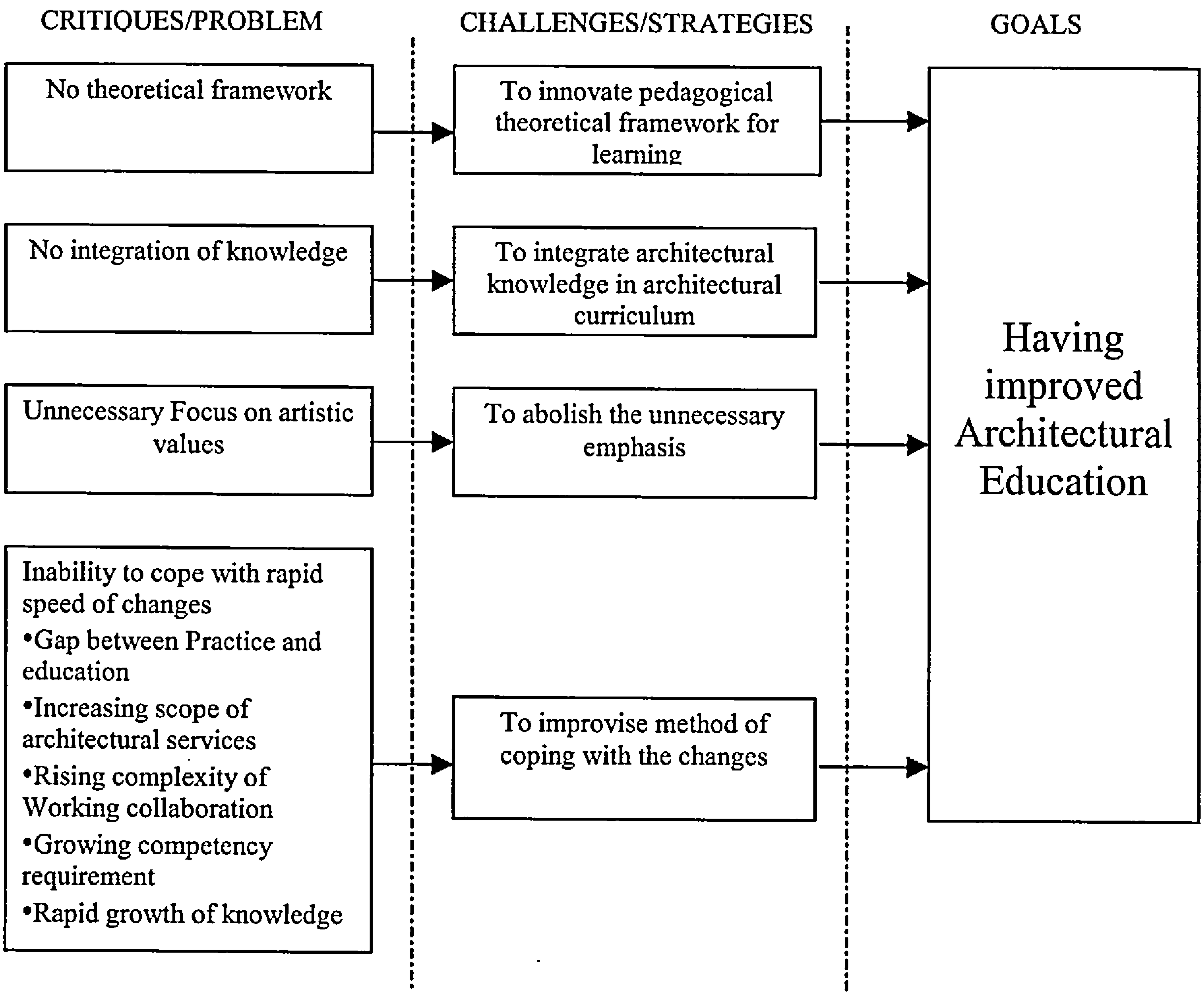

Figure 5: *Summary of the problems in architectural education faced by schools of architecture, and list of strategies to improve the situation.*

Either intentionally or not, the RIBA's suggestions are aligned with Driscoll's theoretical outlines of three basic components of learning: input, means and result (Driscoll, 1994). The increased strength of curriculum proposed by Stansfield-Smith (1999) can be used as the basic input in any proposed pedagogical innovation in architectural education; whilst by means of encouraging innovative modes of thinking, a better learning habit mentioned by Petry (1999) can be achieved as the required result. By having the three basic components of learning in any future innovation of architectural education, a theoretical pedagogical framework can be properly established. However, a question remains as to which innovation or methods of learning might be best suited the current and future architectural education.

2.1.6.2 To Integrate the Architectural Curriculum

One of the most prevailing challenges in architectural education is the integration of knowledge in the content of architectural curriculum. It is popular topic of debate as the successful integration of architectural curriculum is generally very difficult. To make matters worse, the increasing diversity and specialisations offered by many schools of architecture make the integration of the parts of architectural education ever more difficult. Many schools of architecture around the globe have undertaken Stansfield-Smith's (1999) recommendation to strengthen their curriculum with diversity and specialisation, in order to cover some of the inadequacies of the conventional architectural educational structure. Stories of success in providing diversity and specialisations in architectural curriculum are abundant and being recognised (Gutman, 2000; Bothwell, et al., 2004). Durham Jones, the director of the architecture program at Georgia Tech, once pointed out that the diversity in architectural curriculum is important because by having architects receive different training makes the world as a better place (Steuteville, 2004). No doubt it is good for schools of architecture to offer a "range of specialist options to help prepare students for different types of practice" (Stansfield-Smith, et. al., 1999), but the endeavour of having too many specialist subjects creates distant branches of knowledge that sometimes outreach other disciplines of education such as health and military sciences. If to integrate subjects within architectural discipline is already a big challenge faced by architectural education today, then the introduction of specialisations from multi-disciplinary areas "breed even more fractured totality" because "each course of study promotes a distorted emphasis in the context of the whole" (Stansfield-Smith, et. al., 1999). Consequently, the integration process in architectural education is made more complicated.

In order to tackle issues of integration, Egan (1998) implied that schools of architecture should simplify architecture education by reducing the volume of diversity and numbers of specialisations, but at the same time increasing its quality and values. He encouraged simplification, for the reason that the "highly skilled professional" in technical subjects would be provided by the "supply chain" in the construction industry (Egan, 1998) not by architects. This opinion is in accordance to the 4th of the 7 enriched missions presented in Boyer Report: provision of "a connected curriculum" that offers more liberal and flexible studies, with more integrative learning experience for students. As such, responsibility to provide an effective connected curriculum with a high level of integration among subjects within architectural disciplines is laid on schools of architecture.

2.1.6.3 To Abolish theUnnecessary Emphasis on Aesthetic Value

With the intention to establish a pedagogical framework and integration in architectural education, schools of architecture face the challenge to simultaneously abolish the unnecessary emphasis on aesthetic or artistic value amongst design instructors and students, especially in the design studio. Students should be educated to have the realisation that architects are not merely artists, but have many other important roles that are continuously evolving under the influences of current developments in the world, such as the changes in the value system of socio-cultural settings, and technological advancement. Architects who are trained to be concerned with producing individual works of art will not have the necessary skills to cater for a wide range of responsibilities in practice; "including such tasks as programming, feasibility analysis, office management, designing, construction management, financial analysis, building operation, and maintenance" (Akin, 1983; cited in Salama, 1995). Indeed, the public currently requires architects to "develop a wider repertoire of design responses to the built environment" (Nicol & Pilling, 2000). Based on this demand, the realisation of the true roles of architects means that, it is necessary to link students' mind, attitudes and values to the reality of architectural practice.

A new agenda to move away from the aesthetic focus in the training of architectural students should be prepared by having a reformed architectural education paradigm. Academia would need to reconsider their approach in teaching with an epistemological foundation (Moore, 2001), without a total exclusion of aesthetic values. Of course, it is difficult to emphasise all branches of knowledge within architectural disciplines, but the challenge to architectural education is not to complicate the already complex architectural entities. Instead, Brown and Moreau

(2002) propose that a reformed architectural education paradigm should aim to develop students' critical thinking, enabling them "to adapt to new conditions and formulate new responses" in the context of architectural problems. By doing so, both design instructors and students would prioritise their emphasis of architectural education on matters that related to the problem at hand.

2.1.6.4 To Improvise Method of Coping With Changes

Schools of architecture are also challenged to draft an architectural curriculum that is capable of training students to develop necessary skills to cope with the rapid speed of change in architectural disciplines, both in education and practice. As discussed in section 2.1.4, the areas of changes concerned by this thesis include the gap between architectural practice and education, the increasing scope of architectural services, the rising complexity of working collaboration, the growing competency requirement, and the rapid growth of knowledge. Educational innovation in methods of coping with changes should be comprehensive enough as not to consider architectural education as merely a way of passing on a body of knowledge, but to recognise it as needing to develop skills in areas of students' methods of inquiry, processes of problem solving, and their habit of life-long learning (Brain, 2004).

Brains (2004), elaborated that the solution to these challenges might be to design a curriculum that provides "conceptual tools and cultivates intellectual habits necessary to learn constantly" from the evolving world. The idea of lifelong learning means a focus on developing certain skills for seeing and knowing the world, specifically with respect to the core of architectural education. A similar idea is given by Nicol and Pilling (2000), noting that students need to acquire not only skills, but also attitudes that are transferable across contexts and enable continuous lifelong learning. Effective methods of inquiry and comprehensive processes of problem solving are two major components of lifelong learning that can be adapted to make up architectural pedagogical innovation.

2.1.7 Potential Solution

Conclusively, the review of architectural education in this thesis shows that most criticisms of architectural education are responses expressed based on the performance of architectural graduates, who are the products of the conventional methods of teaching architecture. Since the conventional architectural education does not have proper pedagogical framework because it is rooted on tradition, rather than proper educational research of educational theory, any measure of its improvement requires pedagogical references beyond the architectural discipline itself. For decades, education specialists around the world have designed and implemented pedagogical innovations in many disciplines of education. Therefore, architectural education is due to move forward by not being "esoteric" anymore, but to open-mindedly look beyond the discipline to explore what education in other disciplines has achieved.

The skill of lifelong learning, with its inquiry and problem solving methods, seems to be an ideal result that architectural education should be aimed for. There are several pedagogical approaches that claim to develop skills for lifelong learning. However, the rest of this thesis will only focus on pedagogical approach of Problem Based Learning (PBL) as the object of critical evaluation for the reason that it is comprehensive enough to cover the breadth of architectural education. Although Brain (2004) states that "there is no way to pack everything an architect ideally need into a reasonable university curriculum," it is stipulated that PBL may offer ways of strengthening the weakness in architectural education, and provide a solution to problems encountered in the conventional architectural teaching methods, without changing its core content.

2.2 PBL in Tertiary Education

Problem Based Learning (PBL) is becoming an increasingly popular term in tertiary education (Kwan, 2000), as more and more educational disciplines implement the teaching and learning approach associated with the terminology. Previously believed to be monopolised by medical schools, PBL applies widely to learning in most professional schools and disciplines. In fact, some argue that it is the most significant innovation since the move of professional training into educational institutions (Boud and Felletti, 1997). As such, this section of the thesis is intended to examine the reasons behind PBL's popularity in higher education, by analysing the characteristics of this approach that make it so attractive. Discussion about the innovation of PBL in general tertiary education will be followed by a study of its potential applicability and implementation in architectural education.

2.2.1 PBL in Brief

PBL was first applied in business schools (Kwan, 2000), but it gained popularity when McMaster University, Canada, started to implement the method as its major learning approach in its Medical Faculty in the late 1960's (Schwartz, Mennin, & Webb, 2001; Boud and Felletti, 1997). The Medical Faculty in the McMaster University has been using PBL for more than three decades. Having been recognised as an innovative educational approach and shown to have the potential to enhance the education process and its outcomes (Eng, 2000), PBL has gradually been adopted by other medical schools, and recently in many other disciplines, such as engineering, management, and law (Schwartz, Mennin, & Webb, 2001).

Irrespective of the precise branch of educational disciplines in which PBL is implemented, the application usually has two main expected purposes. The first is to use PBL as a method that will assist students towards achieving a specific set of objectives required for professional competency throughout their professional lives. Secondly, to use PBL to support the conditions that influence "effective adult learning" (Engel, 1991), also commonly known as life long learning.

By definition, PBL is a pedagogical approach to structuring the curriculum, which involves confronting students with problems as a stimulus for learning (Boud and Felletti, 1997). The principle idea behind PBL is that "the starting point for learning should be a problem, a query or a puzzle that the learner wishes to solve" (Boud, 1985). As problems initiate motivation and curiosity, students generate hypotheses and then identify learning issues, and finally search for the knowledge that they need to obtain in order to approach the problem (Ross, 1997; Eng, 2000). Unlike the traditional way of dissemination disciplinary knowledge by means of "exposition", PBL primary method of acquiring knowledge and skill is by means of analysing a sequence of problems "presented in context," with support from associated learning material, and from facilitators or tutors (Boud, 1985). In the context of a learning environment, the "problematic" is considered as the stimulus or goal that leads to and organises the learning process (Dewey, 1983; cited in Tam, 2000). On the other hand, Savery and Duffy (1995) use the term "puzzlement" as being the stimulus and organiser for learning. Figure 6 shows the theoretical model of the PBL pedagogical approach developed by Schmidt and Gijselaers (1990).

Although there are many different terms associated with the word "problem," such as an inquiry, puzzlement, a case, a scenario and a problem itself, the essence of PBL pedagogical approach remains the same: having a problem as the centre of learning process. However, problem definition in PBL educational approach depends very much on the context of those educational disciplines within which it is situated and defined. In medical schools, for example, healthcare problems (HCP) are presented as carefully designed "scenarios of clinical situations," from which the issues are identified and the objectives of learning are developed by students (Kwan, 2000).

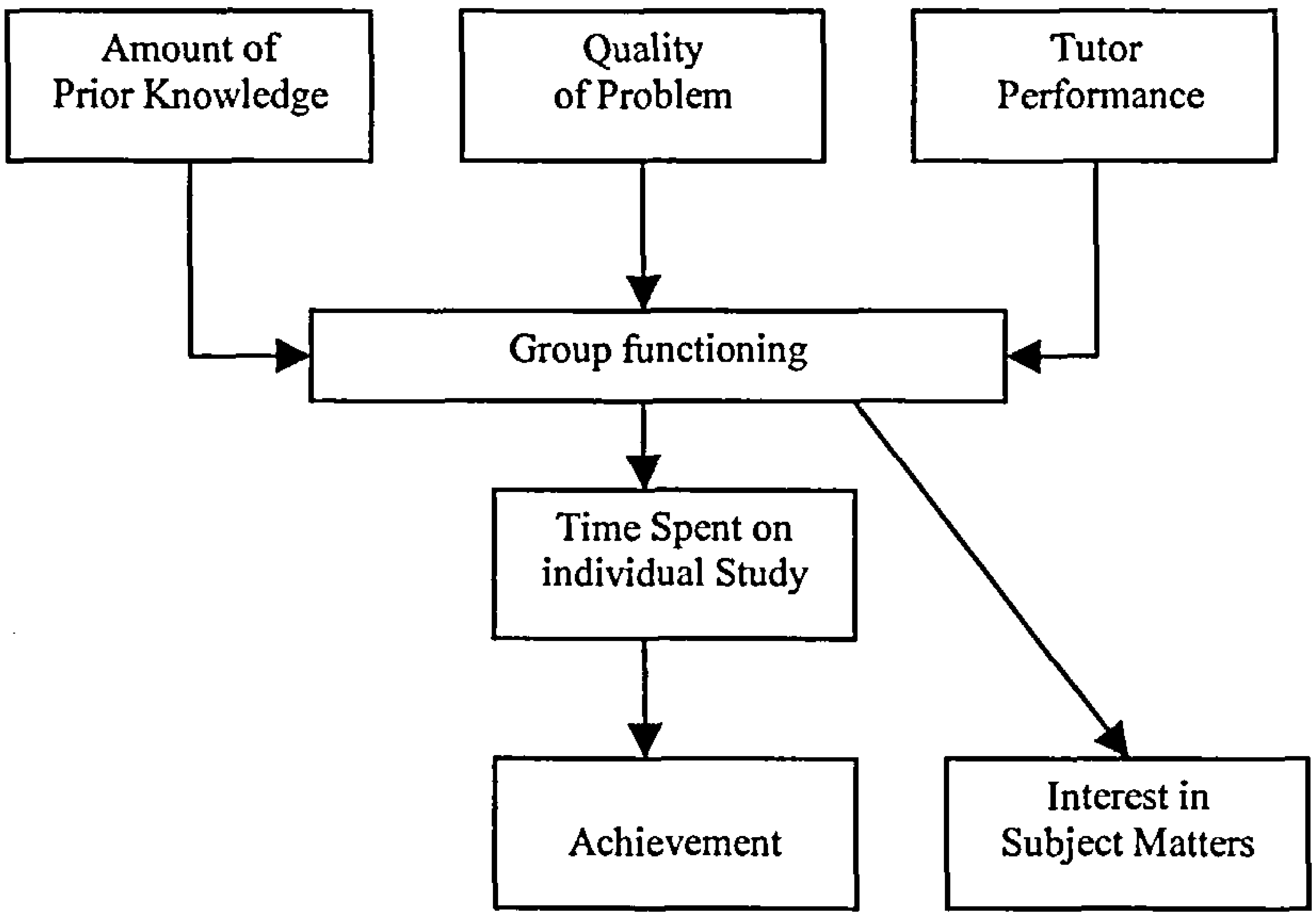

Figure 6: ***Theoretical model of PBL (adapted from Schmidt and Gijselaers, 1990)***

Alternatively, judiciary or law schools use puzzlement as the problem to initiate learning amongst law students. No matter what it is called, the problem provides the context for students to apply their knowledge and to take ownership of their learning (Tam, 2000). The following excerpted text is an example of a puzzlement that is presented in criminology course of law programmes.

Consider the solving of this problem from a Criminology course:

Detective K needs to identify exactly where the 1.7 m suspect, Bozo, was standing when a shot was fired. The bullet was located in a telephone pole at an angle of 60° with an apparent dent in a metal stop sign 2.3 m above the street. Bozo claims that he was standing facing the stop sign but 50 m away. The bullet hole was 3.2 m off the ground. The telephone pole is 10 m away.

(Excerpted from Ong, 2000)

The many different terms associated with the problem do not affect the general theoretical philosophy and ideas of the PBL pedagogical approach. Rooted in the constructivist ideas of learning instruction (Tam, 2000), the PBL approach is significant in terms of providing maximum effectiveness in producing professional competencies among graduates in many professional disciplines. It revitalizes the classroom teaching and learning process, and enables students to get the most from independents studies (Boud, 1985). Practically, PBL is the answer to the changing nature of profession which "require the development of a number of component of competences, such as the skill of communication, critical reasoning, a logical and analytical approach to problems, reasoned decision making, and self evaluation" (Engel, 1997). As such, in order to understand the reason behind popularity of PBL, investigation on characteristic and mechanism of PBL is analysed as to provide the framework for this study. The framework contains a set of ideas and its categories for further analysis on PBL appropriateness in architectural education.

2.2.2 Mechanism of PBL

As implied by its name, PBL pedagogical approach focuses on learning mechanism rather than teaching. The Longman Dictionary of Contemporary English defines learning as to gain knowledge of a subject or skill, by experience, by studying it, or by being taught (Summers, et. al., 2003). This definition is pursued by Driscoll (1994), stating that learning as a life long activity that occur both incidentally through experience and intentionally in formal instructional settings. She adds that learning encompasses a multitude of competencies, from knowledge of simple facts to great skill in complex and difficult procedures, which are acquired by either great effort or sometimes proceed with relative ease. Therefore, as a general idea, learning is a persisting change in human performance or performance potential. Learners are capable of actions they could not have performed before the learning occurred and a change in performance must come about as a result of the learner's interaction with the environment.

As an innovative learning method, the PBL mechanism is divided in two basic features: the learning process and the learning techniques. Learning process refers to a series of actions or activities that are done in order to achieve a particular result, in this case, to have a competency required of the students. On the other hand, learning techniques in PBL are "a special way of doing something" (Summers, et. al., 2003). The word special here indicates that PBL learning techniques have not been commonly adopted in the traditional teaching methods.

2.2.2.1 Problem Based Learning Process

The PBL approach emphasises the enquiry process of learning, where students work towards the understanding of, or resolution of, a problem (Barrows and Tamblyn, 1980; cited in Ross, 1997). They proceed by "asking what needs to be known to address and improve a particular situation" (Boud and Felletti, 1997). During the PBL learning process, students are well served by learning how knowledge, or "product of enquiry", is derived; and how to pursue an enquiry (Margetson, 1997). This particular stress on critical inquiry, and problem-definition and solution, is described by Moore (2001), as the "facilitator method" since facilitators are involved in provoking the students to work towards achieving the PBL objectives.

In order to achieve the learning objectives, of pursuing enquiry and deriving knowledge, PBL promotes the active use of students' existing knowledge. Indeed, PBL "is grounded in the belief that learning is most effective when students are actively involved and learn in the context in which knowledge is to be used" (Kwan, 2000). This belief is in accord to the constructivist perspective that sees the process of learning as happening when learners "actively construct their own knowledge" by mediating input to determine what they will learn (Woolfolk 1993; cited in Tam, 2000). Here, the learning process is considered as active mental work, involving the interplay of learners' existing knowledge, their social context, and the problem to be solved (Tam, 2000).

The PBL pedagogical approach emphasises on active learning with particular relevance to the learning objective, as opposed to the "traditional spoon-feeding rote" to learning via didactic lectures and instruction. Active implies dynamic interaction among learners and learning signifies the focus on the process used by the learners rather than the process imposed by teachers (Kwan, 2000). In order to maximise the effectiveness of active learning promoted by PBL pedagogical approach, four important PBL components should be incorporated in the learning process: cumulative learning, integrated learning, progression in learning, and consistency in learning (Engel, 1997). Engel perceived that by cumulative learning, relevant subjects should be introduced "repeatedly and with increasing sophistication whenever it contributes legitimately to reasoned decision making in a problematic situation." This means to achieve growing familiarity through a sequence of learning experiences that are relevant to the students' goals. Various relevant subjects should also be presented concurrently as integration of parts "in context in which the learning is to be applied" (Engel, 1997). Felletti (1993) stated that assessment should be used not merely for the purpose of recalling knowledge, but to test application of knowledge. In addition, the various aspects of the PBL curriculum should also progressively and consistently change to accommodate the level of competency required as students mature (Engel, 1997). Figure 7 shows the four components of PBL approach used to maximise active learning among students.

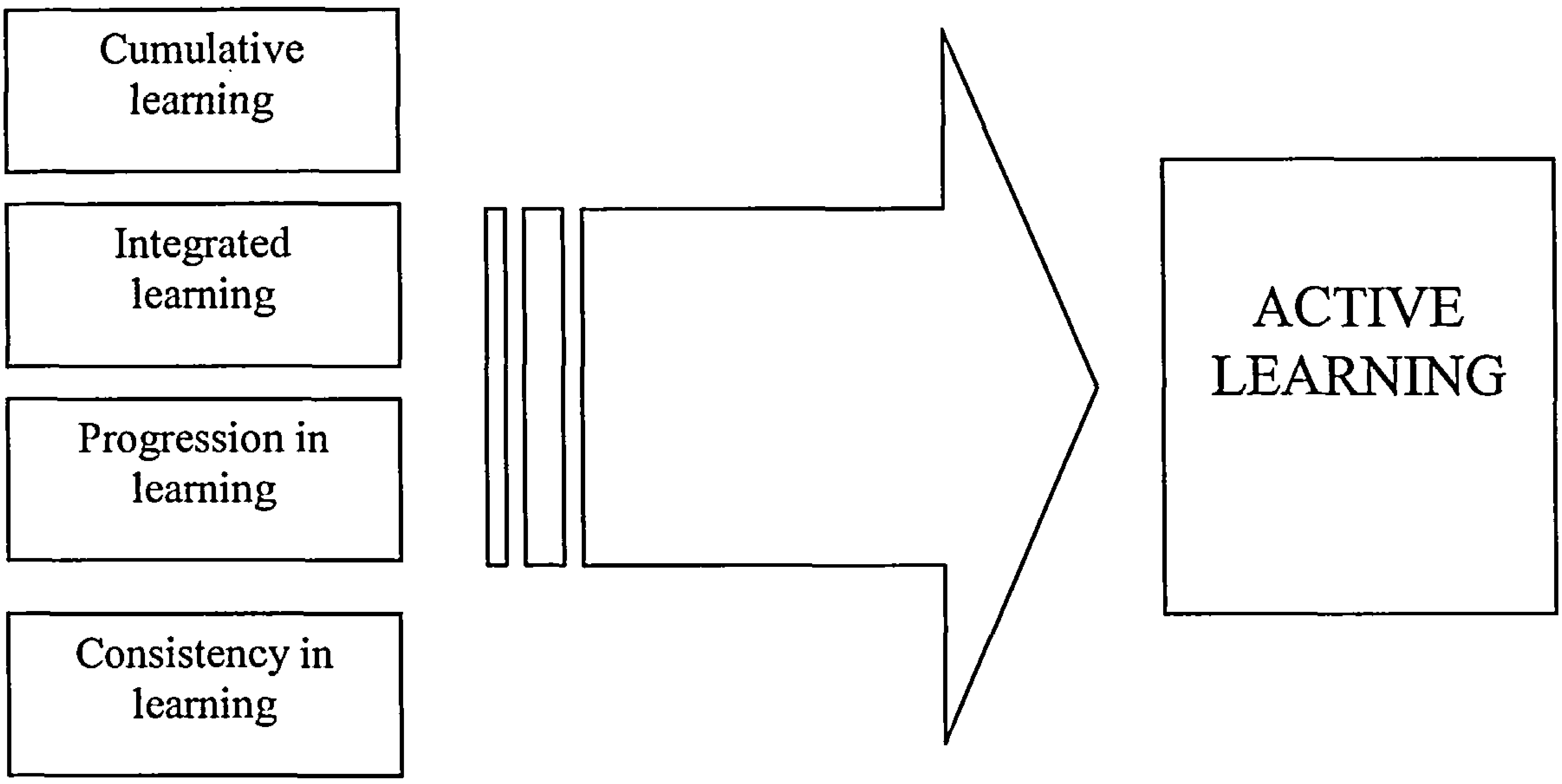

Figure 7: *The four components of PBL approach used to maximise active learning among students (after Engel, 1997).*

On the other hand, Barrows (1992) outlined that, during the learning process in a PBL pedagogical approach, students usually experience five major activities in their tutorial groups: problem presentation, discussion in collaborative teams, proposed solution presentation, reflection and outcome. Similarly, Koschmann (1994) identified five steps of PBL learning process, but uses slightly different terms: problem formulation, self-directed learning, problem re-examination, reflection, and abstraction. Although both outlines seem to be presented in a linear arrangement, the first three steps of a PBL learning process are actually iterative in nature (Kvan, 2000). Figure 8 shows Barrows' (1992) theoretical framework of the learning process students undertakes in PBL pedagogical approach.

Unlike Barrow and Koschmann, who both formulated the PBL process based on medical educational contexts, Watson (2003) presents the PBL learning cycle as a continuous iterative process that has additional features, such as whole class discussion and mini-lectures. Indeed, Watson also uses different terminologies to describe the learning process in a PBL pedagogical approach to make it flexible enough to be adapted by other disciplines of education. Figure 9 shows the learning cycle conceptualised by Watson (2003) in the PBL approach, whilst Table 5 shows the summary of terminologies used by different scholars to describe the learning processes in PBL pedagogical approach.

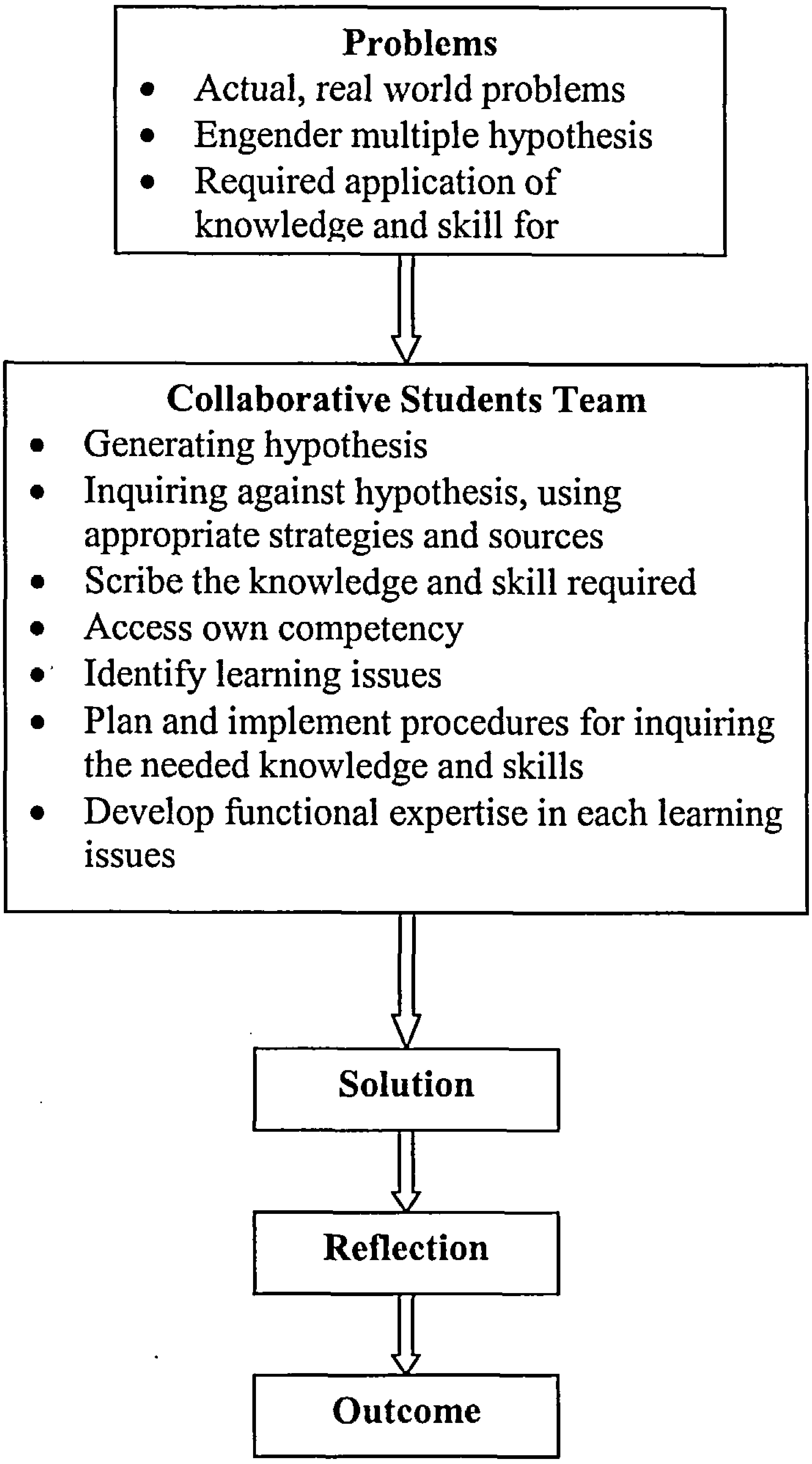

Figure 8: ***Summary of learning processes that students undertake in the medical version of PBL pedagogical approach (after Barrows, 1992).***

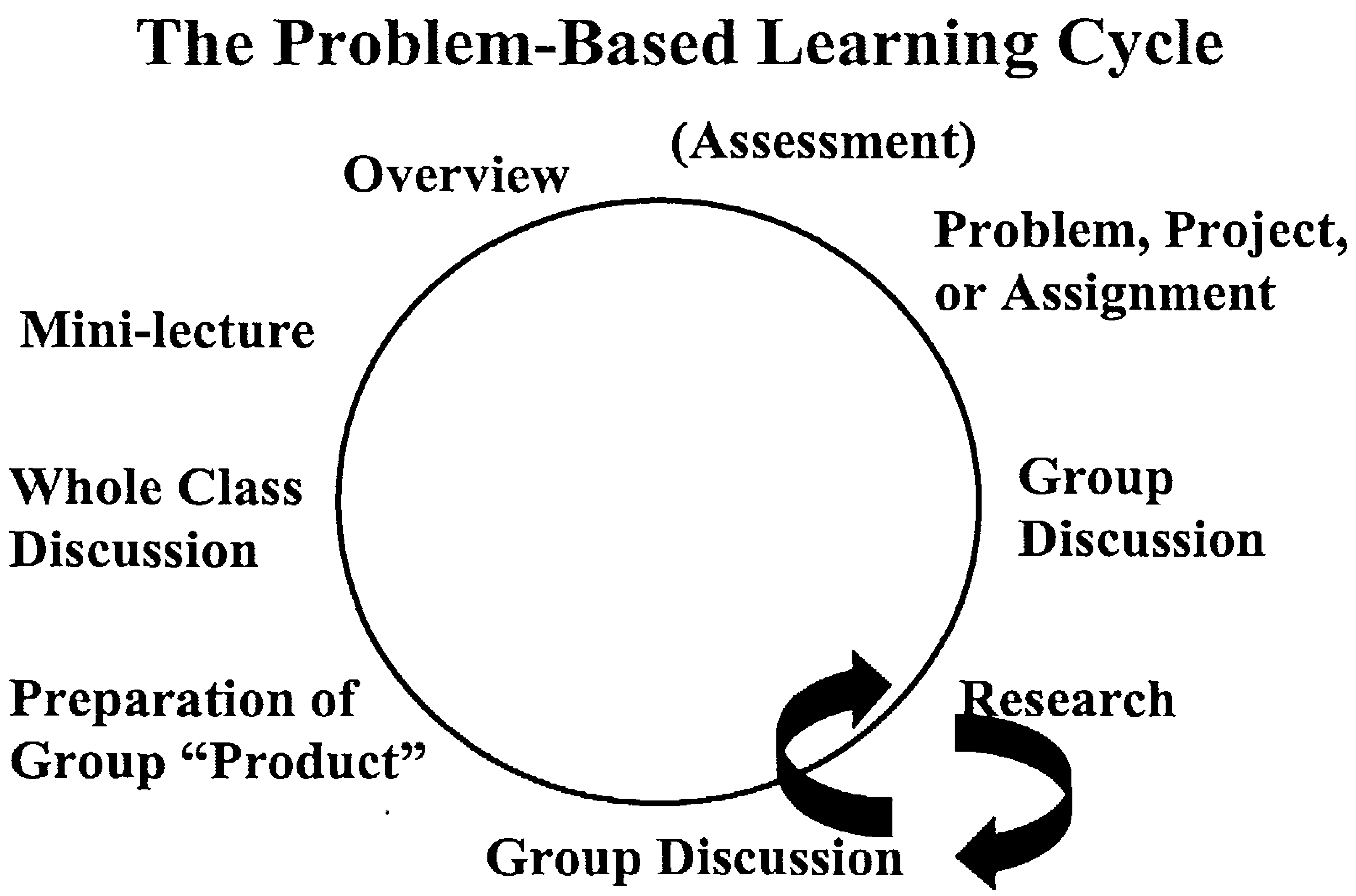

Figure 9: *The PBL Cycle (Watson, 2003)*

Table 3: *Summary of terminologies used by different scholars to describe the learning processes in PBL pedagogical approach.*

Steps	Barrow (1992).	Koschmann (1994)	Watson (2003)
1	Problem Presentation	Problem Formulation	Problem, Project or Assignment
2	Discussion in Collaborative Students Team	Self-directed Learning	Series of Group Discussions and Researches
3	Solution	Problem re-examination	Preparation of Group Product
Addition 3a	N/A	N/A	Whole Class discussion
Addition 3b	N/A	N/A	Mini-lecture
4	Reflection	Reflection	Overview
5	Outcome	Abstraction	Assessment

The students' learning process starts when they are presented with a problem, without having had any preparatory study in the area of the problem (Schwartz, Mennin, & Webb, 2001). Having the problem as a trigger to stimulate learning, students form small collaborative learning teams and soon engage in brainstorming sessions to organise their ideas based on their previous knowledge of the subject discussed. Within this first session of group discussion, students pose questions to each other in order to define what they know and what they do not know, identify what they wish to learn in order to solve the given problem, discuss the needed resources and materials, and assign responsibility for research on formulated questions (Watson, 2003; Kvan, 2000). After the first group discussion ends, each member of the collaborative learning team is expected to embark on research and self study to prepare for the next session of group discussion.

The next session of discussion enables students to share ideas, explore newly learned information, and refine questions before they decide on a solution to the given problem. Here, students have the opportunities to check their progress by re-examining the problems and testing if they have learned "the necessary facts, skills, or concepts" to propose a solution. If the students' collaborative team is satisfied with the information gathered, they might proceed to formulate a solution, and then engage in abstraction and reflection (Kvan, 2000). Otherwise, students would carry on with series of discussions, and self-study between group meetings, until they have enough shared information to formulate a solution. A large proportion of study time is reserved for self-study (De Graaff, 2003). However, students must limit their exploration of relevant material within a proposed timescale (Hutchings, 2003).

In a PBL "enquiry-oriented approach," developing critical reflection skill is vital for students to learn subjects effectively relevant to the problem presented (Boud and Felletti, 1997). Students must reflect upon their knowledge in order to reapply it to the original problem, and to evaluate their learning processes and content. Students are therefore expected to learn from the process as well as the content. Finally, the desired outcome in the PBL pedagogical approach can be achieved by the idea that learning processes lead to discovery, or justification of products (Margetson, 1997).

The process of discovering knowledge is recognised as resulting in a great deal of learning for students. However, although PBL emphasizes students' capability in learning processes, assessment of their possession of content needs to be done to ensure the expected learning takes place (Henderson, 2003).

All Barrows', Koschmann's and Watson's versions of PBL processes are originally rooted from one of the earliest PBL description, presented by Schmidt (1983); the "Seven Jump". Schmidt noted that small group discussion is central to the learning process by means of the Seven Jump, where students are involved in the following learning activities:

1. Clarifying unknown terms and concepts in the problem's description;
2. Defining the problems by listing the phenomena to be explained;
3. Analysing the problem by producing explanations of the problem's phenomena, based on prior knowledge and common sense;
4. Criticising the proposed explanation;
5. Formulating the learning issue for self directed learning (SDL);
6. Filling the knowledge gap through self study;
7. Sharing relevant findings with members of the study group.

The "Seven Jump," is supposed to be cyclic until a comprehensive explanation of the problem phenomena are satisfactory acquired.

By undertaking all the steps outlined in the PBL pedagogical approach, students are eventually expected to develop skills of lifelong learning, including reflective, critical and inventive thinking with high motivation and independency level (Seng, 2000). In addition, students also have self-regulating qualities, such as persistence and time management that will help them to reach long-term goals (Watson, 2003).

2.2.2.2 Problem-Based Learning Techniques

Besides having a special emphasis on the learning process, the PBL pedagogical approach stresses the importance of having numerous learning techniques that eliminate the traditional methods of acquiring knowledge, by lectures and instruction. Scholars have developed PBL learning techniques for the purposes of finding the most appropriated way to maximise effectiveness in the learning process. Rather than mere dissemination of knowledge, PBL learning techniques focus on developing students' skills, to learn with understanding in their chosen fields, that ultimately become a lifelong learning skill.

Two distinct learning techniques adopted in the PBL pedagogical approach are peer learning or peer tutorial, and self-directed learning. Both learning techniques are utilised in small group discussions with minimal facilitators' input.

<u>Peer learning</u>

Peer learning that is promoted by PBL pedagogical approach reduces students' burden of learning too much information within too little time. Especially with the advent of rapidly growing knowledge in all fields, it is almost impossible for a single student to grasp all the content and knowledge relevant to his or her field of study by studying individually. As such, the sharing of responsibility for finding and constructing knowledge among students in a PBL tutorial environment enables students to avoid overload.

Besides, a PBL tutorial environment also encourages cooperative, active, and deep learning, whilst simultaneously leading to a more effective learning process, compared to traditional learning methods. Cooperatively working in groups, students actively develop skills in communication and teamwork and learn to appreciate other people's perspectives by negotiating shared understanding. Sharing ideas and working together to solve a problem creates the potential to achieve a deeper understanding of the subject learned (Jonassen, 1997; cited in Henderson, 2003). It is through active research and debate within peer learning groups that the students' existing subject knowledge base is integrated and expanded, "leading to deeper subject understanding and developing their ability to apply that knowledge in potential real life situation" (Hutchings, 2003). Boud suggests that students can effectively develop problem-solving skills to use throughout their careers when they take responsibility for peer assessment (Boud, 1995).

Self-directed learning

Using the constructivist principles of a student-centred approach, PBL encourages self-directed learning (SDL) among students (Tam, 2000). A collaborative and interactive learning environment enables students to be motivated to control their own learning process and outcomes by exploring the unknown and managing their "learning pace and strategy" with maximum flexibility (Kwan, 2000). Students also learn to identify their own learning needs and appropriate use of available resources (Boud and Felletti, 1997). In addition, self-directed learning empowers the students with the task of learning by identifying learning issues, creating their own learning objectives and criteria, and assessing how well their learning has progressed (Henderson, 2003).

Facilitator Involvement

Both peer learning and self-directed learning challenge students to be responsible for their own knowledge acquisition and performance. However, they are not neglectfully left without guidance in pursuing their learning tasks. The provision of facilitators and guide books in a PBL pedagogical approach enables students to enhance their ability to function in the PBL environment.

Unlike teachers, who function as knowledge providers and direct sources of information (Kwan, 2000; Schwartz, Mennin, & Webb, 2001), facilitators' primary task in a PBL pedagogical approach is to support the students' learning process (Driel, 1993). Facilitators help students to become active participants in their learning and make meaningful connections between prior knowledge, new knowledge, and the process involved in learning (Tam, 2000). In doing so, facilitators ask questions rather than provide answers, resulting in students' active engagement in obtaining knowledge and skills. Facilitators in a PBL pedagogical approach need not be experts in the subjects discussed, but should only have basic knowledge in a relevant field in order to stimulate and understand the discussion, and to know when to intervene (Driel, 1993). Students are still responsible for their own choices in managing their self-directed learning and peer learning.

2.2.2.3 Comparison with Traditional Teaching Method

To further understand the constitution of PBL, comparison between PBL and the traditional teaching method is analysed to provide clarification. There are three major differences between PBL and traditional teaching method: the methods of knowledge acquisition, the students' role in learning, and the role of the academics.

Method of Knowledge Acquisition

In traditional teaching methods, students use an "in case approach" as the main method of knowledge acquisition. In this scenario "students are equipped with as much as basic knowledge in case they need to apply it years down the road" (Kwan, 2000). The "in case" approach has the underlying assumption that large and complex bodies of knowledge are always needed to solve problems (Margetson, 2001). Here, unrelated knowledge of a certain discipline, that has been accumulated via series of courses within time spent in tertiary education, is assumed to be automatically applied by students when they encounter problems. Margetson (2001) claims that the process of acquiring knowledge in this traditional teaching method is not meaningful to students, because the acquired knowledge does not seem specifically applicable to their current interests, understanding, and questions.

On the other hand, the main method of knowledge acquisition in a PBL pedagogical approach is via the so-called "in time approach," where students are supposed to learn whatever they think relevant to the problem presented to them, at that time. Here, students set their own learning objectives of what they want to achieve by learning "what they need, when they need to know it" (Kwan, 2000). In other words, a PBL pedagogical approach has the underlying assumption that knowledge is constructed when students attentively analyse a problem.

Students' Role in Learning

The traditional teaching method is claimed to result in students playing the role of passive learners because they are spoon-fed in a teacher-centred education environment (Engel, 1997; Driel, 1993). Students learn via didactic lectures and instruction, where they passively listen to their teacher with minimal participation. Although knowledge might be transmitted from teachers to students, but students are not involved in deep learning activities, resulting in a lack of understanding of the context in which that knowledge is to be used (Watson, 2003).

The PBL pedagogical approach, however, encourages students to play the role of active learners by utilising the so-called student-centred education environment (Kwan, 2000). Students are actively involved in small group learning activities (Eng, 2000) by constructing knowledge through "gathering and synthesizing information," and developing the "general skills of inquiry, communicating, critical thinking, and problem solving" (Watson, 2003), by their own self-direction. As a result of playing an active role in learning, students acquire the benefit of deep learning (Henderson, 2003).

Academic Staff's Role

The roles of academic staff in a PBL pedagogical approach and in the traditional teaching approach are distinctly different. In the latter, academic staff function as teachers whose primary role is to be the main "information giver" (Watson, 2003). Disseminating knowledge via lecture-based education, teachers are considered as experts in certain areas of specialisations that focus on a single discipline. As specialisation is their major preoccupation (Margetson, 2001), teachers provide students with knowledge without properly developing students' skills in how to use it subsequently.

Quite the opposite, academic staff in the PBL pedagogical approach play the role of facilitators whose primary task is to support students into taking responsibility for their own learning. As such, a PBL pedagogical approach does not use the term teachers or instructors to refer to academic staff, instead using the word facilitators or coaches to illustrate the role played. Here, facilitators do not need to be experts in certain field of studies, but they learn "interdisciplinary" knowledge together with students (Watson, 2003). Having enough basic knowledge to enable them to pose questions to students is sufficient for facilitators to function properly in a PBL environment, yet they must have to adopt specific PBL attitudes and skills towards teaching (Driel, 1993).

Although features of the pedagogical approach described thus far is not unique to the PBL pedagogical approach alone (De Graaff, 2003), it is considered as an innovation that promises to instil the values of

> "open-mindedness, independent learning complementing co-operative peer learning, group work, imaginativeness, rigorous thought, constructive, critical reflection, and appropriate evaluation" (Margetson, 2001)

among learners, both students and facilitators. The promise that PBL develops student's ability to function in a complex professional environment (Henderson, 2003) attracts more and more disciplines in tertiary education to adopt PBL in their educational endeavour.

2.2.3 Manifold Implementation of PBL

Through decades of evolution, the original PBL pedagogical approach has been developed into various versions, depending on the needs and context of certain educational disciplines. The appearance of various forms of PBL threats the nature of the original PBL pedagogical approach, which was developed by scholars in medical disciplines, into explicit controversy as more vocations, disciplines, and profession contribute to the PBL literature. However, this development actually provides a broad based experience and healthy scepticism (Boud on Felletti, 1997).

Kwan (2000) negatively suggests that the emergence of diverse PBL versions is the product of "differences in the mindset as a result of the historical burden chronically carried by an established traditional institution." A rigid mindset within traditional institutions creates a persistent resistance to acceptance of the "true spirit of PBL", causing it to be superficially treated. Nonetheless, Saven-Baden (2000) argues that PBL is an approach to learning that is characterised by flexibility and diversity. As such, it can be implemented in a variety of ways, regardless of differences in contexts, subjects and disciplines.

Differences in contexts, subjects and disciplines distinguished the "level of specifications and approach" to the role of problems in PBL curricula. Regarding this, Ross (1997) clarifies three different terms to justify the diverse PBL versions: problem-based, problem-oriented, and problem-solving curricula. Figure 10 illustrates the differences between the three versions of PBL, as described by Ross (1997).

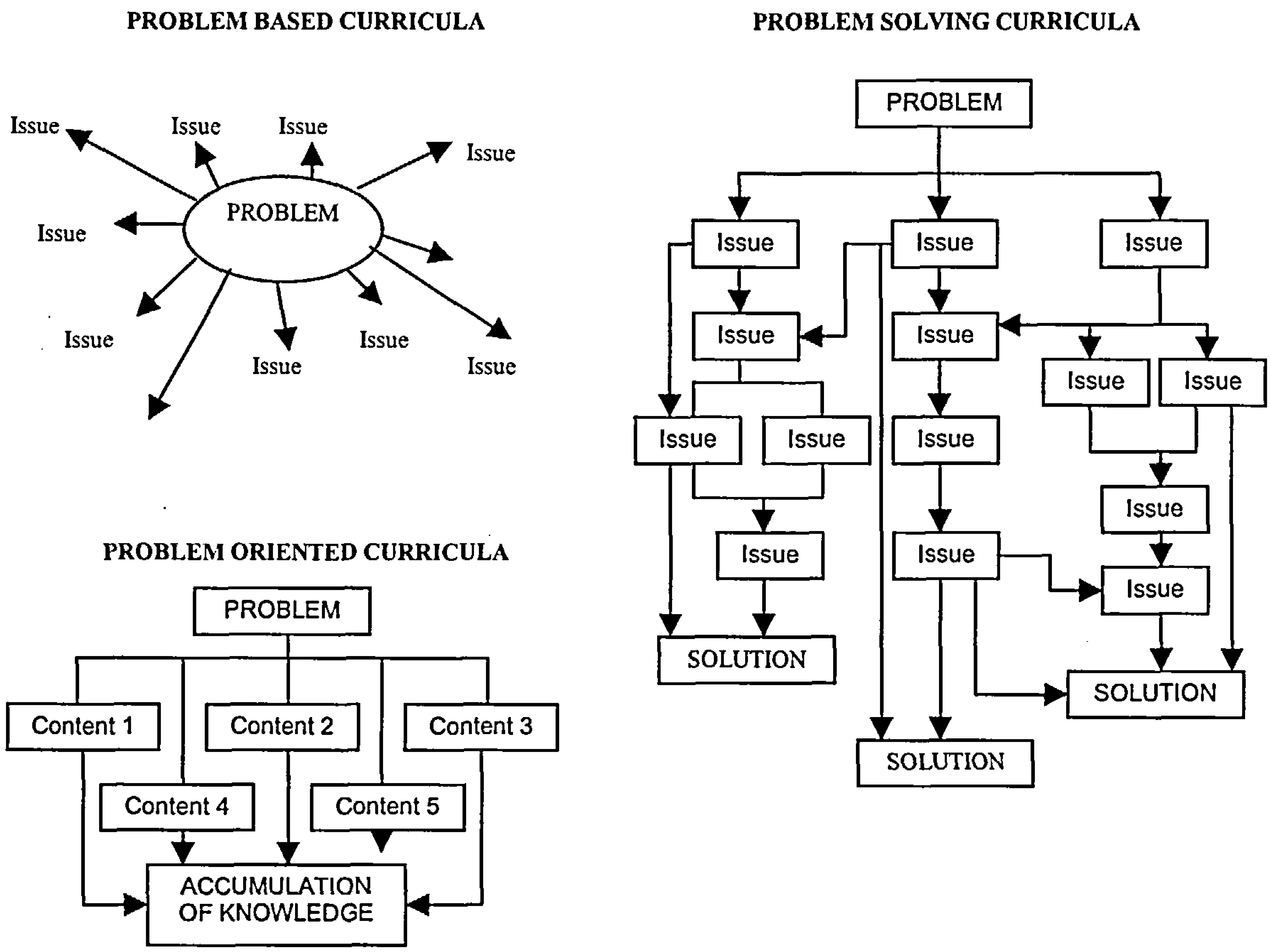

Figure 10: ***Diverse PBL version as described by Ross (1997).***

Firstly, problem-based curricula are ones where students explicitly work on problems to identify, and search for, the knowledge that they need to obtain in order to approach the problem (Ross, 1997). The implementation of this pure version of PBL is always in accordance with the theoretical model of PBL developed by Schmidt and Gijselaers (1990) (See Figure 6). The "Maastricht version" of PBL, implemented in the Medical School of the University of Maastricht, Netherlands, is one example of problem-based curricula, where students work on a problem within six-week long thematic blocks (De Graaff, 1993). In problem-based curricula, students usually have the freedom to choose the issues they wish to analyse, without necessarily producing a solution.

Secondly, problem-oriented curricula are ones where problems are used as selection criteria for content. Here, problem can be presented both in PBL and in the traditional teaching methods, but not necessarily involve problem-solving techniques (Ross, 1997). Students' accumulation of knowledge is basically limited to the selected contents related to the problem presented in the educational programme.

Thirdly, problem-solving curricula gives students specific training via development of experiences for solving problems. The role of the problem here is "appropriately described as puzzles or exercises to problems" (Ross, 1997). Engineering design education uses problem-solving forms of PBL in their curricula, where it is usually implemented within a specific time period of a course. In considering Problem Solving, Hubka (2003) notes that design problems require routine innovative solutions based on well-developed knowledge and existing systems, because they demand both artistic behaviour and science application.

Based on psychological theory of problem solving, Newell and Simon (1972) regard a person as having a problem when he "wants something and does not know immediately what series of actions he can perform to get it." He then has to perform series of actions to get "from the problem to the solution," where the "actions themselves are the problem-solving process or the design process" (Heath, 1984). Here, problem solving takes place as search, and the means by which search takes place is the methods that lead to the realisation of "production system" (Newell and Simon, 1972). As such, problem solving curriculum can be regarded as Problem Based Learning because the process of problem solving is triggered by the existence of a problem.

Ironically, Boud and Felletti (1997) perceive that the addition of problem-solving activities in PBL is erroneously assumed because PBL is actually "a way of conceiving of the curriculum as being centred upon key problems in professional practice." Application of PBL in areas such as agriculture, social work, and community nursing has problems that are "less defined, and solutions are less predictable in term of specific factors, strategies and outcomes" because those areas of studies are considered as field and community based (Boud and Felletti, 1997).

Regardless of the different roles of the problem, a PBL pedagogical approach has given current tertiary education a direction to use learning processes with positive impact on students' motivation, and independency. The promise that PBL develop students' reflective, critical, and inventive thinking that is essential for life long learning encourages more and more institution to explore the PBL pedagogical approach.

2.2.4 PBL Potential in Architectural Education

Previous discussion on the capability of the PBL pedagogical approach to improving the overall tertiary education offers architectural education an alternative to tackle the challenges it faces; to innovate a pedagogical theoretical framework for learning, to integrate the architectural curriculum, to abolish the unnecessary emphasis on artistic value, and to improvise method of coping with the rapid speed of change. Through the promising mechanisms of PBL, which emphasise the learning process and learning techniques in producing competent graduates, it is anticipated that changing its pedagogical practice in the way proposed by PBL educational approach might benefit architectural education. PBL is hoped to be able to answer a question posted by Schon (1987) in a meeting of the American Educational Research

Association, Washington, DC; he asked, "What kinds of education are most likely to help teachers prepare for effective teaching?"

Architectural education, which has been criticised for its hidden curriculum, may strengthen its pedagogical theoretical framework by looking at PBL's strong theoretical outlines, with its three basic components of learning: having problem as the learning **input**, emphasizing process and techniques that encourage mode of thinking as the **means** of learning, and producing students with better learning habit as the **result**. As Driscoll (1994) notes,

> "result refers to the changes of performance to be explained by the theory, the means are the process by which the results are brought about, and inputs are the resources or experience that triggers the process of learning."

By having the same basic components of learning in any future innovation of architectural education, a strong theoretical pedagogical framework can be properly established and consequently help architectural education to banish the practice of the hidden curriculum in architectural education.

The emphasis on the integration of knowledge in the PBL learning process may help to reduce the "disintegration teaching" (De Graaff, 1993) in architectural education. For decades, architectural education has been incoherently focusing on specialisations of subjects, and artistic values of architectural design. As such, providing a "connected curriculum" (Boyer and Mitgang, 1996), with whole-scale integration and a PBL integrative learning experience may help students to have better integrated knowledge, consequently preparing students to meet the complex demands of the architectural profession.

Furthermore, PBL, with its critical thinking property may help both academic staff and students to move away from the aesthetic focal concern in the training of architectural graduates. Unnecessary autonomy of aesthetic emphasis practiced in architectural education thus far only creates an imbalance in students' developing professional competency. Therefore, adapting a PBL pedagogical approach may help architectural education to have a reformed paradigm that prioritises the focus onto the development of students' professional competency. As such, PBL will help to change the architectural general view of design from being an intuitive experience to being a "process of investigating, reasoning and testing" (Salama, 1995).

Peer learning and self-directed learning that are embodied in the PBL pedagogical approach develop lifelong learning qualities among students, very much needed in architectural education in order to cope with the rapid speed of change in architectural disciplines and practice. PBL may offer architectural education effective methods of inquiry and comprehensive processes of problem-solving that cultivate students' intellectual habits necessary to continue learn.

Finally, the review of both architectural education and PBL has opened up the possibilities of adapting PBL to improve architectural education. By open-mindedly looking beyond the architectural discipline to explore what PBL has to offer, it is hoped that the implementation of PBL would be able to address the inadequacies, which have existed in architectural education.

Nonetheless, whether PBL is the right answer to the problems encountered in architectural education can only be determined by undertaking a critical analysis of its implementation in architectural education. Thus far, two architectural institutions are generally known to have implemented the pedagogical approach in their curriculum: the Faculty of Architecture, of the Delft University of Technology (TUDelft), Netherlands, and the Faculty of Architecture, of the University of Newcastle (UniNC), Australia. The next section of this thesis will examine how the PBL pedagogical approach has been applied to improve architectural education in both institutions.

CHAPTER 3

THE CASE STUDIES

3.0 PBL IN ARCHITECTURAL EDUCATION

This chapter aims to review the implementation of PBL in architectural education as a measure of architectural educational improvement. Critical evaluation of PBL implementation will be based on case studies, with insight into any inadequacies of architectural education and the benefits offered by the PBL pedagogical approach discussed in the earlier chapter. Consequently, presenting the research questions for further analysis of the implementation of PBL in architecture education will conclude the discussion of this chapter.

3.1 The Selection of Case Studies

Although PBL has been claimed to be the most important innovation for professional discipline of education (Boud and Felletti, 1997), not many schools of architecture get the benefits of PBL offered, apart from the need from improvement. The Faculty of Architecture, at the Delft University of Technology (TUDelft), the Netherlands, and the Faculty of Architecture, at the University of Newcastle (UniNC), Australia, were two institutions that considered PBL as a serious option to be used in their educational reform. The former, which was then called the Faculty of Building Sciences, started implementing PBL in September 1990 (Jochems, 1993), but stopped it in the early 2000's. On the other hand, the Faculty of Architecture, University of Newcastle, Australia, started the implementation of PBL earlier, in 1985 (Maitland and Cowdroy, 2001; Kingsland and Chen, 1996), and still continues using PBL as its pedagogical approach.

As the leading institutions that initiated and explored the potential of PBL in architectural education, the Faculty of Architecture, TUDelft, and the Faculty of Architecture, UniNC, claimed to be successful in incorporating PBL in their strategic approaches to educational innovation (De Graaff & Cowdroy, 1997). As such, this thesis will analyse the experience of PBL implementation in both institutions for clarification as to how the implementation was carried out.

3.2 PBL Implementation in the Faculty of Architecture, TUDelft

3.2.1 Background

As in most schools of architecture, the Faculty of Architecture, TUDelft, had experienced problems of deterioration in its educational systems due to the long usage of the conventional architectural teaching methods from the French Beaux Arts tradition, mixed with methods of engineering education (De Graaff & Cowdroy, 1997). The faculty had been using the traditional system since 1960's, termed by De Graaff the Project Teaching Approach (De Graaff & Cowdroy, 1997). Consisting of a series of design projects, complemented by discipline courses and skill exercises, the system practiced in the faculty ironically enabled teachers to express their "personal convictions and preference" of architectural style independently (De Graaff & Cowdroy, 1997), which led to the production of more than a thousand different courses and projects (De Graaff, 2001). The independence of the teachers gave birth to large differences in the quality of architectural design in the different projects (De Graaff, 2001), and prevented any central coordination for improvement of the approach (De Graaff & Cowdroy, 1997).

The phenomenon was made worse by the scale of the faculty. Having approximately 2,400 students and over 450 staff members either permanent or part-time, the Faculty of Architecture was considered one of the largest faculties in the university, in which problems of managing the educational program were almost impossible, and integration of the curriculum failed (De Graaff & Bouhuijs, 1993a; De Graaff, 2001). Furthermore, the cost of managing such a large faculty was also considered too high (De Graaff & Bouhuijs, 1993a).

The combination of the unmanageable scale of the faculty, and the high degree of teachers' autonomy in choosing their own educational format for teaching, generated an ongoing debate on the quality of architectural education in TUDelft. This led to a negative report from the Dutch national review committee, threatening to close down the faculty or to merge it with another architectural school if improvement measures were not done to make the architectural curriculum more cohesively integrated and technically emphasized (De Graaff & Cowdroy, 1997; De Graaff & Bouhuijs, 1993b). In addition, the Faculty of Architecture was also instructed to reduce the focus of design in its architectural curriculum, and to produce a clear organizational structure within the faculty (De Graaff & Bouhuijs, 1993a). Worried by the threat, the Faculty of Architecture had no alternative but to find a way to resolve the educational problems (De Graaff & Bouhuijs, 1993b).

In order to overcome the deterioration of the educational situation and to survive the external pressure to close down the faculty, the whole traditional curriculum was "overturned" and a complex process of change was put into action (De Graaff & Cowdroy, 1997). A decision to undergo a large scale educational restructuring was initiated by the Faculty Board in 1989 (Woord & De Graaff, 1993). With support from educational advisors from the Limburg State University of the Netherlands, an appointed committee named the Program Committee Building Sciences (PKB) in the Faculty of Architecture proposed to introduce PBL as the didactic principle for improving the performance of the architectural educational curriculum at TUDelft (De Graaff & Cowdroy, 1997). Although the staff did not agree unanimously, and there was a time constraint on the preparation of the PBL curriculum, the implementation of PBL was executed six months after its proposal (De Graaff & Cowdroy, 1997).

3.2.2 PBL Implementation

Problem Based Learning was chosen to be the remedial solution to the problems faced by the Faculty of Architecture, TUDelft, because it gave "a name and an established body of theory" to architectural education. Within a single theoretical framework, PBL was believed to enable the integration of architectural education at theoretical and application levels, whilst allowing traditional architectural design teaching to remain in the curriculum (Cowdroy and Maitland, 1994). With the introduction of PBL, it was hoped that the Faculty of Architecture would improve its curriculum shortcomings by carrying out a "renovation," and yet "keeping the foundation intact" (Woord & De Graaff, 1993). Moreover, the PBL pedagogical approach was seen to provide "stimulating innovative behaviour" among academic staffs and students, and to function as a bridge connecting architectural education and architectural practice (De Graaff & Cowdroy, 1997).

The Faculty of Architecture, TUDelft, chose to adopt the Maastricht version of the PBL curriculum because it applied a "holistic approach based on themes representing problems" (De Graaff & Cowdroy, 1997), while maintaining the general PBL theoretical principles that focus on problem analysis in its learning process (De Graaff and Kolmos, 2003). This integrative quality of the discipline and skills were expected to eliminate the conventional divisions between disciplines, a problem severely criticized in architectural education.

Developed and implemented in the Maastricht Medical School, the Maastricht version of PBL utilise series of six-week thematic blocks to form the structure of its curriculum. Early in a thematic block, a theme is introduced by means of study task that comes in a form of either a problem, description of cases, or other phenomenon related to the theme. In addition, the Maastricht version of PBL is also characterised by learning-oriented work in small groups of 8-10 students, and self-directed learning. Nonetheless, although the focus of PBL is to have students' discussion on a regular basis, a large proportion of study time is still reserved for independent self-study (De Graaff, 1993; De Graaff, 2001).

3.2.3 The Reformation Involved

Since the method of the PBL pedagogical approach was not invented within the discipline of architecture, the process of adopting the Maastricht version of PBL in the Faculty of Architecture, TUDelft, involved numerous adjustments to ensure a successful reformation. Architectural education has its own distinct traditions and characteristics, therefore the principles of PBL needed to be adapted to suit the specific demands of architectural circumstances (De Graaff, 1993). Based on the Program Committee Building Sciences (PKB) proposal, which was published in November 1989, the new innovation intended architectural education to have a different content, to be more technical and scientific in nature, to contain more major study areas, and to allow students to complete their studies quicker and better

(Woord & De Graaff, 1993). In doing so, the Faculty of Architecture, TUDelft, undertook essential adjustments in the areas of architectural curriculum structure; the faculty organisational structure; culture, attitudes, values, and roles of students and staff in learning; assessment methods; and the content of the curriculum.

3.2.3.1 Curriculum Structure

PBL curriculum structure, adopted from the Maastricht version of PBL, replaced the existing instructional approach of "project work" in the Faculty of Architecture, TUDelft. The new PBL curriculum structure introduced in the faculty was believed to provide a structure for project work, reaching the goals of having integration of various disciplines and a strong organisational framework in architectural education (De Graaff & Bouhuijs, 1993b). Figure 11 shows the PBL curriculum structure in the Faculty of Architecture, TUDelft.

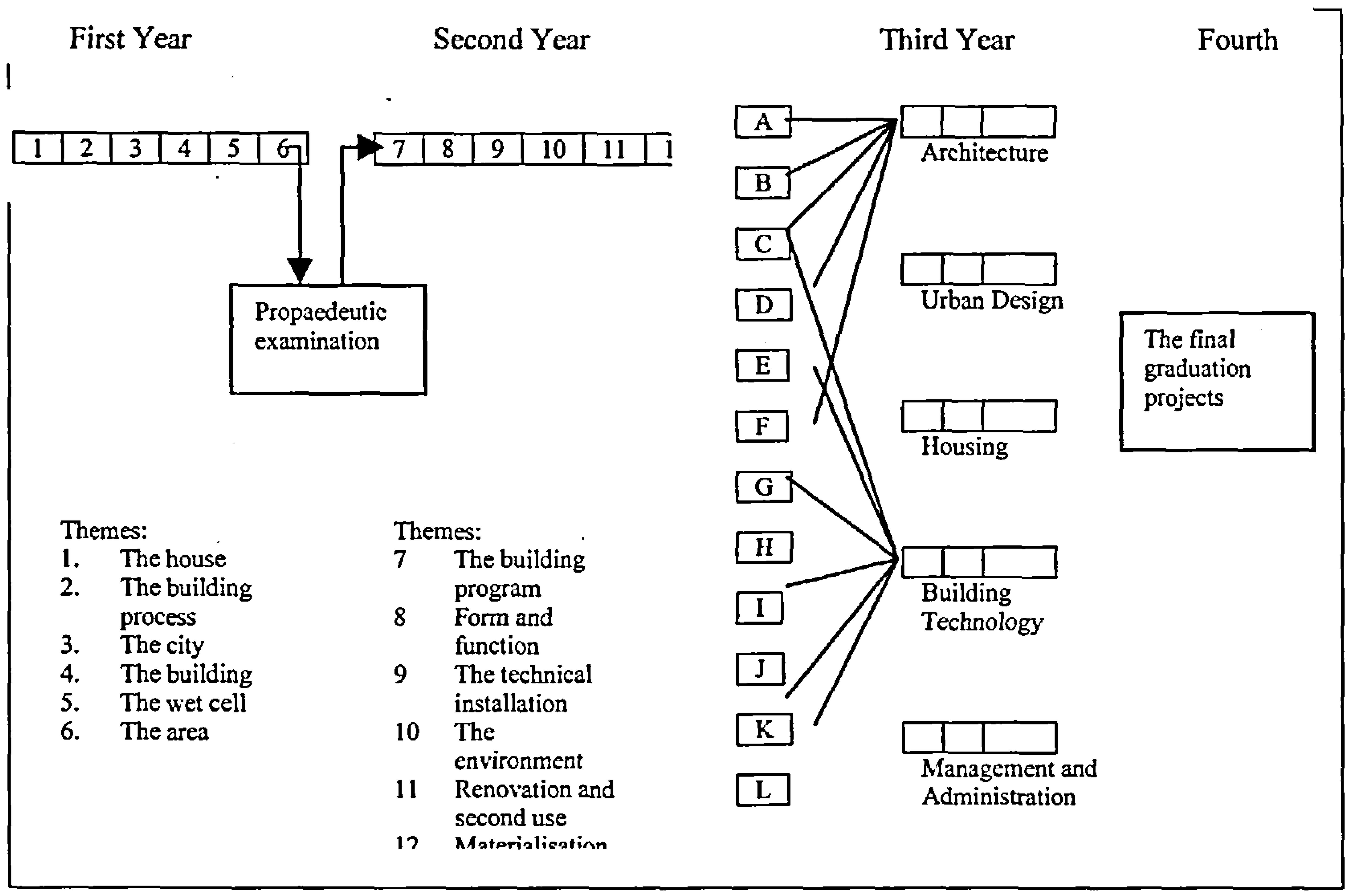

Figure 11: ***Structure of the PBL curriculum in the Faculty of Architecture, TUDelft. (modified after De Graaff & Bouhuijs, 1993a).***

The proposed PBL curriculum structure for the Faculty of Architecture consisted of 4 years study duration divided into 2 cycles. The first cycle was designed for year 1 and year 2 and structured in thematic blocks, each containing a broad introduction in policy and administration sciences (Bosch and Gijselaers, 1993). It was intended to provide students with the basic insight, knowledge and skills required for architectural profession (Woord & De Graaff, 1993). The second cycle was designed for year 3 and year 4, comprising courses with a multidisciplinary character (Bosch and Gijselaers, 1993). Here, each student had the choice to specialise in 1 of the 5 majors, either architecture, building management, building technology, housing or urban design (Woord & De Graaff, 1993).

The first cycle of the PBL curriculum

The first cycle of architectural PBL curriculum was divided into 12 series of study periods, each approximately 6 weeks long, and called the thematic blocks. These thematic blocks were arranged in a sequence of fixed order in a roof-tile-like structure (De Graaff & Bouhuijs, 1993b; De Graaff & Cowdroy, 1997). Each block focuses on a particular theme, for students to work on a series of "cases" related to the designated theme, which was derived from questions or problems areas of building sciences practice (De Graaff & Kolmos, 2003). The themes designed for the 12 blocks were the house; the building process; the city; the building; the wet cell; the area; the building program; form and function; the technical installation; the environment; renovation and second use; and materialisation (De Graaff & Bouhuijs, 1993a).

During the execution of each block, students would meet twice a week in a small group of 10 to 12 students, to discuss and analysis the given cases, or problems, prepared by the block groups. Students would spend approximately 2 hours in each meeting where they were systematically confronted with different scales of building, depending on the level of theme. The content of the theme in a block would gradually increase in its complexity as students moved from one block to the next (De Graaff & Bouhuijs, 1993b). Although physics and science were the main emphasis during this cycle of study, practical exercises and skill training in architectural design were also integrated within the programme by linking them with the specified themes (Woord & De Graaff, 1993; De Graaff & Bouhuijs, 1993b; De Graaff, 2001). Students were expected to spend about half of the time in the 6-week block period to work on the design assignment (Frijns & De Graaff, 1993). In addition, there were also times scheduled for occasional lectures (De Graaff & Bouhuijs, 1993b; De Graaff & Cowdroy, 1997) and directed study assignments (De Graaff, 1993). Although both features were strictly prohibited in the taxonomy of the original version of PBL (Barrows, 1992), the addition was made because the students did not have enough prior knowledge to discuss the complex subject of the theme unaided (De Graaff, 1993). The incorporation of architectural format thematic blocks and the project-based approach formed a variety of PBL. Figure 12 shows the content of a block in the dual systems of PBL methods adapted by the Faculty of Architecture at TUDelft.

Theoretical studies Analysis of Problem, with knowledge-oriented case studies. Self-Directed Learning Lectures	6 E E K S	**Design studies** Design Teaching, exercise and assignment with purpose and challenge
		THEMATIC BLOCK 1- 12

Figure 12: ***The content of block groups in the "dual systems" of architectural PBL approach.***

The overall plan of forming the thematic blocks was intended to replace the traditional teaching of lectures with PBL small group work, and to replace the traditional design project with a "limited" design exercise. In doing so, students were provided with support from teams of teachers, who acted as facilitators during analysis of problem in PBL small group discussions (De Graaff & Cowdroy, 1997) and as supervisors in the design exercises session taking place in "studio like setting" (Frijns & De Graaff, 1993). Besides, students were also provided with various forms of learning resources, such as literature and videos. Indeed, the most important resources were block books, study guides that consisted of series of problem tasks, design assignment or cases that served as a basis for students to formulate their learning goals (De Graaff & Bouhuijs, 1993b).

The second cycle of the PBL curriculum

In the second cycle of the PBL curriculum structure implemented in the Faculty of Architecture, TUDelft, the sequential order of blocks was abandoned and replaced by the provision of compulsory and elective subjects organised in the form of modules. In the third year of study, students would have the options to choose modules that were related to their specialised majors. Those modules were arranged in a matrix form of organisation, an educational structure adapted from the University of Limburg at Maastricht (Woord & De Graaff, 1993). In the early stage of the students' third year study, they were not required to commit themselves to any one of the five majors offered. However, prior to the completion of their third year study, they would have to make a definitive choice, either to majoring in architecture, building management, building technology, housing or urban design. Consequently, the fourth year was dedicated to work on students' final graduation projects (Woord, & De Graaff, 1993). Table 6 shows the matrix organisation used to organise subject modules in the third year of the PBL curriculum structure.

Table 4: ***The matrix organisation used to organise subject modules in the third year of the PBL curriculum structure (adapted after Woord & De Graaff, 1993).***

MAJORS	H	B	A	U	M
M	MH	MB	MA	MU	C
U	UH	UB	UA	C	UM
A	AH	AB	C	AU	AM
B	BH	C	BA	BU	BM
H	C	HB	HA	HU	HM

A=Architecture,
B=Building technology
U=Urban design.
H=Housing
M=Building management
C= Core Differentiations

Despite the availability of secondary research materials about the structure of thematic blocks in architectural PBL curricula discussed above, there was very limited material that described the implementation of PBL at the second cycle. As such, it was not known whether the subject modules were delivered in the form of

PBL learning approach, or taught in the traditional way of teaching. Moreover, discussion of students' final graduation projects was also absent in those materials. In fact, diagrams of the PBL curriculum structures illustrated by scholars (De Graaff & Bouhuijs, 1993a; Woord & De Graaff, 1993) led to the assumption that the final graduation project was carried out in the traditional mode of design education.

3.2.3.2 Organisational Structure

The introduction of the new PBL curriculum structure in the Faculty of Architecture, TUDelft, came with new organisational principles as well. As with the decision to implement a PBL pedagogical approach, the planning for the new organisational structure of the faculty was also done in a top down management style. There are series of hierarchies in which the centralised control over the curriculum was believed to be easily monitored, by having quality control on systematic programme evaluation and attractive assessment system (De Graaff & Bouhuijs, 1993b).

Radical changes to the curriculum structure were considered necessary to establish centralised control over the new curriculum structure, and to ensure successful implementation of the PBL curriculum (Bosch and Gijselaers, 1993; Woord & De Graaff, 1993). This consideration was used as the basis for planning the organisation structure, since the previous organisational structure with departmental sub-divisions had resulted in numerous management problems. PKB was the body responsible for proposing the new organisational structures for planning and monitoring the new curriculum (De Graaff & Bouhuijs, 1993b). Figure13 shows the schematic diagram of the organisation structure, materialized with the introduction of PBL curriculum in the faculty.

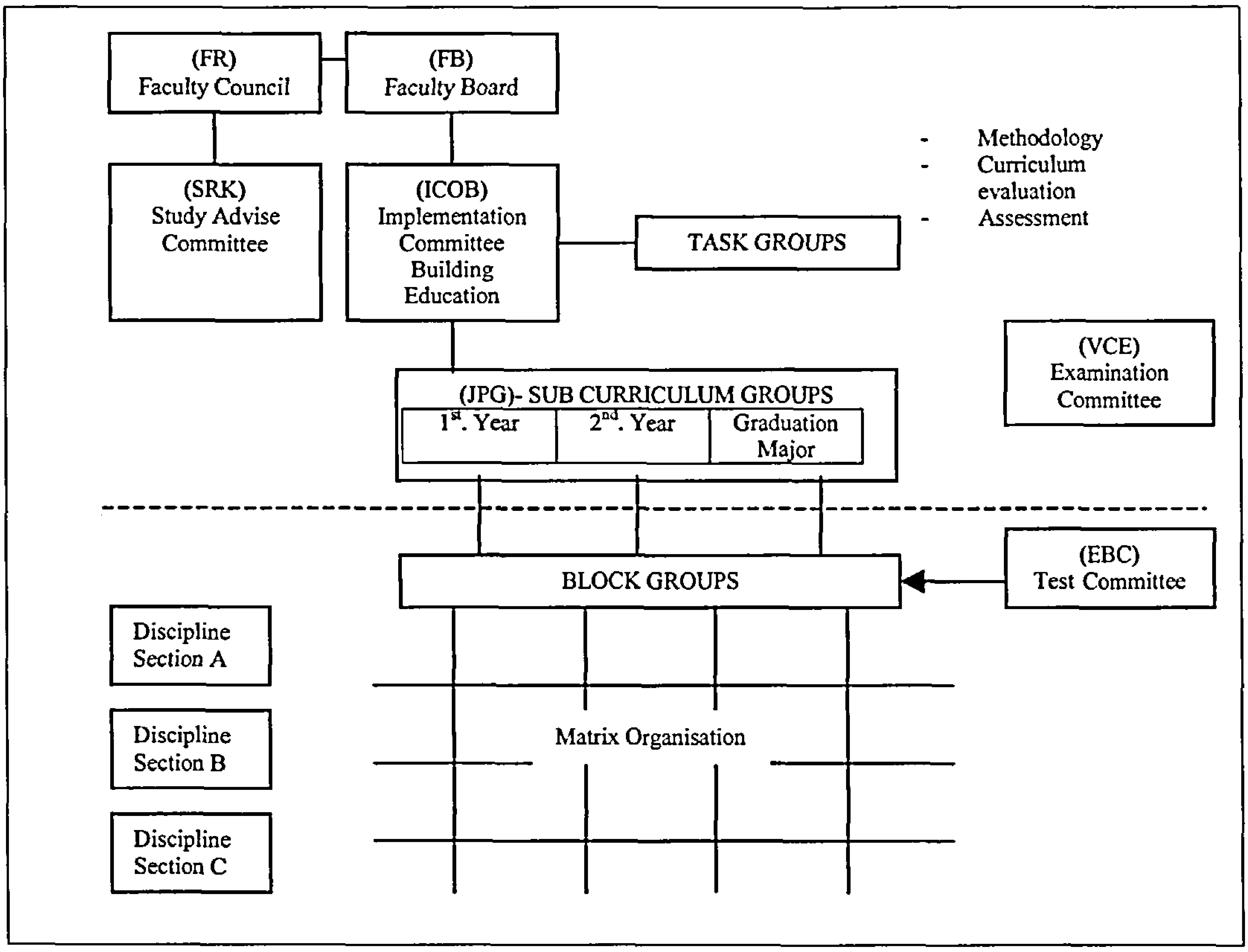

Figure 13: ***Schematic diagram of organization structure of the implementation of PBL curriculum (modified after Woord & De Graaff, 1993; and De Graaff & Bouhuijs, 1993b).***

The proposed organisation structure had two levels of management: macro and micro levels. At the macro level, numerous groups would be responsible for controlling and monitoring the PBL implementation in the Faculty of Architecture, whilst at the micro level, academic staff were responsible for carrying out the implementation process. At the macro level, the Faculty Board (FB) had the authority to effectuate control, with the advice and concerns from Study Advice Committee (SRK) and The Faculty Council (FR) (Woord & De Graaff, 1993). The FB installed the Implementation Committee for Building Education (ICOB) to have the responsibility for the development of the new PBL curriculum, and the coordination of the whole implementation process. ICOB was chaired by the dean of the faculty and coordinated the micro level of the organisation structure. Ironically, members of ICOB were selected on the basis of "personal merit," rather than as representatives of various existing departments within the faculty (De Graaff &

Bouhuijs, 1993b; De Graaff & Cowdroy, 1997). Therefore, the organisation structure could not be well presented.

ICOB played the main role of connecting the macro and micro levels of the PBL organisation structure within the Faculty of Architecture, TUDelft. Some members of ICOB were also members of year planning groups (JPG), or sometimes called sub-curriculum groups. The JPG's main function was to coordinate the educational program and the evaluation of the course year concerned (Woord & De Graaff, 1993): the first year, second year, and the graduation majors that encompassed five disciplines for the third and forth years of students' study period. JPG consisted of twenty three (23) members (De Graaff & Cowdroy, 1997), including the year coordinators who chaired the meeting within block groups, the block coordinators invited from the existing different departments, the skill acquisition coordinator, and one or two students representatives (Woord & De Graaff, 1993). Hierarchically below JPG, the block coordinators chaired their respective curriculum groups, or block groups. Each of the block group had further sub-divisions, six thematic blocks for the first and second years and five disciplines for the major graduation years.

The proposed new organisation structure that accompanied the introduction of PBL in the Faculty of Architecture was far more complex than the traditional organisation structure that had discipline-oriented departments. This complexity proved to be too complicated for the general academic staff to fully participate, especially for reason that the traditional structure was not entirely abandoned, but still functioned to organise the modules offered in the matrix organisation of the third year, and the major graduation projects of the forth year (Bosch and Gijselaers, 1993). The PBL's new curriculum structure, that consisted of thematic blocks and a matrix organisation of "differentiations", was actually erected as a "shadow" to the traditional structure (De Graaff & Cowdroy, 1997). As such, the two didactic systems ran concurrently for several years (see Figure 14). Furthermore, there was another reason for the need to maintain the traditional organisation structure. During the early part of PBL implementation in the faculty, the traditional curriculum was still in practice to accommodate the remaining students who started their architectural education under the traditional system. This shadowed structure phenomenon proved to be logistically difficult to manage (De Graaff & Cowdroy, 1997).

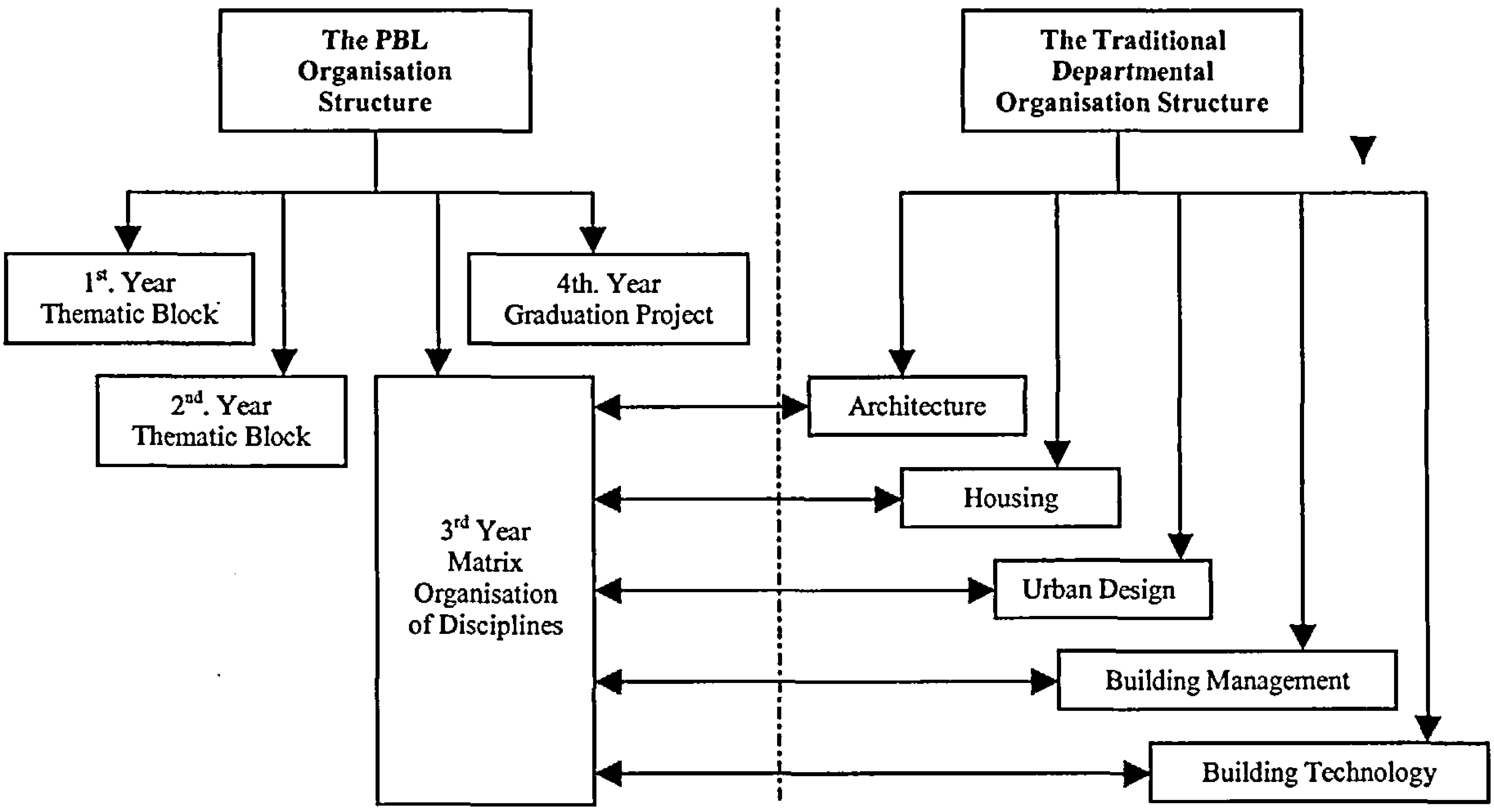

Figure 14: ***The two didactic systems that run concurrently, illustrating the connection between the PBL 3rd. Year Matrix Organisation to the departmental disciplines in the Traditional Organisation Structure.***

Based on the literature review, there has not been much discussion on the development of design skill in the proposed PBL curriculum and organisation structures. This led to the assumption that, at the level of PBL implementation, design skill was not seen as an important part of architectural education. This also raised questions as to how the development of design skill was to be carried out in the new curriculum, and how architectural students could learn design using short exercises within the very limited time constraint of the thematic block. At this stage of the thesis, the questions could not be answered.

3.2.3.3 Didactic Cultural Changes

The curriculum and organisation structures proposed by the PKB were meant to provide a strong theoretical framework to the implementation of PBL in the Faculty of Architecture, TUDelft, yet one of the most important things in ensuring the success of any educational change was the execution of cultural changes. Cultural changes in education constituted reformation of teachers' and students' roles in learning, and their educational philosophy in terms of attitude, value, and ideas about learning. The re-orientation of those learning behaviours, especially among the academic staff who would have to carry out the educational innovation, was an essential factor to determine the success of the planned educational reformation (Woord & De Graaff, 1993). With the realization of such a fact, the proposed PBL implementation in the faculty also included the planning of cultural changes, by means of the provision of staff development.

The Faculty Board (FB) was aware that a staff development program would be needed in order to raise the commitment of staff and students, and to stimulate wide participation in the PBL implementation. Consequently, the staff development program could provide a strong foundation to the PBL implementation process. As such, the FB outlined a staff development program by means of "teacher training" sessions. These were planned to introduce academic staff to the educational strategies of the new curriculum (De Graaff & Bouhuijs, 1993b). The training focused on both development of the new PBL educational techniques, and the acquisition of new attitudes towards the learning concept (Woord & De Graaff, 1993).

The Department of Educational Research and Development of the University of Limburg, Maastricht, the Netherlands, was commissioned to provide the needed teacher training in the Faculty of Architecture, TUDelft (De Graaff & Bouhuijs, 1993b). Academic staff in the Faculty of Architecture received their first training in PBL from the Maastricht consultants in January 1990. To monitor the progress of PBL implementation, the consultants organised the second training session in March 1990 for academic staff in the faculty, and subsequently the third training in June

1990. The training series was considered the best method of conveying the "ins and outs' of PBL as it was proven to successfully instilled staff understanding on the PBL pedagogical approach (Woord & De Graaff, 1993). Nonetheless, there was no literature found which described the details of how the training sessions were carried out.

Moreover, to make the staff development program more effective, some of the academic staff were given the responsibility to prepare blockbooks that served as guides for both academic staff and students in their endeavour to adapt to the new learning philosophy. Constructing their own blockbooks was believed to inspire a deeper understanding of the PBL implementation concept and process. Indeed, the prepared blockbooks had to be approved in advance by the programme committee prior to the implementation to confirm the academic staff's understanding of the philosophy of PBL (Woord & De Graaff, 1993; De Graaff & Bouhuijs, 1993b).

There was no specific programme designed for students' development prior to the implementation of PBL in the Faculty of Architecture, TUDelft, for the reason that staff who had undergone the training sessions were expected to transfer the PBL philosophical concept and its learning techniques to students during the implementation process. Having a series of training sessions, staff should also be able to play the role of facilitators, who stimulate the students to actively pursue the accumulation of knowledge and skills.

3.2.3.4 Other Adjustments

There were other changes associated with the transformation from conventional architectural education to the PBL pedagogical approach undertaken by the Faculty of Architecture, TUDelft. As stated by De Graaff and Kolmos (2003), "change in one of the elements involves changes in all other elements." As such, besides constituting changes in its curriculum structure, organisational structure, and learning culture, the implementation of PBL in the faculty stipulated that all relevant elements of learning, such as choices of content and assessment methods, must be compliant with the new PBL innovation and philosophy.

Assessment Methods

Frijns & De Graaff (1993) noted that the choice of assessment methods should be congruent with the educational and instructional principles of the new PBL curriculum, for the reason that different types of assessment evoke different study behaviour among students. In this case, the Faculty of Architecture, TUDelft, took the decision to assess students' ability in three competency domains: factual knowledge, practical and technical skills, and design proficiency. Similar to the assessment method practiced in general traditional education, students' factual knowledge was tested by mean of examinations, which came in the forms of true or false items, multiple choice questions and open-ended questions. The examination took place at the end of each block period, with minimum passing grade of 5.5 on a ten-point scale. Even after three years of PBL implementation, the examination system in the Faculty of Architecture, TUDelft, was still in the process of construction due to some difficulties (Frijns & De Graaff, 1993). The lack of expertise in the construction of true or false questions raised structural problems with the quality of questions presented to students, and worse, the true or false items were considered to focus too much on factual knowledge in a way that acted against the integrative philosophy of a PBL pedagogical approach. In addition, the open-ended question was seen as lacking reliability, and was too time-consuming to mark.

In a different way, students' practical and technical skills were measured by using assignments, oral presentations, written essays, and work samples. This assessment method was carried out, based on either students' individual works, or their group work. On the other hand, design proficiency was assessed in a very similar way to the traditional architectural design education, where students' works were graded using criteria outlined by "raters". This assessment method still raised points of serious concerns because of its unlimited breadth of "subjectivity of rating,' that resulted in a very time-consuming assessment process (Frijns & De Graaff, 1993).

Although there was a particular stress that new PBL curriculum should have a new system of assessment, factual knowledge and design proficiency remained to be assessed in the traditional manner of architectural education. The only distinct difference of assessment methods between the new PBL curriculum and the traditional curriculum was that the assessment in the PBL curriculum was done at the end of each block session, combining all the marks from all the three competency domains to form the mean of a student's grade, whilst student works in the traditional curriculum was assessed separately based on individual courses.

<u>Content</u>

The content of the architectural PBL curriculum was not very different as compared to the content of the conventional architectural curriculum, because the scope of architectural knowledge required from architectural graduates remained the same. However, the treatment and organisation of content were two features that made up the distinctive differences between the two didactic systems. The treatment of content in the PBL architectural curriculum emphasised the multi-disciplinary and integrative nature of knowledge, whilst the treatment of content in the traditional teaching emphasised the specialization of knowledge.

In term of organisation of the architectural content, the PBL curriculum was designed to categorize knowledge based on themes. For example, the second year thematic block of "building technology" would cover the relevant scope of architectural knowledge that encompassed the details of the construction process, construction technologies, and various building products (Bridges, 1994). All these technical aspects of building technology would not be included in the content of the first year thematic block of "a house" for the reason that the first year students might not have enough accumulated knowledge to discuss such issues.

On the other hand, the traditional architectural curriculum had content that were organised based on individual courses. Here, only the knowledge specific to the courses was disseminated within the constraint of lecture classes. In this manner, there was no cohesion between courses (De Graaff & Cowdroy, 1997).

3.2.4 Questions Which Arose

Although the description of PBL implementation in the Faculty of Architecture, TUDelft, seemed to offer an improvement in architectural education, yet there a question arose of why the faculty abandoned the PBL pedagogical approach. A recent visit to the faculty website confirmed that the faculty did not use the PBL innovation anymore. Instead, the faculty replaced the PBL implementation with BSc and Master Programmes that did not have PBL characteristics. In fact, the faculty officially published a book in 2002 titled Ways to Study and Research Urban, Architectural and Technical Design, to describe eight scholarly methods of design, supplying readers with "perspectives on innovating architectural thought" (De Jong and De Voordt, 2002). This book brought back the focus of architectural curriculum in the Faculty of Architecture, TUDelft, to the importance of design. Besides, the book was written without reference to a PBL pedagogical approach that had been implemented in the faculty earlier.

With all the efforts of PBL adoption, the Faculty of Architecture, TUDelft, was regarded excellent in providing an example of PBL application in architectural education, simultaneously achieving an educational approach that fulfilled the future demands of architectural profession (De Graaff & Cowdroy, 1997). Nonetheless, besides claims for its success, the Faculty of Architecture ultimately abandoned the PBL innovation after almost ten years of its implementation. Furthermore, there was no architectural school known to use the PBL model developed by the faculty as basis of improvement in architectural education. In fact, the "success" of PBL implementation in the faculty of Architecture, TUDelft, was put out of sight as schools of architecture throughout the world ventured in other possible endeavours.

Wondering about this phenomenon, this thesis intended to further contemplate on the success story of PBL implementation in architectural education. In doing so, this thesis examines another model of PBL implementation in architectural education that had been carried out in the Faculty of Architecture, University of Newcastle (UniNC), Australia. This would provide an appropriate comparison of PBL implementation process in architectural education.

3.3 PBL Implementation in the Faculty of Architecture, UniNC

3.3.1 Background

The decision to adopt PBL in the Faculty of Architecture, University of Newcastle, New South Wales, Australia (UniNC) was greatly influenced by the fact that the faculty faced several problems regarding its existence in the university. As the smallest faculty in the university, and one of the smallest faculties in Australia (De Graaff & Cowdroy, 1997), the Faculty of Architecture in UniNC struggled to keep up with 14 larger professionally accredited architecture schools in Australia which provided better facilities to students. In competition with larger architecture schools, the faculty experienced a period of "instability and doubt" over its future (Maitland and Cowdroy, 2001), due to the problems of maintaining distinct disciplines which were found in the larger faculties, keeping academic staff commitment to the faculty development, and keeping design as the central and most important aspect of its architecture course (De Graaff & Cowdroy, 1997). Those problems faced by the faculty were actually rooted in the historical background of the faculty itself.

Formerly known as the Newcastle Technical College, the University of Newcastle was upgraded to a small University College in the early 1960s as a branch of the University of New South Wales (UNSW) located in Sydney. As an architecture course was part of the former Newcastle Technical College, the new upgrading instigated a transformation of the architecture course from a technician's course to a full professional course by means of duplicating the architecture course at UNSW. However, the logistical difficulty of running parallel courses in two geographically isolated campuses led to the establishment of the University of Newcastle in 1970 (De Graaff & Cowdroy, 1997).

Becoming an independent provincial faculty, the new Faculty of Architecture encountered difficulties in keeping the former UNSW "big faculty aspirations", of having various specializations within architectural discipline, while keeping design as the central aspect of its architecture course. The faculty had a small academic staff: only ten full time teaching staff, three staff on fractional appointments, and 20 "sessional" teachers, including several postgraduate tutors (Maitland & Cowdroy, 2001). With this small scale of faculty, the struggle to maintain the same disciplines as in the two tier degree structure of architecture course duplicated from UNSW caused the academic staff to have a substantial teaching load that consequently led to staff dissatisfaction (De Graaff & Cowdroy, 1997).

The phenomenon was made worse by the competition with the demands of a high profile practice. Academic staff, including the dean, were lured to spend more time in architectural practice and declined to teach the time-consuming design studio, causing the faculty to lose students to other courses. The faculty continually languished, as it could not sustain the traditional structure of the UNSW architecture course. As a result, the faculty was confronted with difficulties in sustaining its professional accredited status, and was threatened with merger with the larger Engineering Faculty within the UniNC (De Graaff & Cowdroy, 1997).

Wary about its survival and with support from architects' profession in Newcastle, the Faculty of Architecture, UniNC, planned to initiate changes and renewal within its architecture curriculum. In order to initiate changes, a measure of how to enhance architecture's distinctive profile in the faculty was first carried out by means of "critical self-evaluation". Through numerous debates, workshops and seminars, the faculty came to focus on the key problems of relevancy and integration in the architectural curriculum (Maitland & Cowdroy, 2001). A course review undertaken in 1984 also concluded that the primary objectives of an architecture curriculum should include the relevance of content, and integration of areas of knowledge around the central focus of design (Ostwald & Chen, 1994). Any means of renewal should consider keeping the curriculum relevant to the current changes and innovations in architectural profession regionally and worldwide. In addition, renewal should also be able to overcome the problem of separation between different strands of the architectural curriculum (Maitland & Cowdroy, 2001).

The Faculty of Architecture, UniNC, used the two shortcomings as the basis of its search for educational innovation. It was discovered that the Medical School in the same university had been using a PBL pedagogical approach since 1976 (De Graaff & Cowdroy, 1997) to address similar problems of "relevance and curriculum fragmentation" (Maitland & Cowdroy, 2001). Furthermore, PBL was known to deliver its successes in vocational and professional disciplines in two ways, by the growth of analysis techniques for adult education and training for competencies, and by PBL's wide-ranging aim to develop professionals capable of being lifelong learners (Ostwald & Chen, 1994). Those factors led to the acceptance of PBL as a vehicle to improve architecture curriculum in the Faculty of Architecture, UniNC. The faculty then took advantage of the "smallness and provincial location" of the faculty to get a unanimous decision to experiment with a similar approach of PBL. Since there was still some trepidation, the undertaking of PBL approach would only be done on basis of a trial, in case it did not work, the new programme would be abandoned (De Graaff & Cowdroy, 1997).

3.3.2 PBL Implementation

The Faculty of Architecture, UniNC, developed a PBL architecture curriculum from a variation of medical model with support from curriculum development staff of the Medical Faculty in the same university (De Graaff & Cowdroy, 1997). However, the faculty realised that the natures of medical and architectural disciplines were different, the former was concerned with "discovery and diagnosis" whilst the latter was about "invention and finding responses to problems for which there was no correct solution" (Maitland & Cowdroy, 2001). As such, direct adoption of the medical PBL approach would not be appropriate to architecture. Instead, the faculty referred to Schon's (1985) ideas of enhancing the design studio as a powerful model for an architectural form of dynamic problem solving. The faculty resolved to strengthen the design studio that had declined in the faculty, by using PBL to generate "an integrated problem solving environment" in the studio (Maitland & Cowdroy, 2001). One proclaimed strength of this resolution of coupling Schon's ideas and PBL approach was the relevance of the students' learning to real architectural practice (Ostwald & Chen, 1994).

The Faculty of Architecture, UniNC, officially started to implement the new PBL approach in March 1985 for the first year students (Maitland and Cowdroy, 2001; Kingsland and Chen, 1996). It was the faculty's intention to introduce PBL pedagogical approach progressively to the curriculum of years 2, 3, 4 and 5 in succeeding years with the same cohort of students (De Graaff & Cowdroy, 1997). However, the entire 5-year programme was then converted to the PBL approach in 1987, only two years after its introduction, due to the demands of students in later stages of the course that they should also be included in the new approach (Maitland and Cowdroy, 2001). The decision to accelerate the conversion process was also due to the difficulty faced by the faculty in running two different educational approaches in parallel (De Graaff & Cowdroy, 1997).

3.3.3 The Reformation Involved

In the Faculty of Architecture, UniNC, the PBL pedagogical approach was seen to answer the classic questions in architectural education of how to reconcile and integrate "creative studio and academic lecture rooms," and how to cope with the expanding of knowledge and the broadening of information in architectural disciplines. A comprehensive PBL model for the architecture curriculum was designed to cut across those dilemmas (Maitland, 1997). The basic principles and characteristics of the medical PBL model were adopted, but some adjustments were considered to enable PBL to suit the realities of architectural practice (Maitland & Cowdroy, 2001). Overall, the PBL model implemented in the Faculty of Architecture, UniNC, embodied changes mainly in factors of curriculum structures, organisational structure, didactic learning methods, and assessment methods.

3.3.3.1 Curriculum Structure

The PBL curriculum structure in the Faculty of Architecture, UniNC, was organised in the form of a two-tier degree structure. Three years study was required for students to gain the Bachelor of Science, and an additional two years of study was required for students to receive their Bachelor of Architecture that entitled them to be graduate architects. This curriculum structure was common in many architecture schools all over the world. However, the new curriculum structure in the faculty accommodated PBL, which was implemented mainly in the curriculum of the first, second, and third years of the architectural programme. Whilst in the fourth and fifth years of study, students were presented with "more comprehensively integrated approach" that was called Integrated Learning (IL) or Integrated Problem Based Learning (IPBL) (De Graaff & Cowdroy, 1997), that was in itself an integration of ideas of the studio-based learning model and the Problem Based Learning model (Cowdroy and Maitland, 1994). Ostwald and Chen (1994) proclaimed that by 1987, all five years of architecture curriculum in the faculty had been converted to IPBL curriculum structure. Table 7 shows the subdivision of the two-tier degree structure.

Table 5: ***The two-tier degree structure of the new PBL curriculum (after De Graaff & Cowdroy, 1997), showing the sequence of design problems of increasing scale and complexity (The University Of Newcastle, 1991; Maitland, 1997).***

Programme	Year	Design Problems (Project)	Example of Design Problems	Educational Approach
BSc	Year 1	Problems of workplace:	Design of workstation and small buildings for industrial, office or agricultural work	Problem-based Learning approach (PBL)
	Year 2	Problems of the home and community	Design of private house Some medium density group housing Community building, exp primary school	
	Year 3	Problems of public buildings	Large public building Exp: art galleries, concert halls, theatre.	
B. Arch	Year 4	Problems of the city	Major commercial buildings Both medium and high-rises In context of urban design and town planning consideration.	Integrated Learning approach (IL), viewed as compatible with PBL
	Year 5	Students select their own problems, client and site	A single problem The culmination of the whole process.	Integrated Learning approach (IL), students as professional autonomy

Unlike PBL implementation in the faculty of Architecture, TUDelft, and in most medical schools that focus on short duration of problem cycles in block themes, the implementation of PBL in the Faculty of Architecture, UniNC, maintained the centrality of design problems in its semester-like curriculum structure. A semester lasted for several months, and each one year study was only divided into two semesters. This semester structure enabled the lengthy process of integration and reconciliation to take place successfully and to cover most aspects of architectural content adequately, ranging from the real identification of needs, the conceptual design phase, to the detailed constructional drawings of the proposed solutions (Maitland, 1997). Nonetheless, the two semesters of each year were still linked to a particular theme, based on building typologies, so that students would be exposed to full range of types, each with its particular social, economic and cultural context (Maitland, 1997).

In this IPBL approach, the problem of integration was tackled by eliminating boundaries between disciplines and subjects, so that seven combined study areas emerged. The combined study areas were professional skills, user studies, site studies, cultural studies, design studies, technical studies, and implementation studies (The University Of Newcastle, 1991). The emergent study areas focused on developing particular sets of knowledge, skills, specialisations, and expertise to reflect the modus operandi of architects in current practice, as precisely identified by the Australian Registration Boards and professional institute (Maitland, 1997). Here, the relevance of IPBL curriculum and architectural learning methods were demonstrated by presenting students with real design problem and real clients, selected from particular model firms of architects (De Graaff & Cowdroy, 1997). The IPBL architecture curriculum developed in the faculty kept the design studio as the arena for basic learning activity, but additionally extended the creative and integrative characters of the design studio to the whole academic programme (Ostwald & Chen, 1994).

By eliminating independent lecture courses, the intersected arrangement of a two tier degree structure and seven integrated study areas formed a matrix organisation, in which the "individual study areas were introduced and developed through their successive application of problem exercises". The essence of the integrated approach was that the knowledge and skills developed in each study area must be capable of being applied in the context of design problems presented (The University Of Newcastle, 1991). Presented in the form of project briefs, the design problems set for each theme or semester were meant to drive the integration of various study areas and the content of the curriculum around the central activity of design

(Kingsland, 1990; cited in Ostwald and Chen, 1994). Figure 15 shows the IPBL matrix organisation implemented in the Faculty of Architecture, UniNC.

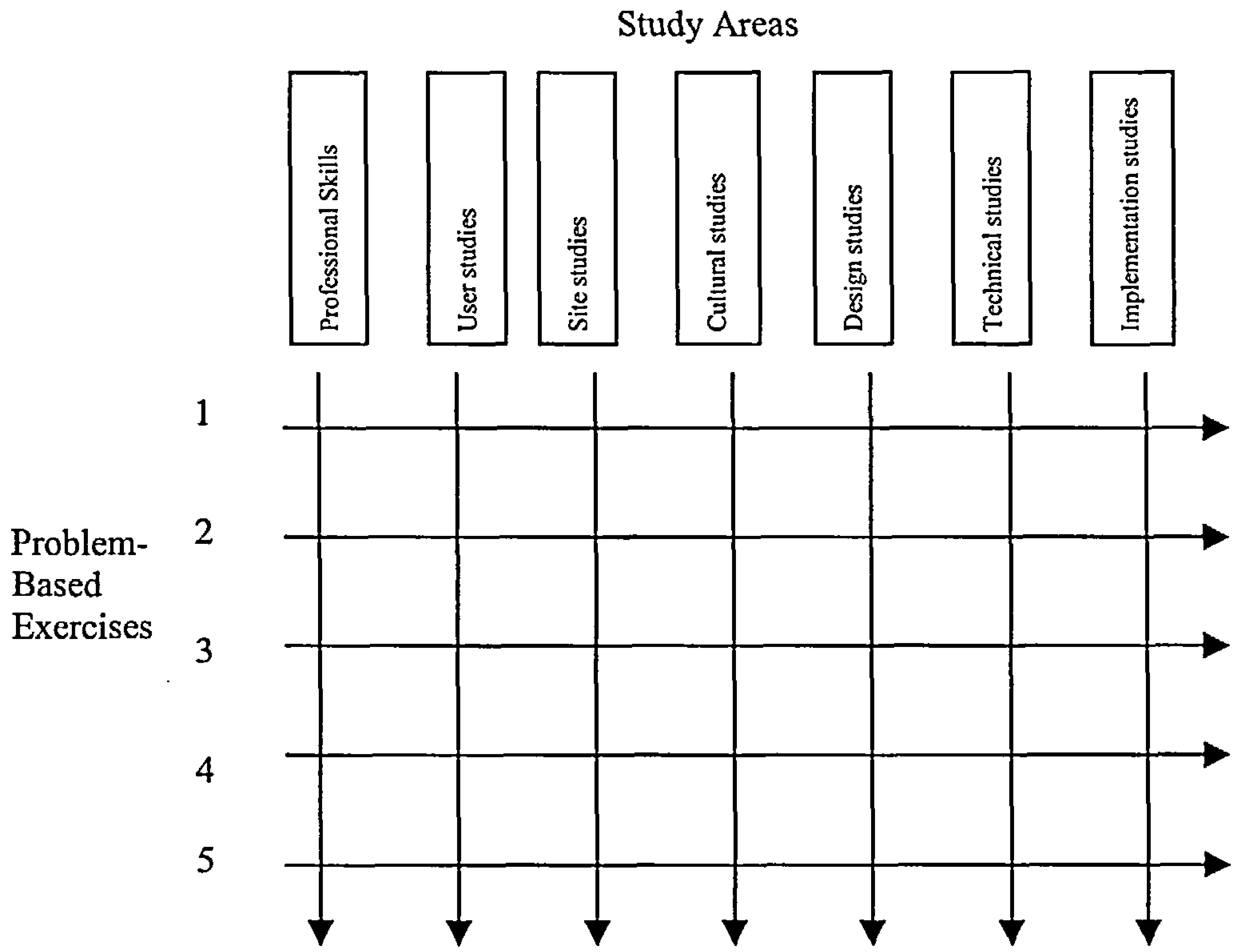

Figure 15: ***The IPBL matrix organisation implemented in the Faculty of Architecture, UniNC (after The University of Newcastle, 1991).***

The implementation of a PBL pedagogical approach in the Faculty of Architecture, UniNC, incurred only a slight change in the faculty organisational structure. There was no need to make significant changes for the reason that the faculty did not encounter any difficulty in establishing control in the management. The new organisational structure, shown in Figure 16, reflected the implementation of PBL by providing design studios with additional support from coordinators and consultants of identified study areas. This additional support meant to replace the lectures classes provided in the traditional curriculum structures.

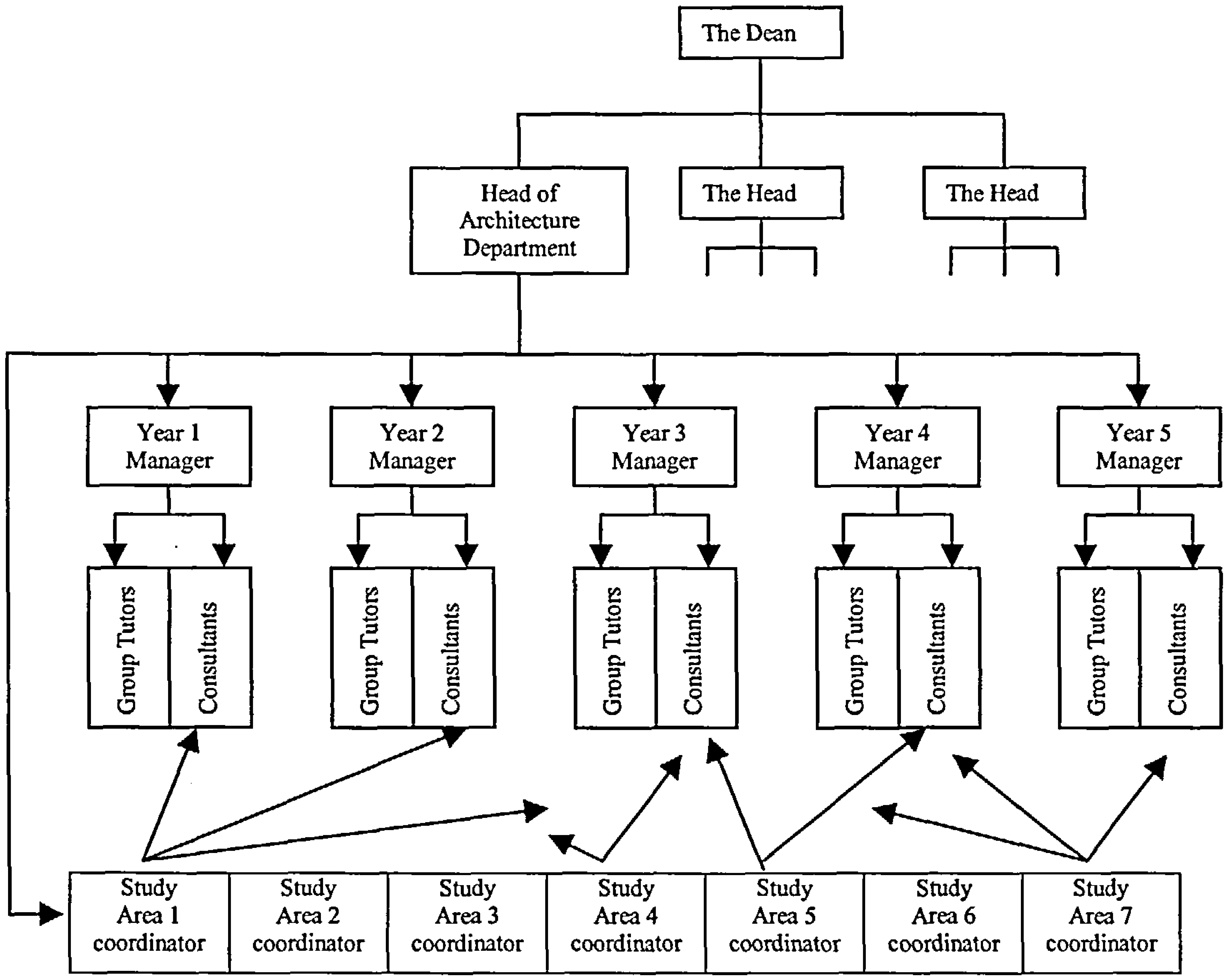

Figure 16: ***shown is the organisational structure that supported the implementation of PBL in the Faculty of Architecture, UniNC.***

3.3.3.2 Organisational Structure

The implementation of PBL in the Faculty of Architecture, UniNC, generally maintained the top down management style that was common in tertiary education. At the top of the new organisational structure was the dean, who monitored the work of several heads of departments. The new organisational structure changed the roles of academic staff specifically at the lower level of the organisation. Instead of managing the design studio and individual classes in the traditional way, academic staff functioned either as year managers, design tutors, consultants, or study area coordinators.

Year managers were responsible for managing, coordinating and monitoring the progress of their years, with help from both tutors and consultants. They designed "problems" to accommodate the needs of each discipline (Cowdroy & Kingsland, 1994a), and monitored the activities of consultants and group tutors within their year. They were also responsible for setting up timetables, writing its phase documents, and ensuring that students had workloads balanced between design and the study areas allocated for that particular year (Maitland, 1997).

Both group tutors and consultants were answerable to the year managers on matters regarding their responsibility. Group tutors were responsible for facilitating a group of 8-10 students working on the given design problems, based on the principles of PBL pedagogical approach. Besides, they had additional roles of helping students to integrate the input of consultants, to manage their study time, and to provide students with design criticisms, which was not envisaged in the original PBL approach (Maitland, 1997).

On the other hand, consultants were responsible for serving the problems with their specific expertise by means of workshops, lectures, and tutorial sessions. They supported the problem-solving process and the development of appropriate skills and knowledge. In addition, specialised consultants would make "learning units" and other specially prepared texts available to students during the course of the problem exercises (The University of Newcastle, 1991; Maitland, 1997). Many of the consultants came from a wide range of practitioners within architectural practices and related disciplines, and were hired on the basis of part time appointments.

In addition to year managers, groups tutors, and specialised consultants, study areas coordinators played important roles in determining the types of expertise required in any particular year of each study area. In order to ensure the smooth coordination of supporting the problem solving process, the central coordinator of each study area must be a full time staff member (Maitland, 1997).

3.3.3.3 Didactic Learning Methods

Undertaking PBL as the pedagogical approach to guiding student learning usually means shifting the didactic learning culture from the teacher-centred approach to a student-centred approach. Similarly, but with a slightly different slant, the implementation of PBL in the Faculty of Architecture, UniNC, represents a progression from a traditional teacher-centred, shifted to a strong "teacher-structured and controlled version of PBL" and then gradually moved forward to a more student-centred approach (Maitland & Cowdroy, 2001). There was a bridging period of "teacher-structured and controlled version of PBL," as a transition between the traditional teacher-centred approach and PBL to student-centred approach, for reason that it was seen appropriate to treat the new educational system as an evolutionary manner for flexibility (Ostwald & Chen, 1994), rather than revolutionary. Therefore, the curriculum in the first year was more "rigidly structured and teacher-driven," as compared to the curriculum of the fifth year that was almost entirely unstructured. There was a gradual change and progression between the two extremes as students moved forward from the first year to the succeeding years (Ostwald & Chen, 1994).

The architecture version of PBL implemented in the Faculty of Architecture, UniNC, was described as a teacher-structured and controlled version of PBL because it combined learning techniques associated with a PBL pedagogical approach and other conventional architectural learning methods. A mix of teaching styles and learning processes were employed to take advantage of the potential of the learning environment created by the use of PBL (Cowdroy & Kingsland, 1994a) and to suit the requirements of architectural disciplines (Maitland & Cowdroy, 2001). In this architectural version of PBL, many methods of delivery were used, depending on the synthesis component of tutorial-based learning, and the individual study disciplines. In the tutorial component that requires students to integrate and synthesise diverse knowledge, methods of delivery were categorised in four main processes: self-directed individual processes, tutor-facilitated individual process, self-directed group process, and tutor-directed group process (Cowdroy & Kingsland, 1994a).

On the other hand, the individual study disciplines that were previously delivered by conventional learning methods, such as lectures, seminars, experiment and private study, would continue to be delivered by the same processes when converting to PBL (Cowdroy & Kingsland, 1994a). It was recognised that these individual study disciplines, such as structural engineering and architectural history, were characterised by bodies of theory, and could not be fully integrated into PBL exclusive learning mode (Ostwald & Chen, 1994). Therefore, in architectural education, it was necessary to combine several approaches or move from one approach to another as progress was made and awareness of implication was developed, as long as the principles of active learning was used and adequate opportunities were provided for "individual queries and intersection" (Cowdroy & Kingsland, 1994a).

In the implementation of PBL in the Faculty of Architecture, UniNC, the architectural tutorial-based component of PBL was called "duplex systems", where students work as a group, but think individually (Maitland and Cowdroy, 2001). Unlike the original version of PBL, introduced by Barrows (1992), where a group tutorial was envisaged to play an important role for students to experience the learning process, the group tutorial in the architectural version of PBL would serve a different purpose. It was seen "as a forum for discussion of students' individual approaches and solutions, rather than for development of agreed group approaches espoused in the PBL literature." The introduction of "individualisations" in PBL was meant to suit the PBL pedagogical approach with the traditional modus operandi of the architectural profession. This adjustment was made to avoid blindly adopting the PBL convention that was strongly "biased towards assumption about medical professions" (Maitland & Cowdroy, 2001). Although individualisations in the architecture version of PBL was in conflict with the notion of a pure PBL approach that emphasised tutorials as the main learning mode, the modification was seen necessary for the reason that architectural problems are not "relatively confined and well defined problems" as the clinical problems in medical science are. In fact, architectural problems were complex endeavours that required the full mix of professional skills and the embracing of the social, political, economic, and feasibility issues to be resolved (Cowdroy & Kingsland, 1994).

In a PBL duplex system, students would firstly work on architectural design problems individually, using the **self-directed individual** process. Here, students must integrate a wide range of disparate knowledge and skills (Maitland & Cowdroy, 2001) to come out with at least a schematic design solution. However, depending on their prior knowledge alone would not enable students to resolve complex architectural problems. The design problems, usually called projects in architectural education, would always need specific requirements that drive the need for "pertinent information and guidance in application of knowledge and processes" in an integrated manner (Cowdroy & Kingsland, 1994a). Those requirements are often derived from certain aspects of theory that will not be properly learnt without a body of background knowledge (Ostwald & Chen, 1994). As such, background knowledge has to be disseminated by means of a **tutor-facilitated individual** process, where both tutors and consultants guide students on their quest to tackle problems and consequently help to stimulate students learning process.

Students, however, were not spoon-fed, but were guided and prompted when they failed to identify and research important issues pertaining to the problem at hand (Cowdroy & Kingsland, 1994a). As generalists, the tutors guided students in matters regarding the development of design solutions, by providing constructive criticisms using the principles of PBL: addressing questions without providing answers. On the other hand, consultants were available for students to refer to in case they needed guidance on matters regarding specific requirements of the projects. In fact, the provision of conventional methods of disseminating knowledge was useful for consultants to provide students with background knowledge of certain requirement of the project periodically. This combination of tutors' and consultants' support would help students to achieve both accumulation of knowledge and multiple professional skills as stipulated in the seven studies areas. Indeed, both the self-directed individual process and the tutor-facilitated individual process incorporated the distinctive self-directed learning technique envisaged by the PBL pedagogical approach.

Nevertheless, it was difficult for a student to achieve a satisfactory outcome without group interaction, co-operation, debate, and support. Therefore, methods of delivery via **self-directed group process** and **tutor-directed group process** were important to achieve "individual outcomes and corporate educational objectives" (Maitland & Cowdroy, 2001). Here, the PBL principles of peer learning, or peer tutorial, was incorporated in the architecture learning environment for students to support each other collaboratively in developing knowledge and overcoming skills deficiencies. Although students were not perfectly equipped to provide "answers", but wide ranging discussion within a group was believed to raise the relevant issues of problems (Cowdroy & Kingsland, 1994a), and prepared students to defend their proposed solutions to the problems (Maitland & Cowdroy, 2001). Research findings demonstrated that self-reflection and peer feedback in studio-based teaching helped to increase students' confidence in their ability to learn and consequently develop the concept of lifelong learning (Shannon & Brine, 1994). Additional support from tutors and consultant in the group discussion or criticism further ensured that students' direction did not deviate from the learning objective of projects or the design problems.

A prolonged period of exposure to the cycle of learning processes in the duplex systems of PBL encouraged students to constantly reflect on their "personal philosophy" about the projects. Reflection involved the identification of conflicts, the determination of priorities, and the proposal of a compromise position (Cowdroy & Kingsland, 1994a). As students progressed in their ability to interpret the problem information, they increasingly engaged in self-directed learning and moved forward to a more student-centred approach.

The modification of didactic learning methods in the architectural PBL approach, which had a more individualistic emphasis, had a profound impact on students' attitudes towards learning. Students had greater enthusiasm and motivation in learning, as they were allowed to have "ownership" of a problem and its outcomes. This had consequently contributed to the higher standard of students' work and outstanding success of graduates in the competition for employment, specifically in Australia (Maitland & Cowdroy, 2001). The positive attitudinal changes among students were directly linked to the changes of academic staff attitudes as well. As one of the agencies that influenced students, academic staff's perception and attitudes toward the new PBL approach had impact on the growth in students' maturity and attitudes (Ostwald & Chen, 1994). It was proclaimed that development of the IPBL approach arose largely from the application of strategic and behavioural management principles to educational processes (Cowdroy & Kingsland, 1994), where specific staff personal development was carried out to ensure staff have a proper attitudinal "reorientation" and "philosophic approach" consistent with the facilitation emphasis of PBL (Cowdroy & Kingsland, 1994a).

3.3.3.4 Assessment Methods

The implementation of PBL in the Faculty of Architecture at University of Newcastle revitalized changes in the assessment method as well, to bring about a "somewhat complex" assessment system (Banerjee, 1994). Here, students were assessed in the form of a "continuous grading of work through the year, with mid and end of year reviews, and a final compilation of assessment into a single graded year result" (Maitland, 1997b). This continuous form of assessment process served not only as evaluation and feedback of students' performance, but also as an integral part of the whole learning process (Cowdroy & Maitland, 1994). Thus, the architecture PBL curriculum had "twin priorities" in its assessment process; students' ability in design integration, and their knowledge and skill development in the seven study areas (Maitland, 1997b). Students' performance in design integration was allocated 50% of the overall assessment, and the remaining 50% was allocated for their knowledge and skill in individual study areas. As both areas had equal importance, students were required to achieve an adequate standard in each of the required domains (Cowdroy & Maitland, 1994; Maitland & Cowdroy, 2001).

Assessment of students' ability in design integration was within the province of group tutors and year managers who played the role of design juries. With the company of invited guests, a panel of juries periodically reviewed and critiqued students' work, most commonly at intermediate and the end stages of a problem phase (Maitland, 1997b). The choice to assess students within the extended design phases was considered because design work required the "laborious and time consuming processes" of integrating disparate dimensions of architectural disciplines for students to achieve satisfactory solutions of the given problem (Maitland and Cowdroy, 2001). During the review sessions, juries were provided with supporting documentation that outlined the design objectives for the project, the assessment criteria, and the feedback students received from both design tutors and consultants during the design process (Maitland, 1997b). Meanwhile, students had design submissions in the form of graphic, written and verbal presentations (Cowdroy & Maitland, 1994) as evidence of their ability to integrate and apply the relevant "philosophical, theoretical and technical consideration into a single complex solution" (Maitland & Cowdroy, 2001). In addition, students were also expected to keep a portfolio of all their work carried out during that year as part of the evidence (the University of Newcastle, 1991). In this formal assessment process, the students were expected, not only to make a presentation of their submission to the jury, but also to defend their "assumptions and choices" in the process of arriving at a design solution. As part of the learning experience, the review sessions were open to questions, discussion, and criticism from the other fellow students of the whole year. This open review was important for students to learn to develop critical skills (Maitland, 1997), to make "value judgements and to form strategies for the creative reconciliation" of their subsequent projects. After completing the open review, the jury would then engage in closed review session to give students appropriate grades (Maitland, 1997b).

The assessment of students' knowledge and skill in the 7 individual study areas was done by study area consultants in two ways. Firstly, consultants assessed students through the main design submissions and its phase works, based on criteria and objectives set by them and given to students at the start of the problems (the

University of Newcastle, 1991; Maitland, 1997b). Secondly, students' knowledge and skill were assessed through a separate design assignment, submission of report, laboratory work, tutorials, and examination (the University of Newcastle, 1991; Banerjee, 1994; Maitland, 1997b). This assessment of subject content might be held in any subject from time to time (Cowdroy & Maitland, 1994), and the cumulative grade of the individual subjects would determine students' standing on knowledge and skill acquisitions. Unless some "concessionary latitude" was given, students would have to pass all the study areas in order to achieve a pass grade for the year (Cowdroy & Maitland, 1994). Having these two ways of assessing knowledge and skill ensured that students knew what they should achieve, as the assessment methods were made more organised and transparent.

The twin priorities in the assessment process of architecture version of PBL the Faculty of Architecture, UniNC, were not applicable to the final year of students' study. The final assessment for graduation in the fifth year was primarily based on integration, which accounted for 85% of the overall grade of that year. The remaining 15% was allocated for a research study. Each graduating student was expected to prepare a comprehensive submission and presentation, and finally to have passing grade in both components of integration and research in order to graduate (Cowdroy & Maitland, 1994).

Since assessment and evaluation were essential as ongoing part of all professional practice (Cowdroy & Maitland, 1994), a panel of external examiners periodically evaluated the architectural programme of the Faculty of Architecture, UniNC for accreditation. This accreditation panel represented several architectural bodies; the Royal Australian Institute of Architects, the state Architect Registration Board, and the Commonwealth Association of Architects. It was consisted of examiners from different backgrounds of architecture: practitioners, academics, state and national education representatives, and student members of the architectural bodies (Maitland, 1997b). The accredited status obtained was important to ensure that the faculty had an international reputation for excellence and educational innovation (De Graaff & Cowdroy, 1997).

3.3.4 Research Questions

Although using the same label of Problem Based Learning in Architectural Education, the Faculty of Architecture at TUDelft, and the Faculty of Architecture at UniNC had different approaches in their implementation of PBL. The former adopted the Maastricht model of PBL that was derived from and commonly used in medical schools throughout the world, where the process of integration of content or knowledge was expected to take place in a discussion session that was separated from the design studio. Whilst, the latter adopted a PBL pedagogical approach in the manner of enhancing the strength of the design studio as the arena of integrative process, thus innovating its own version of PBL in architectural education. The Faculty of Architecture at UniNC basically adopted PBL to provide a proper theoretical framework to the traditional teaching of architecture, without abandoning the good aspects of architectural education that used the design studio as a powerful model for architectural form of dynamic problem solving. As such, the survival of the PBL implementation at the Faculty of Architecture, UniNC, even after 20 years of its implementation, proved that UniNC architecture version of PBL was applicable in architectural education.

Eliminating design as the central tenet of an architectural curriculum had taken its toll in the Faculty of Architecture at TUDelft, as proven by the termination of the PBL programme. Thus far, the literature review has not provided a conclusive idea of why and how the termination of the Maastricht version of PBL in the faculty occurred. Therefore, the rest of this thesis would aim to evaluate the experience of the implementation of PBL in the Faculty of Architecture at TUDelft by having insights into the perception of the implementation, and using the success of the PBL implementation in the Faculty of Architecture at UniNC, as comparison or benchmark.

The PBL pedagogical approach has several varieties, and is still experiencing ongoing expansion to even more diversity (De Graaff, 1993). Similarly, from the literature review, it can be seen that the Faculty of Architecture at TUDelft, and the Faculty of Architecture at UniNC utilised different varieties of PBL implementation, with different characteristics of problem definition. This thesis investigates the detailed account of PBL implementation in the Faculty of Architecture at TUDelft. As such, the following questions are formulated for analysis:

Research questions:

1. What are the factors contributing to the termination of PBL implementation in the Faculty of Architecture at TUDelft?
2. Does PBL give a workable theoretical framework to architectural education?
3. How was the adoption and implementation of PBL in the Faculty done?
4. How was the implementation of PBL in the Faculty carried out, as compared to other PBL implemented in other disciplines?
5. What are the changes influenced by PBL in the curriculum structure of architecture education? Does the commitment of academic staff have any influence on the termination of the PBL implementation?
6. Does students' involvement count as a contributory factor in the termination?
7. What should have been done to ensure the success of PBL in architectural education?

CHAPTER 4

RESEARCH METHODOLOGY

4.0 THE STUDY SCOPE

This research methodology chapter aims to explain the step-by-step research approaches adopted while doing the thesis. This chapter is organised around six major topics; the study scope, the paradigm and methodology, research method and procedures, analysis of interview data, some ethical considerations and concluding summary.

Based on the analysis and synthesis in chapter 2 and chapter 3, the study scope of this chapter focuses on the identification of research objectives and strategies. Two parent disciplines, Problem Based Learning (PBL) and Architectural Education, discussed in chapter 2 of the literature review, had narrowed the focus of this research to an immediate discipline of Problem Based Learning (PBL) Implementation in Architectural Education. The questions of how PBL was implemented in Architectural Education were investigated in chapter 3, focusing on PBL implementation in the Faculty of Architecture, the Delft University of Technology (TUDelft), Netherlands, and the Faculty of Architecture, the University of Newcastle (UniNC), Australia. Nonetheless, the investigation in chapter 3 led to a further question of why the implementation came to a halt in the former institution, while the latter continued using a PBL pedagogical approach in its architectural programmes. The search for an answer to the main question of why PBL implementation in architectural education had not lasted in the Faculty of Architecture, TUDelft, required detailed evaluation of its implementation process. In doing so, a number of research questions were formulated as the means to identify research objectives and strategies of this thesis. The research questions were listed in chapter 3, section 3.4.4.

Research objectives of this thesis were to investigate the experience of Problem Based Learning (PBL) implementation in the Faculty of Architecture, Technical University of Delft (TUDelft), and to identify the reasons behinds its discontinuance. Although architectural studies had existed in tertiary education for centuries, some educational specialists admitted that traditional approaches of studio teaching in the conventional architectural education system did not show itself as an established pedagogical model (Schon, 1991). As such, the Faculty of Architecture at TUDelft had attempted to establish a PBL pedagogical approach in its architectural education, but discontinued the implementation after only ten years of experience. The ending of the PBL implementation raised questions about how the PBL educational approach was implemented, and why the Faculty of Architecture at TUDelft halted PBL implementation whilst claiming it as a success.

Several research strategies were identified to meet the research objectives: to get data from documentation of PBL implementation, and to get first hand accounts from educational and architectural specialists on experience of PBL implementation in the Faculty of Architecture, TUDelft. These identified research strategies were known as "archival" and "opinion" (Buckley at. al., 1975), where techniques of content analysis and interviews were vigorously applied. These identified research strategies led to the decision to select the research format to be undertaken in order to achieve the strategies. Applying a "deduction" mode of using the knowledge and information to understand something and form an opinion, the research was designed using a phenomenological approach of Case Study. Data would be collected, based on the formatted research design, and displayed so that analysis and discussion of the findings would be made possible.

Chapter 4 describes the overall research design, or methodology used to provide data to be investigated, whilst chapter 5 gives the collected data in a format for easy understanding. Chapter 6 will discuss the analysis of data that involved the process of comparison of ideas, and verification of perception. Chapter 7 provides conclusions about the whole research project.

4.1 Paradigm and Methodology

This section outlines the overall structure of the research framework and justifies the use of a phenomenological approach to be applied in this research. Description of the research design is be substantiated with an underlying theoretical explanation of the chosen method. Figure 17 shows the research framework of this thesis.

4.1.1 Research Design: Case Study

A phenomenological approach was chosen as the main methodology in undertaking this research of case studies. Generally, this so-called qualitative research design is often done intensively, and yet offers great flexibility in term of application of research methods. In addition, the analytical method of a phenomenological approach might be quite systematic although the result would not be treated as representative (One Plus One, 2004). Instead, an understanding of the significance of different representations allows interpretative judgement of the research synthesis to be done in the areas where less is known.

In accord with the phenomenological approach of case study research, this research of PBL in architectural education represented a singular event that would never be replicated because the analysis of data focused on specific themes of content. The "singular event" referred to an explanatory case study of the PBL Implementation in the Faculty of Architecture at TUDelft. However, comparison to the same set of events was considered crucial to "pose competing explanation" (Yin, 1994) that might strengthen understanding of the research synthesis. In this instance, the description of PBL implementation in the faculty of Architecture at UniNC was used as the comparison to allow understanding of the significance of different representations.

Although there are various research methods in the phenomenological approach, case study was selected over survey, observation, and experiment because it enabled the writer to focus on subjects under investigation; the reason behind the discontinuity of PBL implementation in the Faculty of Architecture, TUDelft.

Case study is an associated methodology under qualitative research design that correlates research with "developing an in-depth analysis of a single case or small number of cases" (Creswell, 1998). In the instance of this thesis, research project mainly focused on studying one particular case study, the Implementation of Problem Based Learning in the Faculty of Architecture at TUDelft. This case study was considered to be an "explanatory case study" because it described "causal inquiries" of how and why (Yin, 1994; Tellis, 1997). Yin (1994) notes that case study method is normally used because researchers want to deliberately cover "contextual conditions" of why and how certain "decisions" are made, either in "individuals, organisations, processes, programmes, neighbourhoods, institutions, or events.

The Faculty of Architecture at TUDelft was chosen as the main case study because it was the first architectural faculty in Europe to implement PBL as an educational approach to learning architecture. Based on the research questions identified in chapter 3, the study sought to determine how and why Problem Based Learning was implemented in the Faculty of Architectural at TUDelft, and why the implementation was discontinued whilst claiming its success. Subsequently, the findings of the research will determine whether Problem Based Learning was an appropriate approach to be introduced in Architectural Education, and if so, recommendations for its implementation will be suggested to ensure successful implementation in the future.

4.1.2 Justification for the methodology

This research aimed to get data from the documentation of the PBL implementation, and to get first hand accounts from educational and architectural specialists with experience of PBL implementation in The Faculty of Architecture, TUDelft. As such, case study research methodology was the most appropriate methodology to approach the subject studied, because it enabled the writer to look in depth at issues related to the implementation of PBL, although the writer did not have control over the event. It also enabled the research to "focus on meanings, try to understand what is happening, look at the totality of each situation, and develop ideas through induction from data" (Creswell, 1998). In this way, a single case study could be seen to satisfy the three tenets of qualitative research methods: describing, understanding, and explaining, providing it met the established objective (Tellis, 1997). In this instance, an evaluative application of describing, understanding, and explaining the PBL implementation in the faculty of Architecture at TUDelft was carried out to assess the effectiveness of educational initiatives. This type of investigation could not be done by merely quantitative techniques, due to the nature of empirical research that tends "to obscure some of the important information" to be uncovered (Tellis, 1997).

The main data collection methods used in this research study was documentation review and interviews. For practical reason, other types of data collection methods also sometimes used in the case study research approach, such as survey, observation, and experiment, would not be used in this research. The exclusion of observation and experiment was due to the nature of this research, which required investigation of a PBL implementation in the Faculty of Architecture, TUDelft, that had been discontinued. In this instance, the PBL implementation in the faculty was considered as history. Therefore, observation and experiment methods, which usually require the subject investigated to be present, could not be done because the researchers could not play the major roles in the event to be observed and experimented. Something that had happened in the past could not be available to the researcher to participate in the subject of research directly.

Moreover, this research also did not use survey as part of its research design, simply because this research did not aim to produce "laws" or generalization in the same way as quantitative methods. The use of a small number of interviewees could not provide an adequate basis for inferential statistics (Creswell, 1998). Instead, this research aimed to provide awareness of the crucial roles of pattern and context via a non-laboratory setting, in which research was facilitated by the "most hard to specify stimulus, the human face" (Yin, 1994).

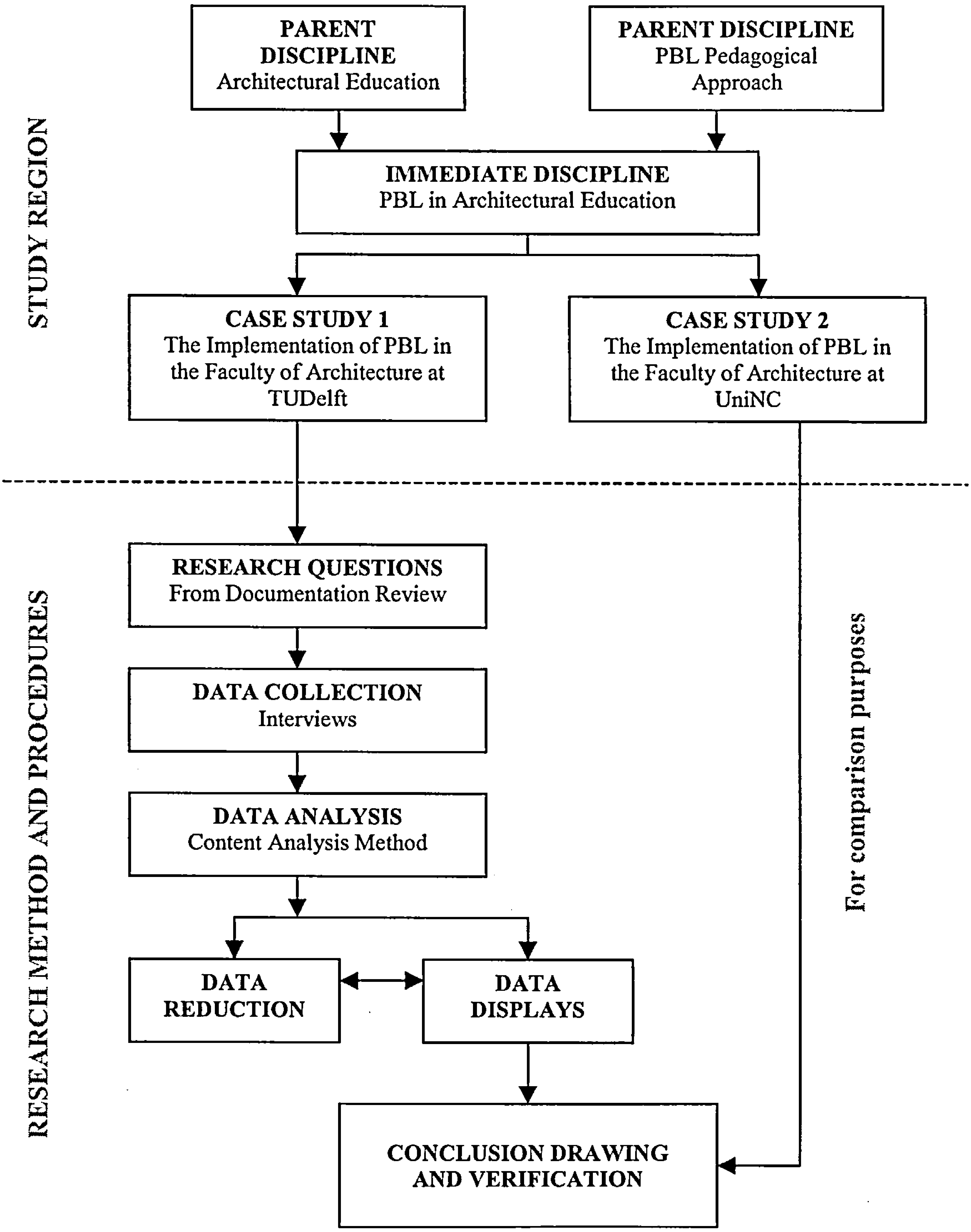

Figure 17: ***Outline of the overall structure of the research framework.***

Hence, the data collection methods of documentation review and interview were left as the strategic options to carry out the research. Document review was useful for making inferences about events, whilst focused interview was used to confirm data collected from the documentation review. In order to get first hand accounts from educational and architectural specialists on the experience of PBL implementation in the Faculty of Architecture at TUDelft, the research demanded face-to-face interviews in the case study research. Besides, this focused face-to-face interview provided "a humanistic validity" (Yin, 1994), whilst the review of documentation provided substantial information to scientifically and iteratively corroborate the evidence from the former source, thus ultimately provided the research synthesis in the case study. This combination of interview and documentation review as research strategies provided comparative explanations to satisfy the "ethical need" of confirming the validity of the processes (Tellis, 1997).

4.2 Research Method and Procedures

In this case study research, data collection methods were done through document review and interviews. Document review of the PBL Implementation in the Faculty of Architecture, TUDelft, provided the framework of this research study that had been generated by the research questions. Meanwhile, face-to-face interview was chosen as one of the data collection methods to explore individuals' opinion in depth about the PBL implementation subject studied.

4.2.1 Unit of Analysis

Three main people who had different and specific roles in the implementation of Problem Based Learning in the Faculty of Architecture, TUDelft, were chosen as units of analysis in this case study research because of their direct involvement in the PBL implementation process. They were expected to give their individual perceptions in detailed accounts of PBL implementation.

The three interviewees were:

1. Professor A, a senior staff member in the Faculty of Architecture at TUDelft when Problem Based Leaning was first introduced and later implemented in the institution. He was responsible for the enforcement of the implementation. He was chosen as one of the unit of analysis to give personal accounts on the implementation of PBL in the faculty based on management point of view.
2. Professor B was brought in from University of Maastricht to act as an advisor to the Faculty of Architecture for the implementation of Problem Based learning. As a specialist in education, he was responsible for providing training for the architecture faculty members. He was expected to provide viewpoints based on pedagogical perspectives.
3. Professor C was one of the faculty members who taught Computer Aided Design during the implementation of PBL. He was expected to give comment on architectural and practical aspects of PBL implementation in the Faculty of Architecture at TUDelft.

4.2.2 Instruments and procedures

4.2.2.1 Review of Documentation

Prior to the interview session, relevant documentation about the implementation of Problem based Learning in School of Architecture, TUDelft, was examined. This review provided the basis framework for the studies, and led to the finding of several gaps in the implementation, which ultimately helped formulate the research questions.

4.2.2.2 Preparation of Interview Questions

In order to understand the constructs of the implementation fully, questions were formulated, to be addressed to the chosen interviewees. Semi-structured questions were prepared prior to the interview to ensure the focus of information collected. The questions mainly functioned as the instruments in the effort to obtain answers to the research questions.

The questions were divided into seven (7) main categories, as follows:

1. Conceptual Framework- to further clarify the concept and philosophy of the implementation
2. Implementation - to provide in-depth information about the implementation.
3. Comparison with Other Approach – to examine the model of Problem Based Learning in architectural schools as compared to other professional disciplines of education.
4. Changes in Curricula, and Management – to examine the changes and transformation involved during the implementation of Problem based Learning.
5. Staff Commitment – to understand the overall involvement of staff, in terms of commitment, acceptance, understanding and perceptions.
6. Students' involvement – to check the students involvement
7. Conclusion – summary of the implementation account.

For the purpose of collecting details information about the PBL implementation, the above questions were developed into more specific questions in a semi-structured format. The semi-structured questions are given in Appendix A.

Semi-structured questions in face-to-face interview session "allowed the respondent freedom of expression, yet still produced data that the researcher considered essential" (Simister, 1995). Besides, the flexibility of semi-structured questions in face-to-face interview provided an opportunity to have the interview sessions appear informal, thus giving an opportunity to the interviewees to deliver data which are not usually expressed in written documentation. This type of interview was known to be

relatively easy to control as the interviewer had the opportunity to lead and guide the conversation within the subject discussed (Denscombe, 2003). In addition, applying the data collection method of face-to-face interview allowed the interviewer to address "further inquiry" whenever necessary (Yin, 1994).
However, there was also a limitation to the method chosen. It was noticed that, although semi-structured questions were addressed to the interviewees, most of the time the answers received were not focused on the subject asked. It was difficult to control the conversation specifically around the subject asked, rather the conversation always diverted from the topic. Interrupting the experts might be considered rude, while letting them get carried away was not preferable because the researcher needed to optimise the time available for the interview sessions. More effective control of the interviews might have been possible with stronger preparatory communication skills training for the interviewer.

4.2.2.3 Interviews

Interview was the best option as tool of data collection when looking at individuals' perception because it provided good interaction via eye contact and tune of voice, and presented emotion of verbal communication. Interview had "an element of personal interaction between the researcher and the respondent not present in other forms of data collection" (Simister, 1995). Through personal interaction, interviewees might give personal opinion about the issues discussed which had not been exposed in written format anywhere else.

The interviewees were contacted via email, some months prior to the preparation of research questions. This correspondence was to get their personal agreement to be interviewed, as subjects of research analysis. The programme of the interview sessions, with suggested times, dates and venues of the interview sessions, was sent to the interviewees via emails. This correspondence also helped in the preparation of questions, based on the interviewees' possible experience and involvement.

Once the agreements from the interviewees had been secured, and the semi-structured questions were satisfactorily prepared, Delft University of Technology was visited, for interview sessions in three different venues, on 23rd and 24th of March 2004. Table 8 shows the detail of interview sessions.

Table 6: ***The programme of the interview sessios.***

No.	Date	Time	Unit of Analysis	Venue
1	23/03/05	02:00 p.m to 04:00 p.m	Professor B	Room: B 1.210 Faculty TBM, IT&C Jaffalaan 5 Office b 1.210 PO Box 5015 2600 GA Delft
2	24/03/05	10:00 a.m to 12:30 p.m	Professor C	Room: 12.12 Faculty Architecture (Dept. of REH and CAAD) Berlageweg 1 2628 CR Delft PO Box 5043 2600 GA Delft
3	24/03/05	02:00 p.m to 05:30 p.m	Professor A	Room: 10.01 Faculty Architecture (Dept. of Urbanism) Berlageweg 1 2628 CR Delft PO Box 5043 2600 GA Delft

With permission from the interviewees, note taking and tape recorder were used as aids to the interview sessions. The purpose of using tape recordings to record the conversation in the interviews sessions was to avoid missing out data. In this research, neither the interviewer nor interviewees were native English speakers. As such, it was expected that the conversation in the interview sessions might not go smoothly because of communication problems. However, the tape recording of the conversation would ensure all subjects discussed were captured for future transcribing of data into verbatim form.

Besides, data from the interview session was also recorded in textual format by means of note taking. During the interviews, the interviewer might catch some of the essence of the conversation and have reflective remarks on some of the subjects discussed. Here, note taking was used to ensure these reflective responses would not be forgotten after the conversation ended. The process of note taking was essential because it functioned as the collection of reflective ideas obtained while listening to the conversation, as the textual capture of emotions involved in the expression of interviewees, and as a reference during the analysis of data.

4.2.3 Limitation of Research Method

Case study research did not have uniform protocols (Tellis, 1997), perhaps partly because the literature available on case study research was "primitive and limited" (Yin, 1994). Although this might be considered as providing freedom for a researcher to formulate a personal method of research, yet it does create difficulty in avoiding criticism of its primacy.

During the interview sessions, note taking was carried out as an aid for analysis to be done later. Nevertheless, note taking during conversation might result in limitation of the interaction between interviewer and interviewees, especially eye contact. Eye contact was known to be essential to see the emotion involved during discussion. The lack of eye contact might lead to an over-formalised conversation. Regarding this, one of the interviewee questioned the attempt to take notes, suggesting that he preferred an interviewer to listen to him attentively.

4.4 Analytical Methods for Interview Data

4.4.1 Content Analysis

Data collected during the interview sessions would not have any meaning without analysing them. In order to make the data obtained during the interview sessions useful, several processes of content analysis were done. In its simplest format, content analysis was the "extraction and categorization of information from text" (Simister, 1995). In this instance, content analysis was done on the interview transcripts to extract meaning and categorise sets of information regarding the implementation of PBL in the Faculty of Architecture at TUDelft. By doing content analysis, the process of "describing, understanding, and explaining" (Tellis, 1997) the findings of the case study research would be made easier, as compared to trying to find information from the whole interview transcripts.

There are 7 main activities involved in the process of content analysis: transcribing the recorded data into verbatim format, coding of the collected data, adding information from marginal and reflective notes to the data, categorizing of data, data reduction, data displays, and drawing conclusions.

4.4.2 Transcribing the Interview Transcripts

Transcribing was the first step in content analysis after the collection of data via interviews. It involved the process of transferring the tape-recorded data into textual format for ease of analysis. The recorded data was transcribed into verbatim format, as closed as possible to the original conversation taking place during the interviews. Some limitations appeared during this process of transcribing.

Since both parties, the interviewer and interviewees, were not native English speakers, the recorded format appeared to have many grammatical errors, unclear pronunciation, and too many pauses taken to find the correct choices of words. As a result, this already lengthy and tedious process was made worse because it was so time-consuming. However, it was essential that this process be done properly because the transcripts produced would be used as the basis for analysis.

To reduce the burden of having the tedious task of transcribing, notes taken during the interviews session offered a great help as aids to the transcribing process, especially if the taped words appeared inaudible. With the completed transcript at hand, data retrieval was made easier as compared to listening to tape recorder for analysis.

As mentioned previously, it was hard to control the conversation around the subject questioned. Some of the information needed for certain questions was answered at different times, while a different question was being addressed. As such, information appeared scattered all over the transcripts, which were difficult to comprehend in the original conversational sequence. Therefore, before beginning analysis, the textual data need to be coded and categorised in the sequence of the prepared semi-structured questions.

4.4.3 Coding the Collected Data

Coding was generally used for the purpose of "systematically searching data to identify and to categorise specific observable actions or characteristic" (Tellis, 1997a). In this instance, coding was used to label sections of text that related to a certain topic, or to a certain question. The coding system was formulated in the same sequence as the prepared list of semi-structured questions. However, the nature of a semi-structured interview with open responses provided ample opportunity to interviewees to give additional information that was not asked by the interviewer. This additional information might be important to the research. As such, additional codes were provided to label this extra information. For example, there were only two questions in the category of conceptual framework: both were regarding architectural educational approach in architectural education. However, information gathered about the subject included the definition of Problem Based Learning. Therefore, additional codes were needed to label the extra information.

In the coding process, a printed version of the transcripts was read several times to retrieve information, and consequently be labelled with the appropriate codes. Besides labelling the text in the transcript with codes, marginal and reflective remarks were added to the transcript hard copy. These informal forms of notes might be used later in the analysis process. The coded transcript would then be categorised and arranged in a new format of information displays for easier analysis. Table 9 is a transcript extract, showing codes labelled to section of text, whereas Table 10 shows the list of codes used in the coding process.

Table 7: *A sample transcript extract, with codes attached to sections of text.*

No.	Interviewee	Conversation	Codes
2	Prof. C	So there was the last minutes decision, there was no real testing, of relevant to the ability, or whatever. So we have to push it through. And it was because just a couple of things, problem based learning. Well, that is, no discussion possible, no nothing. No refinement. So it was implemented, very sketchy, very abstract concept of education, but it did not work very well. It does have to do with Problem Based Learning only, it has to do with other work but I'll come back to that. It survived, the faculty survived by the way, obviously. But we have to review in the mid 90s, early 90s, sorry, in 1994, I believe. It passed with flying colours. Problem based learning was not been discussed very much in that review. It was more in terms of performance, knowledge, technology. I mean the main point, we are not Problem Based learning. Something like that, but management consider it design	CF- ArchHtr IM- Obs CF- ArchHtr IM- Obs IM- PerfScc IM -Dur CF- ArchHtr CF- DefPBL

Notes: No. refers to the sequence of conversation.

4.4.4 Adding Reflective Remarks

Besides taking notes on important information during the interview sessions, the remarks on responses and reflections were noted upon the interviewees' answers and statements. These notes might be highlighted later when embarking on data analysis process. Research specialists recognised the practice of jotting down reflective remarks as an important activity during interviewing. Miles and Huberman (1997) defined reflective remark as raw field notes about the field-worker's reflections, and commentary on issues that emerged during the process .It added substantial meaning to the write-up, not least to other readers. It usually strengthened coding, in pointing to deeper or underlying issues that deserve analytic attention (Miles and Huberman, 1997).

Table 8: ***The list of codes used in the coding system.***

	CATEGORIZATIONS	Codes	Ref. No	Q ref.
	CONCEPTUAL FRAMEWORK			
	CF: Architectural education AK Alexander Koutamanis EG Erik De Graaff TDJ Taeke De Jong	CF-ArchEdu-AK CF-ArchEdu-EG CF-ArchEdu-TDJ		A1
	CF: Educational approach	CF- EduApp		A2
	CF: Architectural Educational history	CF- ArchHtr		
	CF: Definition Problem based learning	CF- DefPBL		NA
	CF: Definition Project Organised Learning	CF- DefPOL		
	CF: Definition Project Organised Problem Based	CF- DefPOPL		
	CF: Definition Case based Learning	CF- DefCBL		
	IMPLEMENTATION			
	IM: Purposes	IM-Pur		B1
	IM:Duration and Process	IM-Dur		B2
	IM: Obstacles	IM- Obs		
	IM: Performance Success	IM- PerfScc		B3
	IM: Performance Failure	IM- PerfFlr		
	IM: Performance Assessment	IM- PerfAssc		
	IM:Opinion	IM-Opi		B4
	COMPARISON			
	CP-Speciality	CP-Spec		C1
	CP-Model Architecture	CP-ModArch		C2
	CP-Model Medicine	CP-ModMed		C2
	CP-procedures	CP-Proc		C3
	TRANSFORMATION			
	TR- Curriculum structure	TR- CurrStr		D1
	TR-Curriculum Changes	TR-Curr Chg		D1 (ii)
	TR-Class scenario	TR-Cls Sce		D2
	TR-Management Changes	TR-ManChg		D3
	TR-Role of Teachers	TR-RolTch		
	TR-Finance	TR-Fin		D4
	TR-Involvement Student	TR-Inv Std		D5
	TR- Involvement Policy makers	TR- Inv PoM		
	TR- Involvement Teacher	TR- InvTch		
	TR- Involvement Practice	TR- InvPrc		
	TR- Involvement Parents	TR- InvPrt		
	STAFF COMMITMENT			
	SC- Involvement	SC- Inv		E1
	SC- Acceptance	SC- Acct		E2
	SC- Understanding	SC- Uds		E2
	SC- Copes management Changes	SC- CopMChg		E3
	SC- Copes Roles changes	SC- CopRolChg		E4
	SC- Advantages	SC- Adv		E5
	STUDENTS INVOLVEMET			
	SI- Acceptance/Response	SI- Acct		F1
	SI- Copes Curriculum Changes	SI- CopCurrChg		F2
	SI- Competency	SI- Cptc		F3
	SI- Copes Roles changes/Adaptation	SI- CopRolChg		F4
	SI- Advantages	SI- Adv		F5
	CONCLUSION			
	CL-Role of Interviewee	CL-RolInt		G1
	CL-Proposal For PBL	CL-PropPBL		G2
	CL-Potential	CL-Ptt		G3
	CL-Research In Past	CL-RscPst		G4
	CL-Research In Future	CL-RscFut		G5

4.4.5 Adding Marginal Remarks

Similarly, some reflective ideas and reactions were noted whilst in the process of data analysis. In research, these textual ideas are known as marginal remarks. However, although marginal remarks are analogous to reflective remarks, they were not done during data collection process. Instead, the process of adding marginal remarks was intensively carried out during the data analysis process when some more new ideas were continuously added throughout the analysis process. Capturing the emerging ideas in textual format was important as they suggested "new interpretation, leads, connections with other part of the data," and they usually pointed towards questions and issues to look into during the next wave of data collection, if applicable (Miles and Huberman, 1997). In addition, those captured ideas would also give direction on ways of elaborating some of the research findings.

4.4.6 Categorisation of Data

As mentioned previously, the textual data was categorised and arranged in the same sequence as the prepared semi-structured questions. Based on the codes labelled to sections of text earlier, text from the three different transcripts was broken down into discrete sections (Simister, 1995), and transferred into categories in new documents. In this process, text excerpts from three different interviewees were combined together according to similar categorisations. As such, there were seven documents produced for the seven categories of the codes. The combination of excerpts from the three different transcripts would later ease the process of comparing interviewees' ideas.

Some of the content of the transcriptions appeared unnecessary for the research project. Therefore, the data were intensively reduced, in order to format the text into useful categories.

4.4.7 Data Reduction

During the categorisation process, data was organised in such a way that final conclusions could be drawn and verified. Besides, intensive data reduction was done to some of the insignificant pieces of information in the transcripts. This process was described by Miles and Huberman (1997) as the process of selecting, focusing, simplifying, abstracting, and transforming the data that appeared in written-up or transcriptions. The process of data reduction occurred continuously throughout the content analysis of this research.

4.4.8 Data Displays

Displaying the data obtained from the interview session was the most important process to ensure the data could be easily understood by readers. Different types of data displays, such as matrices, charts, and networks, were used to show the relationships between information presented. Good data displays were a major avenue to valid qualitative analysis. In this research, intensive analytic activities were required to display data, which had appeared in a dispersed and poorly structured textual format. Only with organised and well-structured displays of data could conclusions be drawn.

Accordingly, Miles and Huberman (1997) described a display as an organised, compressed assembly of information that permits conclusion drawing and action. It functions to reduce complex information into selective and simplified gestalts or easily understood configurations. These "analytic activities" were designed to assemble organised information into an immediately accessible, compact form so that the analyst could see what was happening, and draw justified conclusions.

Illustrations of data displays for all categories of research information in this qualitative research are given in chapter 5, whereas chapter 6 is devoted to the explanation of data and discussion of research findings.

4.4.9 Analytical Analysis of Meaning

The whole process of data analysis was iterative and cyclical, rather than sequential. As such, well-documented processes of this overall content analysis were necessary. Having well-documented processes would eventually help to understand clearly just what was going on during the analysis process, in order to reflect and refine the methods undertaken, and probably make them usable to others.

Although this case study research produced a massive amount of data in textual format, no computer-assisted data analysis program was used. No doubt computer assisted data analysis program would have made the process of retrieval of data much easier, but the nature of this case study research required a high amount of cross-references which could be comfortably done with word processing software and hard copy format. In addition, most of the data should be analysed in context, which was lacking in available computer-assisted data analysis coding systems. The theory-generating features in many of the computer programs were limited to producing a basic format of networks, whilst this research required the use of several forms of matrices for data displays. The whole process of intense analytical handling made it difficult and complicated to embark on becoming familiar with so many options of computer assisted data analysis software. Furthermore, the nature of this research was not intended to produce any law of generalisation in which examination of repetition of words were important. Therefore, the use of a computer-assisted program to perform content analysis in this study was not necessary.

4.4.9 Drawing Conclusions

Chapter 6 is devoted to discussing the data given in chapter 5. This discussion of the displayed data leads to the drawing of conclusions. According to Miles and Huberman (1997), conclusion drawing is the practice of "noting regularities, patterns, explanations, possible configuration, causal flows, and proposition" of information. Such conclusions from the data analysis help to answer the research questions of the thesis, and provide an understanding of the research phenomena.

Nevertheless, the meanings emerging from the data have to be tested for their validity. In this instance, the design of a single explanatory case study research required the construction of an "internal validity", in which multiple sources of evidence were used as the way to ensure construct validity (Tellis, 1997b). Since this research had data collected from documentation review and interview, cross-referencing was cyclically done between both materials to construct a "corroborating mode" of validity (Tellis, 1997a).

4.5 Ethical Considerations

During the data collection process of interviews, there were three obvious ethical considerations. Permission was sought from the interviewees on instruments to be used during the interview, respected the time allocation for the duration of the interview sessions, and managed the interviews in ways most convenient to the interviewees.

Permission was sought from the interviewees about the use of tape recorder and note taking prior to the commencement of interviews. As expected, all the three interviewees granted their permission on the use of tape recorder, but Professor A seemed to prefer the interviewer to listen to him attentively without taking notes. Moreover, Professor B requested that he should be notified if any of the content of the interviews was to be published.

In addition, the time allocation given by the interviewees was respected. Although it was suggested that the interview session would take two hour of each interviewee' time, only two of them agreed with the proposal. Professor B informed that he could spare only one hour for the interview to take place. Lastly, the date, time and venue of interview sessions proposed also took into consideration whatever was the most convenient for interviewees. Table 8 in section 4.2.2.3 shows the tabulated programme agreed by the interviewees.

As suggested by research specialists, a set of rules of conduct was also observed during the data analysis process. The importance of observing the ethical issues in doing research was raised by Denscombe (2003), stating that researchers should produce truthful and transparent research; should not do any harm while doing research; should conduct randomised controlled experiments; should observe privacy and confidentiality; and should observe legality and professionalism. Although the process of doing this case study research did not deal with controlled experiments, every effort was made to observe the other issues listed.

4.6 Comments on The Research Design

This research was an example of a single case study research in multi-disciplinary fields of architectural education and Problem Based Learning. Specifically, this research would provide a critical analysis of the implementation of Problem Based Learning educational approach in architectural tertiary education. It was hoped that this research would encourage educational specialists and architectural professionals to have a greater enthusiasm for improving architectural education by appropriately applying formal pedagogical innovation in architectural curriculum structure.

Using a phenomenological research approach as its paradigm, this research employed the use of interviews as the main data collection method, and content analysis as the main analysis method. Unfortunately, guidance on the how to employ manual content analysis in a phenomenological approach of a single case study within educational research was severely limited. As such, the method of manual content analysis of interview data obtained from specific participants, or in this case the interviewees were called units of analysis, needed to be explored further. Having made the attempt to explore this type of research, it was hoped to expand the horizon of qualitative single case study research.

CHAPTER 5

DATA DISPLAYS

5.0 DATA DISPLAYS

This chapter is intended to display data in an organised manner that permits conclusion drawing and action. It presents results to be analysed for their relevancy to the research questions. Most of the data is displayed in the form of tables and matrices, which are easier to be understood, compared to verbatim data of the interview transcripts. The displays of data in this chapter use data collected mainly from the interviews sessions, without reference to the documentation review. Nevertheless, as suggested by Perry (1998), information about each research questions is presented with some preliminary reflections about the subject discussed.

The data displays are restricted to a presentation of the collected data, without drawing general conclusions or comparing results to those of other researchers who were discussed in chapter 2 and chapter 3.

5.1 Subject of Research

In this research, the Faculty of Architecture at the Delft University of Technology (TUDelft), the Netherlands, was chosen as the main case study. This selection was the result of the search to find an implementation of Problem Based Learning (PBL) in architectural education. This institution was the first architectural school that implemented a PBL pedagogical approach in Europe, but the implementation was discontinued after a decade. This research was an inquiry into how the implementation was done, and why the Faculty of Architecture at TUDelft decided to bring the implementation to a halt, despite the increasing interest in PBL among educational researchers. Research had shown that PBL was shown to be a way of improving education in many disciplines of professional education. Therefore, this research meant to identify the experience of the implementation and find out the reasons behind its termination.

In order to achieve the above objective, some of the key personnel who were directly involved with the implementation of PBL in the Faculty of Architecture at TUDelft were interviewed. These personnel had different and specific roles in the implementation of PBL in architectural education. Therefore, they were chosen as units of analysis, whose perspectives would be examined in this research. The three interviewees were as follows:

1. Professor A was one of the senior members in the Faculty of Architecture at TUDelft when PBL was first introduced in the institution. He was responsible for the enforcement of the PBL implementation.
2. Professor B was seconded from University of Maastricht to act as an advisor to the Faculty of Architecture for the implementation of PBL. As a specialist in education, he was responsible for advising on the development of the new curriculum structure and for training staff members in the faculty.
3. Professor C was one of the faculty members who taught Computer Aided Design during the implementation of PBL.

5.2 Pattern of Data Research

This part of the research analysis displays data in the same sequence as the semi-structured questions that were prepared for the interview sessions. Generally, the same questions were addressed to the three interviewees. Table 11 shows the general sequence of the questions' categorisation.

During the interview sessions, not all interviewees provided answer for each question addressed to them. Beside, as is common to any interview session, it was difficult to control the conversation to strictly follow the original format of the prepared questions. Some of the information gathered was not directly related to the sub-topic discussed, whereas some other information was very important although it was not included as required information. Nevertheless, this additional information actually helped to add detail to the experience of Problem Based Learning Implementation in the Faculty of Architecture at TUDelft.

Table 9: *The sequence of questions and its categorisations.*

Question Number	Categories
A1-A2	Conceptual Framework
B1-B4	Implementation
C1-C3	Comparison with Other Approach
D1-D5	Changes in Curricula, and Management
E1-E5	Staff Commitment
F1-F5	Students' involvement
G1-G5	Conclusion

As such, some additional subjects of analysis were added to include the relevant new information. For example, in the "Conceptual Framework' category, data analysis not only discussed data from questions A1 and A2, but also the new related information gathered, such as architectural educational history, the definition of Problem Based Learning (PBL), and the definition of Project Organised Learning (POL). All the seven categories of questions had either data addition, reduction, or both. Therefore, this analysis discusses subjects based on the categories, while adding more sub-subjects wherever appropriate.

5.3 Interview Question and Data Displays

5.3.1 Conceptual Framework

5.3.1.1 Conceptual framework: Question A1

Do you think it is important for an architectural school to implement a formal educational approach (Where problems of integration and collaboration exist)?

Question A1 wished to explore the interviewees' opinions on the importance of an architectural school in implementing a formal educational approach. Here, formal educational approach is referred to a theoretical pedagogical framework that is recognised by education specialists. Table 12 shows the interviewees' related statements on the subject of the importance of implementing a formal educational approach in architectural education. In addition, interviewees provided information on what components were required in order to have a formal educational approach in architectural education, as shown in Figure 18.

Table 10: ***The importance of implementing formal educational approach in architectural education.***

Interviewees		Quotations on relevant information for question A1
Professor B	1	"I do not think that it is possible to have formal education for a profession like architecture. I mean, that can never imply that. Anyone can be claimed to be an architect, but that people need training to become architect, just like any profession."
	2	"I think there is a different trend in architecture schools and I do not really recognise."
	3	"I think the training is based on working together with experienced architects. No formal curriculum what so ever. But then, it is a choice to do that way, so there is a system. The training from experts."
	4	"If you compare architecture to.., except engineering or applied physics, then they do not have theoretical framework so much. They do have however, tradition in matters and practically in architecture. You have all series of styles. And teaching often relates to styles of architecture."
Professor C	1	"Yes, I have a very great belief in learning from the specialist."
	2	"You realise people have been thinking about this thing for at least 50 years before your time. Quite a lot to explain. And most of them you know, psychology, in term of psychological development. In term of everything, so why ignore them."
Professor A	1	"No, scientific methods. So, like empirical methods, statistic or something like that. What do we have for architecture? What method do we have? Because if we have, if all the students is going to study, they don't do anything because we don't have a method."

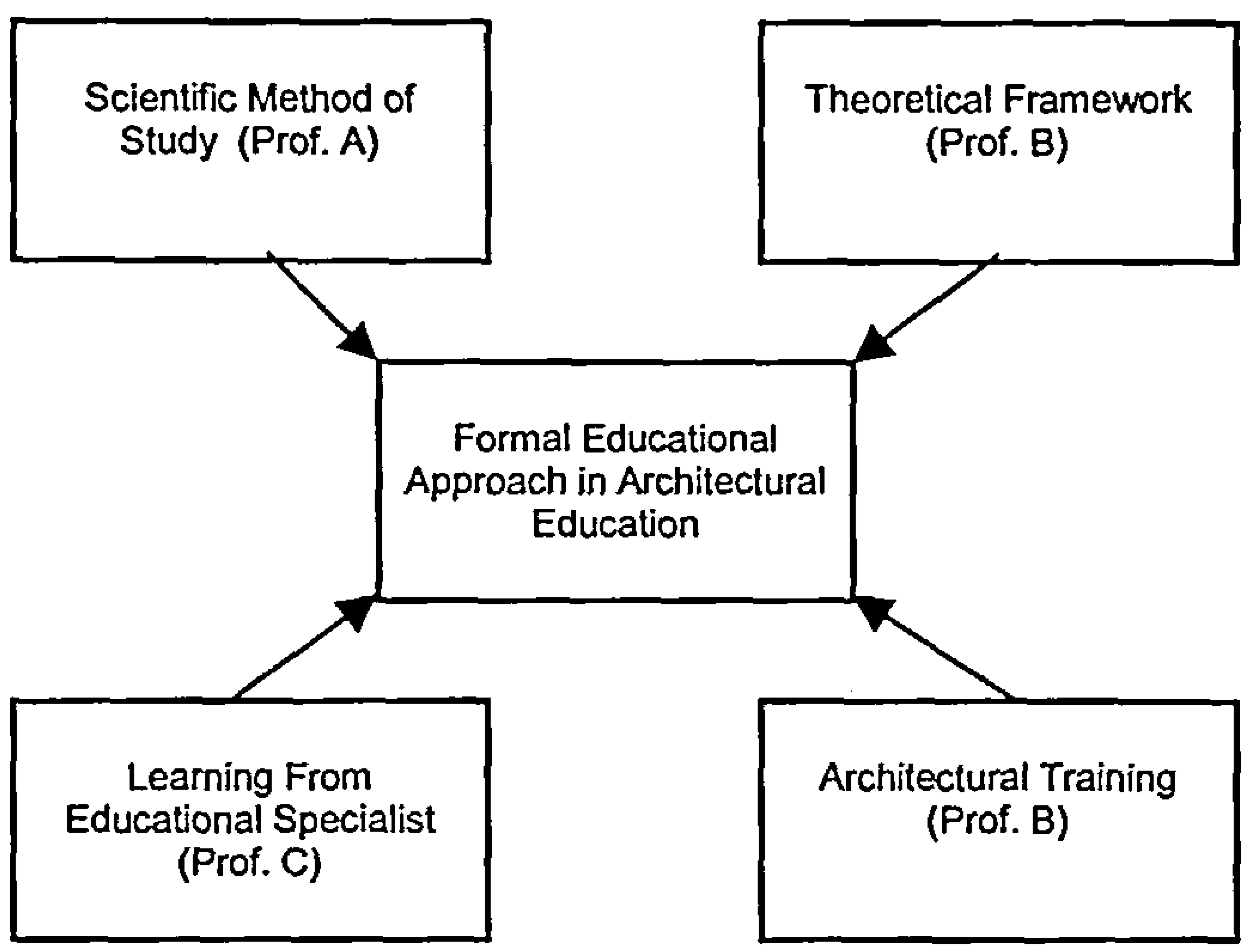

Figure 18: ***Conceptual Clustered Network of components required to have formal educational approach in architectural education, as mentioned by the interviewees.***

5.3.1.2 Conceptual framework: Question A2

Do you know any other approach implemented in architectural education, besides problem-based learning (PBL)?

Question A2 sought interviewees' knowledge on known educational approaches implemented in architectural education, besides Problem Based Learning. The interviewees related that there were other educational approaches implemented in architectural education, either as major or minor innovations. The data gathered about this question was displayed in the form of "Partially Ordered Display" (Miles and Huberman, 1997), where variables streams network was used to focus on the different types of educational approaches which existed. Figure 19 presents the educational approaches implemented in architectural education, as mentioned by the interviewees.

One of the interviewees, Professor B, also explained the nature of Project Organised Learning (POL), considering that it was the method of architectural teaching implemented prior to the conversion to PBL in the Faculty of Architecture, at TUDelft. Table 13 summarises his perception on the characteristics of POL.

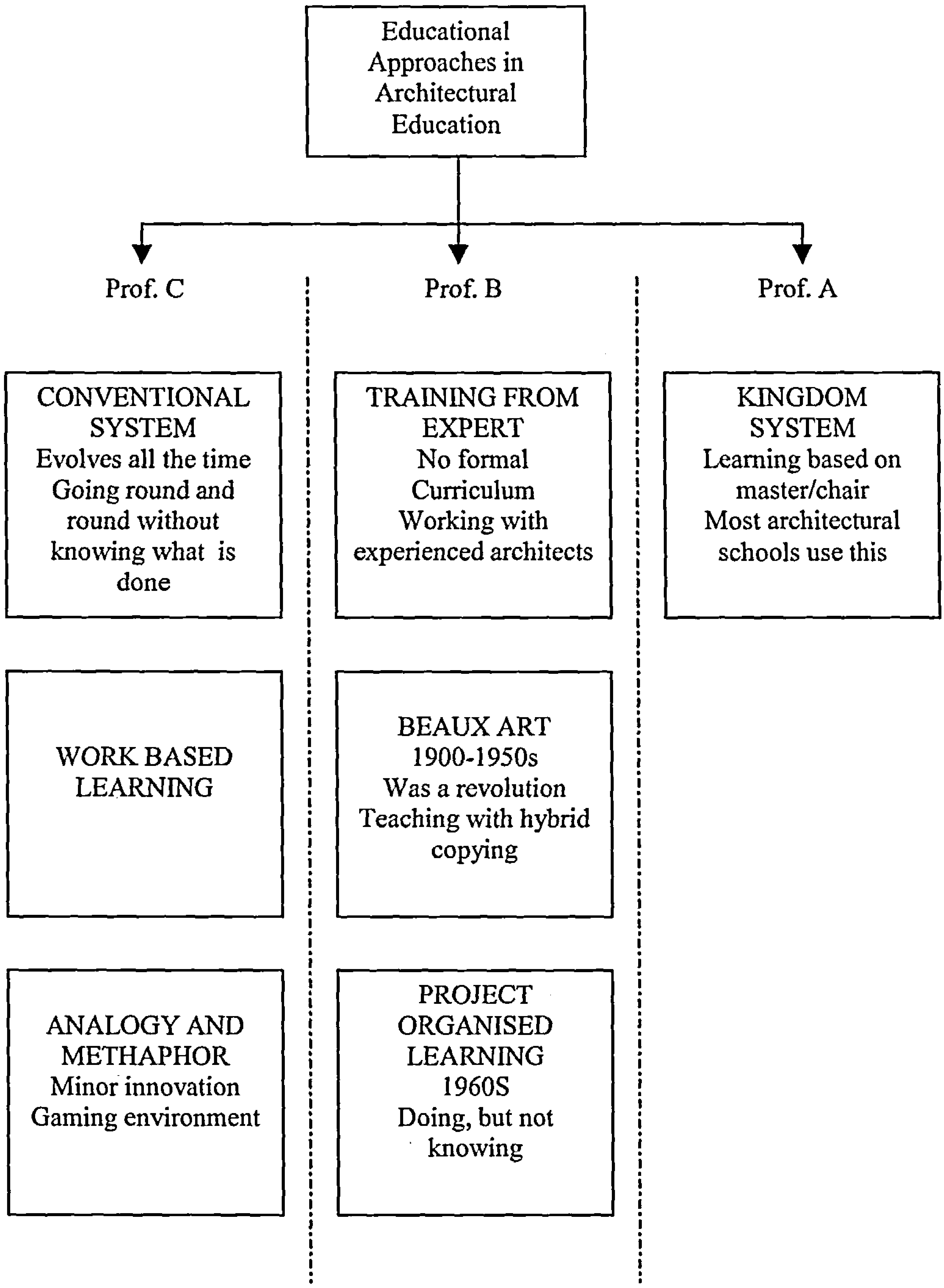

Figure 19: ***Type of educational approaches in architectural education.***

Table 11: ***Interviewees' Perception of Project Organised Learning, as explained by Professor B.***

Interviewees	What POL is
Professor B.	• A revolution because it shifted (to) a lot of the possibilities for choosing what a project is • Teachers have lot of freedom • Educational methods that fit well with the need of the profession like architecture. • Primary goal is to produce something, to create something, to make a design. • The assessment is based on the production • The output is much more important than the learning reason. • Focus on working together (collaboration), like there are in practice. • In collaborating, they split, they define task, and make everyone do what is requested • Learning experience, well they miss out on learning the things that they are not told. • Becomes playing in practice, it is nice, very motivated, students love it, but the learning effects are limited. • Is also very effective. Because learning is more effective if it comes from within. • Teachers have more difficulty to control of what the students learn. • The teachers are the focal point of the educational programme

5.3.1.3 Conceptual framework: Other Relevant Information

While questions A1 and A2 focused on educational approach in architectural education, the analysis of the conceptual framework also revealed other information that might be important in the research. Firstly, the conversation in all the three interview sessions roughly described the circumstance in the Faculty of Architecture at TUDelft before the implementation of PBL. The diagrams in Figure 20, Figure 21 and Figure 22 illustrate the different interviewees' perceptions of the circumstances of the faculty prior to PBL implementation.

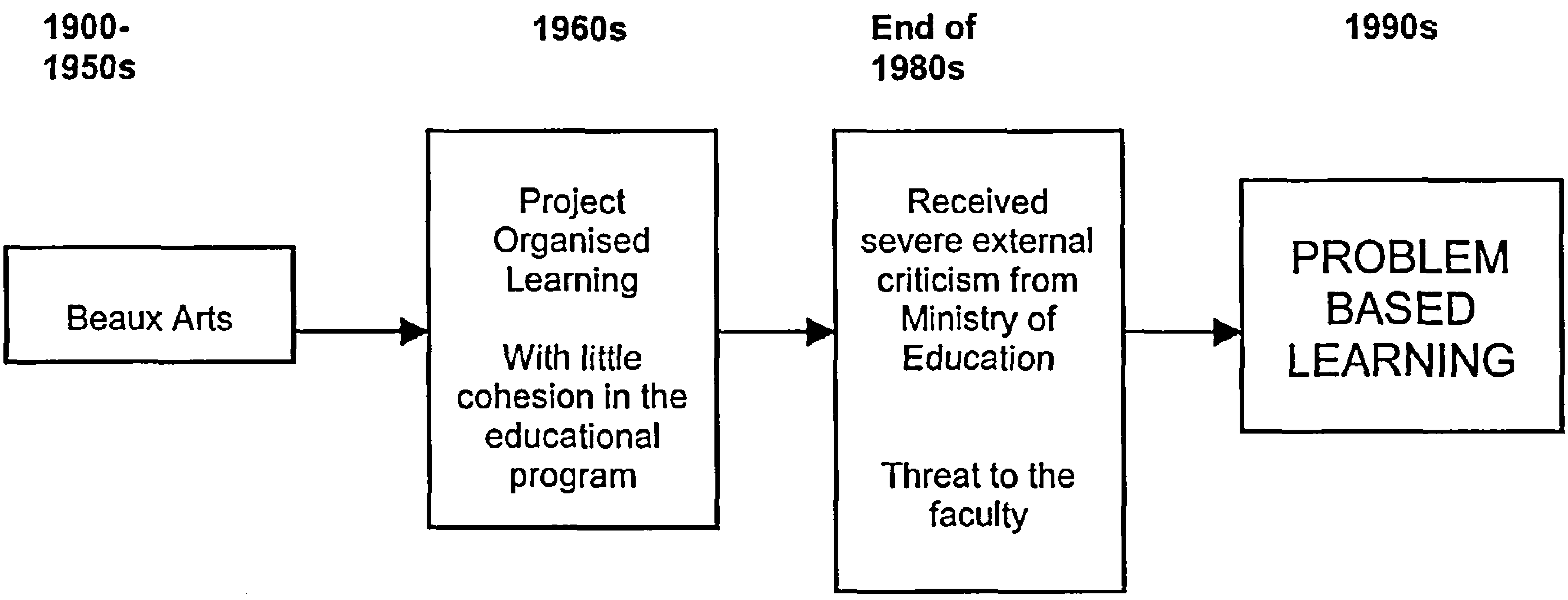

Figure 20: ***Diagram shows Professor B's perception of the situation before implementation of Problem Based Learning.***

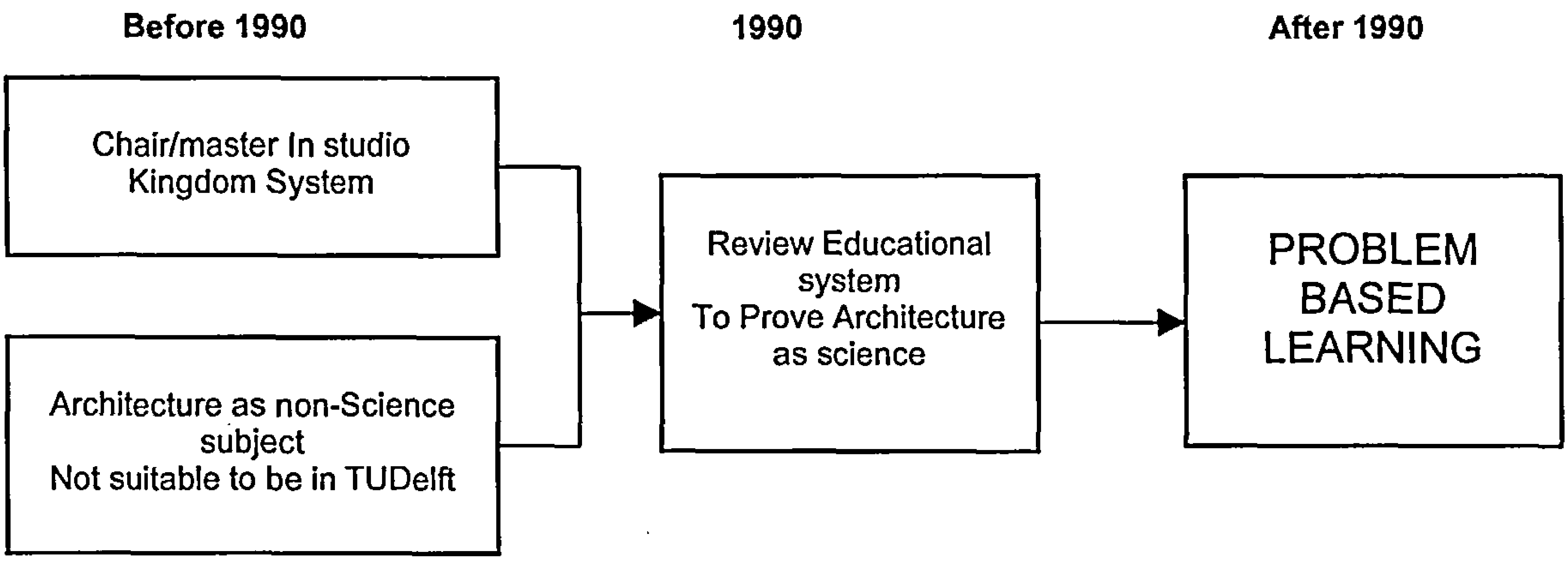

Figure 21: ***Diagram shows Professor A's perception of the situation before implementation of Problem Based Learning***

In Figure 21, Professor A termed the existing educational approach practiced in the Faculty of Architecture at TUDelft as the "kingdom system." He explained that kingdom system refers to the phenomenon where design instructors have full autonomy of controlling their studio teaching. Detail description of Kingdom system will be discussed in section 6.1.2 of this thesis.

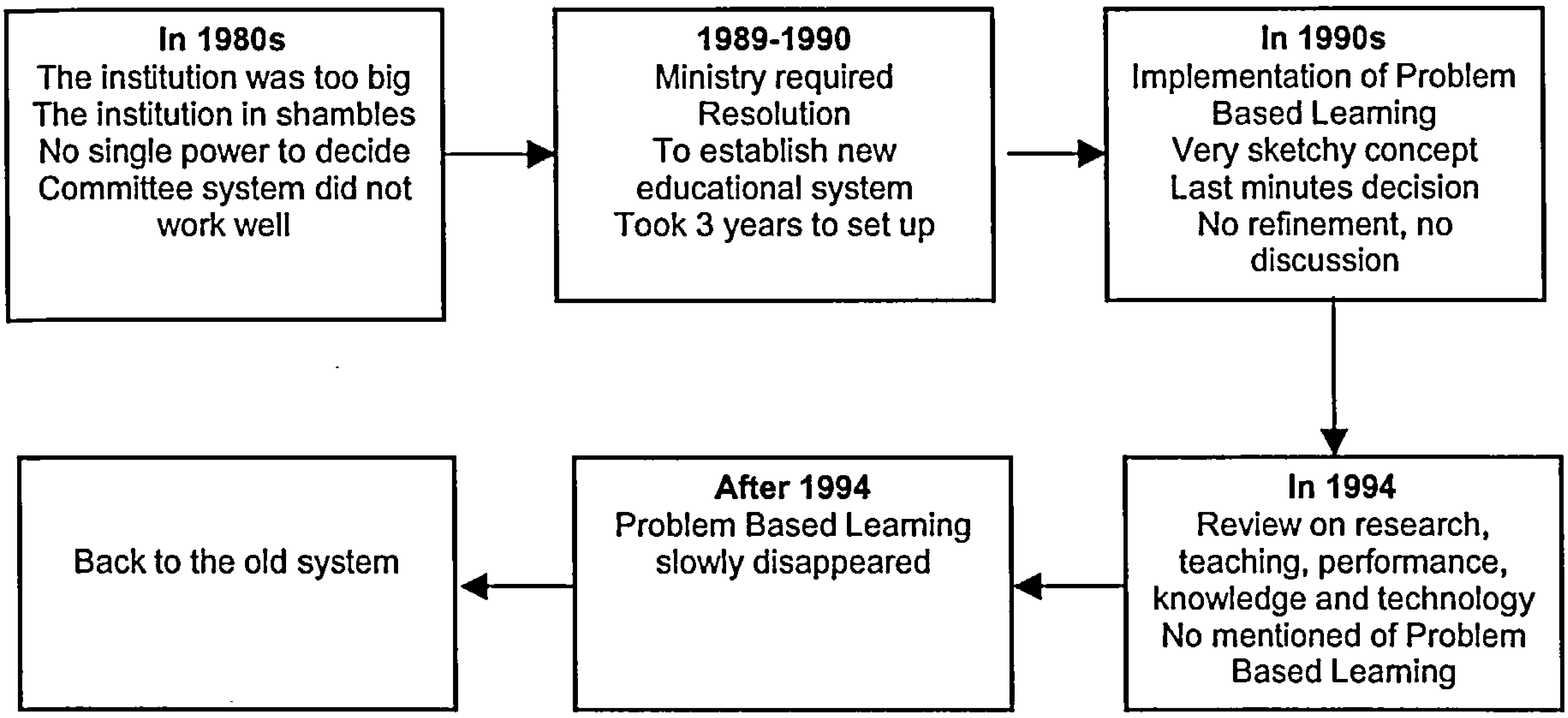

Figure 22: ***Diagram shows Professor C's perception of the situation before and during implementation of Problem Based Learning.***

In addition, the section of the interviews dealing with the area of the conceptual framework also revealed the interviewees' description of Problem Based Learning. Data collected on this subject is given in matrix tables, to summarise their descriptions, as shown in Table 14.

Table 12: ***Definition of Problem Based Learning.***

Interviewees	What PBL is	What PBL is NOT
Prof. B	• Evolving, and changing. • Educational methods that fit well with the need of the profession like architecture. • Learning environment, to be most effective to the students in term of learning, rather than in term of working together, like there are in practice. • Performance is accessed much like the traditional exam, on an individual basis. • Teacher indirectly control on the process of the learning. • Students are in the centre of attention (student-centred). • To do away with the separation of discipline • Actually part of active Learning	• Not a universal recipe for success, it will depend quite a lot on how you can involve people, and elaborate the whole system in their own fashion.
Prof. C	• Irrelevant to architectural thinking, and the	• Not relevant to the way

		• way architecture works. • Was very much didactic, and too mechanical • Use of analogical thinking to find solutions	architecture is applied.
Prof. A		• To be understand as case based learning • The philosophy is not giving student problems, but give students cases.	• Not the right term, but Case Based Learning. • Not to give them (students) all the problems, but let them make problems (make problem statement out of case)

In comparison, Professor B gave the most detailed description about the differences between PBL and POL. Table 15 summarises the differences based on his perception.

Table 13: ***Comparison of PBL and POL.***

		PROBLEM BASED LEARNING **(PBL)**	PROJECT ORGANISED LEARNING **(POL)**
1	Learning environment	Student centred	Teacher centred
		Focus on learning process	Focus on collaboration
		Active learning	Playing in practice
		To do away with the separation of discipline	-
2	Educational Program	Based on theme	Many possibilities for choosing projects
		Fit well with the need of the profession like architecture.	Fit well with the need of the profession like architecture.
3	Effectiveness	Effective	Effective
4	Output	Learning experience	Design Production
5	Assessment	Individual basis like traditional exam	Production basis
6	Students	-	Miss out on things they are not told
		Unlimited learning effect	Limited learning effect
7	Teacher	-	Freedom to choose project
		Indirectly control the process of the learning.	Find difficulty to control what students learn

5.3.2 Implementation

5.3.2.1 Implementation: Question B1

What do you think were the main purpose of the implementation of PBL in your department?

Question B1 sought the reasons behind the decision to implement Problem Based Learning in the Faculty of Architecture, at TUDelft. Throughout the interviews, interviewees mentioned some purposes repetitively as compared to others, to show the importance of them. Table 16 summarises the purposes of implementing PBL in a checklist matrix format, as a partially-ordered chart of data display. The summary shows categorisation of the purposes into several sub-headings, namely curriculum, management, survival, finance, performance and philosophy.

Table 14: ***The purposes of implementing PBL.***

Categories	Prof. B	Prof. C	Prof. A
Curriculum	To organise the curriculum better	To improving efficiency	To reorganise the curriculum structure in theme
	To provide effective learning environment for the students	To provide the modern curriculum structure as part of modernising	To break the kingdom systems by establishing control on subjects learn in studio.
	To be more effective and coherent	To become the instrument for the refurbishment of the curriculum	To have less lectures, less longitudinal input, and more self study.
	To exercise more control of what the students learn, even though it would be indirect control.	_	To know what people learn
Management	To impose some order to the administrating measures.	To establish control	To break the Kingdom system.
	To enable management to getting all the teachers to pull about (get involve)	To organise teaching in the faculty	_
Survival	To help the faculty to survive.	With centralised control, help the faculty to survive	To remain in TUDelft as science field
	-	To overcome the threat of closing the faculty	-

	-	To avoid moving of academic staff to other university, exp: Technical University of Eindhoven	-
	-	To avoid losing jobs for some staffs	-
Finance	-	To reduce cost.	To reduce the number of lectures
	-	To have PBL as a selling point, extremely attractive to students	-
Performance	-	To improve the quality and performance of staff work in teaching	-
Philosophy	-	-	To be established as a scientific field

The purposes of PBL implementation listed in Table 16 were interrelated to each other. Some of the answers given by the three interviewees were repetitive, even though they usually used different terms and words. As such, a further summary of the purposes was charted in the network format of figure 23, to show the relationship of purposes in event flow network format or context chart format. This network format implied the level of importance of each sub-category, and showed how achieving one purpose may lead to achieving other purposes.

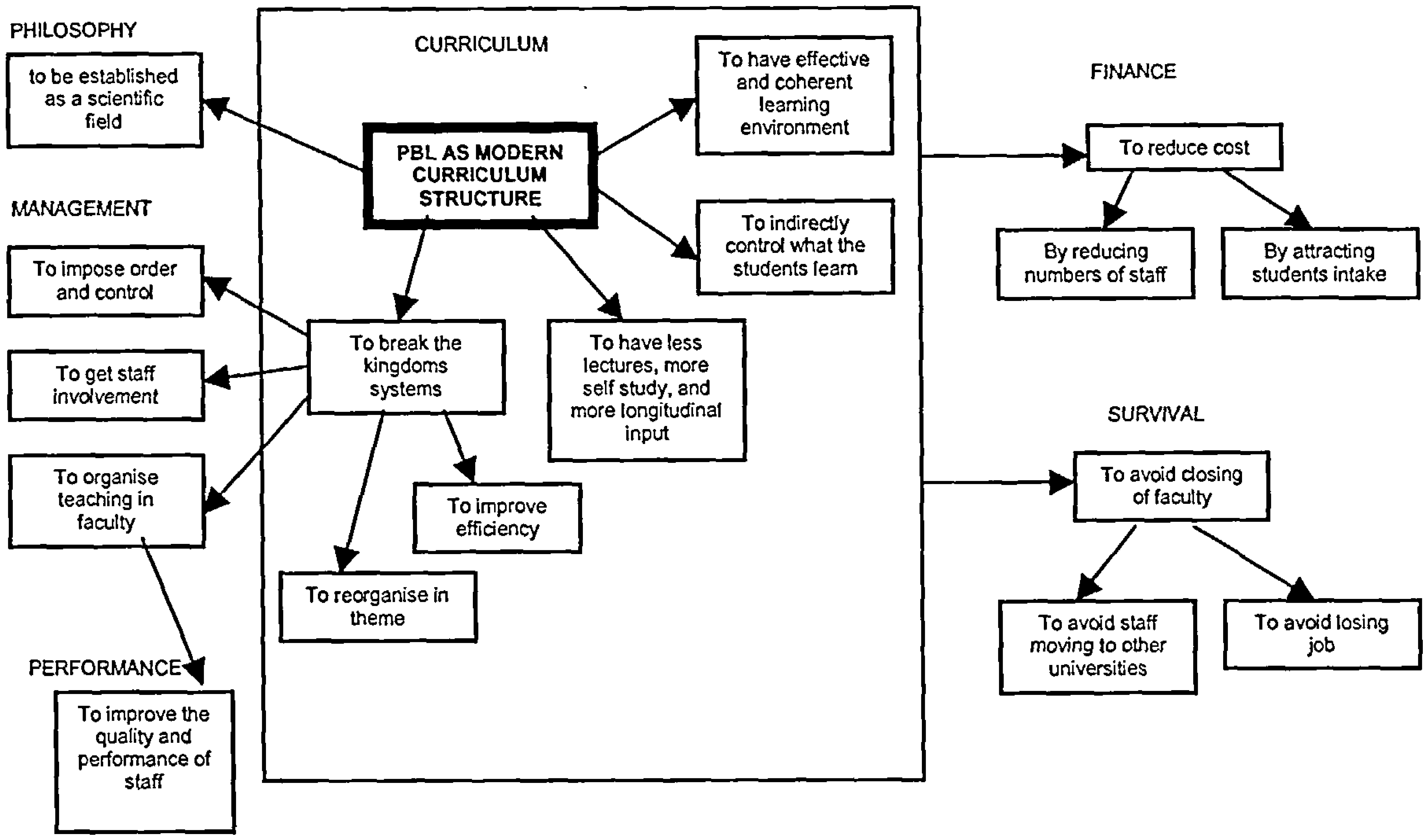

Figure 23: ***The relationship of purposes in PBL implementation.***

5.3.2.2 Implementation: Question B2

How long is the duration of PBL implementation in your institution? (Start, end or still going on).

Question B2 sought to explore the process and duration of the implementation of PBL in the Faculty of Architecture at TUDelft. Although the answer for this question was found in the literature, yet it was considered necessarily to verify this matter via interviewees' personal observation. Table 17 shows the duration and process involved in PBL implementation, as described by the interviewees.

Table 15: ***The duration and process involved in PBL implementation.***

PROCESS/YEAR	DURATION														
	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02
Design of PBL	**Discussion Planning**														
Implementation of PBL				**PBL was continuously changing for practical reasons, not educational reason.**											
Ministry Review															
Implementation of PBL								**PBL in theoretical subject POL in architectural design**							
2nd. review															
Bachelor and Master Programme														**Back to conventional method with theme based**	

5.3.2.3 Implementation: Question B3

Do you think the implementation is a success? Please explain.

How do you measure the success? It is by measuring students' performance, or by recognition of professional body and the community?

Are there any problems?

Question B3 and its sub-questions sought interviewees' opinion on the success of PBL implementation in the Faculty of Architecture, at TUDelft. However, the interviewees did not discuss much about how they undertook to measure success. As such, since the consideration of success of PBL implementation was interrelated to implementation purposes, the table was arranged in similar sub categories to the list of purposes. Table 18 summarises the interviewees' opinions on the success and failure of PBL implementation. Table 19 displays interviewees' opinion on success of PBL implementation in another way, by displaying the excerpts of the interview transcripts.

Table 16: ***The interviewees' opinion on the success of PBL implementation.***

Categories	Opinion of Success			Description
	Prof. B	Prof. C	Prof. A	
Curriculum	YES	NO	-	To have effective and coherent learning environment
	-	-	-	To control what the students learn indirectly
	-	-	-	To have fewer lectures, more self study, and more longitudinal input
	-	-	YES	To break the kingdoms systems • To improve efficiency • To reorganise in theme
Management	-	-	YES	To impose order and control
	NO	NO	-	To get staff involvement
	-	NO	YES	To organise teaching in faculty
Survival	YES	-	YES	To avoid closing of faculty • To avoid staff moving to other universities • To avoid losing job
Finance	NO	NO	-	To reduce cost • By reducing numbers of lectures • By attracting student intake
Performance	-	NO	-	To improve the quality and performance of staff/students
Philosophy	-	-	NO	To be established as a scientific field
	-	NO	NO	PBL to be understood as Case Based Learning

Note: (-) indicates no discussion on that matter.

Table 17: ***Quotation excerpted from interview transcripts regarding the performance of PBL implementation.***

Categories	Interviewees' Opinion		Relevant Quotation
Curriculum	Prof. B	YES	"It has been successful in terms of providing effective learning environment for the students for several years."
	Prof. C	NO	"The way it was applied here, unfortunately it was not a success" "So I would say the implementation is really a ....for failure. No real communication, no real preparation, not really applicable to architectural education."
	Prof. A	NO	"So make a problem from that case." That is the intention. And they were never succeeded."
Management	Prof. B	NO	"It was not successful in terms of the succeeding in getting all the teachers to pull about (involve). I think from the perspective of management, it had not been a success; it had not been possible to manage the change process very effective." "Yes, I think that is what terminating the process at the end. Because management was not able to deal with the remaining resistance."
	Prof. C	NO	"In a sense, it fails the teachers and students?" (question by researcher) "Always, always. Never had been otherwise."
	Prof. A	YES	"So I was not very surprised that the organisation succeeded, but not the philosophy." "The organisation was the break of the kingdoms in themes."
Survival	Prof. B	YES	"It managed to help the faculty to survive."
	Prof. C	-	-
	Prof. A	YES	"So I was not very surprised that the organisation succeeded, but not the philosophy."
Finance	Prof. B	NO	"Of course, it is. Changing would be more expensive."
	Prof. C	NO	"Actually it cost quite a lot, ..." "So problem based learning has actually has cost impact in the institution, in the university?" "Negatively, yes. It incurred more cost because this kind of stuff had a book affair."
	Prof. A	-	-
Performance	Prof. B	-	-
	Prof. C	NO	"But when it came to the synthesis of designing, it did not really improve the understanding or performance." "So in term of speed of study, did not really improve."
	Prof. A	-	-
Philosophy	Prof. B	-	-
	Prof. C	NO	"In that sense, I understand, there is not such Problem based learning model actually implemented here."
	Prof. A	NO	"Well, you are supposed to become scientific. So make a problem from that case. That is the intention. And they were never succeeded. So I was not very surprised that the organisation succeeded, but not the philosophy."

Note: (-) indicates no discussion on the matter, and shaded cell highlight the opinion of success.

Table 20 shows an individual perspective of the problems arisen during PBL implementation. The writer categorised the obstacles to success in four main categories: organisational obstacles, obstacles from staff, obstacles from students, and obstacles of philosophy of PBL Educational Approach.

Table 18: ***The individual perspective of the problems arisen during PBL implementation.***

Categories	Individual Perspective of Obstacles Arisen		
	Professor B	Professor C	Professor A
Organisational Obstacles	Faculty scale was too large to implement PBL • Very difficult and lengthy process. • Lack of unanimous decision • Lack of faculty development	-	Scale of the faculty • Too many students, caused the themes in block system to loose their sequence.
	PBL was imposed • Resistance arose • Not able to deal with the resistance.	PBL was imposed • Staff refused external influences • Inability to change staff understanding	PBL was imposed • Difficult to adapt without understanding • Lack of communication
	-	PBL for reputation • Nobody has a clear opinion	-
Obstacles from Staff	Lack of Acceptance • Frustrated, PBL took away a lot of freedom • PBL was imposed upon the faculty	Lack of Acceptance • Other priorities in Architectural education • Severe doubt about the relevant of PBL • Not way of improving the quality of architectural teaching and making.	Lack of Acceptance • Disappointed, lost their authority • Staff resisted the idea of complete dependent on the school. • Staff had obsession of working load
	Lack of understanding • Confused on change of role • Not convinced and consistent.	-	Lack of understanding • Not understanding concept of PBL
	-	Labour intensive • For preparation of materials • Including hiring outsiders.	-

	-	Time consuming • Too much time in preparation • Too much time in discussion. • Took time from architectural studio	-
Obstacles from Students	Time management • PBL and POL competed for the student's time • Students focus only on what they were motivated to; POL		
	Students were not inspired • Design is most inspiring. • Try to find minimum requirement to pass grade.	Students were indifferent • Current trend of performance oriented • PBL did not improve speed of study and thinking skill.	
		Lack of appeal • Because PBL was irrelevant • Had never lived up to the expectation • Academic staff were just going through the motions and did not get a fair chance	
Obstacles of Philosophy	Mixture of two didactic systems • PBL in theoretical subjects • POL for architectural design.	Priority • What architecture should be with subjects, with specialisation • Not how architects learn	-
	Irrelevancy Designers are used to finding solutions, not to discussing problems.	Irrelevant • PBL seen as very didactic and too mechanical • Irrelevant Use of analogical thinking • Blindly adapted from Maastricht model • Was very sketchy • Abstract concept of education • Not appropriate to architectural teaching.	Irrelevancy • PBL was not suitable for some subjects: like history and hand drawing. • Some discipline could not use theme

	Lack of Curriculum Definition: • No planning of objectives • Methods not matched to the goals	Lack of Refinement • Irrelevant to Architecture • Last minute decision • No real testing of the ability and relevancy of implementation. • No discussion possible • No instrument • Not enough training	-

5.3.2.4 Implementation: Question B4

Do you think PBL is the best approach to teach or to train students in architectural education?

Question B4 sought interviewees' opinions on the appropriateness of PBL to architectural education. Table 21 shows the interviewees' comments on the best approach to teach or to train students in architectural education.

Table 19: ***Interviewees' comments on the best approach to teach or to train students in architectural education.***

Interviewees	Approach	Comment
Professor B	Combination of PBL and POL	I think to have them both, and to use the didactic of Problem based learning in a project organised environment. It might be the most natural solution for faculty of architecture
Professor C	Approach designed by architect and specialist, with explanation and tools	"This is the way educational approach should approach the subject. Explained on the one hand, and provide tools."
		"So architecture should be work with specialist." "Architectural teacher and educational specialist communicate. So it means that you will be able to set a research unit for the researching the educational approach. That would be very nice." "He (researcher) has to be qualified in both works."
Professor A	Architectural Methods of Study	Methodology has been in my opinion, is a great success. Because now we have a book, ways to study architecture or technical design. With 48 booklets of this faculty, explaining how they do their study and research. And that is a milestone. Because it is now open in every year, it was used by bachelor, and it is used by master.

5.3.3 Comparison

5.3.3.1 Comparison: Question C1

What do you think the speciality of the PBL innovation in your school of architecture compared to approaches that has long been used in architectural schools all over the world? (For example: compared to general USA and UK systems)

This question aimed to identify the distinctive features of PBL innovation in the Faculty of Architecture at TUDelft. Based on the review of the interview transcripts, three distinctive features were identified. Table 22 shows the distinctive features mentioned by each interviewee, together with the quotation relevant to the subject.

Table 20: ***The distinctive features of Problem Based Learning at TUDelft.***

Interviewees	Approach	Comment
Professor B	No separation of disciplines (theme)	"One of the planning methods in Problem based Learning is to do away with the separation of discipline and to redesign the curriculum in term of themes. And themes are related to professional practice in architecture."
		"The basic strong point of the problems based learning; defined as a whole curriculum, not as a summing up of these parts."
	More freedom for students	"You get much bigger discrepancy/range between the best and the worst. And then you can ask yourself, is this what I want? If you want the curriculum to encouraging excellent right from the start, then you need to work in Problem Based Learning and Project and POL, because it helps the student to excel, at the cost of allowing students to fail, terribly. Yes, some would fail that might have survived in the traditional curriculum."
	Adaptation of Maastricht model	"Problem Based Learning (PBL) in architecture will be different than Problem Based Learning in medicine. I think you will found out that you need to redesign the concept of Problem based Learning in a new environment, and of course they is an experience of people who had already done that, that it really is different kind of practice."
		"No, we did not institute labelling. Some people do, if you look at this magazine, you will find all sort of brand, and we just did not do that. We don't invent our own brand."
Professor C	Adoption of Maastricht model	"The problem based learning model was called the Maastricht model."
Professor A	No separation of disciplines (theme)	"The program or theme. That was different from the education before. That is the most important revolution that took place. All these kingdoms were, there was something horizontal instead of these longitudinal courses divided."
		"Well, we have to order the theme in a way that the next theme can use the earlier (theme). So we don't have to choose theme without any order. That is a conditional sequence."

5.3.3.2 Comparison: Question C2

Whose/which model of PBL innovation has your department adopted? Is there any modification involved?

Question C2 intended to find out the model of PBL implemented, and details of the modifications involved to suit architectural studies. Since there were varieties of PBL models implemented in many different disciplines of education, this question aimed to identify and confirm which model had been implemented in the Faculty of Architecture at TUDelft. The interviewees stated that the faculty adopted PBL from the University of Maastricht, which had implemented the PBL innovation in their school of medicine and school of law for decades. Table 23 shows the examples of problems or cases used in PBL educational approaches in three (3) different disciplines; architecture, medicine, and law.

Table 21: ***Examples of problems (cases) used in 3 different disciplines.***

<table>
<tr><th>Discipline</th><th>Problem/Case</th><th>Students' task</th></tr>
<tr><td rowspan="2">Architecture</td><td>Condensed mirror
"I am in the bathroom. And the mirror is ....has some moist on it. I can't see myself in the mirror" (Prof. A).</td><td rowspan="4">"Effective communication for students would have to be, about what do we know already from this problems? Now they need to discuss it before they start working out and figure the solution" (Prof. B).

"The student has to think what the problem is. So he learns to make a problem statement." (Prof. A).</td></tr>
<tr><td>20 photographs of buildings
"Well, look at it. And state the problems." (Prof. A).</td></tr>
<tr><td>Medicine</td><td>Fever
"I am not able to say anything that makes sense about fever. Okay, we have questions. And now, we have rooms for problem based learning." (Prof. A).</td></tr>
<tr><td>Law</td><td>A postman
"He got me a letter to the front door of the house. And in the garden there was a dog. And he bites the postman. Who is responsible? Who is going to pay for the medicine and his damage and so on?" (Prof. A).</td></tr>
</table>

5.3.3.3 Comparison: Question C3

What procedures are involved in implementing a PBL approach?

Question C3 sought to identify the process involved as procedures to implement PBL at the Faculty of Architecture, TUDelft. Information about the procedures involved during the planning and implementation stages appeared scattered throughout the interviews' transcripts. As such, excerpts of the important parts of the procedures were presented in Table 24. It was important to note that the procedures mentioned did not occur in chronological order. Instead, some of the items occurred concurrently.

Beside the procedures, it was also important to note that there were some important personnel with varieties of position in the faculty that were involved directly in the implementation of PBL implementation. Figure 24 shows the relationship between personnel and procedures involved in the PBL implementation.

Table 22: ***Procedures involved in implementing a PBL approach.***

<table>
<tr><th>Step</th><th>Procedures</th><th>Comment</th></tr>
<tr><td>1</td><td>Decision making
Top down decision
Advice by experts of PBL
Advice on organisation structure
Chair set up and meeting</td><td>PBL initiated by the Dean
No council however (Prof. A)</td></tr>
<tr><td>2</td><td>Design of the curriculum
Formation of Theme in the curriculum
No more lecture
Theme Coordinators appointed by faculty committees,</td><td>Curriculum
Each year has 6 blocks/theme
Each theme runs for 8 weeks
Theme led by a coordinator. (Prof. A)</td></tr>
<tr><td>3</td><td>Faculty development
Series of training of the faculty
Workshop to have skill in PBL
Workshop to accept the role changes
To have positive attitude toward the implementation</td><td>Workshop by expert in PBL
Very effective in involving people
Labels new teaching skill
Starts thinking about their new roles as teachers. (Prof. B)</td></tr>
<tr><td>4</td><td>Preparation of PBL material
Staff prepared unit books, modules, or log books.</td><td>PBL material, just like the old fashion lecture notes, consist of:
Collection of paper, examples, great architecture, and exercises. (Prof. C)</td></tr>
<tr><td>5</td><td>Implementation
The students centred systems</td><td></td></tr>
</table>

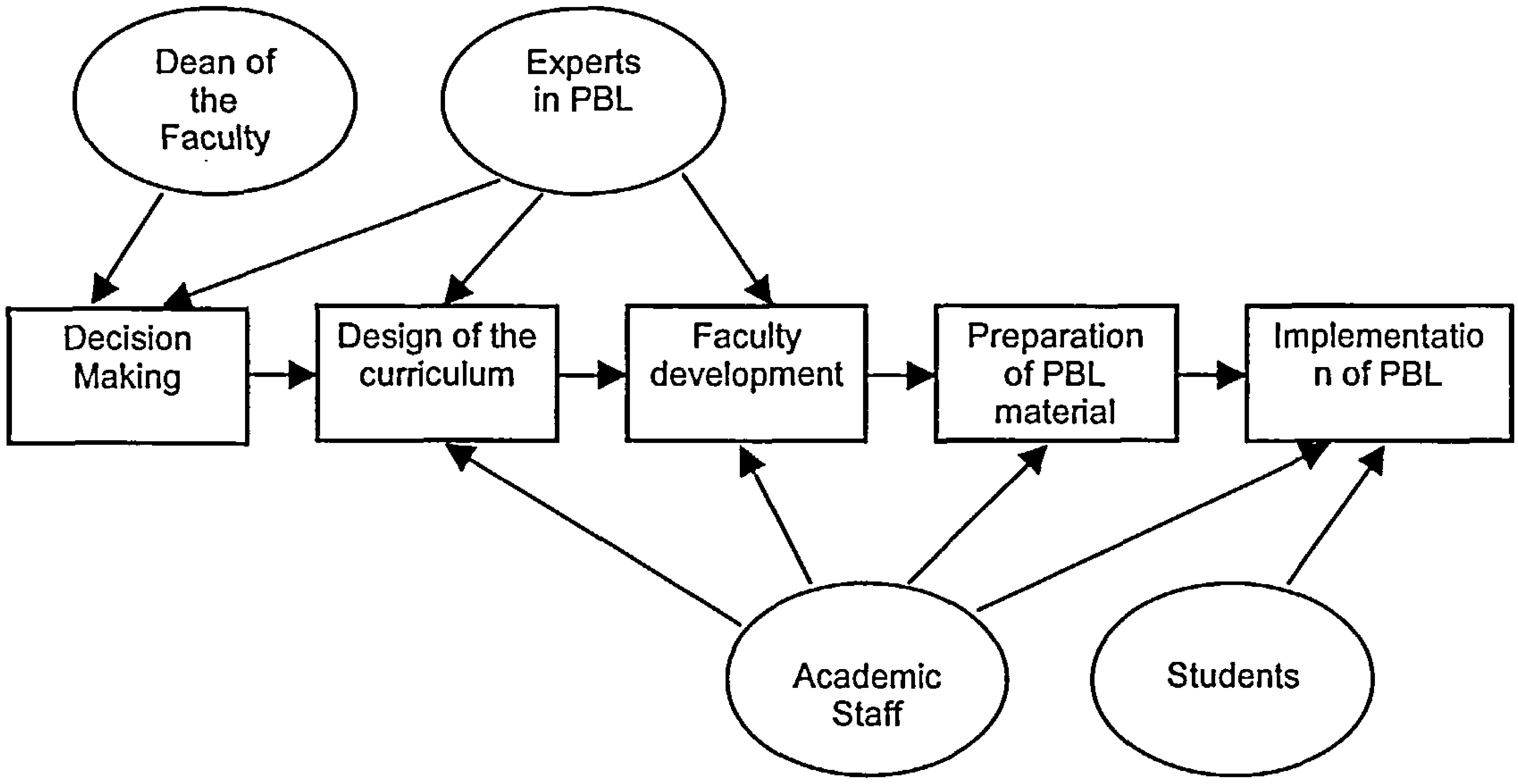

Figure 24: ***The relationship between personnel and procedures involved in the PBL implementation.***

5.3.4 Changes in Curricula, and Management

5.3.4.1 Changes in Curricula, and Management: Question D1

Does the implementation of PBL require changes in the curricula of the architectural school?

Can you describe the nature of curriculum structure or instructional design before and after the implementation of PBL?

There were two (2) questions in category D1. The first question sought to find out whether there was any change required in the architectural curricula, to implement Problem Based Learning, whilst the latter sought an explanation of the changes which occurred. Table 25 summarises the elements of changes which occurred in the architectural curricula of the Faculty of Architecture at TUDelft, as mentioned by the interviewees.

Table 23: ***Elements of changes required by PBL in the architectural curricula.***

No.	Changes	Before PBL	During PBL
1	Set Learning Objectives	Learning architecture by separation of subjects	Learning architecture as a whole Subjects are integrated
2	Decide Educational methods to use	Using Conventional Method or Project Organised Learning.	Using Problem Based Learning
3	Examine the assessment methods	Subjects - Assessment by examinations and paper submission Design - Assess the end product and verbal presentation	Subjects and design are integrated - Assessment by examinations and paper submission
4	Build the whole curriculum	Defined by teachers, without relating to the environment.	Defined as a whole curriculum,
5	Students' learning methods	Subjects – lectures 600 subjects tabulated Design – Learning by doing	Subjects and design are integrated – learning by discussion and self study
6	Students' role	As passive learners	As active learners
7	Academic staff's role	As teachers	As facilitators
8	Students performance	-	Expected better

In addition, Table 26 shows the changes in curriculum time allocation for students' learning, whilst Table 27 shows the summary of changes in the faculty's curriculum structure.

Table 24: ***The changes in curriculum time allocation for students' learning.***

Time	Morning	Afternoon
Before PBL	Lectures in separate subjects No coherence among subjects Subject lecture based on hours/week	Design studio Each studio as a self sufficient unit Studio led by mentor (design master) Redundancy and repetition of knowledge learned
During PBL	PBL discussion on case/problem given Generate study issues	PBL Self Study Research on study issues
Real Practice during PBL	PBL discussion on case/problem given Generate study issues Fragmentation of subject still exist	Design studio Studio arranged in sequential order based on themes

Table 25: *Summary of changes in the faculty's curriculum structure.*

No.	Changes in Curriculum Structure	
	Before PBL	During PBL
1	Kingdom concept	PBL concept
	Self-sufficient studio 1 master studio 15 students	PBL group working on a theme 1 coordinator Few facilitators Students
	Quarter semester 4 semester of 8 weeks in a year	No semester, but conditional sequence of themes 6 blocks of 8 weeks in a year
2	Each semester had project	Each week has 1 case 6X8 cases = 48 cases/year
3	Longitudinal courses	Became horizontal courses Longitudinal lines were broken into themes

5.3.4.2 Changes in Curricula, and Management: Question D2

Can you explain in detail what the scenario of PBL class/instruction is like?

This question sought to find out what the scenario was in PBL classes, whilst PBL implementation was carried out in the Faculty of Architecture, at TUDelft. The answer given for this question was vague because there was no proper PBL class discussion conducted. Table 28 gives interviewees' perspectives on the class scenario, with quotes from their comments.

Table 26: *Interviewees' perspectives on the scenario of PBL classes.*

Interviewees	Class Scenario in PBL	Quotations
Professor B	Teacher did not act as facilitator	"No. There is something that would be very difficult for me to answer. I have trained teachers in Delft who are working with Problem based Learning groups and as teachers, they need to act as facilitator, they need not to act as expert, explaining how it is done. In design, I noticed there are a lot of teachers take the attitude of let me show you how to do it. So, you know, this is something you can see happening to the, with engineer, always."
	PBL was not correctly implemented.	That is what I mean. Yes, it is important thing to students' feeling that the teacher is not lecturing to them, but asks them, or challenges them to speak about the topic that they don't know anything about. It is not doing the job right.
	PBL was discouraging students' interaction	"The whole discussion is as I said, were very passive affair. Somebody hijacked the whole discussion and teacher was completely bored to death, and the rest of us will say, Okay, we have another 15 minutes of discussion and then go to bed."

Professor C	PBL had never lived up to the expectation	"I cannot really honestly say whether it has work to the way it supposed to. Because the problem was that we never really implementing problem based learning. We just, you know, going to the motion. Had a group discussion, you know, gave the students and the tutor in a space like this,..."
	Students depended on guidebooks.	"Yes, we have the so called the unit books, modules, or log books. And it short of in case the students have not taken their extensive note. They might just have jot down kind of formula, and explain with some example, examination example."
	Students were indifferent	"Students were indifference because current trend of performance oriented, and Problem Based Learning did not improve the students' speed of study and thinking skill."
	PBL developed into a talk society	"...Most design remains really schematic. So students still have quite a lot of problems, which they tried, not too easy to design a real building..." "Exactly. Test it. It is a talk society now!"
Professor A	–	–

5.3.4.3 Changes in Curricula, and Management: Question D3

Is there any change in the management or structural system of your department while implementing PBL?

Question D3 sought to investigate whether the PBL curriculum re-structuring affects management structure or not. The information related to this question will be discussed in chapter 6.

5.3.4.4 Changes in Curricula, and Management: Question D4

Do you think the implementation of PBL has any financial impact to the institution?

Since PBL implementation clearly affected management structure in the Faculty of Architecture, TUDelft, this question attempted to identify if it also had cost impact on the university. Table 29 shows interviewees' perspective on the cost impact of PBL implementation.

Table 27: ***Interviewees' perspectives on the cost impact of PBL implementation***

Interviewees	Cost impact	Quotations
Professor B	PBL increase cost	"Of course, it is. Changing would be more expensive. It is very well possible to organise Problem Based Learning curriculum that it would not be just as cost effective as the traditional curriculum, even more saving."
	May also reduce cost	"It would be difficult to make money on it. But it can be more cost effective in terms of higher output grade."
Professor C	Increase Cost	"Negatively, yes. It incurred more cost because this kind of staff had a book affair….."
		"We keep doing this kind of things, preparing. You know, extensive lectures notes. But it has become a very expensive material. This start ……………insanity. Personally, I know people do it, taking articles from list of books, make a photocopy and, all journal are nowadays, electronic, or library. So I don't think given a list is how we should start, we should study."
Professor A	No idea	"No idea, I have no idea."

5.3.3.5 Changes in Curricula, and Management: Question D5

Beside students and teacher/lecturer/tutor, who else involve in the implementation?

This question attempted to find out who involved in the implementation of PBL in the Faculty of Architecture at TUDelft. Table 30 shows the involvement of other personnel, arranged in the basis of hierarchical order.

Table 28: ***The involvement of other personnel in the PBL implementation.***

No	Group	Area of Involvement	Interviewees' comment
1	Policy makers	Decision Making	"There were decision makers, the dean, the dean and they hired me to implement the policy." (Prof. B)
2	Dean of the Faculty	Decision Making	"….in the executive board of the faculty to impose it, take it home as part of modernising and everything." (Prof. C)
			"No council however, the whole project was initiated by the dean of the faculty. His choice to start with Problem Based Learning, he managed to convince all the staff to go along." ((Prof. A)
3	Expert in PBL	Decision Making	"But Erik De Graff had the consulting and guiding pro of the process…." (Prof. C)
			"He was here not as the one who decided as what happened, but the one to advise the decision makers." (Prof. C)
		Design Of	"Yes, we have the advisor from university of Maastricht. And they came here, they even got a job here to organise the whole process." (Prof. C)

		Curriculum	"One of the thing they ask me to suggest to sort of organisation within the faculty, specifically aiming to the implementation of the new curriculum." (Prof. B)
		Faculty Development	"And in Delft, we gave workshop with my colleagues from Maastricht, so we have external expert who were not architect, but they were specialising in education research and they were able to provide the effective workshop." (Prof. B)
4	Academic Staff	Design Of Curriculum	"We invited professor of all the key groups in the faculty and they approved and design the new curriculum. We draw up the plan and we discuss it with the curriculum implementation and, planning group and when they were approved, then they were brought into the faculty. We did that with support from the key professors, through out the faculty." (Prof. B)
		Faculty Development	"And some points of times, they have series of training programme, for the staff." (Prof. B)
		Preparation of Material	"Yes, we have the so called the unit books, modules, or log books." (Prof. C)
		Implementation of PBL	What I found from my experience in architecture is that, the workshop in Problem based Learning. In itself it was very effective in involving people. (Prof. B)
5	Students	Implementation of PBL	"Problem based Learning group. If students are prepared to take responsibility for their own studies behaviour. But they need to be trained in study skill before they can effectively do that." (Prof. B)
6	Parents		"Very remotely" (Prof. B)

5.3.5 Staff Commitment

5.3.5.1 Staff Commitment: Question E1

How do you describe the involvement of academic staff in the implementation of PBL?

Question E1 sought to investigate in detail academic staff involvement in the implementation of PBL in the Faculty of Architecture, TUDelft. Although subject of staff's involvement had been mentioned in section 5.4.3.5, question E1 attempted to find out the actual conduct of their participation in four areas of involvement: the design of the PBL curriculum, the faculty development, preparation of material, and implementation of PBL. Interviewees had different accounts of academic staff's involvement, as they seemed to disagree about the level of participation of academic staff in all 4 major areas. Table 31 shows the interviewees' perspectives on academic staff involvement in the implementation of PBL in the faculty.

Table 29: ***Interviewees' perspectives on area of academic staff involvement in the implementation of PBL.***

	Areas of involvement	Interviewees' perspectives			Remarks
		Prof. B	Prof. C	Prof. A	
1	Design Of Curriculum	/	X	/	Not all academic staffs participated
2	Faculty Development	/	NA	NA	
3	Preparation of Material	NA	/	/	
4	Implementation of PBL	/	X	/	Had never been really implemented

Note: the symbol (/) represent agreement to the ideas, (x) represents disagreement.

5.3.5.2 Staff Commitment: Question E2

What is the level of understanding/acceptance among the academic staff of the conceptual philosophy behind PBL implementation?

Question E2 attempted to investigate the level of understanding among the academic staff of the conceptual philosophy behind PBL implementation. Staff understanding was a factor very important in determining the success of the overall implementation. As such, interviewees gave their perspectives on how the staff understood the concept. Table 32 summarises the interviewees' comments on the subject.

Table 30: ***Summary of interviewees' perceptions of staff's understanding of the PBL concept.***

No	Factors of understanding	What academic staff did	What they were supposed to do
1	Role changes	Acting as teachers	Acting as Facilitators
		Acting as experts (show students how to do)	Acting as motivators (inspire students to learn)
		Criticising students works	Stimulating students in thinking process Inspiring students to do their works Challenging the students to trace their own solution
2	Mechanism of PBL	Teacher centred Teacher as centre of focus.	Student centred Pay attention to students
		Teacher educated students	Both teachers and students should educate each other
3	Concept of PBL Implementation	Incorrectly implemented	-
		Not convinced with the relevancy of PBL	-
		Not thought about PBL	Should think, and then learn
4	PBL Curriculum Design	Theme were designed as problem statement	Theme should be designed as cases

5.3.5.3 Staff Commitment: Question E3

How do you think staff copes with management and organisational changes in implementing PBL?

Since PBL curriculum innovation influenced the management of the Faculty of Architecture at TUDelft, this question sought to find out how academic staff coped with the changes. There was no detailed information regarding this subject discussed by any of the interviewees. However, a brief explanation of this matter will be discussed in chapter 6, based on reflections from the whole analysis.

5.3.5.4 Staff Commitment: Question E4

How do you think staff copes with role changes in implementing PBL?

Question E4 attempted to investigate how the academic staff coped with role changes that they had to undertake while implementing PBL. There were various reactions to these subjects. Table 33 summarises interviewees' perspectives on staff's conduct of the situation, while Table 34 shows the allocation of students in themes, in the implementation of PBL in the Faculty of Architecture at TUDelft.

Table 31: ***The interviewees' perception over the reactions upon staffs' roles changes in PBL.***

No	Role Changes	Interviewees	Summary of Reaction
1	Teacher to Facilitator/tutor Specialists to non specialist /non expert	Professor B	• Staff felt PBL was not good teaching approach • Staff felt frustrated for not being allowed to do their work anymore. • Staff felt disappointed and reacted to change back to the old system.
		Professor C	• Staff were "all against Problem based learning." • Staff had never implemented PBL. • Staff felt that "Architecture has to be a specialist for consultant." • Staff felt difficult to organise learning environment with 3000 students. • Staff felt "it could cost too much time and money."
		Professor A	• Staff felt bad because working load is not evenly distributed. • Staff accepted the changes after 7 years of implementation. • Still, some of the old way of teaching came back and it was allowed.

Table 32: ***Allocation of students in theme.***

Items	The computation	Remarks
Students	3000 students at a time 5 years architectural study programme. 3000students /5 years = 300 students/year	
Theme	6 themes of each study year 15 students each class	
Classes	300 studens/15 students per class = 40 classes for each theme 40 X 6 themes/year = 240 theme /year 240 classes/year X 5 years programme = 1200 classes each year	1200 classes each year to be conducted

5.3.5.5 Staff Commitment: Question E5

Do you think academic staff have advantages in terms of their own self-development during the implementation?

Question E5 sought to identify any advantage received by the academic staff with the implementation of PBL in the faculty. Table 35 shows interviewees' perspectives on advantages of the implementation of PBL, received by the academic staff.

Table 33: ***Advantages of the implementation of PBL, received by academic staff.***

No	Interviewees	Advantages	Interviewees' perspectives
1	Professor B	NO on Salary	Question: "In terms of their salary, whatever, is there any different from the implementation." Answer: "NO"
		YES on Self satisfaction	"I think the reward for teachers is in watching the students to gain independence. That is how traditional teachers very often, they don't want to let go. If you can give them to enjoy growing , be independent, then they will find the reward in seeing that happening and getting the feedback from students, how much they enjoy the independence in their own performance."
2	Professor C	NO on Career Development	"Not improve lecturers' development in their research or whatever because that (there) was no real, you know, understanding of what educational approach and educational technology mean."
3	Professor A	YES on appreciation	"When you answer on those questions, you are very much appreciated much more than you are giving the answer before they question anything. That is the cultural effect which has given many teachers much more relief and, but otherwise, teachers are frustrated."

5.3.6 Students' Involvement

5.3.6.1 Students' Involvement: Question F1

What are the students' responses over the implementation of PBL?

Question F1 attempted to investigate students' responses to the implementation of PBL. The interviewees had diverse ideas about students' responses, in which some of the answers seemed to contrast to each other because of the different roles and positions interviewees held during the implementation. The contrasting ideas might also caused by their personal experiences and feelings towards the whole implementation. The range of answers given ranged between positive to negative. Table 36 shows the interviewees' perspectives of students' responses to the implementation of PBL.

Table 34: ***Students' responses to the implementation of PBL.***

No	Interviewees	Response/ Students attitude	Interviewees' perspectives
1	Professor B	Enthusiastic	"The students were so enthusiastic about the new problem based curriculum that they carried the implementation further."
		Like PBL	"Most of the students like it very much. If we can do it the right way, you have much support from the students group. You need to organise as part of the innovation process. The students' response groups, they will carry the innovation process."
2	Professor C	Attracted to PBL	"As I said earlier, in terms of proposition, so high school graduates were, people were attracted to go to a system of educational reform."
		Hate PBL	"But in terms of performance and everything, No. Everybody, well, practically, everybody hates it. The discussion group and this kind of stuff, because it is a waste of time. It was a minor irritation, but otherwise. I don't think the response is really a positive or negative, except, it was a waste of time."
			"A little bit negative, but in general term, indifference."
			"The reaction is just what I should and I will do it to the best of my capacity."

		Indifferent -Do the best to pass -Calculative Students. -Performance oriented.	"The phenomenal of this is described as calculative students. How many points do I get for this, and how many points do I get for that? It is not simply in architecture. How many points do I have to get in order to pass this exam, this course." "Yes, Not in terms of learning, not in terms of specialisation, most of the time spending for studies, is finding the easiest way to (pass). It is a universal phenomena."
			"Performance oriented. But not of maximising performance, but in terms of, well, you know, optimising efforts. So, obviously they would pass and get a degree and something like that, but not at all cause, not at all cause."
3	Professor A	No ideas	"Well, they cannot compare because they don't have."
		Supportive	"So there is the Club of that STILOS, always support the problem based Learning systems."
		Adaptive	"Then the students can easily adapt to the systems. Yes, because there is no anything else. New students cannot compare. Only that short period that the system was introduced to the first year."

5.3.6.2 Students Involvement: Question F2

How do you think students coped with the curricular/instruction changes in architectural education?

Question F2 sought to investigate how students coped with the curricular changes in architectural education. Chapter 6 will discuss some of interviewees' comments on this subject.

5.3.6.3 Students Involvement: Question F3

Do you think PBL equipped students with all the demands of competencies expected for their future professional practice?

Question F3 attempted to investigate if the PBL implementation equipped students for all the demands of competencies expected for their future professional practice. In general, only two of the interviewees offered their perspective on this subject. Table 37 shows interviewees' perspectives on students' improvement on competency level.

Table 35: ***Students' improvement on competency level.***

No	Interviewees	Interviewees' perspectives on Competency level
1	Professor B	-
2	Professor C	"No, no big change. It has not has any significant influence on the performance, you know, education."
3	Professor A	"I have no idea. That would mean that you have to compare what jobs they got afterwards. In 1990, in 1980s, and in 1990s. And then 2000s. I don't have that material, I can't compare them. But I have the idea that all students in architecture, only partly became architects. Some are becoming manager, some are becoming a graphical design, we have different architect that has become computer design."

5.3.6.4 Students Involvement: Question F4

Do you think students can easily adapt to PBL approach?

Question F4 in particular sought to investigate students' adaptive capability in implementation of PBL. Table 38 shows Professor Erik De Graaff's perspective on the issue.

Table 36: ***Summary of Professor Erik De Graaff's perspective on how to adapt PBL educational approach.***

No	Methods	Quotation
1	To talk freely	"Students are expected to talk freely, talk about ideas that they are not quite certain about. It may be wrong, and with those uncertain ideas, they discuss with each other and even to contradict teacher. And western students have no problems in doing that. Not knowing anything about the topic is not a barrier to talk whatsoever."
2	To take responsibility for learning.	"If students are prepared to take responsibility for their own studies behaviour."
3	To learn study skill	"But they need to be trained in study skill before they can effectively do that."

On the other hand, two of the interviewees offered information on the type of students who might succeed in a PBL educational innovation, and those who would not. Table 39 compares students, based on the interviewees' perspectives.

Table 37: *Comparison of two types of students.*

Interviewees	Type of Students		Quotation
	Proactive Students (To succeed in PBL)	Passive Students	
Professor B	Need freedom to study	students needs discipline,	"Because some students are triggered by excitement, by allowing them freedom. The other students needs discipline, outside discipline, they will work when they are told. And that is the kind of students who is prone to failure in Problem based environment. I think this is one of the reasons why problem based learning works so well in architecture. Because in architecture, I think it always work that people are motivated for the best. Architecture attracts people who want to excel."
	Students are triggered by excitement to work	Students will work when they are told	
	Want to excel	Students who are prone to failure in Problem based environment	
Professor A	Students are activated by problems	Sit lazy back when addressed with problem	"So this teachers said, well, they need a problem, otherwise they did not do anything. They sit lazy back. They don't do anything. Well, they were all kind of tutor instruction and somewhere it succeeded. The students were activated. So for 2 sessions. Or they were lazy, so, what do we have to do?"

5.3.6.5 Students' Involvement: Question F5

What are the advantages received by students involved in PBL system?

Question F5 sought to identify any advantages received by students in PBL implementation. One of the interviewees did not agree that PBL implementation brought any advantages to students, while the other two interviewees were very much agreed with the ideas. Table 40 shows the advantages received by students from the implementation of PBL, in the views of interviewees.

Table 38: *Advantages received by students on the implementation of PBL.*

Interviewees	Advantages received by students	Quotation
Professor B	Students were motivated to outdo everyone expectation.	"If the students are really motivated, they can create marvellous things, they can learn marvellous things, They can really outdo everyone expectation."
	Students were encouraged to excel	"If you want the curriculum to encouraging excellent right from the start, then you need to work in Problem Based learning.... because it helps the student to excel, at the cost of allowing students to fail, terribly. Yes, some would fail that might have survived in the traditional curriculum."
	Students were inspired to study	"Some project, some teachers, they are very inspirational and they manage to inspire students to do great work and those they attract students who are willing to put in double hours or triple hours."
Professor C	(disagreed on advantages)	Question: "So there was no particular advantage for students who involve in Problem Based Learning?" AK: "Not really, not really."
Professor A	Students learn from peers	"You see, and this is coming in a form of group. So they are learning from each other. That was the intention."
	Students were introduced to Socrates' concept of learning (self Learning)	"Well, it is modern. Because the teachers knows the things of 30 years ago. And nobody knows the things for the past 2 years. Or for the past year, or past week, or past day. I don't know anything. And I now teachers just like Socrates."

5.3.7 Conclusion

5.3.7.1 Conclusion: Question G1

Do you have a special role in the implementation of PBL approach in your institution?

This question attempted to investigate the involvement of interviewees in the implementation of PBL by means of their own personal account. This question was addressed to establish the reliability of the interviewees' perceptions on the PBL implementation. Table 41 shows the roles of interviewees in PBL implementation in the Faculty of Architecture, TUDelft.

Table 39: ***Roles of interviewees in PBL implementation.***

Interviewees	Roles	Responsibilities
Professor B	an education advisor	• To suggest sort of organisation within the faculty, specifically aiming to the implementation of the new curriculum.
	the facilitator of PBL implementation	• To facilitate the implementation process for the faculty. • To draw up the plan. • To discuss with the planning group for approval. • To get support from the key professors.
Professor C	the chairman of educational committee	• To advise orders of the different aspects of teaching. • Involved in the evaluation of different things, the evaluation was mostly in term of practical aspects. • Content and methods (in PBL) were practically had never been evaluated at this point.
Professor A	the co-coordinator of the first year	-
	the secretary of nearly all the committees	-
	member of committees	-

5.3.7.2 Conclusion: Question G2

What are the changes that should be carried out by other architectural schools if they decide to take up PBL challenges?

Question G2 attempted to seek interviewees' suggestions on how to conduct PBL implementation properly, if other architectural schools decided to take up PBL challenges. Their suggestions could offer ways of improvement to the PBL educational approach, especially in architectural education. Only two interviewees, Professor B and Professor C, offered their suggestions on ways of improvement. Table 42 and Table 43 show interviewees' responses on the subject.

Table 40: *Professor B's responses.*

Aspect of Improvement	Ways of PBL implementation	Quotations
Curriculum Design	Combination of PBL and POL	"I think to have them both, and to use the didactic of Problem Based Learning in a project organised environment. It might be the most natural solution for faculty of architecture.."
	Set learning objective	"Basically it all starts with learning objectives and try to figure out which of educational methods works best with which types of objectives, and then you will look at the assessment, and then you build the whole curriculum, based on the planning, starting with learning objectives."
		"And this is the effect of not defining curriculum in term of planning of objectives, the goals of methods matched to the goals, and I think only very few university curriculum is clearly defined in educational satisfactory manner."
Decision Making	Get unanimous decision	"I think It is very difficult to manage the school of architecture and to make them go along with one general decision for the best."
	Not top down decision, but bottom up	"Also, and if you manage the curriculum changes from the top down, tell the teachers that starting next year, we have changed the system and then you are not allowed to teach anymore, and you have to work, and then they will really (feel) frustrated, and it was really difficult to deal effectively with the frustration."
		They never thinking about it, so you need to stimulate the process that can be, manage in a way the experience is bottom up.
	Get involvement of staff	"Of course, the incentive is, management will have a goal. So it would be efficient from educational leaderships from a group of people who are designing out a plan for a new curriculum. Then, it will involve the people who have to do the work at full steps."
	Get support from all staff	"I think the chance to success is quite high, it depends on the condition. You need a lot of small group of people with patience who want to work with it."
Proficiency to perform	Faculty development for staff (training)	"Faculty development is the key to success in implementing education innovation of this type, because you need to make teachers experience the power of Problem Based Learning for themselves, through within, in order to get them go along and work that way with the students."
		"I think that is what you will find in all successful educational innovation, and all implementation that are successful. You will find that at some points of times, they have series of training programme, for the staff."
	Understanding of concept PBL	"That is in design teaching. I think if you want to change the curriculum of architecture, this is the basic attitude of teachers that you need to tackle. You need to make teachers aware that, in order to become effective, they need to pay attention to what the students have done and not tell them how they should have done."
		"Very good teachers can use their capability of oversee comprehensible methods to stimulate students in thinking process with this type of questions. I think that would be the best design teaching."

Table 41: *Professor C's responses*

Aspect of Improvement	Ways of PBL implementation	Quotations
Curriculum Design	Analyse its appropriateness to architectural teaching	"But (PBL) did not really go into the why and how. We did not really make it appropriate to architectural teaching."
		"This is the way educational approach should approach the subject. Explained on the one hand, and provide tools."
		"Convenience, communication, and explaining things".
	Should have had appeals	"Education technology simply tells us do this, does that. It does not have appeal. It should tell us, you see, you know, the way you teach is this, and like that. And you know, some mass instrument you can used in order to improve those things. That, that is better."
		"You know if you start with a label, and say, this is the way we do, it is not convincing..... We are not afraid to label. But label is being use to explain a thing. If you call this a pen, and we can communicate. The main thing is how can I write with this."
	Should be applied to appropriate subjects only	"If you try to apply Problem Based Learning in all aspect of architectural education, I don't know if its works. But if choose the appropriate subject and you said, this is much better than this problem in this situation."
		"Yes. I mean, all those things about human problems solving and about the nature of problems, it is fascinating stuff. The only question is how much can you expect. I don't think that any educational approach can cover a complete spectrum of study of an application area."
	Proper research	"Architectural teacher and educational specialist communicate. So it means that you will be able to set a research unit for the researching the educational approach. That would be very nice."
		"Work with specialist. We need specialist, people. Well, for example, coming from both areas, trying to make something of it."
		"So it has potential, that is, it has to come from architecture, rather than from the outside."
Decision Making	Use bottom up decision	"The only possibility to change this faculty is bottom up."
Proficiency to perform	Staff understanding	"So the thing is not changing everything, but improve and learn. When the university had this challenge, you know all research is not simply a making things, but mostly is understanding things. And if you don't understand, how can you improve. Big question."

5.3.7.3 Conclusion: Question G3

Do you think there is potential for success of implementing PBL in other schools of architecture?

This question G3 attempted to investigate if PBL had potential to be successful when implemented in other schools of architecture. Table 44 shows the interviewees' perspectives on PBL potential for success if implemented in architectural education elsewhere.

Table 42: ***Potential for success.***

Interviewees	Yes with Condition	Quotations
Professor B	With Support from staff and top management	"I think the chance to success is quite high, it depends on the condition. You need a lot of small group of people with patience who want to work with it. Like you pick up your score. You can just joined ideas, if no one will listen, to work on it. You need a group of people around. You need a dean who will support and who really believe it. Who make the decision to make it works."
	With Proper Planning	"And second difficulty is to establish a new system, to make a room into the school. ...Very often it goes five years back to the theories."
Professor C	With interaction	"So if there is no interaction between the subject matter and the educational specification, there can be no future. But if you put those together, yes it do means future."
Professor A	-	-

5.3.7.4 Conclusion: Question G4

Why do you think Architectural education is left behind in PBL research and implementation?

The writer did not have the opportunity to address this question to any of the interviewees.

5.3.7.5 Conclusion: Question G5

Do you think there is a need to further research on PBL in architectural education?

The writer addressed question G5 to find out interviewees' perspectives on research in PBL and architectural studies.

Table 43: ***Interviewees' perspectives on future research in PBL***

Interviewees	Yes/No	Quotations
Professor B	Yes	I think, yes. For the research in that area because there is still very little known about what make the curriculum effective.
Professor C	No to PBL	"Problem based, learning still have potential, but it has to be in society, Come from the society, Architecture as a profession, operate within the society, so with the combination of a social and "achitecturism" can give you something to start with , yes."
	Yes to societal research	But if you try to make society think in Problem based learning way, does not work. Why? May be it is very closed to serving social and intellectual activities, these are the one you have to explore. You need some work, study point, you know, that is the nice thing about good ideas. The best ideas are the ones that after hearing, they say, yes, obviously.
		So there is quite a scope, the only problem is accepting society, there is reason trying to improve society rather than reform society.
Professor A	Yes	Yes, but I think it is more interesting to see what happen when you can solve the kingdoms problem by theme based learning. But the main question is what is the different between design education on a university level and empirical study.

Detailed explanations of the data displayed in this chapter will be discussed in chapter 6.

CHAPTER 6

DATA ANALYSIS AND DISCUSSION

6.0 DATA ANALYSIS AND DISCUSSION

This chapter will analyse and further explain the data given in Chapter 5. As chapter 5 only laid out the data from the interview sessions, this chapter will discuss and explain the data, leading to the drawing of general conclusions from this research. In doing so, comparisons with information from other references used will be considered.

The discussion in this chapter is arranged in the same format and sequence as the interview questions categorisation. This is to ensure that process of cross reference between data displays in chapter 5, and discussion in chapter 6, could be easily followed. However, rather than going through each question, the discussion will generally focus on each of the following categorisations:

A. Conceptual Framework
B. Implementation
C. Comparison with Other Approaches
D. Changes in Curricula, and Management
E. Staff Commitment
F. Students' involvement
G. Conclusion

6.1 Conceptual Framework

6.1.1 Conceptual Framework: Question A1

Question A1 aimed to explore the interviewees' opinions on the importance of architectural schools to implement formal educational approach. Since none of the interviewees gave absolute answers of "yes" or "no" to the question asked, excerpts are given in Table 12 to show related quotes of the interviewees' points of view on the importance of having a formal educational approach.

Discussion of this conceptual framework category sought in-depth meaning of the interviewees' statements on the importance of educational approaches in architectural education. The discussion interpretively described the detail of a statement, or words presented by the interviewees. Some of the terms mentioned might require background information for readers to grasp the ideas presented. Some statements might need explanation to be considered relevant to the subject discussed.

Answering question A1, Professor B did not give an absolute "yes" or "no" on the importance of having a formal educational approach implemented in architectural schools. However, he emphasised that, as in any other profession, people needed training to be architects. He admitted that, although architecture had a different trend of educational approach, he did not recognise it as a formal educational approach. In architecture, there was no formal curriculum, yet there was a system where training was based on working with experienced architects, or getting training from experts. He added that architectural education did not have a theoretical framework as such, but had a tradition in practical architecture. It also had various series of styles, and teaching often related to styles of architecture.

On the other hand, Professor C answered the question with an absolute "yes". He believed in learning from the specialists, because an educational approach, in terms of psychological development, had been thought of for at least 50 years, and it could not be ignored.

There was no direct comment from Professor A on the importance of educational approach in architectural education. However, he expressed the concern that architectural education did not have a scientific theory of how students should study.

Interpretatively, Professor B's viewpoint on architectural education represented the idea that schools of architecture had been training architects without formal educational methods or theoretical frameworks. Instead, he said that schools of architecture practiced traditional methods in their educational systems. Traditional methods, sometimes called conventional methods, of teaching architecture had been used for centuries in architecture schools around the world. However, there was no clear definition of what was this traditional or conventional method really meant, and what constituted the method. The only indication that he mentioned about the constitution of "tradition in matters" was training from experts, the training which was "based on working together with experienced architects." As an educational specialist, Professor B did not recognise what had been practiced in architectural schools as a formal educational method.

Meanwhile, Professor C did not have any hesitation in saying yes to the idea of the importance of an educational approach in architectural education. In addition, he expressed the idea that he believed in learning from the specialist, contextually referring to educational specialists. Architectural education could not ignore educational approaches that had been developed in the psychological area by educational specialists. His viewpoint, that architectural education should learn from educational specialists, supported the importance of having a formal educational approach.

Based on the above, the importance to architectural schools of implementing a formal educational approach in their curriculum could not be denied. The educational approach would "place architecture on a sounder intellectual and practical foundation" (Heath, 1984). Although Professor B and Professor A did not actually say "yes" to the importance of having a formal educational approach in architectural education, Professor B's statement that people needed training to become architects, and Professor A's comment on the lack of scientific methods in learning architecture expressed concern for its importance. Professor B suggested the "most natural solution" that is appropriate to architectural education, but this subject will be discussed in section 6.7.2.1.

In addition, the discussion also provided information on the components required in order to have a formal educational approach in education. Figure 25 shows the conceptual clustered network of components required in a formal educational approach for architectural education. All the components of the formal educational approach mentioned by the three interviewees were seen as necessary for architectural education to develop its own formal method. Those components were:

having a scientific method of study, having a proper theoretical framework, having educational specialists to guide on forming the educational approach, and having proper architectural training for students.

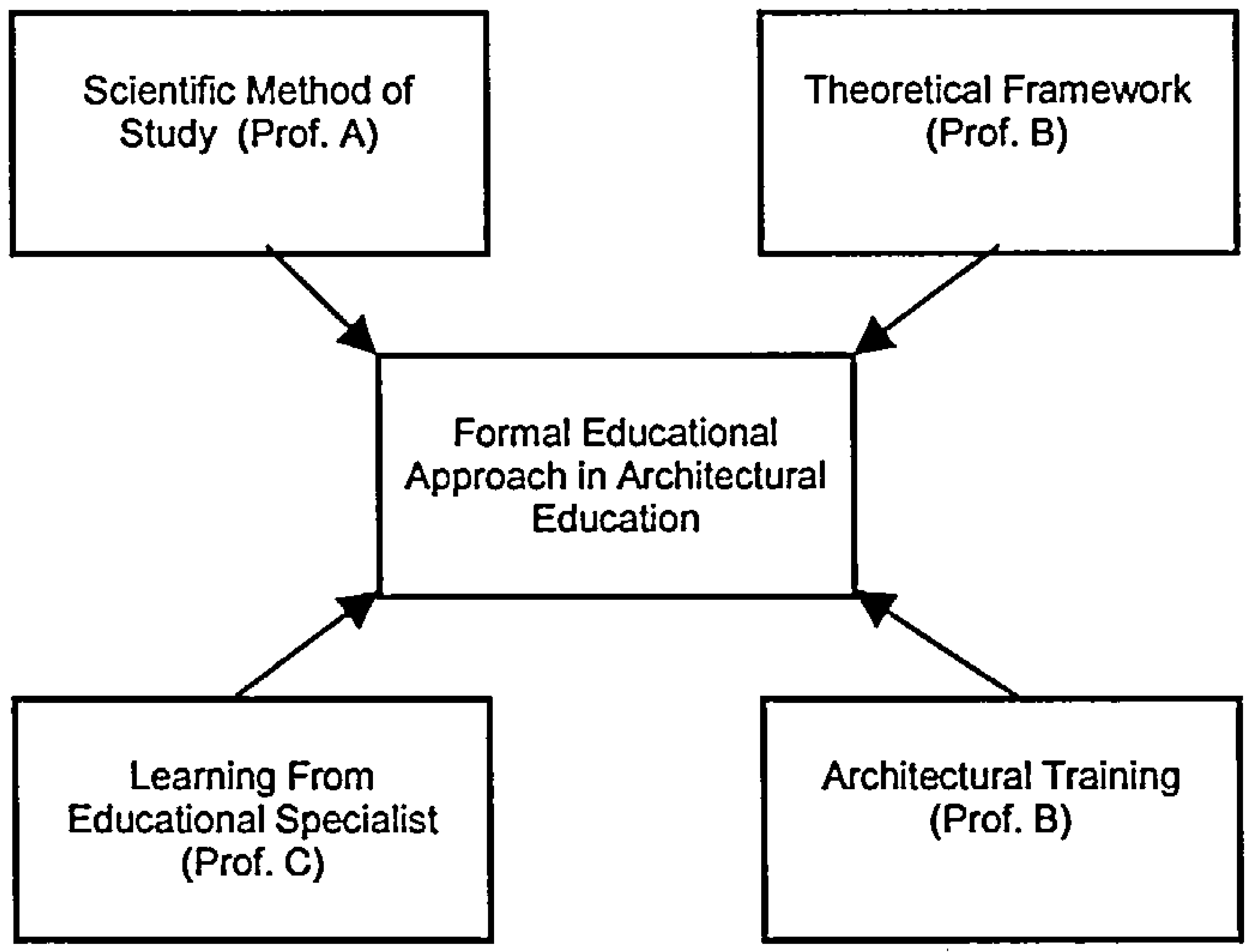

Figure 25: ***Components required to have formal educational approach in architectural education.***

Although it had been claimed that most architectural schools used the conventional architectural teaching method, the lack of definition of the conventional method resulted in its lack of recognition in general educational practice. Therefore, it was concluded that having an educational method with a proper theoretical framework was important for architectural schools. Although, thus far, architectural schools around the world have managed to survive without proper labelling of their educational systems, the importance of having educational methods with a theoretical framework was significantly apparent as the current lack of it caused many problems. Some of the problems were discussed in chapter 2, the literature review section.

6.1.2 Conceptual Framework: Question A2

Discussion on question A2 of conceptual framework category sought to find if there was any educational approach implemented in architectural education, besides Problem Based learning (PBL). In addition, the information gathered from this question might suggest what architectural schools had been practicing and what might constitute their educational systems. This question was related to question A1, in which answers given by the interviewees indicated that there was no formal educational approach practiced in architectural education. Educational specialists did not recognise what was practiced thus far as being formal educational methods.

Data regarding this subject gathered during the interviews sessions were presented in Figure 19. It shows the type of educational approach implemented in architectural schools that were known to the interviewees. Professor C identified three educational approaches known to be used in Architectural Education: Conventional System, Work Based Learning, and Analogy and Metaphor. He specifically did not define each of the approaches, but briefly identified conventional systems as something that was evolving, without people necessarily recognising it. He described that the development of the conventional systems as having unclear evolving process, which sometimes was considered the "best way" of dealing with architectural education.

Also, Professor C commented that the concepts of Analogy and Metaphor in architectural education were considered a very "minor" advancement in architectural education approach. One example of this kind of metaphorical thinking was "learning in gaming environment," which was very popular. Furthermore, he also suggested that "educational technology" might be more appealing to be explored in architectural research, as compared to Problem Based Learning.

Similarly, Professor B identified three educational approaches that he knew in architectural education, namely Training from Experts, the Beaux-Arts method and Project Organised Learning. He described Training from Expert as a system without theoretical framework, or with no formal curriculum. It did "have however, tradition in matters and practically (practical) in architecture." Students were supposed to work with experienced architects, and teaching often related to series of styles in architecture. Indeed, he explained that the training from experts basically was a system by choice. Meanwhile, Professor B described Beaux-Arts movement as a revolution in which teaching was done "with hybrid copying."

The third educational approach mentioned by Professor B was Project Organised Learning, which was introduced in the Faculty of Architecture at TUDelft in the end of the 1960s. It was also considered as a revolution because it shifted architectural education into the possibilities of choosing projects among professors, teachers, and students, so that every one had a project to work on. The primary goal in most Project Organised Work was "to produce something, to create something," and "to make a design." In Project Organised Learning, the output was considered much more important than the learning process. He perceived that the focus on output encouraged students towards "doing", but not "knowing."

There was no opportunity to ask question A2 directly to Professor A. Nevertheless, his opinion on architectural approach was basically excerpted from part of the conversation which took place in the interview session. He described that, before the implementation of PBL in the Faculty of Architecture at TUDelft, the faculty did not have a "scientific method" of how students should learn. In fact, the institution actually adapted an approach that he identified as the "Kingdoms Concept," where students learned from a master or chair of the studio who independently decided on which lectures, projects, and exams were to be given to students, and how. The teachers, who were considered as mentors, worked individually without concern on repetitions of subjects and knowledge delivered to students. The only guide that the mentor had was some key words of the theme of the studio. Professor A claimed that most architectural schools used the same system as their educational method in their architectural curriculum.

Overall, the interviewees mentioned seven educational approaches implemented in architectural education, besides PBL. There were identified as the Conventional System, Work Based Learning, Analogy and Metaphor, Training from experts, the Beaux-Arts movement, Project Organised Learning, and the Kingdoms Concept.

Although the interviewees mentioned Work Based Learning, Analogy and Metaphor, and The Beaux-Arts movement, definition of these terms will not be elaborated upon in this section, as they are not seen as significant to the finding of this research.

Nevertheless, the other four educational approaches in architectural education mentioned by the interviewees were seen as significant to the research. Although Conventional System, Training from experts, Project Organised Learning, and Kingdom system were named differently, and separately mentioned by different interviewees, there were some similarities in terms of their components. Therefore, this discussion may lead to a definition of these terms, based on the discussions during the interviews session. The following texts elaborated on the similarities and differences among them.

None of the interviewees gave an absolute definition of the Conventional method practiced in architectural schools. Professor C described the conventional system as something that was "evolving, without people necessarily recognising it." The conventional system in architectural education did not have absolute methods of teaching and learning, and he explained that the development of the conventional system of architectural education "as going around and around without knowing where to head for." He said that this method was sometimes considered as the best practice in architectural education.

Since the interviewees gave no absolute definition of the conventional system, its definition was based on literature review. However, it is also necessary to consider the meanings of the other methods mentioned by interviewees, which at the end might be similar to conventional methods. Although all three interviewees identified different terminologies for the educational approaches, they were probably describing the same approach.

In order to define the meaning of Architectural Conventional Methods of Educational Approach, perhaps it is important to see the meaning of the word conventional itself. The dictionary of Contemporary English (Biber, et. al., 2003) defines conventional method, product, or practices as something that had been used for a long time, and was considered the usual type. Therefore, the conventional methods in architectural educational approach should be defined as what was acceptable and common in architectural education. De Graaff and Cowdroy (1997) stated that architecture education throughout the western world was dominated by "studio teaching," which varied between what educationalists referred to as "tutorial based teaching," and "apprentice-based teaching" or "mentor-based teaching". Meanwhile, Salama (2003) perceived that design pedagogy was generally founded on two approaches: Problem based Learning (PBL) was used to explore 'hypothetical" design problems, and Action Learning (AL) which involved learning by experience to solve "real life" problems. He also claimed that those two approaches were critical and important to the intellectual and professional development of architecture students.

Based on De Graaff's, Cowdroy's and Salama's perception of what was generally common in architecture, it was concluded that studio teaching, PBL and Action Learning constituted the Conventional Methods of Architectural Educational Approach. Furthermore, De Graaff and Cowdroy also mentioned the use of different terms to describe studio teaching: as "tutorial based teaching" and "apprentice-based teaching" or "mentor-based teaching." The word tutorial, which literally meant "a period of teaching and discussion with a tutor" (Biber, et. al., 2003), explained the process taking place in order to disseminate knowledge between two parties. "Mentor" has the synonyms of adviser, counsellor, guide, tutor, teacher and guru, and could be defined as an experienced person who advises and helps a less experienced person. Meanwhile, "Apprentice" means trainee, learner, beginner, novice, and tyro. In the interview session, Professor B described training by experts as the training that was based on working together with experienced architects. Therefore, "training from experts" mentioned during the interview was the third method of architectural educational approach that conclusively could be constituted as part of the conventional method, because it involved the presence of two parties, basically the one who disseminated knowledge and the one who received the knowledge.

Professor B perceived that the Faculty of Architecture at TUDelft used POL prior to the introduction of PBL approach. Table 13 in chapter 5 listed the characteristic of POL described by him during the interview session. POL was described as an educational approach whose primary goal was to produce something, to create something, and to make a design. Assessment of students' performance was based on the final product, where output was considered much more important than the learning process. Just like the real practice of the architectural industry, students focused on working collaboratively on projects chosen by the teacher. Here, teachers had lots of freedom in choosing design projects, and acted as design experts to whom students referred. The teacher became the focal point of the educational systems. Professor B described this so called teacher-centred learning environment as effective, but "learning effects" were limited because, in terms of the learning experience, students missed out on the things that they were not told.

In De Graaff's and Cowdroy's article titled Theory and Practice of Educational Innovation, Introduction of Problem Based Learning in Architecture: Two Case Studies, they termed the same method as Project Teaching (De Graaff & Cowdroy, 1997). Project Teaching was "characterised by principles which reflected the social ideals of the democratic movement of the time." Those principles were: learning should be relevant in a social context; students should develop independence; and teaching should be nondirective (De Graaff & Cowdroy, 1997). Within the project teaching approach, teachers were able to express their personal convictions and preferences of architectural style, and styles such as traditionalism, functionalism, constructivism, de-constructivism, realism, and postmodernism were all represented. The independent position of the teachers, however, prevented ongoing centrally guided development and refinement of this approach. Ongoing debate about the quality of education was part of the culture, and overall planning could be ignored in favour of individual philosophies (De Graaff & Cowdroy, 1997).

While project organised learning was claimed to reflect the social ideals of the democratic movement (De Graaff & Cowdroy, 1997), contrarily it also allowed expression of teachers' personal convictions and preferences of architectural style, and ultimately developed individual philosophies. This self-centred, egocentric, or egoistic stance was also revealed in the Bauhaus idealistic basis where an artist must be conscious of his social responsibility to the community, but at the same time the community had to accept the artist and support him (Gordeeva, 2004). Conclusively, the POL approach in architectural education was also called Project Teaching, and had some similarities with the Bauhaus Teaching method. In Architecture, Bauhaus teaching had influenced architectural education everywhere in the world in the early 20^{th}century (Salama, 2003).

Thus far, based on the connection between the subjects discussed, Conventional methods could be considered as using a system of Learning from Experts. Meanwhile POL was officially called Project Teaching (De Graaff & Cowdroy, 1997), and it also had the same characteristics as Bauhaus Teaching. Therefore, the Conventional System, Training from experts and Project Organised Learning constituted the same educational approach of teaching architecture.

The above conclusion that Conventional Method as the same as Training from Experts and Project Organised Learning, leave Professor Taeke De Jong's description of Kingdoms Concept to be further explored. In the interview session, he described the Kingdom System as learning based on a master of the studio, and claimed that most architectural schools used the system. Architectural educational teaching approach in the Kingdom system originally started with a master as the centre of studio teaching. The master of studio would organise studio teaching according to his preference: ranging from the types of project chosen, methods of knowledge dissemination, to the methods of students' assessment. Students were expected to do design projects based on the requirement set up by the master of the studio, and the master would then assess the students independently. As leader in the studio, the master had "all the possibilities" to manage his or her design studio. The master of the studio often gave lectures to students whenever and whatever he thought appropriate. There was no central control and guidance for the master on how to handle the studio, except for the key words of themes associated with the year of students' studies. This independency led to the formation of the Kingdom system, in which the master of the studio treated his studio as his own territory, his kingdom. All the decisions regarding learning and teaching were based on his/her preference. As a consequence, each master of a studio developed his or her own kingdom independently, with his or her own curriculum, with no cohesion between courses, and regardless of repetition of subjects. In the case of the Faculty of Architecture at TUDelft, the kingdom system ultimately caused the faculty to have 600 subjects tabulated, in which many subjects of general architectural studies were being taught repeatedly.

The method of design teaching in the Kingdom system described by Professor A was about the same as the conventional system discussed previously. However, the exploitation of power by a master of a studio, as explained by him, was actually describing the lack of proper management in handling the process of implementation of conventional architectural educational approach. Therefore, the Kingdom system was basically not an educational approach, rather it was a description to explain the mis-application of architectural conventional educational approach, specifically referring to TUDelft only. This deficiency was the product of incorrect implementation of the conventional method where individualistic surpassed strategies. Indeed, the term Kingdom system was more appropriate in reference to the incorrect managerial process of the educational approach.

6.1.3 Conceptual Framework: Other Relevant Information

While the discussion in questions A1 and A2 focused on educational method, there was other relevant information provided by the interviewees that was considered relevant to the whole research. This section discusses the information which was extracted from the interview transcripts and displayed in section 5.3.1.3 of chapter 5.

All interviewees described the situation in the Faculty of Architecture, TUDelft, prior to the implementation of PBL. The diagrams in figures 20-22 in Chapter 5 illustrated the different perceptions of the situation in the views of the three interviewees. In addition, the interviewees also described their perceptions about what was constituted as PBL. The description is summarised and displayed in Table 14 in Chapter 5.

6.1.3.1 History of the Faculty

All the interviewees agreed that the Faculty of Architecture at TUDelft was in a "shambles" prior to the introduction of PBL. Professor B stated that, before the implementation of PBL, the existing Project Teaching had little cohesion in its educational program as the program had the artistic components mixed with the methods of engineering education. He described the situation as the balance between two influences on teaching in architecture that had been "swinging back and forth like a pendulum." Consequently, the Project Teaching implemented gradually deteriorated and any cohesion within the curriculum was lost. "Some subjects were duplicated by different teachers, other areas were neglected and, eventually, the students' freedom of choice was reduced to choosing a project mentor" (De Graaff & Cowdroy, 1997). This information was consistent with Professor A's description of the Kingdom system, where academic staff formed and monitored their own territories as kingdoms.

In term of management, Professor C's viewed the Faculty of Architecture at TUDelft as being in a "shambles" due to the lack of central control in its organisation. The institution was too big and there was no single power to control the overall cohesion of the architectural program. Although the organisation was divided into several committees to monitor the process of the educational program, the committee did not work well due to the size of the institution.

In addition, the question of whether architecture was a scientific course or purely art had arisen in the university. The sheer existence of the Faculty of Architecture in TUDelft was in question because, in the Netherlands, architecture teaching was usually taught in art colleges. There were 30 art colleges teaching architecture in different ways, and only two schools of architecture existed in technical universities. They were the faculty of Architecture at TUDelft, and the Faculty of Architecture in the Technical University of Eindhoven (TUE). The Faculty of Architecture at TUDelft received a threat to be merged with the School of Architecture in Eindhoven, unless proven to be a science stream.

These three factors resulted in a review by the National review committee, of the Dutch Ministry of Education. The review concluded that the architectural program in TUDelft neglected technical study areas and the curriculum lacked cohesion (Bouwkunde, 1988; cited in De Graaff & Cowdroy, 1997). This criticism from the national report resulted in ambitious plans to improve the curriculum, where PBL was proposed as the solution.

PBL pedagogical approach was considered as the solution of problem encountered by the Faculty of Architecture at that time, not only educationally but also in management. In terms of education, it gave "a name and an established body of theory to a form of education" which embodied the best characteristics of traditional design teaching and allowed them to be applied to the whole curriculum within a single theoretical framework, thereby achieving integration at both the theoretical and application levels (Cowdroy, 1994; cited in De Graaff & Cowdroy, 1997). De Graaff also claimed that PBL represented a significant change and challenge which were innovations in themselves and could provide an environment stimulating innovative behaviour among staff and students.

6.1.3.2 Definition of PBL

All three interviewees offered their perceptions on what characteristics constituted the PBL pedagogical approach. Table 14 in chapter 5 summarises their points of view of PBL implemented in the Faculty of Architecture, at TUDelft. There were some contradictory statements about their perceptions, due to the different roles played by each interviewee during the implementation of PBL in the institution. As mentioned in chapter 5, Professor A was one of the senior members in the faculty and responsible for the enforcement of the implementation. On the other hand, Professor B acted as advisor to the PBL implementation process, while Professor C was one of the faculty members who felt that the implementation was enforced upon the faculty.

As an educationalist, Professor B's perception of the implementation of PBL was based on his didactic point of view, where an educational issue of how students learn was the main focus of discussion. On the other hand, Professor A took the managerial point of view of breaking the "Kingdoms System' into an organisation with central control. The PBL implementation in the faculty was perceived as helping the institution to establish control within the faculty, to reorganise the faculty, and eventually to ensure the survival of the faculty in TUDelft. Ironically, from a practical point of view, Professor C felt that the whole implementation of PBL in the faculty was irrelevant to the nature of architectural thinking.

Based on the summary in Table 14 in chapter 5, Professor B's description of PBL was quite closely related to the general PBL laid out by Barrows (1992). However, the philosophy of applying PBL as Cased based Learning (CBL), as mentioned by Professor A, was generally not understood by most members of the faculty. Many medical schools in their implementation of PBL generally used this philosophy of treating a case as a problem. The direct adoption of PBL model from medical school was seen as irrelevant to architectural education in the view of Professor C.

Based on Professor A's description, the philosophy of CBL was that a case was taken as the basis for students' quest for knowledge. Students were expected to undergo a series of inquiries, such as research, self-study, and discussion to come out finally with a problem statement about the case investigated. The final concern of this CBL implemented in medical schools was having a problem statement rather than solution to the problem, or more appropriately, to the case. In contrast, CBL as generally understood by the academic staff in the Faculty of Architecture at TUDelft, was as having a problem to be solved by way of lengthy discussion. This understanding was considered to be inconsistent with the conventional architectural education in which solutions generally could be seen in tangible formats. Therefore, the academic staff in the faculty tried to revolve PBL as a pedagogical approach that focussed on having design solutions.

In line of the above discussion, it is worth considering that architectural problem solving creates tangible design solutions, because design processes and activities give "form that is essential" to makes method, the mean by which search takes place, into design (Heath, 1984). Bekkering (2004) stresses that, the Faculty of Architecture at TUDelft "has its own particular focus on the physical living environment, both built and natural, at every conceivable scale." Although there are scholars who consider much of an "architect's activity is not problem solving and much of his problem solving is not design" (Heath, 1984), but at least in architectural education students know what they want to achieve: having design product as proposed solution that eventually would be assessed as measure of their achievement and performance. As such, activities in design studio are generally expected to generate tangible design solutions.

Moreover, Professor A also described the process of learning in a PBL curriculum. Although he was more comfortable to call it Case Based Learning (CBL), he did not intend to change the term PBL to CBL, rather insisted that PBL should be understood as CBL. Figure 26 shows the differences and similarities of learning process student experienced during the implementation of PBL, as described by Professor A.

The intended model of PBL, described by Professor A, was actually the model taken from PBL implemented by many medical and law schools. In the model, cases were taken as the basis for learning. For example, in a law school, a group of students were given a case about a postman bitten by a dog while delivering letters to a house. In that instance, students were expected to look for clauses in legal documents of who might to be blamed for that incident, and what were the legal provisions given for all parties involved in the incident. Similarly, medical students were often presented with a case, in which they were expected to find reasons for symptoms experienced by a patient, before finally suggest the diagnosis of the patient's problems. Indeed, the legal provisions and the diagnosis presented at the end of PBL learning process by both law and medical students were considered as a "problem statement," a component required by the general PBL pedagogical approach.

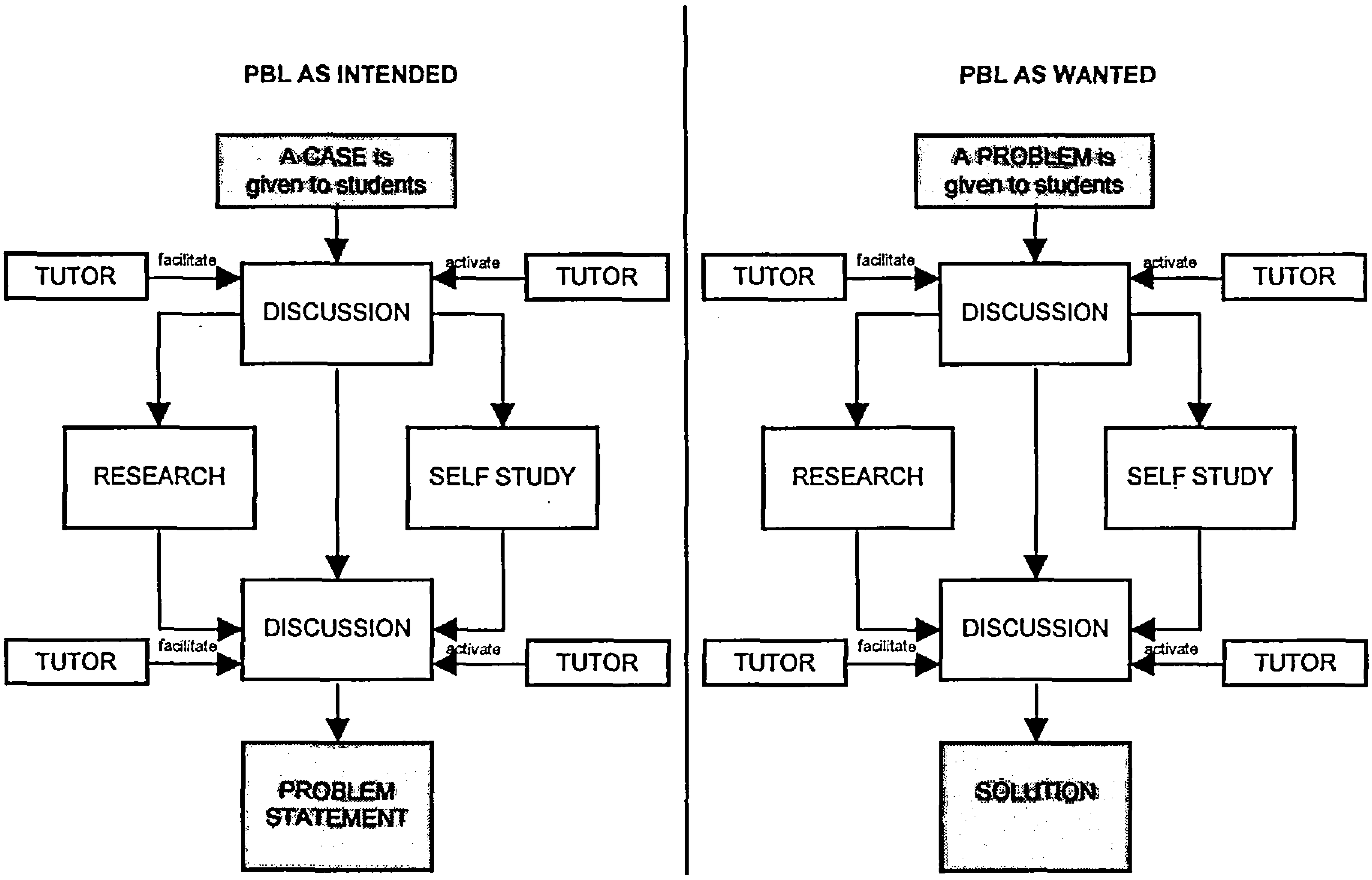

Figure 26: ***The summary of Professor A's description of PBL implementation in the Faculty of Architecture at TUDelft.***

The search for a problem statement, as a learning process in the PBL implemented in law and medical schools was questionable if applied to architecture. Professor C found the methods as irrelevant to architectural education, as design was not considered as problem solving in an objective sense; rather it is problem solving in a very subjective way. In architectural education, design solutions could be indefinite, whilst in many other disciplines, an answer or solution would always be definite. He emphasised that the use of "analogical thinking" to solve a problem was very much "didactic and too mechanical."

Professor C's argument was intuitively supported by Professor A in his statement that "to teach design is (was) something else that to teach imperial studies," because the methodology of design was different. Professor A perceived that the main difference existed in architectural studies as compared to other disciplines was that, it had a "complete compact sensibility of the architecture object." Design problem was a "context" which raised enormous methodology problems that could not be realised openly. He elaborated that in architecture, the classical way of proposing the research method using a problem statement in a hypothesis cannot be applied. Indeed, while researchers and designers in other field of studies tried to find the causes, architects would always try to find reasons. The following extract of Professor A's statement explains the concept further.

> *"An architect does not have a problem. He has a problem field, a complex with thousands of problems. And if you would choose one of the main problems to solve, he would raise other problems. So it has to, the problem statement has to be the vague ideas of the field, of problems that he is supposed to put the concept that put everybody together, much more than solving and define problem."*

Based on the discussion above, it was concluded that PBL pedagogical approach that was generally applicable to many disciplines of studies could not be literally adapted to architectural education. Modification of the PBL pedagogical approach should be carried out to ensure the learning method was responding to the needs of architectural thinking. Since architectural education had different learning goals, the strategies designed to achieve the goals should also be different.

6.2 Implementation

6.2.1 Implementation: Question B1

This discussion on the implementation of PBL in the Faculty of Architecture at TUDelft begins with the analysis of the purposes of PBL implementation. By addressing question B1, "what do you think the main purpose of the implementation of PBL in your department?", this study attempted to analyse the reasons behind decision of PBL implementation in the faculty.

Table 16 in chapter 5 summarised the purposes of PBL implementation, as perceived by the interviewees. Throughout the interviews, interviewees mentioned some purposes repeatedly as compared to others to indicate the hierarchical level of importance; therefore, categorisation of the purposes into several sub-headings was made for easy understanding of the situation.

Based on information gathered during the interviews with all three interviewees, there were six reasons or purposes for the Faculty of Architecture at TUDelft to embark on the implementation of PBL. Although the purposes that had been identified were categorised in several sections, it was important to note that they were actually related and dependent on each other. As such, a detailed discussion of this subject would have some points mentioned repetitively. Discussion of each purpose of PBL implementation will also be arranged in hierarchical order of its importance.

6.2.1.1 Curriculum

All the interviewees agreed that the reorganisation of the curriculum structure was the main reason for the Faculty of Architecture at TUDelft to undertake PBL implementation. Regarding this, Professor C perceived that "the instrument for the refurbishment of the curriculum" provided the faculty with a modern and clear curriculum structure. On the other hand, Professor A suggested that the reorganisation of the curriculum structure was successful in breaking the kingdoms systems by establishing control over subjects learned in studio. The new arrangement of curriculum with themes was seen by Professor B as a means to improve efficiency, to be more effective and coherent, and to provide effective learning environment to students. In his view, this new curriculum would also enable teachers "to exercise more control of what the students learn, even though it would be indirect control." Besides, according to Professor A, this system would have "less lectures, less longitudinal input, and more self study." In general, the PBL curriculum was considered the way architectural faculty solved the problem of an incoherent educational system they had prior to the PBL implementation.

6.2.1.2 Management

With the new arrangement of the PBL curriculum system, the organisation of management systems in the Faculty of Architecture at TuDelft instinctively changed. Professor B perceived that undertaking PBL had enabled the faculty's management "to impose some order to the administrative measures." He commented that the new PBL curriculum structure would enable "the management to getting all the teachers to pull about." Similarly, Professor A viewed that in terms of teaching, breaking the practiced kingdom system spontaneously helped to establish control on academic staff, and to organise teaching in the faculty.

6.2.1.3 Survival

All interviewees agreed that one of the purposes of implementing PBL was for the survival of the Faculty of Architecture in TUDelft. Although all the interviewees mentioned this purpose, only Professor C detailed how the faculty survival might affect the future of the faculty members. The Faculty of Architecture received an external threat of closing down the faculty, if reorganisation of the faculty and its curriculum were not done promptly. The advent of this threat was the result of a review done by the Dutch National Review Committee, claiming that the faculty had neglected the technical study areas and the architectural curriculum lacked cohesion. Academic staff realised that the threat of closing the faculty would lead to moving of staff to other university, specifically to the Technical University of Eindhoven where another school of architecture existed. Ironically, some of the faculty members might face a worse scenario of losing their jobs. Therefore, undertaking PBL helped to convince the Dutch National Review Committee to spare the existence of the Faculty of Architecture at TuDelft.

6.2.1.4 Finance

Financially, the implementation of PBL was seen as a method to reduce the cost of managing the faculty. Professor C perceived that having a very big faculty with too many students was very costly. He said that "one big problem of this faculty is (was) the cost of teaching. Architectural education for 3000 students is (was) extremely expensive." Therefore, the faculty decided to undertake PBL because it might help to reduce costs by having fewer lectures delivered to the students. In addition, the implementation of PBL in the faculty was also considered as a selling point to attract students to come to the university, spontaneously helped the faculty to survive.

6.2.1.5 Performance

Professor C perceived that the implementation of PBL aimed to improve the quality and performance of staff in teaching. Although Professor B and Professor A did not mention this aspect, they indirectly implied it by emphasising the importance of PBL in improving the teaching and management system of the faculty.

6.2.1.6 Philosophy

One of the severe criticisms the faculty received from the Dutch National Review Committee was that the curriculum of the Faculty of Architecture at TuDelft had neglected technical study areas. The Dutch National Review Committee considered architecture as a non-scientific area of studies. Therefore, the existence of the faculty at TUDelft was in question. As a resolution, Professor A stated that the top management of the faculty decided to re-establish philosophically architecture as a scientific field. Indeed, the design of the PBL architectural curriculum was seen as a solution to the status problem faced by the faculty at that time, and aimed to respond to requirement of the Dutch National Review Committee.

Based on the above discussion, it is apparent that the purpose of ensuring the survival of the faculty was the most important objective of PBL implementation, while other purposes of reorganising the curriculum, rearranging the management system, improving performance of staff, reducing cost, and philosophically re-establishing the scientific field of architecture, were sub-objectives that ultimately could help the faculty to survive.

The conversation in the interview sessions did not touch much upon the educational or learning aspects of PBL implemented. Instead, the focus concentrated on establishing control of many aspects of management for the survival of the faculty. Indeed, it was implied that the whole process of PBL implementation in the faculty was for its survival at TUDelft. The insignificance of PBL as an educational approach was even proven by Professor B's statement that, "there were different goals for implementing the PBL in Delft (TUDelft), and I think many of, in terms of what it is (was) introduced for, it was not a success. It managed to help the faculty to survive."

6.2.2 Implementation: Question B2

Besides the purposes, the duration of implementation was also important to discuss in finding the significance of PBL implementation in the Faculty of Architecture at TUDelft. Question B2 sought to find out how long it took and also to examine the process involved in planning the implementation of PBL. The question was: how long was the duration of PBL implementation in your institution? The answer to this question would explain why and when it was necessary to change the curriculum.

Table 17 in Chapter 5 shows the duration and process involved in PBL implementation in the faculty of Architecture at TUDelft. Based on what the interviewees reported, the faculty implemented PBL for twelve years. The phases involved were: design of PBL curriculum, its implementation, its reviews and ultimately the conversion to other curriculum structure. Those phases were divided into a planning stage of 3 years, implementation stage of 10 years with 2 reviews in

1994 and 2001, and the conversion to Bachelor and MSc educational programmes in 2001.

6.2.2.1 Design Stage

The decision to design the PBL curriculum was made in 1988, and it took the faculty about 3 years to actually set up the PBL curriculum structure. Discussion and planning took place not only among the faculty members, but also involved some advisors hired from other universities. Professor B was one of the advisors involved in giving advice and training to the faculty regarding the PBL implementation.

6.2.2.2 Implementation Stage

Although all interviewees acknowledged the commencement of PBL implementation in the early 1990s, Professor B and Professor C agreed that the implementation of PBL had actually never been put into practice because there was severe resistance coming from academic staff. Reasons for the staff's resistance will be thoroughly discussed in section 6.2.3.7. Interviewees' statements regarding the implementation proved that PBL was never fully implemented. Professor C said that "for ten years, we have been doing nothing". He commented that, after constantly changing the essence of PBL architectural innovation, the educational system in the faculty went back to the conventional method formerly implemented. Meanwhile, Professor B commented that "to some extend, they had never started." Although officially the faculty publicised that they were using PBL as the educational approach, but under continuous change, growth and adaptation, they actually implemented "a mixture with Problem Based Learning in theoretical subjects, and Project Organised Learning for architectural design."

6.2.2.3 Reviewing Stage

In 1994, the Architectural Curriculum in the Faculty of Architecture at TUDelft underwent a scrutiny, organised by the Dutch National Review Committee, Ministry of Education. However, rather than reviewing the progress of PBL, the review committee examined the curriculum system in terms of its performance, knowledge (content), and technology. Professor C confirmed that the faculty passed the review "with flying colours," although PBL had "not been discussed very much in that review." He said that they were not actually evaluated on the implementation of PBL, but on the architectural or building application, and subjects. The priority given for the review was subjects of building management and computer aided design.

Revision and refinement of the PBL architectural curriculum took place after the Ministry review. Although the faculty continued their Bachelor Programme in the face of implementing PBL, Professor C stated that the essence of PBL educational approach actually disappeared because the faculty members were "not glad with the concept of the application of PBL." Regarding this, Professor B said that the faculty formally announced that they did not work with PBL anymore in 2002. He perceived that most of the time during the PBL implementation, they had a mixture of PBL in theoretical subjects, and POL for architectural design.

6.2.2.4 Conversion Stage

In 2001, the Bachelor of Architecture programme offered in the faculty was reviewed once more by the Dutch Ministry of Education, to concur with the Bologna Declaration of European Union. This put pressure on the Faculty of Architecture at TUDelft to reconsider changing the curriculum to suit the requirement of the Bologna Declaration. As a result, rather than offering Bachelor of Architecture Degree as a five year study programme, the programme structure of architectural education was changed to a combination of 3 years undergraduate Bachelor Programme plus 2 years Master Programme. Details of the Bologna Declaration are given in section 6.2.2.5.

Based on information provided by the interviewees, the implementation of PBL in the Faculty of Architecture at TUDelft experienced various phases during its implementation, including two sessions of reviews done by the Ministry of Education. Nevertheless, the process needs further explanation for full understanding of the situation that led to the termination of PBL implementation in the faculty.

The planning of the implementation of PBL in the architectural curriculum of the Faculty of Architecture, TUDelft, started in 1988, and was spontaneously inspired by the needs to improve the educational system, for the survival of the faculty. Since the faculty was under external pressure to alter the structure of the course to be more scientific in nature, the faculty made a resolution to implement PBL because it had the potential to improve the educational system of the faculty. Indeed, the introduction of PBL in the faculty was aimed to prove architecture as a scientific subject, and to claim its right of existence in TUDelft. Only after three years of planning and preparation that the faculty embarked on the PBL implementation in 1991.

Theoretically, the PBL implementation in the Faculty of Architecture at TUDelft carried on for 10 years, from 1991 until 2001. During the PBL implementation, changing and evolution of the curriculum system took place continuously to adapt it to the architectural discipline. As a result, the implementation of the new curriculum system was not entirely with PBL, but the hybrid between the previous educational approach of POL, and the new innovation of PBL. All the interviewees accepted the fact that PBL was not fully implemented, that it was only theoretically implemented, not practically. Although there were ministry reviews, at intervals, the reviews were not intended to scrutinise the PBL systems. On the other hand, review done by the Dutch Educational Ministry in 1994 was simply to evaluate the faculty's performance, knowledge (content), and technology; where priority was given to management and computer aided design. As such, the use of a hybrid educational system persisted in the faculty, despite the claim of having PBL as its main educational approach.

Another review done in 2001 by the Dutch Educational Ministry was also not for the purpose of evaluating the performance of PBL implementation. Instead, it was intended to fulfil the demands of the European Union to standardise educational systems among European countries. As the result of this review, the faculty of Architecture at TUDelft redesigned its curriculum structure to suit the needs of the Bologna Declaration, which demanded that tertiary educational systems in European countries were to follow the standard system of offering 3 year degree programmes and 2 year master programmes, so that the transfer of students between European universities would be made easier than before.

The conversion of the curriculum structure from a five-year architectural degree programmes into the combination of 3-year undergraduate Bachelor Programmes plus 2 year Master Programmes, marked the termination of the PBL implementation in the Faculty of Architecture at TUDelft.

6.2.2.5 Bologna Declaration

Under the Bologna Agreement of European Union, European countries established a commitment to have communal objectives, among which included "13 qualitative objectives for educational policy" that would be adopted by the European (Education) Council. Subsequently, on 5th. May 2003, the European (Education) Council set a "Target Value" for 2010 with regard to five educational objectives, as stated below (Dutch EU Education Benchmarks Action Plan, 2002):

1. Lowering the number of early school leavers throughout the EU.
2. Increasing the number of science/technology graduates throughout the EU.
3. Increasing the number of those achieving diplomas in higher secondary education throughout the EU.
4. Lowering the number of 15-year olds with low reading ability throughout the EU.
5. Increasing the number of adults participating in learning activities throughout the EU (Dutch EU Education Benchmarks Action Plan, 2002):

In place of the Target Value set by the European (Education) Council, the Dutch set their own specific objectives for 2010 with regard to five educational objectives. Table 46 shows the list of the Dutch Educational Objectives.

Table 44: *Dutch Educational Objectives.*

NO.	OBJECTIVE
1	**Reduce early School Leavers** 30% less early school leavers in 2006 as compared to 1999 50% less early school leavers in 2010 as compared to 2000thsi means that by 2010, the percentage of 18 to 24-year olds not following a programme of education and not in possession of a basic qualification needs to come out at 8%.
2	**Science and Technology Graduates** Before 2007: increase in intake to science/technology secondary education courses of 15% with a better male/female balance. In 2010: 15% more outflow from higher science/technology courses as compared to 2000. This will result in 6.7 graduates and PhD students in science/technology per 1000 residents aged between 20 and 29 years by 2010.
3	**Higher Secondary Education Certificate Holders** 85% of 22-year-olds to have gained a higher secondary education diploma by 2010.
4	**Basic Skill** By 2010 a maximum of only 95 of 15-year-old pupils to have low reading kills (scale 1 or lower in the PISA test)
5	**Lifelong Learning** At least 20% of 25-64 year olds to participate in educational and training activities by 2010.

Note: Adapted from Dutch EU Education Benchmarks Action Plan (2002).

In order to achieve the Dutch National Objective, a joint effort on the part of the Dutch Ministry of Education, Culture, and Science; and the Ministry for Social Affairs and Employment was required (Dutch EU Education Benchmarks Action Plan, 2002). As such, under the influence of the Dutch Ministry of Education, universities in the Netherlands took the initiative to contribute in the expanding Europe by "promoting and encouraging European dialogue among all partners involved in crucial issues." Among the issues concerned was "expanding students and staff mobility, and developing further mutual academic recognition based on acceptable qualitative criteria and transparency" (Caspersen, et. al., 1997).

Furthermore, the Bologna Declaration and "discussion about increased internationalisation" had inspired the Dutch Ministry of Education to adopt the recommended structures and levels of tertiary education (Heitmann, 2001). Table 47 shows factors leading to the establishment of the combination of 3-year undergraduate Bachelor programmes plus 2 year Master programmes in the Faculty of Architecture at TUDelft. Thus, the conversion of the architectural curriculum structure into the standard structure of tertiary education in European countries confirmed the ending of the PBL implementation in the Faculty of Architecture at TUDelft.

Table 45: ***Factors leading to the establishment of Bachelor and Master Programmes in the Faculty of Architecture, TUDelft.***

Time	Organisation	Description
2000	Council Of European Union	Lisbon Initiative • To establish European Knowledge Society by 2010 • To achieve stated objectives by adopting " open coordination method' • Consisting of 13 qualitative objectives for educational policy in the member states • To translate the agreed objectives into national policy
2000	Kok II Cabinet (Netherlands)	• Started on translating the Lisbon Agreement into the Dutch situation.
March 2002	European (Education) Council	• Adapted the Lisbon Objective Report
5 May 2003 (Brussels)	European (Education) Council	• Set target Values for 2010 with regard to five (5) educational objectives
Spring 2004	European (Education) Council	• (Spring Report) • To report to Council Of European Union on progress made.
Spring 2004	Dutch Education Council	• Informed Dutch Parliament to translate the five EU objectives agreed in Brussels into national Objectives and policy measure for education.
Spring 2004	Dutch Education Council	• Endorsed the central role for education in establishing the Lisbon objective. • Action Plan: EU objectives as guideline for the Dutch contribution to education in Europe

Note: Adapted from Dutch EU Education Benchmarks Action Plan (2002).

6.2.3 Implementation: Question B3

In conjunction with the purposes of PBL implementation, it was also important to examine the performance of PBL implementation in the faculty. Question B3 and its sub-questions sought interviewees' opinions on the success or failure of PBL implementation in the Faculty of Architecture at TUDelft. The questions were: "Do you think the implementation is a success? Please explain. How do you measure the success? It is by measuring students' performance, or by recognition of professional body and the community? Are they any problems?"

Table 18 in chapter 5 shows the summary of answers of the interviewees' opinions on the success of PBL implementation, while Table 19 illustrates the quotations excerpted from interview transcripts, regarding the performance of PBL implementation. Although the interviewees did not discuss much about the measure of success they undertook, their response to the questions was enough to indicate PBL performance in the faculty.

Since the success of PBL implementation was interrelated to the implementation purposes, the discussion about the measure of success should also be related to the purposes of implementation. Therefore, the sequence of discussion on the subject of PBL performance was arranged in a similar order to the sequence of purposes of PBL implementation discussed earlier. Besides, interviewees also elaborated on the problems arose during the PBL implementation, which was tabulated in Table 20. This table shows interviewees' individual perspectives of the problems arising during PBL implementation.

6.2.3.1 Curriculum

One of the reasons why the Faculty of Architecture at TUDelft undertook PBL curriculum innovation was to organise its curriculum system. Based on the information gathered, PBL innovation had **successfully** reorganised the curriculum systems in the faculty, and spontaneously broke the kingdom system associated with the former educational approach of POL. This claim was supported by Professor C who perceived that the PBL curriculum system introduced in the faculty was successful in breaking the kingdom system by establishing control of subjects learnt in studio. He stated that PBL implementation introduced theme organisation in the curriculum systems, spontaneously improved the efficiency in the faculty.

Beside organising the curriculum system, the sub–purpose in the curriculum categories were to have an effective and coherent learning environment, to control indirectly what the students learn, and to have fewer lectures but more self study, and more "longitudinal" input in the curriculum. Professor B perceived that PBL curriculum had been **successful** in terms of providing an effective and coherent learning environment for the students for several years. However, there was no statement by Professor A or Professor C to support the claim.

In fact, none of the interviewees commented on the success of the PBL curriculum specifically in terms of indirectly control what the students learn, numbers of lectures, amount of self study, and input, although they were part of the sub-purpose of PBL implementation. Perhaps, this was due to the lack of discussion on matters regarding the details of how PBL was implemented in the faculty.

Ironically, Professor C perceived that the PBL implementation was **far from success** in term of curriculum innovation. He perceived that the way PBL was applied in the faculty of Architecture at TUDelft was not a success because there was no real communication and preparation to undertake PBL curriculum. He also viewed that PBL innovation applied in the faculty was not really applicable to architectural education. Professor A supported his statement by saying that academic staff **had never succeeded** in making problems from cases, as intended by PBL innovation in the faculty. Professor A's comment was, "...so make a problem from that case, that is (was) the intention, and they were (had) never succeeded." In fact, architectural academic staff continuously saw architectural problems as something to be solved by means of design processes and activities (see figure 10: Problem solving curricula). Illustration of cases will be presented in section 6.3.2 of this thesis.

6.2.3.2 Management

The PBL implementation in the Faculty of Architecture at TUDelft was considered successful in terms of imposing order and administrative control in the faculty. Professor A perceived that the PBL curriculum structure and implementation **succeeded** in breaking the autonomy of the kingdoms system practiced by academic staff. With themes assigned to years of study, the top management in the faculty was able to monitor how the teachers taught, and what the students learned in the PBL-organised syllabus and subjects. For proper monitoring, teachers were supplied with handbooks, guiding them as to what they should deliver and how to approach the new learning environment.

Although the PBL implementation was successful in organising the curriculum into a themed system, it failed to get the full co-operation and involvement of academic staff. Professor B perceived that PBL was **not successful** because it was not possible to manage the change process effectively, without co-operation from the academic staff. He mentioned that the management was not able to deal with staff's resistance, which ultimately contributed, to the end of the PBL process. Indeed, resistance emerged because some of the teachers saw the PBL curriculum structure as a restriction on their freedom to express their preference of teaching style. In addition, most academic staff did not really understand the philosophy of how PBL should be implemented. Regarding this, Professor A commented by saying, "...so I was not very surprised that the organisation succeeded, but not the philosophy. The organisation was the break of the kingdoms in themes."

Indeed, the PBL curriculum structure enabled the faculty to impose some order on the administrative measures, as intended. Therefore, on paper, the curriculum structure appeared to be very much organised. Nonetheless, without full co-operation from the academic staff, the imposed order of organised teaching approach was not carried out properly, resulting in resistance to the implementation of PBL. As such, the implementation of PBL in the faculty of Architecture, TUDelft, succeeded in improving the organisational structure of the teaching systems, but failed to get staff involvement and to organise teaching properly.

6.2.3.3 Survival

Although the PBL implementation had some difficulties and resistance, Professor B said that, "it **managed** to help the faculty to survive." The new curriculum structure in PBL implementation had convinced the Dutch Ministry of Education that Architecture was also one of the scientific disciplines that had the right to exist in TUDelft. As such, the previous idea of closing the Faculty of Architecture was abolished. Consequently, the threats of academic staff losing jobs or having to move to other academic institution were also avoided. This survival of the faculty of Architecture in TUDelft was considered as a **success** contributed by the implementation of PBL.

6.2.3.4 Finance

Professor C was very convinced that the implementation of PBL in the Faculty of Architecture, TUDelft, had a negative cost impact on the institution. He said that the PBL implementation incurred higher costs because it required the preparation of guidebooks that was considered very expensive. The implementation of PBL required academic staff to prepare two versions of guidebooks for every theme assigned to the PBL teaching approach. One version was for tutors to use as guidance, and another version was provided for students as their study materials. Most of the time, the guidebooks contained examples of architectural designs reproduced from various resources, such as books, magazine, and journals. The preparation of the guidebooks incurred high costs to the institution in two ways: the cost of photocopied study guide material for every student and academic staff, and the cost of paying owners of the original resources for the copyrights permission. This claim that PBL implementation had a negative cost impact to the institution was supported by the Professor B by responding that, "of course, it is, changing would be more expensive," when asked about the subject. Conclusively, the purpose of implementing PBL to reduce the cost of running the faculty was **not a success.**

6.2.3.5 Performance

Although Professor C mentioned that the implementation of PBL aimed to improve the quality and performance of staff's work in teaching, he did not touch whether or not the aim was successfully accomplished. However, he mentioned that PBL implementation did not really improve students' performance in understanding the synthesis of designing, and speed of study.

On the other hand, Professor B disregarded the idea that the measure of success of PBL implementation could be determined by measuring students' performance, or by obtaining recognition of professional bodies and the community. He mentioned that "the student success is (was) determined mostly by the factor of students, and only to a very minor part, by the factor of educational environment. Students will (would) always make up for the deficiency of the curriculum." In addition, in regard to the recognition of professional bodies, he perceived that the reputation of the faculty did not depend on the educational method that was being used. Rather, it depended "on the status of top teachers, the top professor, and the reputation of the institution."

According to Professor B's comments, it was concluded that the question of whether or not PBL implementation had successfully improved the performance of staff and students should be disregarded. This was due to the fact that no measure of performance improvement had ever been done to compare the performance of students and staff before and after undertaking PBL implementation.

6.2.3.6 Philosophy

The survival of the Faculty of Architecture in TUDelft proved that the institution had succeeded in convincing the Ministry of Education that, philosophically, Architecture was a scientific field of studies. Nevertheless, unrelated to the philosophical issue of scientific studies, there was one major philosophical problem that arose in the implementation of PBL in the faculty. Most of the academic staff misunderstood what PBL meant philosophically. This lack of understanding impaired the way academic staff implemented the educational approach. Professor A perceived that, in a PBL educational approach, academic staff were supposed to design cases for students to work on and come out with a problem statement. However, rather than presenting cases as the basis of students' learning, academic staff often presented design problems to be solved by students, which ended up just like the conventional methods of learning architecture. As such, he thought that philosophically, the implementation of PBL was **not successful** in disseminating the true concept of a PBL educational system to academic staff. Professor A commented on this aspect of philosophical confusion by saying that the academic staff had never succeeded in making a problem statement from a case as intended. Therefore, he was not surprised that the organisation (the faculty) succeeded in surviving, but not the philosophy of PBL. Ironically, the formulation of cases as architectural problems as understood by Professor A could also be considered as misunderstanding of PBL philosophy. This is because architectural problems in the successful PBL model implemented in the Faculty of Architecture at UniNC are not treated as cases, but as design problems. Sample of "problems" in architectural discipline are provided in Appendix B. Moreover, Professor C's view was that there was no such PBL actually implemented in the faculty.

Based on the above discussion, there were mixed opinions among the interviewees on the success or failure of PBL implementation in the faculty of Architecture at TUDelft. All of them agreed that one major achievement generated by the implementation of PBL was the survival of the faculty. Meanwhile, two of the interviewees namely Professor B and Professor A perceived that the faculty had also succeeded in re-establishing the managerial control over the curriculum structure practiced in the faculty. Nevertheless, this opinion was objected to by Professor C, who insisted that the way PBL was applied in the faculty of Architecture at TUDelft was really a failure because there was no real communication and preparation to make the educational approach applicable to architectural education.

Based on the mixed opinions on the success of PBL implementation on areas of curriculum structure and management, it was not appropriate to conclude whether the PBL implementation was a success or a failure. However, the other aspects of discussion on problems that arose during the PBL implementation might strengthen one of the claims, and this subject will be discussed later in section 6.2.3.7 of this thesis.

Financially, PBL incurred more costs to the running of the faculty. However, the aspect of financial problem was not significant in this research of PBL performance in the Faculty of Architecture, TUDelft. Therefore, it was felt better to leave this financial aspect aside. Similarly, whether PBL implementation improved academic staff performance in teaching, and students' performance in study also will not be discussed further because no measure of performance had ever been analysed during the implementation of PBL in the faculty.

Misunderstanding of the philosophical aspect of the PBL educational approach implemented in the faculty was considered to be one of the reasons why the PBL implementation failed. The lack of understanding among the academic staff of how to carry out the PBL implementation led to the reversion to the old system of teaching.

The claim of failure, in terms of curriculum structure and management of PBL implementation, was mainly because the supposedly involved personnel in the implementation did not give full co-operation because they did not really understand the concept of the PBL approach. This put the interrelated aspects of curriculum, management and philosophical basis as the causes of resistance to the implementation, directly causing failure to the implementation. As such, the next discussion will see the reasons behind the resistance expressed by the academic staff, and also other obstacles faced by the management during the implementation.

6.2.3.7 Obstacles and Resistance

Based on the data obtained during the interview sessions, it appeared that several obstacles the faculty experienced during PBL implementation led to the unsuccessful implementation. Problems arose in many different aspects of implementation and each of the interviewees had their own unique perspectives of the problems. Table 9 in chapter 5 shows individual perspectives of the problems arising during PBL implementation. Four categories of obstacles were discussed in this session: Organisational Obstacles, Obstacles from Staff, Obstacles from Students, and Obstacles of Philosophy of PBL Educational Approach.

Organisational Obstacles

In terms of organisational obstacles, there were three factors which influenced the unsuccessful PBL implementation in TUDelft. The first was the scale of the faculty: it was too large for the management of the faculty to manage the implementation of PBL. The introduction of PBL implementation required changes in many aspects of running a faculty. Professor B perceived that having a very large faculty, of approximately 200 academic staff and 3000 students at one time; made it a very difficult and lengthy process to manage changes constituted by the implementation of PBL. Professor A's analysis was that the scale of the faculty was too large for sequential themes in a PBL curriculum structure to be organised. The faculty had approximately 600 students in each academic year of study, and to arrange that number of students in six sequential blocks in one yearly theme was difficult due to the time constraints and shortage of tutors. To make things worse, there were four student intakes in each academic year, and those students who had failed certain blocks of studies needed to re-sit the failed themes. Eventually, the problem of managing the regularity of students' enrolment in blocks of studies led the themes to lose their sequence, and PBL implementation was finally abandoned.

Moreover, due to the large scale of the faculty, the management was unable to get unanimous decisions among the academic staff on the changes to be undertaken, causing severe resistance. This resistance resulted in them refusing to learn the concept of PBL educational approach. Professor B felt that the scale of the faculty also led the implementation of PBL in the Faculty of Architecture at TUDelft to be lacking on faculty development such as training of staff for profound understanding of the concept behind PBL educational approach.

Secondly, an obstacle faced by the management was the severe resistance towards the management in the faculty from academic staff. Most academic staff felt that PBL implementation was imposed on them due to external influences. They claimed that the top management decision to have PBL as the new curriculum innovation was done without any discussion and communication with those staff who would eventually have to carry out the implementation. The top down decision was not welcomed and the management faced difficulty with the severe resistance thrown upon them. Attempt to create staff understanding of the implementation was difficult, and ultimately, the management was not able to deal with the resistance.

Thirdly, Professor C thought that some of the academic staff felt that the implementation was meant only to benefit the reputation of the faculty, but nobody in the faculty had a clear opinion on the PBL implementation itself.

Obstacles from Staff

The severe resistance to the implementation of PBL mainly came from the academic staff. This was due to the lack of acceptance among them, the lack of understanding of the PBL concept, and their refusal to get involve in PBL implementation, which in their opinion was labour intensive and time consuming.

a) Lack of acceptance

All the three interviewees agreed that staff did not accept the implementation of PBL because of the following reasons: the PBL implementation was imposed upon them, it took away their authority and freedom they enjoyed in the previous teaching method, and there was doubt on the relevancy of PBL in architectural studies.

The decision to undertake PBL as an educational approach to teaching architecture was seen as a top down decision imposed upon the faculty. With external influences, specifically the pressure from the Dutch Ministry of Education for the faculty to prove its right to be in TUDelft, the top management in the faculty decided to adopt PBL innovation implemented in the Faculty of Medicine, University of Maastricht. Few educational advisors from the University of Maastricht were brought in to advise the faculty's decision makers on the adoption of PBL. Professor C claimed that the discussion on the adoption of PBL innovation was done without the involvement of academic staff in the faculty, who had specialisations in architectural subjects. Therefore, top down decision were not accepted and, due to the large scale of the faculty, it was difficult to ensure the enforcement of PBL implementation by all academic staff.

Regarding this, the sociological aspect of "the Dutch Polder Culture" might have had the influence over staff acceptance of top down decision policy. The Dutch particularly have very strong individual "sense of justice", by which they use to guide "innovative processes". The Dutch concept of personal integrity or human honour comes in any informal and formal organization, where implementation of top down approach of modern corporate management model is considered "irreverence" of their perception. This culture always leads to friction and complication, when the "relationship between rationality and emotion" is misjudged (Schonbeck, 2003). In the instance of top down decision imposed upon the Faculty of Architecture at TUDelft to implement PBL, many academic staff were demoralised by the situation and consequently lost interest in any related activities.

According to Professor B, most of the staff got frustrated because PBL implementation took away their freedom to choose and monitor design projects. Previously, they had complete independency in teaching, creating authority over the students to do whatever they thought appropriate and good for their design projects. With the implementation of PBL, they suddenly lost their authority and became completely dependent on the faculty for what and how they were supposed to teach. Professor A stated that things got worse because some staff had an obsession with work loads and were concerned that not being invited to be tutors in PBL teaching sessions was a further frustration for them.

On the other hand, Professor C thought that part of the reason for the staff's resistance was that the way PBL was implemented in the Faculty of Architecture at TUDelft was irrelevant to the nature of architectural studies. Although some modification was done to the PBL innovation to correlate with architectural teaching, academic staff still had doubt about the relevancy of PBL in architectural thinking. The teaching of architecture was encompassed around specialisation of subjects among the academic staff. With the implementation of PBL, which focused on discussion of issues related to cases, the specialisation of subjects lost its importance, thus causing the students to have a lack of knowledge of many aspects of architectural studies. As such, Professor C perceived that the PBL educational system implemented in the faculty was very didactic and mechanical. He said, people supposed that there were a lot of areas of architectural knowledge where solutions could be found by using analogy. He considered that a particular stress on analogy in architectural thinking for solving problem as making "a jump to refer to a similar condition without even analysing it". This, in his opinion, was not the way to improve the quality of architectural teaching and making.

Moreover, Professor A admitted that some architectural subjects, such as design and freehand drawing, could not be cultivated through the main PBL methods of learning: discussion and self-study. Those subjects concentrated on developing students' design and artistic skill, which were among the essential skills required in producing competent architects. In such subjects, there was no way of assessing students' design and artistic skills development without the delivery of students' design products and drawings. Regarding this, Professor C stated that PBL did not explain how architects think and learn in design. In addition, the subject of architectural history, which was mainly facts, should be disseminated to students as knowledge and would not be appropriate to be discussed as learning issues to generate problem statements in PBL.

Professor C thought that there were other priorities in Architectural Education to be concerned about. In his opinion, architecture studies should concentrate on how architects should be, rather than focusing on how architects should learn, as anticipated by the PBL innovation. He added that how architects learn had never been the subject of discussion among academic staff in the faculty, but what architecture should be with relation to specialisations was always there as topic of discussion. In his opinion, architecture studies should concentrate on improving the quality of architecture itself.

b) Lack of understanding

There were three main factors that influenced the lack of understanding among academic staff about the implementation of PBL in TUDelft. They were: confusion about the concept of PBL, confusion among the staff about their changes of roles, and unconvinced and inconsistent implementation of PBL.

Professor A made a comment that most of the academic staff did not really understand the concept of PBL itself. Attempting to implement the imposed PBL, academic staff used problem statements as the basis of discussion, rather than a case as anticipated by the PBL implementation in TUDelft. Thus far in the former POL, design teaching had been using Design Problems as the basis of design tasks for students to work on in the process of learning by doing. By the end of a design project, students would produce tangible evidence of their design work, in various forms ranging from physical models, drawings, oral presentations, to submission of dissertations. However, using PBL educational approach, they were asked to give students cases based on the assigned themes. Then, from the cases presented, students were expected to have a series of discussions, guided by tutors, and eventually come out with problem statements without having any design production for assessment. This new approach was an alien to the teaching of Architecture, especially the model of using a case as the basis for learning, which was referred as a 'problem' in PBL educational approach, was actually adopted from the School Of Medicine, University of Maastricht. Although training was provided by educational advisors to inform staff how to prepare cases for discussion session, most architectural academic staff remained unconvinced and found the method to be irrelevant to the teaching of architecture.

Secondly, the circumstances of having misunderstandings about the concept of PBL led to the inconsistency of PBL implementation in the Faculty of Architecture at TUDelft. Some of the staff obediently tried to enforce the implementation using cases, but the majority of academic staff who remained unconvinced simply refused to participate on the grounds of irrelevancy to architectural thinking. In fact, they continually used the foregoing POL practiced before. As such, there was inconsistency in the PBL implementation, where both PBL and POL were ran concurrently in the faculty. Professor B stated that it was impossible to manage when two educational approaches ran simultaneously in the faculty.

Furthermore, the conversion from POL to PBL created confusion among the academic staff about their role changes. Previously, academic staff were contented with the idea that teachers were supposed to teach in the classes, not facilitate. Especially with the autonomy in staff's own creation of kingdom systems, staff simply felt that they were the role models whom the students were supposed to copy in preference and style of architecture. Regarding this, Professor B commented that with the power of assessment in academic staff's hands, they were used to telling the students what and how to design. However, with the implementation of PBL in architectural teaching, academic staff were supposed to act as facilitators whose responsibility was to stimulate the discussion among students. The presence of facilitators in a series of PBL discussions was meant to encourage students' participation, but practically they were discouraged from answering questions or providing solutions in the discussion. As such, facilitators were unable to express their preferences and ideas, which they enjoyed very much when POL was implemented. Some academic staff were unable to accept the new roles given to them, and they found this new pedagogical approach did not have appeal. This confusion of role changes, and the lack of understanding of the actual concept of PBL remained unchanged, as most academic staff refused to improve their understanding and simply turned back to POL methods.

c) Labour intensive and time consuming

Besides, due to lack of acceptance and understanding of PBL concept, some of the academic staff refused to cooperate with the implementation of PBL simply because they felt that the preparation of material and the PBL discussion session were very labour intensive and time consuming. Professor C explained that there were numerous guidebooks to be prepared before the commencement of certain blocks of theme studies, and each student was supposed to be given a copy of the prepared guidebook as a reference to undertake self-study. This labour intensive process was made worse by the fact that the faculty had a staff shortage. Therefore, to implement the PBL pedagogical approach required the faculty to hire outsiders to make up the deficiency. In fact, some practiced architects were hired to help prepare the guidebooks for students. Not only in terms of preparation of PBL material that was labour intensive, but also it was worsened by the problem of too much time consumed in the discussion sessions designed in the PBL implementation. Apparently the discussion sessions often consumed time previously allocated for students to work in the architectural studio.

Obstacles from Students

Professor B admitted that students had problems in terms of time management, which originated from faulty implementation of PBL. In addition, Professor C perceived that obstacles also arose due to students' indifference towards the implementation of PBL. Nevertheless, Professor A stated that generally students accepted the PBL implementation, as they did not have choices or a clue of the previous implementation of POL.

a) Time Management

Professor B commented that, with the introduction of PBL, students experienced problems due to time management. Although PBL had been introduced, some of the staff continued using POL as the educational approach in the faculty. As a result, students were presented with two didactic systems, namely POL and PBL, running concurrently. These two systems competed for students' time, and led students into resolving the problem by focusing only what inspired them the most: design work in POL, and ignoring the new PBL. Regarding this, Professor C commented that the PBL curriculum innovation applied in the faculty lacked appeal, and failed to motivate the students to participate. In PBL, students were presented with cases or problems, which required them to spend so much time on series of lengthy discussion. On the other hand, POL presented students with design tasks in which they were able to express their artistic ideas. As a result, most students "focused on what they were motivated to": design tasks in POL. They found design was the most inspiring among the two tasks and so neglected the PBL discussion sessions.

b) Students' Indifference

Professor C's view was that, since the implementation of PBL failed to motivate students to participate, most students remained indifferent towards the implementation. With the contemporary performance oriented trend, plus the claim that PBL did not improve the speed of study or thinking skills, students simply focused on trying to find the minimum requirement to get a pass grade. As such, the indifferent attitude of students contributed to the failure of the PBL implementation. It appeared that academic staff's stances towards the implementation reflected students' attitudes.

Obstacles of Philosophy

Staff resistance and students' attitudes were partly caused by the misunderstanding of the philosophy of the PBL educational innovation. Philosophically, Professor C's view was that academic staff thought that PBL was irrelevant to architectural thinking and the way architecture was applied. As such, they reluctantly implemented PBL as imposed upon them, while continuously using the educational method of POL that they were familiar with. According to Professor B, for many of the years of the PBL implementation, the faculty had actually practised a mixture of two didactic systems: PBL in theoretical subjects and POL for architectural design.

a) Irrelevancy of PBL

The irrelevancy of the PBL innovation implemented in an architecture faculty came in many ways: faulty adoption of the PBL Maastricht model, the lack of curriculum definition and refinement, uniqueness of the problem-solving method among designers, and PBL's inappropriateness to certain subjects.

b) Faulty adoption of the PBL Maastricht model

The top management of the Faculty of Architecture at TUDelft, decided to adopt the PBL curriculum implemented in Maastricht School of Medicine, because it had been successful in using PBL in its medical curriculum. However, some of the academic staff in the Faculty of Architecture at TUDelft considered the adoption of "the Maastricht model" of PBL was blindly made, without considering the nature of the architectural discipline. Although some educational specialists from the University of Maastricht were involved in the discussions of curriculum structure planned for the faculty of Architecture at TUDelft, academic staff in architectural faculty claimed that the PBL curriculum prepared for them lacked architectural input. They further claimed that they were not given any chance to give inputs during the planning of the PBL curriculum. As such, Professor C stated that the adopted Maastricht model was not suitable for implementation in the faculty of Architecture unless further refinement was done to the innovation.

c) The Lack of Curriculum Definition and Refinement

Professor C said that the decision to adopt the Maastricht model was done as a "last minutes decision" in order to fulfil the ministry requirement of reorganising the curriculum structure in the Faculty of Architecture at TUDelft. As such, the adopted PBL model lacked refinement, with no discussion possible for the academic staff to see the relevancy of PBL to architectural thinking, and "no real testing to its ability and relevancy of implementation." In addition, staff also did not receive enough training or guidance of how to carry out the PBL implementation. His argument was supported by Professor B statement that the implementation of PBL in the faculty lacked curriculum definition. He added that PBL implementation did not have planning of objectives in the curriculum structure, and there was no method matched to the goals of architectural studies.

d) Uniqueness of Problem Solving Methods among Designers

Professor B's perception was that the irrelevancy of PBL in architecture education arose because designers, including architects, were accustomed to finding solutions, not merely to discussing problems. In architectural studies, students were expected to produce design products as solutions to their design problems. Meanwhile, the PBL curriculum innovation required a series of discourses to discuss problems or issues related to certain cases. This method of discussion, on issues generated from cases, was practised by medical and legal professionals, but was unfamiliar to architectural thinking. Furthermore, Professor A perceived that architects did not simply solve problems in their practice, but tried to seek compromises and solutions to a complex of problems in order to find solutions. Referring to the matter, he said the following:

> *"...because an architect does not have a problem. He has a problem field, a complex with thousands of problems. And if you (he) would choose one of the main problems to solve, he would raise other problems. So it has (had) to, the problem statement has (had) to be the vague ideas of the field of problems that he is (was) supposed to put the concept that put everybody (everything) together, much more than solving and define problem."*

As such, PBL was seen as irrelevant to architectural thinking in general. Indeed, the question of different problem solving methods among professional disciplines made the PBL adopted from Maastricht only appropriate to be implemented in certain areas of studies, but not in architecture.

e) PBL's Inappropriateness to Certain Subjects

Architectural studies covered vast areas of knowledge, and the PBL educational approach was not appropriate to be used as a basis for all subjects in architectural studies. Professor A perceived that some disciplines, such as mechanical subjects, hand drawing, and history were impossible to include in the PBL themes, or the discourse in PBL implementation. He elaborated that in mechanical subjects, students would have to learn and apply knowledge by experimenting, while in hand drawing classes, students would have to develop drawing skills by practicing. Both subjects required practical experience, and could more appropriately be called learning by doing, which was not made available in the discussion sessions of PBL. In addition, Professor A said that academic staff insisted that the subject of architectural history should be disseminated via lectures in chronological order, or a linear programme.

Conclusively, due to the obstacles mentioned in the interview sessions, it was apparent that the PBL implemented in the Faculty of Architecture at TUDelft was far from being successful. Throughout the discussions, interviewees focused on the obstacles of PBL implementation, rather than any measure of accomplishment of the mentioned purposes. Based on the analysis of the purposes of PBL implementation, and the obstacles the faculty experienced during the implementation, there were two major aspects that influenced the failures of PBL implementation in the architectural faculty: the scale of faculty was too large to undertake PBL, and the method of PBL educational approach was not carefully analysed to suit architectural thinking.

In terms of the scale of the faculty, it was impossible for the management to get a unanimous decision from all the academic staff on the decision to take up PBL. It was also impossible to fit so many students into sequential blocks of themes in the PBL curriculum structures. Although the faculty had tried to fit the sequential blocks of themes together in a superimposed manner, it still did not work and ultimately the themes lost their sequence. Professor A referred to this as "a great misery about the whole system." Indeed, the PBL implementation might have been successful if unanimous agreement had been obtained within the faculty, and if the number of students was manageable to be fitted in the theme sequence.

Although the PBL educational approach had been widely used in many professional studies in higher education institutions, its appropriateness to any particular discipline would depends on proper analysis and adaptation of its mechanisms. In the faculty of Architecture at TUDelft, the Maastricht model of PBL adopted did not have enough scrutiny to check on its relevancy to architectural thinking. It was the neglect of this crucial aspect of undertaking a major change in educational approach that caused the confusion over the philosophy of PBL. The nature of architectural studies was not comparable to other professional fields of studies, such as medicine and law. The procedures of solving problems in architectural thinking were assumed to be similar to legal and medical procedures, where discussion of cases could be used to obtain answers or solutions to problems. In fact, as stated by Professor A, using empirical methods could not solve architectural problems. Indeed, it was concluded that the PBL implementation in the Faculty of Architecture at TUDelft, could be successful if more input from architectural specialists had been used in the planning of its adaptation.

Nevertheless, the establishment of PBL as the new curriculum structure in the Faculty of Architecture had helped the faculty to survive in TUDelft. Although internally it experienced obstacles, the PBL curriculum innovation was seen as the tool for the faculty to keep its existence in TUDelft.

6.2.4 Implementation: Question B4

Interviewees' opinions were sought on whether or not PBL was the best approach to teach or to train students in architectural education. The question addressed to them was: "Do you think PBL is the best approach to teach or to train students in architectural education?"

None of the interviewees gave a direct answer of "yes" or "no" to this question. However, during the interview sessions, all the interviewees suggested other educational approaches as the best, implying that PBL was not the best educational approach to be implemented in the Faculty of Architecture at TUDelft. Table 21 in chapter 5 shows the interviewees' comments on the best approach to teach or to train students in architectural education.

All of the interviewees suggested that there were other educational approaches that should be implemented in the Faculty of Architecture at TUDelft. Professor B suggested that the most natural solution for the Faculty of Architecture might be to use PBL in a project organised environment. Similarly, Professor C perceived that the faculty should use an educational approach that was designed by both architects and educational specialists, with explanations and tools of how to implement the approach effectively. He stated that architectural teachers and educational specialists should communicate and set up a research unit for researching the PBL educational approach. The architectural teachers and educational specialists who functioned as the researchers should be qualified in both areas of studies, architecture and education. Professor C was also against the idea that somebody outside the profession of architecture could design architectural studies. He stated that he was not interested in "somebody else" telling him how to think and to work.

However, he was very much interested in working with people who could help "along the way".

On the other hand, Professor A recognised that there were numerous architectural methods of study. He explained that the faculty had produced a methodological book to describe eight methods of how architectural students should study. Those methods were: naming and describing; design research and typology; evaluating, modelling, programming and optimising; technical study; design study; and study by design (De Jong & Der Voordt, 2002). Nevertheless, his explanation of these methodologies of studies specifically referred to architectural design, and did not refer to any well-known educational approach.

Conclusively, all the interviewees perceived that there were other educational approaches that fit architectural studies better than the PBL pedagogical approach.

6.3 Comparison with Other Approaches

When PBL was implemented in the Faculty of Architecture at TUDelft, it was considered an innovation in architectural education. Contrastingly, in the education of other professional fields, such as at medicine and law schools, the use of PBL as an educational approach had been widespread. Therefore, this section will examine the similarity and differences of PBL implementation between those professional fields of studies. Although the interview sessions did not provide much information about the similarities and differences, this section will discuss the topic based on remarks made during the interviews, with reference to other sources.

6.3.1 Comparison with Other Approach: Question C1

The purpose of addressing question C1 to interviewees was to identify the distinctive features of PBL innovation in the Faculty of Architecture at TUDelft, as compared to traditional or conventional methods of architectural studies.

Table 22 in chapter 5 shows three niches mentioned by interviewees, together with the quotations relevant to the subjects. Although not all the interviewees mentioned these three special aspects of PBL implementation in the faculty, the distinctive features mentioned were worth analysing. The PBL implementation in architectural studies had no separation of disciplines, had given more freedom for students, and adapted the Maastricht Model.

6.3.1.1 No Separation of Disciplines

Both Professor B and Professor A mentioned that there was no separation of disciplines among subjects in the PBL educational approach. Whilst the problem of integration of the architectural curriculum had always been one of the major topics of discussion in architectural education (Nicol & Pilling, 1991), Professor B stated that the implementation of PBL in TUDelft tried to integrate subjects in the architectural syllabus by "do (doing) away with the separation of disciplines."

Professor B said that the faculty came out with the theme system in order to design a "whole curriculum, not as a summing up of these parts." The theme system was designed so that several areas of architectural studies related to a certain theme were discussed, learned and analysed during the leaning process. There were 5 themes assigned to 5 years of architectural studies. Each year of study would have a theme of studies, which then to be divided into 6 blocks, each of 8 weeks' study duration. For example, "house" was the theme to be studied by students of the first year. Lecturers who specialized in relevant topics of house design would get involved as facilitators in the learning process, by invitation of the theme coordinator. Although students were encouraged to find out their own issues related to house design, facilitators played the part of provoking the students with questions and motivating them to play active roles in discussion and self-study. By the end of a particular block, which consisted of a series of discussions and time off for self-study, students were expected to learn all aspects of house design. Aspects of house design in architectural studies would be discussed and analysed in the theme systems, using cases as the basis of discussion. As such, there would be no lecture class necessary to teach students about architectural subjects because the discussion sessions of the theme were assumed to have covered the necessary scope of architectural studies. Both academic staff and the students were provided with guidebooks to implement the systems.

6.3.1.2 Adoption of Maastricht Model

Professor C claimed that academic staff referred the PBL innovation implemented in the Faculty of Architecture at TUDelft as the "Maastricht Model". Although it was generally known as the Maastricht model, Professor B emphasized that the faculty "did not institute labelling, and did not invent brand." As such, he thought the educational approach implemented in TUDelft should remain as what it was pedagogically called, Problem Based Learning.

However, he admitted that the architectural PBL implemented was adopted with reference to what had been practised in Maastricht University. Professor B highlighted the importance of modification to the PBL model to suit architectural studies by saying, "PBL in architecture will be different than PBL in medicine. I think you will found out that you need to redesign the concept of PBL in a new environment, and of course there is an experience of people who had already done that, that it really is different kind of practice." The themes systems appeared as a modified version of PBL that was thought to be appropriate to the nature of architecture.

6.3.1.3 More freedom for students

Thirdly, the PBL educational approach was designed to give freedom to students to control their own learning process. As mentioned by Professor B, when students controlled their own study, there would be a "bigger discrepancy (range) between the best and the worst." This "helps students to excel, at the cost of allowing students to fail, terribly. Yes, some (students) would fail that might have survived in the traditional curriculum. "

Unlike the traditional educational approach in architecture, the implementation of PBL had the distinctive features of no separation of discipline, adoption of the Maastricht Model, and giving more freedom to students to control their learning process. Nevertheless, as discussed in section 6.2.3.7 of this chapter, many of the academic staff were sceptical about the effectiveness of this PBL adoption of the Maastricht Model in architectural studies.

6.3.2 Comparison with Other Approaches: Question C2

The next question, C2, was used to identify the model of PBL that has been adopted by the Faculty of Architecture at TUDelft and to distinguish details of the modification involved to suit architectural studies. The question was: "Whose/which model of PBL innovation has your department adapted? Is there any modification involved?"

All interviewees agreed that the Faculty of Architecture at TUDelft had adopted the PBL Maastricht Model to be implemented in Architectural Education. Although University of Maastricht did not have a faculty of architecture, the PBL curriculum was designed by looking at examples of PBL implementation in Medical Faculty and Law Faculty of University of Maastricht. In order to adopt the so-called new educational approach, educational specialists were hired from University of Maastricht. They acted as advisors to help faculty members in TUDelft to design their own architectural curriculum. Both Medical and Law faculties in Maastricht University used cases as the basis of learning. For comparison, table 23 in chapter 5 shows the examples of problems or cases used in PBL educational approaches in three different disciplines: architecture, medicine, and law.

The Maastricht model of PBL educational approaches utilised cases as basis for students to embark on the learning process. Students were given cases, which were presented in the form of scenario or problem, and then expected to have "effective communication" of what did they already knew about the problems. Then, students needed to discuss the issues generated from the presented case before they started to work out and figure the solution. Professor A explained this scenario of PBL educational mechanism by saying, "the student has (had) to think what the problem is (was). So he learns (learned) to make a problem statement."

For examples, the School of Medicine in University Maastricht had used a case of "fever" for students to undertake PBL educational approach, while the School of Law used a case of a postman delivering letters. In explaining the latter, Professor A illustrated an incident where a postman who delivered a letter to one particular resident was bitten by a dog. From this, students were expected to discuss the legal issues related to the incident, such as who was responsible for the occurrence, and who would pay for the cost of medical expenses the postman needed. As discussion on this subject went on during a series of discussions, students were expected to learn about the legal issues associated with the case.

In order to adopt the use of cases as the basis of PBL educational approach, the architectural PBL curriculum designed architectural cases, such as having a condensed mirror in a bathroom, and having 20 photographs of buildings on a table. Professor A illustrated these cases as examples of cases presented in theme blocks for first year students. In the first case, students were expected to discuss what might have caused the condensation of mirror in the bathroom. They were to come up with all kinds of possibilities, and discuss each possibility thoroughly, based on their prior knowledge. By the end of a series of discussions, students were expected to gain vast amounts of knowledge related to condensation on mirrors. Besides, they were also expected to generate study issues to be further researched during their self-study sessions. Similarly, in the case of having 20 photographs of buildings on a table, students were expected to discuss what the photographs were all about and generate study issues related to the photographs.

Professor C argued the relevancy of having cases or problems to learn architecture. He said that architectural education should give priority to "how architecture should be, rather than how architects should learn." His statement implied that PBL approach emphasized the learning process, regardless of its relevancy to "architectural thinking" and specialized subjects. He considered cases or problems used in PBL as the use of analogical thinking, which was too didactic and too mechanical to be applied in architectural studies. Applying analogy as "the particular stress of architectural thinking" was a mistake because upon seeing a problem, students would "jump to refer to a similar condition without even analyzing it."

Indirectly, Professor A agreed with the irrelevancy of cases in the architectural learning process. He mentioned that, although the implementation of PBL had a great impact on the faculty, it "did not give a solution to a design faculty." This was due to the fact that the methodology of design was different from the methodology of other empirical studies. He stated that "while all the other designers, but (and) also researchers try to find the causes, we (architects) try to find reasons." He perceived that to learn design from the basis of analyzing a problem or a case had raised "enormous methodology problem" because architectural solutions could not be realised openly. In fact, there was no single solution to a design problem; rather the **"uniquecity"** (uniqueness) of the design solution was a "complete compact sensibility of the architecture object." He added that architects do not work from a single problem. Instead, there is a field of problems, a complex with thousands of problems. In his view, if an architect chose one of the main problems to solve, he would raise other problems.

Based on perceptions given by both Professor C and Professor A, the adoption of the Maastricht model in the PBL Implementation in the Faculty of Architecture at TUDelft, was seen as irrelevant to architectural thinking. The implementation of PBL in the faculty gave the understanding that "the classical method of empirical study" did not help architects to learn design. This understanding provided the faculty a great impact in terms of progressing with developing methods of study that were suitable to the nature of architectural disciplines. Professor A considered the experience of implementing PBL as an important revolution that took place, which helped them to develop a system of "how to learn design based research."

6.3.3 Comparison with Other Approaches: Question C3

Question C3 was, "What procedures are involved in implementing PBL approach?", which attempted to identify the process involved in implementing PBL in the Faculty of Architecture at TUDelft.

Table 24 in chapter 5 shows the procedures involved in implementing PBL approach in the Faculty of Architecture at TUDelft. Beside the procedures, it was also important to note that there were some important personnel with various positions in the faculty that were involved directly in the implementation of PBL. Figure 24 in chapter 5 shows the relationship between personnel and procedures involved in the PBL implementation.

The decision to have a new educational approach in the Faculty of Architecture at TUDelft was mainly taken by the top management of the faculty. The Dean of the faculty decided to reorganise the faculty organizational structure and curriculum structure because of problems encountered with the Kingdoms system. Besides, the pressure given by the Dutch Ministry of Education for the faculty to establish scientific architectural study in TUDelft, led to the proposal to adopt a PBL model from the University of Maastricht. This was where the educational specialist experts of PBL came to light. Based on their experience in implementing PBL at the University of Maastricht, those specialists advised the Faculty of Architecture at

TUDelft to adopt PBL as its new educational approach. They also provided series of training for academic staff to learn the new PBL educational approach.

Based on Figure 24, the academic staff were supposed to be the main group who would be involved in four out of five procedures mentioned: the design of the PBL curriculum, the faculty development to undertake PBL, the preparation of PBL material, and its implementation. However, resistance to the PBL implementation also came strongly from this group of personnel. This situation led to a major problem for the success of the PBL implementation. Although the dean of the faculty had the authority to enforce the whole operation of implementation, he did not have full control of the overall implementation. This indicated that top down decisions might not always work as suggested by Professor B.

On the other hand, Professor C identified that there was a limitation on the advisors' involvement because the educational experts did not really understand how architectural study was applied. He insisted that only an educational specialist, who was also an architect and had a proper understanding of architectural application, could propose an educational approach for architectural schools. As such, he regretted that architects and academic staff were not involved in the decision to adopt PBL.

Students did not have direct influence on the decision to implement PBL. Their involvement was limited to participating in the learning process of PBL innovation.

The PBL innovation might have been properly adopted into the design of PBL curriculum in the Faculty of Architecture at TUDelft, if academic staff had had a more direct involvement in the procedures of implementation. Not being involved in decision-making caused the resistance to the whole implementation, causing them to refuse involvement in other processes of implementation.

6.4 Changes in Curricula and Management

Questions in this category attempted to examine the changes and transformation during the implementation of PBL in the Faculty of Architecture at TUDelft. There were five questions related to the changes in curriculum and management of the faculty.

6.4.1 Changes in Curricula, and Management: Question D1

Detailed information on the implementation of PBL in the Faculty of Architecture at TUDelft was sought by asking two questions in category D1. The first question sought to find out whether any changes were required to the curricula. Furthermore, the latter question sought an explanation of the changes which occurred. The following questions were addressed to the interviewees:

1. Does the implementation of PBL require changes in the curricula of architectural school?
2. Can you describe the nature of curriculum structure or instructional design before and after the implementation of PBL?

Answers for to these questions were excerpted from the interviews transcripts. Table 25 in chapter 5 shows the summary of elements of changes required in the architectural curricula, as mentioned by the interviewees. Table 26 shows the changes in curriculum time allocation for learning dedicated to students. Lastly, table 27 shows the summary of changes in the architectural PBL curriculum structure.

In table 25, Professor B suggested that changes were proposed to the architectural curriculum of the Faculty of Architecture at TUDelft in the planning phase. He said that the changes required were in the area of setting learning objectives of the curriculum, deciding on which educational methods to be used, examining the assessment methods of the educational approach, and building the whole PBL curriculum to be used in architectural studies. The situation before and after the PBL implementation will be discussed in each of the change areas. In addition, the four changes required were expected to influence students' learning methods, students' role, academic staff's roles, and students' performances.

6.4.1.1 Setting Learning Objective

Professor C stated that the learning objective of the PBL implementation the Faculty of Architecture at TUDelft was to provide the architectural faculty with a better learning environment for students, via a "modern and clear curriculum structure" which was expected to be achieved by the PBL implementation. Before the implementation of PBL, the Faculty of Architecture at TUDelft used POL, in which subjects of architectural studies were taught separately. Students would attend designated classes conducted by lecturers who specialised in architectural subjects. In addition, students would also have to attend design studio to learn design skills by applying what they had learnt in other classes. Lecturers of specialised architectural subjects would not have any control over what students did and applied in their studio design practice.

With the introduction of PBL, one of the changes was that there would not be any separation of subjects. Instead, students would learn architecture as a whole in PBL discussion, by analysing cases within the theme assigned to their year of study. Students were required to generate issues of studies related to a certain cases, within the scope of the assigned themes. By doing this, PBL implementation was intended to integrate subjects learnt by students. There would be no lecturer to conduct the discussion session, but some facilitators were assigned to monitor and activate the discussion process with minimal input. This method of learning was part of PBL's general mechanism, which Professor B viewed as providing a better learning environment for students, as compared to the POL.

6.4.1.2 Deciding Which Educational Methods to be Used

The top management of the Faculty of Architecture at TUDelft decided to implement PBL partly because PBL was seen as the instrument to achieve learning objectives stated in 6.4.1.1. As such, the curriculum structure was designed in accordance with the mechanism and requirements of PBL.

Although undertaking PBL meant abandoning POL, most academic staff persistently continued to use POL as an instrument of teaching. As such, PBL was maintained in name only, rather than as the true architectural teaching method applied in the faculty.

6.4.1.3 Examining the Assessment Methods

The implementation of PBL involved changes in the assessment methods of students' achievement. Professor B stated that in the PBL structure, students were assessed as in the traditional system in general higher institutions, by examination and coursework. Nevertheless, PBL implementation did not require students to produce design products as a measure of learning competency.

Unlike PBL, POL approaches practiced by the faculty previously separated the methods of assessment applied between the academic subjects and the design studio. In academic architectural subjects, assessment was by examination and coursework. In conjunction with that, students' works in the design studio were assessed by their design products, presented in a variety of formats, such as drawings, models, verbal and textual presentations.

Methods of assessment in PBL educational innovation in the Faculty of Architecture at TUDelft, did not assess students' competency in design skills, but focused on communication and learning skills. This contradicted the requirements of most architectural professional bodies, which required architectural graduates to be competent in many aspects of architectural professional skills, including design skills.

6.4.1.4 Building the Whole PBL Curriculum

The decision to take up the PBL educational approach meant that the curriculum structure in the Faculty of Architecture at TUDelft needed to be updated as well. Based on the general concept of PBL, subjects within the architectural studies should be integrated and learnt by students through the series of discussion sessions and self-study. As such, the PBL curriculum was defined as a whole, without specialisation of subject. On the contrary, Professor B claimed that the POL curriculum previously applied in the faculty was controlled and defined by individual lecturers, without relating to the whole environment. This resulted in the lack of cohesion among subjects, which consequently caused the management to lose control over staff's autonomy.

The nature of POL practiced prior to the implementation of PBL was specific to the Faculty of Architecture at TUDelft only. Although there were other schools of architecture which used POL, they might not have had the same problem of Kingdom Systems, a term used by Professor A to refer to the autonomy of lecturers in the faculty.

6.4.1.5 Students' Learning Methods

The proposed PBL approach ruled that all subjects in architectural studies should be integrated in themes in which students learnt by sharing thoughts and opinions with peers in discussion sessions, and self-study. Knowledge was no longer disseminated by lectures in classes as practiced in the traditional method of education. Professor B perceived that, in PBL curriculum structures, students did not need as many lectures as under the conventional method because learning issues had been thoroughly discussed in a series of discourses. Students only needed allocated time for self-study to further analyse learning issues generated in discussion sessions.

According to Professor B, previously in POL educational methods, students learnt architectural subjects by consistently attending lectures. Design skill was learnt separately in the design studio using "learning by doing." In the design studio design tutors would monitor their progress. Sometimes, the studio would have "critic session," where the students' designs would be criticised for them to further improve their design skills.

Table 26 in chapter 5 displays Professor B's explanation of the changes in time allocated for students to study. He stated that, during the implementation of POL, various lecture classes were conducted in the morning, whilst the design studio was in the afternoon session. Subsequently, the introduction of PBL was supposed to change the time allocation specifically for discussion sessions in the mornings, and then time for self-study in the afternoons. Nevertheless, Professor B's explained that what had actually happened was that students used the time allocation for self-study to work on design projects. This was not the intended goal of PBL implementation.

PBL discussions did not lead to the production of building designs. This phenomenon was considered out of the ordinary to an architectural environment, as viewed by both students and academic staff. As such, teachers conducted PBL in such a way that, rather than giving students time for self-study in the afternoons, students had design studio. Similarly, students felt that PBL discussions took so much time and were not fruitful enough. As a result, students turned to the design studio because it was more motivating to them. This practice took place throughout the duration of the PBL implementation in the Faculty of Architecture, TUDelft. Consequently, there was no time left for students to occupy themselves in self-study in order to continue working on study issues generated in PBL discussion.

Architectural subjects ranged from the scientific to arts. As such, some of the subjects taught in conventional methods of architectural studies could not be absorbed to be in the realm of PBL. For example, hand drawing was one of the most important subjects in architectural studies. Unfortunately, there was no place to develop drawing skills by discussion alone. This obstacle, confirmed the irrelevancy of PBL in architectural curriculum in the eyes of academic staff. Besides, subjects like the history of architecture were learned based on facts. It was inappropriate to request students to generate learning issues, and to produce problem statements out of historical facts learned.

Throughout all the three interview sessions, not enough detailed information about the changes of curriculum structure was discussed. However, some relevant information was excerpted and presented in table 27. It shows the summary of changes in PBL curriculum structure.

6.4.1.6 Students' Role

The changes generated by the implementation of PBL also required changes of students' roles in learning process, from being passive learners to active learners. Professor B mentioned that students in conventional lecture classes were seen as passive learners, because they received knowledge disseminated by lecturers simply by listening to the lectures. Although lecture classes sometimes had questions and answer sessions, students' involvement was always limited to receiving information only, not digging out knowledge.

On the other hand, PBL was supposed to motivate students to be active learners by giving them the opportunity to seek knowledge via discussion among themselves. Minimal input from facilitators was supposed to encourage students to find out about learning issues arising during discussion sessions. In a PBL pedagogical approach, students could not rely on their facilitators to disseminate knowledge or to provide answers, but must collaborate among themselves to learn.

The assumption that students were passive learners prior to the implementation of PBL might be incorrect. Architectural students, learning by conventional methods, had separation of subjects and design. Unlike subject lectures, building design required students to learn by doing, which was also considered as experimental learning. In this, students were active in experimenting with design solutions, without much talking except during tutorial and verbal design presentations.

6.4.1.7 Academic staff roles

With the implementation of PBL, academic staff were expected to change their roles from being teachers to facilitators, from disseminating knowledge to encouraging students to find the knowledge themselves. Previously in the POL educational approach, teachers not only taught in classes, but also acted as studio masters who had all the full command of their studio. Each studio functioned as self-sufficient unit, in which about fifteen students relied on their studio master for setting the design project, assessment, examination and grades. There was no coherence between various design studios, making administrative monitoring impossible. PBL attempted to change the role of teacher to facilitator. Rather than criticizing students' work and acting as exemplar designer, facilitators should be able to motivate students to excel in their quest of knowledge.

6.4.1.8 Students' performances.

Students were expected to perform better under a PBL curriculum because they were supposedly to have full control of their studies, and so should improve their learning skills. This was part of the general theoretical mechanism of PBL, where ultimately students were supposed to be equipped with competencies for lifelong learning after leaving university. On the contrary, students in the POL system were assessed periodically on their performance in subjects learnt, not on their lifelong learning capabilities. However, the assumption that students trained by PBL may perform better during their studies cannot be confirmed.

All the elements of changes stipulated above were expected by the introduction of PBL in the Faculty of Architecture at TUDelft. However, the PBL implementation did not really occur according to what was stipulated by Professor B. In fact, the POL educational methods were still in practice, despite the attempt to change to PBL. Obstacles have already been discussed in the analysis of question B3, section 6.2.3.

6.4.2 Changes in Curricula and Management: Question D2

The scenario in PBL classes was investigated by asking this question, "Can you explain in detail what the scenario of PBL class/instruction is like?"

Although no direct answer related to this subject was given during the interview sessions, some related information was extracted from the interview transcripts. Table 28 displays interviewees' perspectives on the class scenario, with quotes from their comments. Some of the comments made by the interviewees did not specifically refer to the scenario in PBL class alone, but also to the general scenario of the PBL implementation.

In general, Professor B perceived that teachers did not act as facilitators, as stipulated by the implementation of PBL, but continually acted as experts in studio teaching who took the attitude of showing students how to do things. In this manner, PBL was not correctly implemented. There was no comment from Professor A regarding this subject.

Professor C commented that the implementation of PBL had never lived up to expectations. He described the whole PBL discussion as a passive affair that discouraged students' interaction, especially if somebody assertive hijacked the whole discussion and teachers were left to get bored. Moreover, in terms of self-study, students depended too much on the guidebooks provided, so that they were no longer active in jotting notes of important information. This situation was made worse by the performance-orientation trend among students, who became indifferent to the PBL implementation. Professor C also expressed his apprehension on the idea that PBL developed into a "talk society", resulting in students supporting any unfinished schematic designs simply by talking.

6.4.3 Changes in Curricula and Management: Question D3

The question of whether the PBL curriculum re-structuring affected the management structure in the faculty or not was investigated by asking:, "Is there any change in the management or structural system of your department while implementing PBL?"

Interviewees did not give detailed accounts of how the management and structural systems of the faculty were affected by the PBL implementation. However, as discussed in section 6.2.1 of this chapter, one of the main objectives of PBL implementation was to secure an administrative measure to control the curriculum system. Professor A stated that the objective of breaking up the kingdom systems into themes was the best thing they had achieved since the implementation. As such, the writer concluded that there were changes made in the management or structural system of the faculty in order to achieve the objective required. Professor A's statement on this subject supported this claims. He stated that "...and it is important to understand that in fact the old fashion education came back in a certain way, but one important thing had happened and that was all those kingdoms were divided into themes. And there was a program. The program or theme. That was different from the education before. That is the most important revolution that took place."

6.4.4 Changes in Curricula and Management: Question D4

Question D4 attempted to identify if the implementation of PBL had cost impacts on the Faculty of Architecture at TUDelft. The question was, "Do you think the implementation of PBL has any financial impact to the institution?"

Interviewees gave diverse answers to this. Table 29 shows the interviewees' perspectives on the cost impacts of PBL implementation. Professor B admitted that changes would be more expensive, implying that PBL implementation incurred costs to the faculty. However, he suggested that the PBL implementation might be more cost effective in terms of higher output grades. Professor A said that he had no idea about financial impacts experienced by the Faculty of Architecture at TUDelft during the PBL implementation process.

On the other hand, Professor C had a very clear idea that PBL implementation had negative financial effects for the institution. The implementation of PBL in the Faculty of Architecture at TUDelft required academic staff to produce study material "just like the old fashion lecture notes, consist of collection of paper, examples, great architecture, and exercises." In addition, academic staff also had to prepare unit books, modules, and log books. Most of the time, staff produced these study materials by compiling materials from various published books. Most published books were protected by copyright reserved law, where permission and royalty were required before large amounts of copying were done. As such, the faculty had to pay a lot of money to produce those materials. This situation was very costly to the institution.

6.4.5 Changes in Curricula and Management: Question D5

Attempt to find out who was involved in the implementation of PBL in the Faculty of Architecture at TUDelft, was carried out by asking: "Besides students and teacher/lecturer/tutor, who else was involved in the implementation?"

Table 30 shows the involvement of the various personnel, arranged in hierarchical order. Although section 6.3.3 discussed the main personnel involved in the implementation and their roles, this section showed additional parties involved in the PBL implementation. Dean of the faculty, expert in PBL, academic staff and students had direct involvement in the implementation, whereas outsiders, such as policy makers and parents of students had indirect involvement.

The decision to have PBL as a new educational approach to be implemented in the Faculty of Architecture at TUDelft in the late 1980s was mainly decided by the dean of the faculty, with the advice of some PBL experts brought in from the University of Maastricht. Although outside influences affecting the decision were discussed, the so-called policy maker in the Dutch National Review Committee only put pressure on the faculty to find a way of organizing its curriculum structure. This policy maker did not specifically direct the faculty to choose PBL. As such, all the planning and implementation process of PBL remained as an internal affair. This top down decision to have PBL as the new educational approach also was not influenced by parents of the students.

6.5 Staff Commitment

6.5.1 Staff Commitment: Question E1

Question E1 was, "How do you describe the involvement of academic staff in the implementation of PBL?" This question attempted to investigate in detail staff's involvement in the implementation of PBL in the Faculty of Architecture at TUDelft. There were four areas of involvement tabulated in table 31, namely Design of PBL curriculum, Faculty Development, Preparation of Material, and Implementation of PBL.

6.5.1.1 Design of PBL curriculum

The interviewees had contrasting opinions on the involvement of academic staff in the design of the PBL curriculum. Professor C denied the idea that academic staff had a certain level of involvement in the design of the curriculum. He mentioned that a couple of people were "consulting actually, not necessary developing" the curriculum. The reason that academic staff did not participate in the design of curriculum was simply because "they had other priority" at that time, and the decision to implement PBL came mainly from "very high level" command.

On the other hand, Professor B mentioned that some professors in the Faculty of Architecture at TUDelft were invited to participate in the design of PBL curriculum. In addition, the professors were also involved in approving the curriculum to be implemented in the architectural faculty. The following is Professor B's statement about the subject.

> *"We invited professor of all the key groups in the faculty and they approved and designed the new curriculum. We drew up the plan and we discussed it with the curriculum implementation and, planning group and when they were approved, then they were brought into the faculty. We did that with support from the key professors, through out*

the faculty. For the implementation, that was important aspect of trying to manage the implementation process in such a large faculty."

Based on Professor Professor C's statement, it was obvious that not all academic staff members in the faculty were involved in the planning and approval of PBL curriculum designed to be implemented in the early 1990s.

Professor A's comment on this matter seemed to justify why the former two professors had different perspectives. He said that the workload in implementing PBL was not evenly distributed, causing some staff to be very busy, while the others were not. Involvement in the design of the PBL curriculum depended on invitation by the coordinators of themes. The top management appointed coordinators to be in charge of themes and blocks. Then, it depended on the coordinators who and what specialties they needed in their themes. The factor of workload based on invitation was the reason why some staff felt that they were neglected, and some felt they had much more involvement. Professor A added that, during the implementation, the coordinators were very busy especially during one of his block periods, while some other staff were busy during the implementation, and some others did not have anything to do anymore because they were not invited to participate in any one of the themes.

6.5.1.2 Faculty Development

One of the interviewees claimed that the introduction of PBL in the Faculty of Architecture at TUDelft came with planning of staff development. Professor B stated that at "some points of times, they have series of training programme for the staff." The training was given by outside educational experts who offered the training that would help architectural academic staff "to look at their job differently."

6.5.1.3 Preparation of Material

Although Professor B claimed that most academic staff were not involved in the decision to undertake PBL implementation and in the design of PBL architectural curriculum, he however agreed to that academic staff were very much involved in the production of study materials for the implementation of PBL. In terms of content, the material produced for the PBL curriculum was not so different from what they had been doing previously in the former curriculum. Previously, they prepared lecture notes, which contained collections of papers and collections of examples. Similarly, the study materials produced for the PBL curriculum contained very nice examples of great architecture, exercises and collections of published articles, which cost the academic staff "an arm and a leg."

Professor A also mentioned that teachers had to prepare study materials, booklets containing cases associated with themes. These booklets were used as the basis of PBL discussions in the theme designed for each block of the PBL architectural educational approach. However, problems arose when the teachers "did not know how to make cases." Instead of producing cases for the blocks of study themes, those teachers prepared materials that "already stated the problem and the case."

6.5.1.4 Implementation of PBL

Many academic staff were not really involved in the PBL implementation because there was no real implementation taking place, as confirmed by Professor Alexander Koutamanis' statement, "the PBL had never really implemented."

6.5.2 Staff Commitment: Question E2

Question E2 was, "What is the level of understanding and acceptance among the academic staff of the conceptual philosophy behind PBL implementation?" It attempted to investigate the level of understanding among the academic staff of the conceptual philosophy behind PBL implementation. Table 32 shows interviewees' comments on the level of staff understanding of the conceptual philosophy behind PBL implementation.

Professor B commented that many of the academic staff did not understand the role changes they had to undertake while implementing a PBL educational approach. In PBL, academic staff should act as facilitators who motivate students to participate in discussion sessions and stimulate students' thinking process by asking questions, rather than acting as teachers, who were experts in subjects and design. He stated that if academic staff acted as facilitators, they could "inspire students to do great work." Nevertheless, Professor B observed that in design, many teachers took the attitude of experts who showed and explained to students how things should be done. This attitude actually contradicted the philosophy of PBL pedagogical approach.

One of the mechanisms of PBL educational approach was to have a student-centred learning environment. However, in the practice of PBL in the Faculty of Architecture at TUDelft, academic staff did not understand the educational environment that they were supposed to create. Even though they claimed to implement PBL, staff remained as the centre of attention in which students were taught, criticized, and instructed to follow examples given by staff. Professor B perceived that teachers should tell the students the quality of students' solutions, rather than criticising. He further stated that students often felt neglected because their design teachers did not pay attention to their work; instead, the teacher kept telling them how things should be done. In addition, Professor A stated that academic staff did not understand the concept of PBL, where both students and academic staff where supposed to educate each other. Academic staff were also "not used to wait until students comes and questions." Therefore, rather than patiently motivating students to participate in PBL discussions, staffs gave answers beforehand, as they were used to this type of teaching approach.

Based on the way academic staff handled the learning environment in the PBL implementation, it was obvious that they did not understand the philosophy of a PBL educational approach. As such, the PBL educational approach was not accurately implemented. Professor C made a comment on this by saying;

> *"I cannot really honestly say whether it has work to the way it supposed to, because the problem was that we never really implementing PBL. We just, you know, going to the motion. Had a group discussion, you know, gave the students and the tutor in a space like this: I mean PBL, furthermore when we really talked about it, but nobody has a clear opinion, I guess."*

In addition, staff also remained sceptical about the relevancy of PBL to architectural teaching. Professor C said that "to discuss about a problem as learning methods was not a way of improving the quality of architectural teaching and making." Since academic staff were not convinced of the relevancy of the PBL approach to architecture, they therefore failed to convince students on the effectiveness of the learning system. As Professor B put it, "It depends on the teacher. If you have teachers who do not believe in PBL, they would fail to convince students."

Most of the ordinary staff were not really involved in the design of the PBL architectural curriculum. Professor C saw that there was no real understanding of the concept of PBL implementation because it was very mechanically implemented. Staff simply did not know what educational approach and educational technology meant, and they simply implemented PBL as they were instructed. Professor C said that, "if you don't have to think about it, then you don't learn."

On the other hand, according to Professor A, the design of the PBL curriculum in the Faculty of Architecture at TUDelft was supposed to be understood as Cased Based Learning (CBL), in a sense that problem statement should be generated from discussion of cases given to students. However, academic staff got confused on the term PBL, and gave students problem statements "with appropriate requirement". In this situation, students had already been given a problem; therefore they did "not have to state the problem." Indeed, some academic staff did not know how to create cases as a basis for PBL discussions. Therefore, they immediately took their former exam questions as cases to be presented to students.

In terms of acceptance of the whole programme of PBL implementation, Professor B commented that about 60% of the academic staff could be considered as enthusiasts, 20% did not care much, and the other 20% were opposed to the implementation of PBL. However, the implementation was finally terminated because the last 20% of the staff who opposed to the project had the strongest influence on the resistance. Indeed, staff members' understanding, acceptance, and involvement were very important as factors to determine the success of the overall implementation.

6.5.3 Staff Commitment: Question E3

Interviewees were asked question, "How do you think staff coped with management and organisational changes in implementing PBL?" This was an attempt to find out how academic staffs coped with the changes.

Professor C mentioned that rather than worrying about the management changes, most of the academic staff simply had other priorities. He stated that, "If you are a lecturer in a certain subjects, you would say, I am not interested with the educational technology or educational approach. I am interested in my own subjects, with construction."

On the other hand, Professor B perceived that academic staff got frustrated when the curriculum changes were managed from the top down. Academic staff were instructed to start implementing the designed PBL approach, were forced to work into the systems and were not allowed to teach. As a consequence, the management found it was really difficult to deal with the frustration. Indeed, those frustrated teachers reacted and tried to changed back to the old system, in which they succeeded.

In addition, Professor A described how most of the teachers were angry about the management changes caused by PBL new educational approach, because suddenly they were completely dependent on the faculty. Staff felt that the PBL implementation caused them to lose their design studios, and sometimes were not invited by the theme coordinators to take part on the implementation of the PBL educational approach. Related information regarding this subject had also been discussed in section 6.2.3.7.

6.5.4 Staff Commitment: Question E4

Question E4 was, "How do you think staff copes with role changes in implementing PBL?" By asking this question, it was intended to investigate how the academic staff coped with role changes that they had to play while implementing PBL.

There were various reactions received on this subject. Table 33 shows the summary of interviewees' perspectives on staff's reaction to the situation. The reasons for academic staff's resistance were identified as the followings:

i. Disappointment over the top down instruction to change to PBL educational approach.
ii. Staff's dissatisfaction with the uneven workload distribution.
iii. Disappointment over the loss of freedom in teaching.
iv. The difficulty staff faced to organize the learning environment based on the PBL approach.
v. The feeling that PBL implementation cost too much time and money.
vi. The feeling that PBL implementation was not a good teaching approach.

Generally, the academic staff felt disappointed with the top down instruction to change to a PBL educational approach. As mentioned in the discussion of section 6.5.1, only some academic staff were appointed to be involved in the designing of PBL curriculum. Therefore, most of the staff considered that PBL was being forced on them without discussion as to its appropriateness.

Secondly, Professor A saw that staff felt dissatisfied with the uneven working load distribution generated by the implementation of PBL. PBL approach designed for the faculty of Architecture in TUDelft required staff to be invited to be involved in PBL discussion sessions. Some of the staff were appointed as the coordinators of themes by the top management, while some others had to wait for invitations from coordinators to be facilitators in any of the themes. If their specialties were needed in certain themes, they would get invited. However, if their specialties were not wanted, they would be left without any work. This environment created disappointment among the staff as they had had "the enthusiasm of teachers' load."

In addition, Professor B stated that many of the academic staff in the Faculty of Architecture felt disappointed over the loss of freedom in teaching. In the traditional architectural curriculum, they used to have freedom on how to handle their classes as they wished. They managed their own subjects, prepared their own methods of assessment, and controlled the classes, without being too dependent on the university. Before the implementation of PBL, there was no centralized power to monitor their progress. Suddenly, the implementation of PBL in the faculty took away their freedom of teaching the way they wanted. The staffs abruptly felt frustrated for not being allowed to do their work anymore.

Besides, Professor C explained the resistance by saying that staff faced difficulty in organizing the learning environment based on PBL approach, because the scale of the faculty was considered too large. Table 34 shows the allocation of students in blocks of themes in PBL architectural curriculum.

The Faculty of Architecture at TUDelft had approximately 3000 architectural students at a time. For those academic staff who had PBL teaching loads, they felt that to organize a PBL educational approach with 3000 students would be very difficult. One of the mechanisms of a PBL educational approach was to have a class size up to 15 students only, monitored by a number of facilitators. In a 5-year programme of architectural studies, each study year had approximately 600 students to be accommodated in 6 blocks of a theme. Since the blocks were arranged in sequential order, and one theme was considered as prerequisite to the others, students must follow the order sequentially for them to systematically acquire architectural knowledge disseminated. In order to accommodate 600 students in classes of 15 students, 40 classes of the same blocks must run concurrently. Therefore, 240 classes would have to be allocated for each year of architectural study programme in order to comply with the designed PBL requirement. In a 5-year programme of architectural study, a total of 1200 classes needed to be arranged to accommodate all the students. To make thing worse, student intakes were done 4 times per year and some students who failed in any of the blocks needed to retake the block they failed. Therefore, this enormous "shamble" of management problems was considered by the academic staff as too difficult to cope with. There was an attempt to rectify the shambles of the PBL learning environment of this type, by introducing superimposed block modules, where each blocks were partly overlaid with the next. Before the duration of study in a certain block ended, the next would start. However, this attempt did not provide solution for the problem, as the blocks eventually lost their sequences. Professor A described this situation by saying that the arrangement of themes in implementation of PBL at last lost its sequence, as staff could not cope with the situation.

One of the interviewees, Professor C, perceived that the implementation of PBL had cost too much time to the academic staff and too much money to the institution. The organization of themes, and preparation of study materials, and the lengthy discussions required in the learning environment were considered as taking too much of the academic staff's time. Moreover, the preparation of required study materials for students incurred very high costs to the faculty.

Finally, according to Professor B, most of the staffs did not believe that PBL was a good teaching approach for architecture. This statement was supported by Professor C who commented that academic staff believed that architecture should be about specialisation for consultant, where each teacher become specialist in a particular field of architectural subjects. Having this stance, "no discussion was possible" as the academic staff refused to involve themselves in the implementation process. He considered that all academic staff were against PBL, and as a consequence, it had never been implemented.

As the consequences of the 5 factors of staff's attitudes of coping with the role changes, the PBL educational approach reverted back to the traditional system. All the interviewees agreed that the PBL curriculum finally regressed to the original curriculum, but their perspectives on the time duration of reversion varied. Professor C perceived that PBL had never been implemented. On the other hand, Professor B perceived that PBL was implemented with much resistance, while Professor A perceived that after seven years of implementation, the PBL curriculum was finally accepted with part of the curriculum reverted back to the traditional methods. He stated that "yes, after 7 years it was accepted, but everybody was happy. But some of the old way of teaching came back and it was allowed, of course."

6.5.5 Staff Commitment: Question E5

Question E5 was, "Do you think academic staff has advantages in term of their own self development over the implementation? This was to identify any advantage received by the academic staff with the implementation of PBL. Table 35 shows interviewees' perspectives on advantages of the implementation of PBL, received by academic staff.

Professor B commented that the implementation of PBL did not have any influences on staff salaries. However, he perceived that the reward received by academic staff with the implementation of PBL was "in watching the students to gain independence" and "seeing that happening and getting the feedback from students, how much they enjoy the independence in their own performance." This fulfilment of seeing students growing and becoming independent gave the academic staff the reward that could be termed as self-satisfaction.

Similarly, Professor A perceived that a reward received by academic staff came from the feeling of appreciation among students towards the teachers. The feeling of appreciation was considered by him as a cultural effect that gave teachers relief, while otherwise, they had felt frustrated in the PBL implementation itself. In PBL implementation, students were required to come out with questions. Whenever the questions were addressed, teachers, more appropriately called facilitators, would feel more appreciated compared to if they themselves gave answers before questions were addressed, as in the traditional curriculum. Indeed, the difference was between answering questions in PBL curriculum, and informing students in traditional curriculum.

On the other hand, Professor C suggested that the implementation of PBL did not contribute to the career development of the academic staff, specifically in research. They did not gain any development as they were lacking "understanding of what educational approach and educational technology mean."

6.6 Students' Involvement

6.6.1 Students' involvement: Question F1

Question F1 was addressed to the interviewees as an attempt to investigate students' responses over the implementation of PBL. Table 36 in chapter 5 shows the interviewees' perspectives of students' responses over the implementation of PBL.

Professor B said that students were enthusiastic about the new changes in the curriculum as they carried the implementation further: "if we do it the right way, you have much support from the students group." This account appeared uncertain, indeed, the word "if" used by Professor B to describe students' preference showed that the statement that students liked PBL implementation was based upon an assumption that the implementation was done correctly.

On the other hand, Professor C said that "people were attracted to go to a system of educational reform." However, once they were in the system, they hated it because the discussion groups appeared to be a waste of time and did not help in terms of performance. In addition, students also have indifferent attitudes towards the implementation. This indifference among students was shown in two ways: being calculative students and performance-oriented students. Students thought that, no matter what the educational approach was, they just tried to do the best they could and find the easiest way to pass. This phenomenon was described by Professor C as 'calculative students', whose main concern was to get just enough points to pass certain courses. Students were also described as being performance-oriented, "not of maximising performance," but in term of "optimising efforts." This phenomenon enabled most students to pass their examinations and get a degree. Professor C claimed that calculative and performance-oriented students were universal phenomena, and did not specifically refer to those involved in PBL implementation in the Faculty of Architecture at TUDelft only.

On the other hand, Professor A's perception was that students did not have any preference towards the PBL implementation because they simply had not experienced the previous educational approach. PBL implementation was introduced to a new batch of first year students, and the implementation went on until the same group of students graduated. As there was nothing else for them to compare to the PBL approach, the students easily adapted to the system. Besides, he claimed that the independent students' association (STILOS) of the Faculty of Architecture at TUDelft remained very supportive of the implementation of PBL.

6.6.2 Students' involvement: Question F2

"How do you think students cope with the curricula/instruction changes in architectural education?" Question F2 sought to investigate how students coped with the curricula changes in architectural education.

In the PBL educational innovation, students were supposed to control their own learning process. One of the ways was by being active in group discussions. Rather than being good listeners to teachers in traditional lectures, students were expected to participate actively in PBL group discussions. In the PBL implementation in the Faculty of Architecture, the role changes students had to undertake were from being listeners to being active participants.

Professor B stated that the students did not have many problems coping with the changes because they did not know about the previous tradition, and they were young and flexible. He explained that the first generation of PBL students that came to the Faculty of Architecture, TUDelft, actually grew into the new system. This statement was consistent with Professor A's perception discussed in section 6.6.1, that students were very adaptive to the PBL educational approach. Furthermore, Professor A remarked that students varied in how they coped with the implementation of the PBL educational approach. Some students were activated by the group discussion, while others just "sit lazy back" and waited for the discussion to end.

6.6.3 Students' involvement: Question F3

Two of the interviewees offered their perspectives on the subject of whether or not PBL implementation equipped students with all the competencies expected for their future professional practice. Table 37 shows the interviewees' perspectives on students' improvement in competency level.

Professor C thought that there was no big change in terms of performance of students in the PBL educational approach as compared to learning architecture using a traditional educational approach. In contrast, Professor A commented that to answer that question required a comparison of the types of jobs students obtained after graduation. Unfortunately, there was no assessment done on the students' competency levels after graduation.

Nevertheless, Professor C gave some additional information on the comparison between architectural university graduates and polytechnic graduates. He said that architectural graduates from polytechnics could find jobs more easily than university graduates, simply because poly-techniques responded to the requirement of the market. Besides, graduates from polytechnics were also more advanced in financial and career development skills even though the facilities offered in the Faculty of Architecture at TUDelft were good enough for students to experience "learning, in order to start a practice." He commented that the university only "explicitly prepare student intellectually to understand how architecture and building works."

Professor C's description of polytechnics actually referred to "hogescolen," universities that focus on applied science. The Dutch higher education system is a binary system consisting of a university sector, which comprised of 14 "research universities" or "universiteiten", and the non-university sector comprised of 60 universities of applied sciences or "hogescolen" (Clark, 2004). *Hogoscolen* is also known as the universities of professional education (Rotterdam Academy of Architecture and Urban Design, 2006). In research universities, the educational programmes are accredited as "academic", whilst educational programmes in hogeschools (hogescolen) are accredited as "higher professional" (Clark, 2004). The Delft University of Technology (TUDelft) and the Eindhoven University of Technology (TUE) are the only two universities that offer "academic" architectural programmes in the Netherlands. Nonetheless, there are approximately 30 academies in hogeschools that offer architectural programmes, among those are Maastricht Academy of Architecture, Rotterdam Academy of Architecture and Urban Design, and Amsterdam Academy of Architecture (Van Der Veen, 2006). In these academies, students are required to work for 24 to 32 hours a week at a relevant job within the field of architecture whilst engaged upon their studies (Rotterdam Academy of Architecture and Urban Design, 2006). This explains Professor C's perception of why graduates from polytechnics could find jobs more easily than university graduates.

6.6.4 Students' involvement: Question F4

Question F4 was: "Do you think students can easily adapt to PBL approach?"

Table 38 shows Professor B perspectives on the issue of students' ability to adapt to the PBL implementation. Instead of discussing how easily students adapted to the educational approach, Professor B discussed the methods of adaptation students should undertake in a PBL educational approach. On the other hand, two of the interviewees offered information on the types of students who might be successful in PBL educational innovation, and who would not. Table 39 compares the two types of students.

In regard to the adaptation of a PBL educational approach, Professor B suggested that students should not hesitate to talk freely, to express ideas, take responsibility for their own learning, and to learn study skills. The PBL educational approach was known to allow students to talk freely about ideas, even though they were not quite certain about the validity of the ideas. The ideas expressed by students might be wrong, but the uncertainty about the ideas would encourage discussion among students. Furthermore, they were also allowed to contradict teachers even though the teacher was an expert in the field of study discussed. He commented that, generally, western students did not have any problem adapting to the method, talking freely. They saw that "not knowing anything about the topic is (was) not a barrier to talk."

Professor B further stated that a PBL educational approach encouraged students to take responsibility for their own learning. By discussing learning issues amongst themselves and spending some time away for self-study, students were not supposed to rely on teachers to disseminate knowledge. Instead, students would independently take the responsibility to acquire as much knowledge as possible in the areas of any learning issues generated during the discussion sessions. By doing this, students would subsequently develop their own study skills.

Professor A and Professor B offered their perspectives on the types of students who might succeed in a PBL educational environment, and those who would not. Table 39 compares two types of students, and gives excerpts from the interview transcripts. There were two types of students: proactive and passive. Professor Erik De Graaff's view was that proactive students wanted to excel and were always "triggered by excitement to work". As such, they needed freedom in order to control their own learning. Having this type of students might make PBL work well in the Faculty of Architecture at TUDelft, because, in architecture, people were motivated to do their best, and architecture always attracted people who wanted to excel. Similarly, Professor A thought that proactive students were activated by problems.

On the other hand, passive students needed discipline to control their learning. They would only work if they were told to do so. According to Professor B, this type of student was likely to fail in a PBL environment.

The above discussion, on methods of adaptation students should undertake in a PBL educational approach, and the two types of students' likelihood of success, did not specifically refer to what had happened in the PBL implementation in the Faculty of Architecture at TUDelft. Rather, they were general descriptions of PBL learning methods that students should undertake, and generalised types of students who might be seen in the PBL implementation.

6.6.5 Students' involvement: Question F5

Question F5 was to identify the advantages received by students in PBL implementation. Table 40 attempted to show the advantages received by students on the implementation of PBL, in the views of the three interviewees.

Professor C did not agree that PBL implementation brought some advantages to students, while the other two did think there were advantages. Professor B perceived that the implementation of PBL in the Faculty of Architecture at TUDelft gave some advantages to students. In this educational innovation, students were motivated to outdo everyone's expectations, were encouraged to excel, and were inspired to study. He said that, if students were really motivated, they could create and learn marvellous things. He perceived that, by applying PBL, an educational curriculum could encourage excellence because PBL helped some students to excel at the cost of allowing some students to fail terribly.

Moreover, Professor B perceived that the PBL implementation benefited students by letting them learn and exchanges ideas among themselves in discussion sessions. He added that, by using PBL, students were introduced to the Socrates' concept of learning, where questions addressed to students would trigger more curiosity for them to gain knowledge. He implied that students should not rely on their teachers to disseminate knowledge because knowledge acquired by the teachers might not be updated.

The excerpt below was taken from Socrates: Philosophy's Martyr (Gottlieb, 1997), to illustrate Socrates' concept of learning.

"Socrates believed that coming to understand the virtues was a necessary precondition for possessing them. A man could not be truly virtuous unless he knew what virtue was, and the only way he might be able to get this knowledge was by examining accounts of the particular virtues. That is why Socrates went around questioning people and arguing with them."

The problem, which Socrates sets the slave, is that of determining the sides of a square of a given area. He starts by drawing a square whose sides are two feet long, and whose area is thus four square feet, and asks how long the sides would have to be if its area were instead eight square feet. At first the slave ignorantly reasons that the sides would have to be twice as long as those of the original square, i.e., four feet. By drawing another diagram, ``Socrates" soon shows him that this must be wrong, since the area of such a square would be not eight but 16 square feet. The slave is surprised to learn that he does not know as much as he thought he did. ``Socrates" notes that at this point ``we have helped him to some extent toward finding the right answer, for now not only is he ignorant of it but he will be quite glad to look for it". Next, with the aid of further diagrams and by asking the right questions about them, Socrates gradually leads the slave to work out the answer for himself: the sides of a triangle with twice the area of the original one would have to be the same length as a diagonal drawn across the original square---which, in effect, boils down to the famous theorem of Pythagoras. Bingo: since Socrates never actually told him this, the slave must have ``known" it already.

This little episode does not really prove Plato's theory of recollection, as Plato himself acknowledged. But the story does illustrate a distinctly Socratic thesis about knowledge and how it can be imparted. Socrates' questions to the slave are indeed leading ones (and the diagrams help, too), yet it is nevertheless true that the slave comes to see the answer for himself. He has not simply been told it as one might be told how many feet there are in a yard or what the capital of Greece is. He has come to appreciate something through his own intellectual faculties. So Socrates can modestly make his usual claim that he has not handed over any knowledge himself but has just acted as a midwife to bring it out of somebody else. And there is another thing: as Socrates points out, in order for the slave to know this piece of mathematics properly, it is not quite enough for him to work through the example just once:

> *At present these opinions [of the slave's] being newly aroused, have a dreamlike quality. But if the same questions are put to him on many occasions and in different ways, you can see that in the end he will have knowledge on the subject as accurate as anybody's...*

This knowledge will not come from teaching but from questioning. He will recover it for himself.

Repeated doses of Socratic questioning are called for. In other words, what the slave needs is exactly the sort of treatment that the real Socrates offered the largely ungrateful Athenians. As he says in the *Apology,* if anyone claims to know about goodness "I shall question him and examine him and test him". Thus in his fanciful story of assisted recollection, Plato has given us a striking illustration of the sort of thing Socrates was doing when he claimed to help other people deliver their own opinions. It is as if Socrates were drawing out and firming up some knowledge that was already there.

6.7 Conclusion

6.7.1 Conclusion: Question G1

Answering question G1, interviewees gave their personal accounts of their involvement in the implementation of PBL in the Faculty of Architecture at TUDelft. Table 41 shows the summarised description of the interviewees' roles in the implementation.

Professor B said that he was hired by the dean of the faculty to act as advisor and facilitator to the PBL implementation process for about four to five years. As advisor, he suggested the "sort of organization within the faculty, specifically aiming to the implementation of the new curriculum." As the facilitator of the implementation process, he, together with all the key professors in the faculty, was responsible for drawing up a plan for the PBL implementation, to discuss with the planning group for approval and to get support from all the key professors for the implementation of the PBL policy.

During the implementation of PBL, Professor C was the chairman of one of the educational committees. He gave advice on the different aspects of teaching, and was involved in the evaluation of practical aspects of "many different things." During his involvement, "content and methods" of PBL implementation "were practically had never been evaluated."

On the other hand, Professor A was the co-coordinator of the first year study programme, and the secretary and member of nearly all the committees in the faculty.

6.7.2 Conclusion: Question G2

This question sought interviewees' suggestion on how to carry out PBL implementation properly, if other architectural schools decide to take up PBL. Having their suggestions could offer ways of improving a PBL educational approach, especially in architectural education. Only two interviewees, Professor B and Professor C, offered their suggestions on ways to improve a PBL implementation in architectural studies. Table 42 in chapter 5 shows Professor B's response on the subject, and table 43 shows responses given by Professor C.

The suggestions given on ways to improve PBL implementation in architectural studies could be divided into three groups: curriculum design, decision-making, and proficiency to perform. Both interviewees had independently given their accounts in these sub-categories.

6.7.2.1 Curriculum design

Professor B view was that the most natural solution to using PBL in architectural schools was by using the didactic methods of PBL in a POL environment. Firstly, those who designed a curriculum should set learning objectives in order to decide which educational method might work best with what type of objectives. After the learning objective had been set, the assessment methods appropriate to the learning objectives could be selected. He suggested that the design of a curriculum should always start with learning objectives, to match the goals of methods with the goals of curriculum. He perceived that very few universities had curriculum that were clearly defined in educational satisfactory manners.

Professor's perception was that, in order to adapt the PBL educational approach to architectural education, the didactic method should be analysed to ensure its appropriateness to this field. Those who were in charge of the PBL implementation should be able to explain how the methods worked, besides providing tools and instruments to implement the methods. He also suggested that by so doing, the educational approach would appeal to people.

In addition, Professor C suggested that the PBL educational approach should be applied to appropriate subjects only. He was not sure if the approach would work if it was applied to all aspects of architectural education. Instead, he said that he did not think that any educational approach could cover a complete spectrum of study in application to an area like architecture.

Professor C further suggested that architectural teachers and educational specialist should work together in order to have thorough research on the PBL educational approach. He claimed that architectural education needed specialists who were experts in the areas of both architecture and education, so that any proposal to undertake a PBL educational approach would come from those who were inside the architecture profession.

6.7.2.2 Decision-making

Both Professor C and Professor B thought that a decision to undertake a PBL educational approach should come from a bottom-up decision, not top-down. Otherwise, teachers would feel that the implementation was imposed upon them and this might create frustration over the implementation. By having bottom-up decision-making, the management would be able to get staff's unanimous decision, involvement and support over the implementation. All these would ease the management process of PBL implementation effectively. Professor B said that by doing this, the chances of a successful implementation would be quite high.

6.7.2.3 Proficiency to perform

Academic staff's proficiency to implement PBL was another important aspect that should be looked at if any architectural school decided to undertake the educational approach. Professor C suggested that when a university decided to take up the challenge of PBL, research on how to understand the educational method should be given a high priority, as compared to the designing of it. The new educational approach should not be used to attempt to totally change the existing system; rather it should be used as a means of improvement and learning. He claimed that the existing system could only be improved by having a proper understanding of how it works.

Similarly, Professor B perceived that understanding the concept of PBL was critical for teachers to use their ability to oversee comprehensible methods to stimulate students in the thinking process. Teachers should be aware that, in order to become effective, they needed to pay attention to what the students did, but not to tell students how they should do something.

One way to get a proper understanding of the concept of PBL implementation was by having staff development seminars. For example, staff should have a series of training programmes, to enable them to really experience the power of PBL from within. As such, academic staff would be able to reflect on the experience to their students. Indeed, Professor B said that "faculty development is (was) the key to success in implementing education innovation of this type."

6.7.3 Conclusion: Question G3

The purpose of addressing question G3 was to investigate if PBL has a potential to succeed if implemented to other schools of architecture. Rather than simply saying yes, Professor B and Professor C elaborated that success could be achieved, based on certain conditions that schools of architecture should undertake. Table 44 in chapter 5, shows the interviewees' perspective on PBL's potential to succeed.

Professor B thought there was good potential for PBL as educational approach to be implemented in other schools of architecture. However, he stated that success could only be achieved if two difficulties could be resolved. He proposed that:

- The institution that plans to implement PBL must have full support from all stakeholders involved, such as the dean of a faculty and the staff. The support required should come from those who really believed in the educational approach, and who were willing to combine ideas and work on it.
- The institution to undertake PBL educational approach should allow time and space to establish the new system, and theoretical planning should be done four to five years prior to the implementation.

Professor C stated he was not really qualified to give an opinion on this subject because he thought that PBL had never really been implemented in the Faculty of Architecture at TUDelft. However, he did mention that success could be achieved if interaction was made between the subject matters (architecture) and the educational specialisations.

6.7.4 Conclusion: Question G4

There was no opportunity to address this question to any of the interviewees. The question that was supposed to be addressed was, "Why do you think Architectural education is left behind in PBL research and implementation?"

6.7.5 Conclusion: Question G5

Question G5 was addressed for purpose of finding out interviewees' perspective on whether or not there was a need to do further research on PBL in architectural education. Table 45 shows the excerpt of interviewees' perspectives on PBL's future research.

Professor B particularly agreed that further research on PBL in architectural studies should be done because "there is still very little known about what makes the curriculum effective." Moreover, Professor A suggested that further research should be done on "what is the difference between design education on a university level and empirical study."

On the other hand, Professor C mentioned that PBL had the potential for success only if it came from society. He said that, he would favour research done on improving society by ways of "serving social and intellectual activities," rather than trying to reform society to think in a PBL manner.

CHAPTER 7

CONCLUSION

7.0 CONCLUSION

7.1 Overview of the Research

As an innovative pedagogical approach, Problem Based Learning (PBL) was found suitable and relevant for implementation in architectural education if the implementation was done with appropriate modifications to suit architectural thinking. The pure form of PBL, developed in medical schools, could not be adopted blindly, simply because the nature of architectural education was distinctively different from the medical field in aspects of its education, disciplines, practice, and profession. If the medical field is concerned about providing health services, architecture is, on the other hand, involved with not only providing services but also with delivering products in the form of building construction. As such, adoption alone was not enough in order to carry out PBL implementation in architectural education, but adaptation of its features in relation to the existing nature of architectural education should also be incorporated.

Nevertheless, based on the evaluation done on this thesis, the implementation of PBL in the Faculty of Architecture at the Delft University of Technology (TUDelft) could not be considered as successful, 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 comparison, successful undertaking of PBL pedagogical approach in architectural education could be observed in the implementation of PBL in the Faculty of Architecture at the University of Newcastle (UniNC), Australia. This faculty had 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.

Theoretical Framework

The claim that PBL re-established a pedagogical theoretical framework on the structure of the architectural curriculum in the Faculty of Architecture, TUDelft, was considered questionable. There was severe resistance from the faculty members during the implementation process, due to the irrelevancy of the Maastricht version of PBL approach introduced in the faculty and the revolutionary manner of its implementation. The PBL pedagogical approach beyond doubt provided an attractive label for the architectural curriculum in the faculty, but the actual implementation was carried out on a refutable basis and then eventually abandoned, as the academics moved back to the conventional methods of architectural teaching.

Irrelevancy of Cases as Problems

The evaluation presented in this thesis concluded that the implementation of PBL in the Faculty of Architecture, TUDelft, was unsuccessful because the implementation philosophically adopted the medical Maastricht version of PBL. This latter 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 architectural fields. A constructional case, for example; the condensed mirror in a bathroom, presented as a problem in PBL implemented in the faculty, 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 "problem" 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 architectural discipline, practice, and even profession. 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.

On the contrary, 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 stimuli 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.

Revolutionary vs. Evolutionary

Another reason for academic resistance, towards the overall implementation of PBL in the Faculty of Architecture at TUDelft, was because it took place in a revolutionary manner, rather than evolutionary. It significantly reduced the importance of design studio work, which had been the core of conventional architectural studies. Although tied by the designated themes, the curriculum structure of the PBL implemented in the faculty separated the PBL group discussion sessions and the design exercises. PBL group discussion was seen as the venue for the integration of knowledge in architectural studies to take place, whilst short design exercises were separately structured in the design studio, without a similar emphasis on the integrative aspect of PBL. The design of the PBL architectural curriculum in the faculty concentrated heavily on discussion groups, expecting students to come out with "problems statements" rather than design products. As a result, the emphasis on PBL group discussion had the effect of reducing the time spent on design exercises, consequently limiting students' capability to develop their architectural design skills. Students often presented sketchy design solutions that might severely affect the development of the design skills, which would be very important in their future professional lives. Hence, the architectural learning process was changed in an unprecedentedly revolutionary way, from the conventional method to the PBL, such that no compromise position was available to the academic staff in the faculty. As the proposed Maastricht version of PBL was relentlessly rejected, the actual teaching practice of architectural education in the faculty remained using the conventional architectural learning method, despite the label of PBL in its curriculum structure.

The Faculty of Architecture at the University of Newcastle, Australia, in implementing their PBL, undertook a different approach. Rather than revolutionarily abandoning the importance of the design studio, the faculty evolved the PBL pedagogical approach by enhancing the importance of the design studio in architectural education, and strengthening the integrative nature of its architectural curriculum. The design studio remained as the arena of integration, where most of architectural study areas were incorporated in the students' design process, with the help of both design tutors and consultants. Group discussions, meant for peer and self-directed learning as stipulated by the pure form of PBL pedagogical approach, were also incorporated in the design studio. Moreover, lectures and other methods of traditional teaching were not strictly banned in this version of PBL, as opposed to the pure form of PBL in other tertiary disciplines of education. The provision of flexibility allowed knowledge and skills in architectural subjects that could not be integrated in PBL group discussions, such as history and drawing, to be continuously disseminated via traditional teaching methods. In these ways, the academic staff's expertise and specializations were not neglected, hence encouraging a unanimous acceptance that eventually raised staff's commitment to the implementation of PBL.

Based on the irrelevancy of cases as problems and the revolutionary manner of PBL implementation, the Faculty of Architecture at TUDelft could be considered to be a sketchily adopted PBL pedagogical approach that contributed to its own demise. The Faculty experienced severe resistance from the staff members, such that any attempt to improve the implementation was consequently made very difficult. Although it was claimed that the duration of PBL implementation in the faculty was about ten years, it was in reality, never properly implemented as academic staff continued to use the conventional methods of architectural education. However, the main aim of ensuring the survival of the faculty in TUDelft was successfully achieved by the introduction of PBL labelling in the faculty's curriculum structure of architectural studies.

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.

Although both the faculties of architecture at TUDelft and at UniNC had tried implementing PBL as their curriculum structure to improve the existing architectural education, they took distinctively different approaches. The former had actually **adopted** the Maastricht version of PBL with slight modifications to the types of cases presented to students to suit architectural studies, whilst the latter **adapted** PBL in ways that considered the overall application to architectural studies. Of course, different approaches resulted in different outcomes. The PBL implemented in the Faculty of Architecture at TUDelft was not really applicable to architectural education as the features of the implemented PBL pedagogical approach were not fully refined and understood. Therefore, it was found that the suitability of PBL pedagogical approach for architectural education depended very much on how PBL was understood, and how the adjustment of the pedagogical approach was carried out and practiced.

7.2 Contribution of the Research

This thesis makes several contributions to research in architectural education. It is the first systematic evaluation of PBL implementation in architectural education. The evaluations done on the implementation of PBL in the Faculty of Architecture at TUDelft and the Faculty of Architecture at UniNC contributed to the comprehensive understanding of the suitability of PBL pedagogical approach for implementation in architectural education. Comparison of the case studies showed that it was important for the academic staff in architectural educational institutions to not only understand the philosophical background of a PBL pedagogical approach, but also to understand the relevancy of the approach to the nature of architectural disciplines. The understandings generated by this research may ensure successful implementation of PBL, if any other architectural schools wish to take advantage of the innovation. By providing appropriate understanding, future attempts to implement a PBL pedagogical approach would be properly planned by taking into consideration the lessons learned in the two case studies presented in this thesis.

The comprehensive critical review presented in this thesis on the implementation of PBL in the Faculty of Architecture at TUDelft, and the brief evaluation on the PBL implementation in the Faculty of Architecture at UniNC has developed understandings of PBL's relevancy to the improvement of architectural education. Understanding PBL's relevancy to architectural education has expanded the horizon for implementing the pedagogical approach in architectural education, without jeopardizing the nature of architectural thinking itself. As such, ways of beneficially developing architectural PBL can be achieved by selecting the most appropriate PBL features to be applied to architectural education, simultaneously improving whatever shortcomings are perceived in current educational dilemmas faced by architectural education.

This evaluation of PBL in architectural education confirmed that PBL has the potential to solve problems of declining morale faced by current architectural education, by providing a theoretical pedagogical framework to the problematic architectural education that has been utilising a system initially developed more than a century ago. With minor modifications to curriculum and organisational structures, to suit today's scenarios in architectural education, disciplines, and profession, a PBL pedagogical approach can re-establish the architectural pedagogical framework that had been misused by the existence of hidden curricula, or kingdom systems. The development of a formal theoretical framework, accomplished by the implementation of PBL in the Faculty of Architecture at UniNC, had provided an alternative teaching and learning method for architecture and simultaneously abolished the practice of the 'hidden curriculum'.

Besides having the benefits of providing an understanding of PBL implementation and confirming the potential of a PBL pedagogical approach to solve shortcomings in architectural education, this thesis also contributes to educational research by giving ideas for the direction of future developments of PBL in architectural education. Applications of knowledge acquired in this research offer a way forward to stimulate change in current and future architectural education. New ways of understanding PBL may formulate new responses that make adaptation to PBL more meaningful and beneficial.

This thesis contributes to the body of knowledge reflecting on the curriculum experience of a comprehensive implementation of PBL in architectural education. Thus far, much educational research on PBL, in other disciplines and professions of tertiary education, has focused on descriptions of implementations. However, this research provided analytical reflection on the planning, process, and outcomes generated by PBL implementation in architectural education. It specifically analysed a single case study at TUDelft, and used another example of PBL implementation in architectural education at UniNC as a comparison, so that the research highlighted the strengths, shortcomings, and negligence of implementing PBL in architectural education. It provided an insight into the impact in both faculties, as regards the suitability of PBL in architectural education.

This case study research was unique, in the sense that it did not look for generalisations of knowledge. Instead, it analysed specific cases to produce an accurate reflection based on the real insights into the causes and reasons of PBL's strengths, shortcomings, and negligence, given by the very people involved in the implementation. This thesis provided a sample of case study research, which did not look for generalisations to educational research and to PBL educational research specifically. It concluded that the reflective study in this thesis confirmed that an educational approach, developed from a strictly educational perspective, could not be assumed to be suitable to architectural education, although the method was successfully implemented in other tertiary fields of education.

7.3 Future Work

As an awareness and understanding of PBL in architectural education has been learnt via the implementation of PBL in the case studies presented, there is a potential for further research on the process of staff development. Any future undertaking of a PBL pedagogical approach in architectural education requires the full support, acceptance and commitment from the academic staff to ensure successful implementation. Therefore, staff development is an important area to be researched and eventually organised, so that architectural academic staff could completely comprehend the educational philosophy and mechanisms behind the PBL approach. Moreover, having comprehensive research on staff development would enable architectural institutions planning to use the pedagogical approach to train their staff accordingly, so that they would play their facilitators' roles effectively. Research on staff development would also provide solutions as to how to encourage acceptance of and commitment to PBL implementation among academic staff. Consequently, staff who have had proper training on PBL implementation would be able to disseminate the learning techniques to their students. Since this thesis only created awareness and understanding at a theoretical level, the proposed future research on staff development would help to strengthen PBL establishment practically in architectural education.

Secondly, future research on the integrative quality of a PBL pedagogical approach in architectural education could also be carried out as a succeeding study of this thesis. Although evaluation on both case studies presented the integration aspects of

PBL implementation, no measure of the integrative quality has been analysed. How far students covered the scope of architectural disciplines in the PBL integrative feature remained as an open subject to be studied in future. The integrative quality of PBL can be studied by specifically observing the process of architectural PBL group works, and by analysing the performance of students via multiple assessment methods. Students' capability in accumulating knowledge and developing architectural professional skills could be measured using a well planned benchmark to measure the integrative quality of architectural education under PBL.

The same type of performance measurement could also be extended to research into the performance of architectural graduates during their post-graduation stage. Thus far, the professional performance of architectural graduates who have had architectural training under the PBL approach has never been systematically studied. Whether or not those graduates perform better than other architectural graduates, who were trained by the conventional architectural teaching method, is still unanswered.

Another potential research would be to evaluate the impact, of the implementation of PBL in architectural education, on the architectural profession. The questions of whether or not those PBL graduates improve the architectural profession could be analysed by looking at their performance in the ever-changing scope of architectural practice and services. This type of research may link the gap between architectural education and architectural practice, and encourage positive co-operation between the two entities.

7.4 Limitation of the Research

This thesis was only able to analyse and compare two case studies of PBL implementation in architectural education, because the PBL pedagogical approach was not widely used in the education of architects. Thus far, only two institutions, the Faculty of Architecture at TUDelft, the Netherlands; and the Faculty of Architecture at UniNC, Australia, have formally announced that they used the system in their curriculum structures. Research and material related to PBL in architectural education were also limited to articles specifically dedicated to the implementation of PBL in those two universities. Although there were other educational institutions that claimed that architectural education had been using PBL all along, before the system was formally established, there was no theoretical framework specifically describing PBL implementation in their institutions to support such a claim. For example, the Department of Architecture in the University of East London, United Kingdom, made a claim on their department website that they, too, used PBL pedagogical in their curriculum structure. Nonetheless, no detailed information on the implementation in the department was available. In addition, there was one case where PBL was implemented in architectural education for a single subject, not integrated across the whole curriculum. In the Faculty of Architecture and Urbanism, at the University of Brasilia, Brazil, a PBL-like approach was implemented in a specific course of Design Computing, within its traditional programme of architectural education (Silva and Lima, 2002). In this case, the intended conceptual elements of PBL, as a pedagogical approach that encouraged the integration of parts, were lost.

Observation might be one of the best formal data collection techniques that could be used to see the process and progress of PBL implementation in architectural education. However, due to time, financial, and geographical constraints, observation of the PBL implementation process could not be done in both institutions. In terms of the time factor, the implementation of PBL in the Faculty of Architecture at TUDelft was history. Therefore, no observation could be carried out because the current architectural curriculum implemented in the faculty does not have PBL elements anymore. Meanwhile, although the Faculty of Architecture at

UniNC is still implementing a PBL pedagogical approach in its architectural programme, the time, financial, and geographical constraints mentioned hindered the use of observation as a research instrument to collect data. For that reason, the main evaluation of PBL in the former institution used methods of content analysis on archived materials and interview transcripts as the strategies to examine PBL implementation, in terms of finding its suitability in architectural education via analysing the features of PBL mechanism implemented. On the other hand, only content analysis of secondary research materials was examined in the analysis of the PBL implementation in the Faculty of Architecture at UniNC. Hence, this thesis focused more on the evaluation of PBL in the Faculty of Architecture at TUDelft, as compared to the PBL implementation in the Faculty of Architecture at UniNC.

7.5 Recommendations

On the basis of analysing the implementation of PBL in the Faculty of Architecture at TUDelft and the Faculty of Architecture at UniNC, several significant recommendations are made to guide successful undertakings of a PBL pedagogical approach in architectural education in the future. Prior to the decision to undertake the PBL approach for the improvement of architectural education, architectural schools throughout the world should consider the following strategies in the planning stage of the PBL endeavour:

1. The decision to undertake PBL pedagogical approach should not be done on the basis of trial and error, but should be properly planned, in terms of taking consideration of its theoretical and practical implications. Adequate time provision to study the implications of the new PBL innovation in architectural education should be given for a thorough examination of the proposed new approach, before the actual implementation is carried out. Speculations about consequences of undertaking PBL should be discussed among, not only the decision makers, but also the architectural academic staff who would be involved in the implementation process. This reflection may serve as contextual guidance on the implementation process later.
2. In terms of management, the decision to undertake PBL pedagogical approach should be managed from bottom-up decisions, rather than top-down decisions, as

practiced in the PBL implementation in the Faculty of Architecture at TUDelft. This should ensure less resistance would be received if the decision to implement PBL was perceived as a co-operation, rather than enforcement. The decision to implement the PBL pedagogical method should be the concern of everybody involved in architectural education of a certain institution, to ensure the PBL implementation receives full support, acceptance and commitment from the academic staff who would eventually have to carry out the implementation.

3. 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. There is no doubt that educational specialists can provide the theoretical framework of the architectural version of PBL, but input from those academics who have been involved in architectural education is important to provide practical aspects of PBL implementation. With this co-operation, both parties can learn from each other, thus, making the designed architectural version of PBL theoretically and practically compatible to architecture's disciplines and studies. This co-operation for designing the architectural version of PBL is suggested because academics in architectural education should understand the nature of architectural studies and disciplines better than those who are not directly involved in architectural education, and they can also better speculate on the consequences of the changes undertaken by PBL implementation.
4. 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. Lack of refined research and development in the relevancy of architectural problems may result in misunderstanding the complete spectrum of PBL philosophy. 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.

5. 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.
6. 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.
7. 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 overemphasise 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.

8. 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.
9. 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 in the 'hidden curriculum' of conventional architectural education system should be completely 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, so that the practice of the kingdom system would no longer exist. Yet students should be allowed to be individualistic in developing their design skills.
10. 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.

7.6 Concluding Remark

It is hoped that the evaluation of case studies carried out in this thesis will provide reflections on the theoretical and practical aspects of architectural PBL implementation in architectural education. Although this thesis cannot propose a complete theory of PBL implementation in architectural education, the framework presented provides the contexts of improvements to the current problems in architectural education. The introduction of PBL in architectural education should be seen as an alternative solution, in the attempt to tackle the problems and challenges faced by current architectural educational systems. It is also hoped that this thesis will promote more research in architectural Problem Based Learning, simultaneously continue to improve architectural education in general, and PBL implementation in architectural education in particular.

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APPENDIX A

List of Questions

A. Conceptual Framework

Question A1

Do you think it is important for an architectural school to implement a formal educational approach (Where problems of integration and collaboration exist)?

Question A2

Do you know any other approach implemented in architectural education, besides problem-based learning (PBL)?

B. Implementation

Question B1

What do you think were the main purpose of the implementation of PBL in your department?

Question B2

How long is the duration of PBL implementation in your institution? (Start, end or still going on).

Question B3

Do you think the implementation is a success? Please explain.

How do you measure the success? It is by measuring students' performance, or by recognition of professional body and the community?

Are there any problems?

Question B4

Do you think PBL is the best approach to teach or to train students in architectural education?

C. Comparison

Question C1

What do you think the speciality/niche of the PBL innovation in your school of architecture compared to approaches that has long been used in architectural schools all over the world? (For example: compared to general USA and UK systems)

Question C2

Whose/which model of PBL innovation has your department adopted? Is there any modification involved?

Question C3

What procedures are involved in implementing a PBL approach?

D. Changes In Curricula, and Management

Question D1

Does the implementation of PBL require changes in the curricula of the architectural school?

Can you describe the nature of curriculum structure or instructional design before and after the implementation of PBL?

Question D3

Is there any change in the management or structural system of your department while implementing PBL?

Question D4

Do you think the implementation of PBL has any financial impact to the institution?

Question D5

Beside students and teacher/lecturer/tutor, who else involve in the implementation?

E. Staff Commitment

Question E1

How do you describe the involvement of academic staff in the implementation of PBL?

Question E2

What is the level of understanding/acceptance among the academic staff of the conceptual philosophy behind PBL implementation?

Question E3

How do you think staff copes with management and organisational changes in implementing PBL?

Question E4

How do you think staff copes with role changes in implementing PBL?

Question E5

Do you think academic staff have advantages in terms of their own self-development during the implementation?

F. Students' Involvement

Question F1

What are the students' responses over the implementation of PBL?

Question F2

How do you think students coped with the curricular/instruction changes in architectural education?

Question F3

Do you think PBL equipped students with all the demands of competencies expected for their future professional practice?

Question F4

Do you think students can easily adapt to PBL approach?

Question F5

What are the advantages received by students involved in PBL system?

G. Conclusion

Question G1

Do you have a special role in the implementation of PBL approach in your institution?

Question G2

What are the changes that should be carried out by other architectural schools if they decide to take up PBL challenges?

Question G3

Do you think there is potential for success of implementing PBL in other schools of architecture?

Question G4

Why do you think Architectural education is left behind in PBL research and implementation?

Question G5

Do you think there is a need to further research on PBL in architectural education?

APPENDIX B

Sample of problem in Architectural Studies

Attached here are samples of PBL design courses carried out in the Faculty of Architecture at TUDelft and the Faculty of Architecture at UniNC using PBL environment. In the former, the "problem" was to learn about "parametric design". The students were provided with a "Blokbook" which contained all the required lecture notes, examples, exercises and background reading required to undertake the module. The particular example shown looks at the design of different arrangements of stairs. The parametric variation is the interaction between "riser", "going", "tread depth" and "floor to floor height". The students were required to model the problem in an Excel spreadsheet which was then linked to AutoCAD to provide a drawing of the different designs. During the design process, 6 sessions of 4 hours time was allocated for students to work in a computer lab with supports from instructors and computing teaching assistants. Meanwhile, students were also given 3 sessions of 3 hours time to work independently (Delft University of Technology, 1995; Koutamanis et.al., 1994). Based on the description of students' task, there was no indication that students carried out the learning processes via peer learning mechanism of PBL, yet self-directed learning (SDL) was an important part of PBL learning techniques that students undertook during the design processes. In addition, the integration of comprehensive architectural knowledge was also not exhibited.

In the Faculty of Architecture at UniNC, design problems were presented to trigger learning in the studio environment. Design course facilitators would give students design brief, with specific requirements of what knowledge and skills students should acquire by the completion of a certain design course (The University of Newcastle, Australia, 2006). Based on the samples given, PBL pedagogical approach was clearly emphasised as the strategy for learning and teaching.

MODULE D7 ONTWERPMETHODOLOGIE EN TOEGEPASTE INFORMATICA

Met de huidige computertechnologie en elektronische media is men in staat architectonische vormen en ruimten te ontwerpen die de gewone fantasie te boven gaan. De ruimtelijke beelden die nu gecreëerd kunnen worden, zijn zonder deze technologie en media niet mogelijk.
Voor de ontwerpers zijn daar interessante uitdagingen aan verbonden. Om die in het architectenvak te integreren is een nieuwe manier van denken over het ontwerpen nodig. Er dreigt op dit moment een visuele chaos waarin het ontwerpen verloren kan raken. Maar ook zijn er nu instrumenten beschikbaar gekomen die het ontwerpen kunnen versterken.
In de module D7 wordt de literatuur betreffende Computer Aided Design (CAD) besproken, worden voorbeelden gepresenteerd en practica voor computertechnieken gegeven. Daarnaast wordt veel tijd besteed aan het uitvoeren van ontwerpexperimenten met de computer.
De deelnemende studenten moeten de technische beginselen van het ontwerpen met de computer beheersen: tekenen, visualiseren en rekenen met Autocad, 3-D Studio en Excel. De CAD-practica in de blokken 7,9,10,11 en 12 van het basisprogramma zijn daarvoor voldoende.

De module D7 is als volgt ingedeeld:
Ontwerpmethodische kennis (25 %):
- ontwerppresentaties en de afbeelding in computersystemen
- ontwerpmethodieken en de rol van kennissystemen
- ontwerpprocessen en de functie van ontwerpsystemen
- ontwerpgegevens en de opbouw van informatiesystemen
- ontwerppraktijk en de betekenis van communicatiesystemen

Computer ondersteunde ontwerpvaardigheden (25 %):
- grafische technieken: Autocad/Allplan/Arkey/Micro Station
- visualisatietechnieken: Autovision/3-D Studio/Photoshop
- rekentechnieken: Excel/Visual Basic
- communicatietechnieken: Mosaic/Netscape/Internet

Ontwerpexperimenten (50 %):
- driedimensionale representaties van gebouwen en gebouwdelen
- functionele en vormkundige architectonische analyses
- genereren van nieuwe architectonische vormen en ruimten.

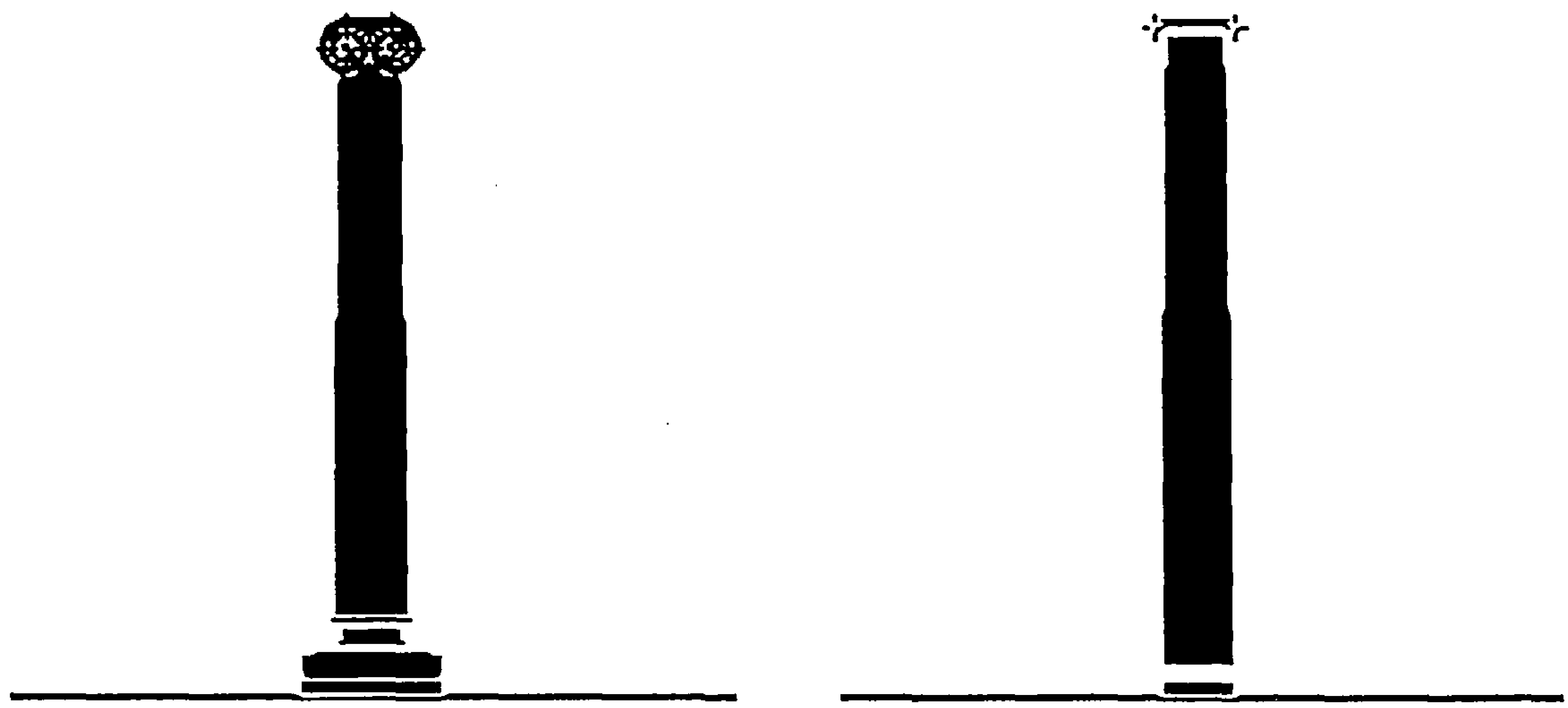
Onderdeel afstudeerprogramma: keuzeprogramma voor Architectuur

Modulecoördinator	ir. P.P. van Loon, vakgebied: Bouwinformatica/Ontwerpinformatica
Plv. modulecoördinator	Prof.ir. C.J.M. Weeber, vakgebied: Architectonisch ontwerpen; vorm en functie
Uitvoerende vakgroep	Geschiedenis, Theorie, Media en Informatica en Architectuur

Betrokken vakgebieden in de module
Bouwinformatica/Ontwerpinformatica
Architectuurtheorie/Ontwerpmethodieken
Architectonisch ontwerpen/Vorm en functie

Samenstelling modulecijfer

Toetsing vakgebieden:	Moduletoets	40%
	Toetsing kennis	**40%**
	Werkstuk/ontwerp	60%
	Totaal vaardigheden	**60%**
Studiepunten	Kennisdeel	3,4 stp
	Vaardigheidsdeel	5,0 stp
	Totaal studiepunten	**8,4 stp**



PARAMETRISCH ONTWERPEN VAN TRAPPEN

Ten opzichte van parametrisch ontwerpen zijn trappen een interessanter onderwerp dan kolommen. Een trap is een van de meest gestandaardiseerde delen van de gebouwde omgeving. Toch kent zelfs een eenvoudige rechte trap twee met elkaar verbonden verhoudingen van parametrische karakter:

1. het aantal treden dat nodig is voor het overbruggen van een hoogteverschil tussen twee vloerniveaus, en

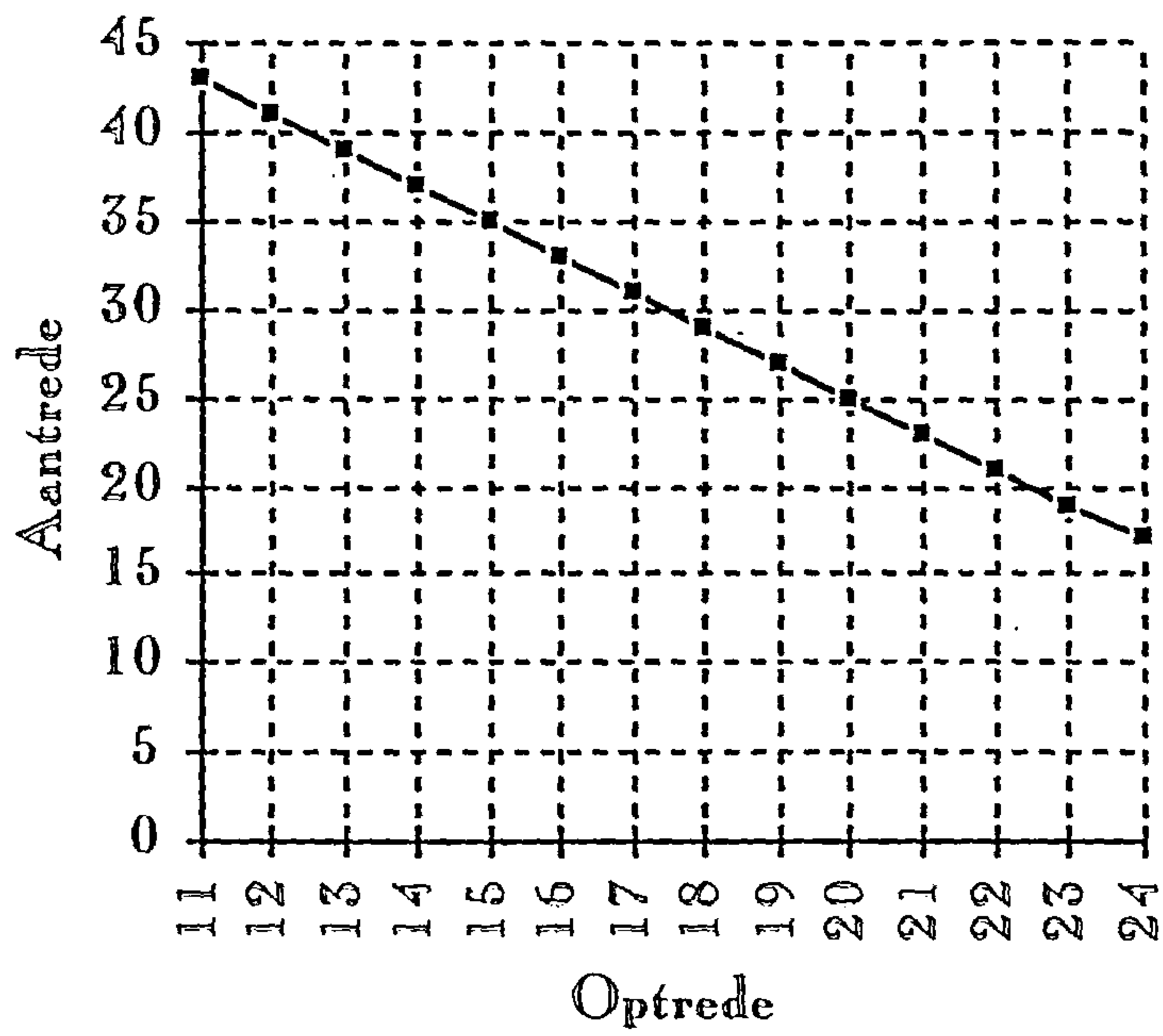
2. de hoogte (optrede) en de lengte (aantrede) van elke trede van de trap.

De afmetingen van een trap zijn in de eerste plaats afhankelijk van de verhouding tussen de op- en aantrede. Het bepalen van hun grootte is geen gemakkelijk probleem als we alleen al denken aan de ergonomische eisen van de mogelijke gebruikers van de trap (kinderen, volwassenen en bejaarden). Al sinds de oudheid zijn bouwkundigen bezig geweest met het vaststellen van de perfecte afmetingen en proporties van een trede. In vrijwel alle theoretische werken vinden we opmerkingen en voorschriften over de minima, maxima en optima van de op- en aantrede.

De echte doorbraak vond pas plaats in de zeventiende eeuw met François Blondels formule die de geometrie van een trap verbindt met de menselijke pas [Blondel, 1675–1683]. Deze formule

$$2 \times \text{optrede} + \text{aantrede} = \text{paslengte}$$

vormt al ruim drie eeuwen de basis van de meeste bouwvoorschriften en -normen over trappen. Toch kent deze formule ernstige beperkingen. Als de optrede hoger of lager wordt dan gebruikelijk, dan wordt de aantrede respectievelijk te smal of te breed. De volgende illustratie toont de verhouding tussen op- en aantrede in Blondels formule voor een paslengte van 65 cm:



In de loop der jaren zijn er talloze aanpassingen en verbeteringen van Blondels formule voorgesteld. Ook deze kennen beperkingen. De flexibiliteit van het menselijke lichaam en gedrag kan niet op zo'n lineaire, deterministische wijze voorgeschreven worden.

Recent onderzoek bewijst dat het belopen van trappen gemakkelijker is:

- bij lagere optreden, en
- bij een goede verhouding tussen op- en aantrede.

Hogere optreden gecombineerd met smallere aantreden zijn niet moeilijker dan lagere optreden gecombineerd met diepere aantreden (dit binnen bepaalde grenzen). Deze verhouding is echter flexibeler dan in de formules van Blondel en zijn opvolgers. Templer stelt voor dat de verhouding tussen op- en aantrede beter wordt uitgedrukt in een tabel (alle maten in cm) [Templer, 1992]:

optrede	aantreden						
18,3	27,9						
17,8	27,9						
16,5	27,9	29,2	30,5	31,8			
15,2	27,9	29,2	30,5	31,8	33,0	34,3	35,6
14,0	27,9	29,2	30,5	31,8	33,0		
12,7	27,9	29,2	30,5				
11,7	27,9						

Ondanks de ernstige beperkingen van Blondels formule kunnen we deze als basis gebruiken voor het parametrisch ontwerpen van trappen. Een voorwaarde is dat de op- en aantrede binnen bepaalde grenzen blijven.

De berekening van een trap kan plaats vinden in een spreadsheet. De spreadsheet berekent een trap op basis van Blondels formule, de menselijke paslengte, de gewenste op- en aantrede, de minima en maxima voor de op- en aantrede, en het te overbruggen niveauverschil. Deze variabelen en hun relaties vormen een *constraint propagation* netwerk dat de precieze afmetingen van de trap calculeert op twee alternatieve wijzen:

A. *Op basis van de gewenste optrede.* Deze wordt eerst vergeleken met het gekozen minimum en maximum. Als de gewenste optrede-hoogte groter of kleiner is dan het respectievelijke maximum of minimum, wordt het maximum dan wel het minimum in plaats van de gewenste hoogte verder gebruikt. Vervolgens wordt de aantrede berekend op basis van de optrede, de gewenste paslengte en de bovenstaande formule. Het aantal op- en aantreden wordt berekend en afgerond op gehele getallen. De precieze hoogte van de optrede wordt dan berekend op basis van het te overbruggen niveauverschil en het afgeronde aantal optreden. Tenslotte wordt de totale lengte van de trap berekend zodat men kan controleren of de trap in de daarvoor beschikbare ruimte past.

B. *Op basis van de gewenste aantrede.* Het enige verschil met de vorige wijze is dat de berekening van de trap begint met de controle van de gewenste aantrede ten opzichte van het gekozen minimum en maximum. Hierna wordt de optrede berekend op basis van aantrede en paslengte. Verder vindt de berekening van de trap op precies dezelfde wijze plaats als in (A).

Het constraint propagation netwerk van de berekening weerspiegelt het *parametrische karakter* van de berekening. Als gevolg hiervan zijn veranderingen toegestaan in de variabelen en in de constraints, zoals keuze van een andere paslengte of een andere formule. Deze veranderingen beïnvloeden lokale berekeningen (de inhoud van enkele cellen) en niet het netwerk waarmee lokale berekeningen met elkaar verbonden worden.

OEFENING

DE OPDRACHT

Je ontwerpt de trappen van een bestaand gebouw aan de hand van numerieke modellen. Hiermee worden de afmetingen van elke trede en het aantal treden voor elke trap. De resultaten van het praktikum zijn:

(i) een nauwkeurige representatie van de bestaande trappen van het gebouw, en

(ii) een alternatieve oplossing voor deze trappen.

DE AANPAK

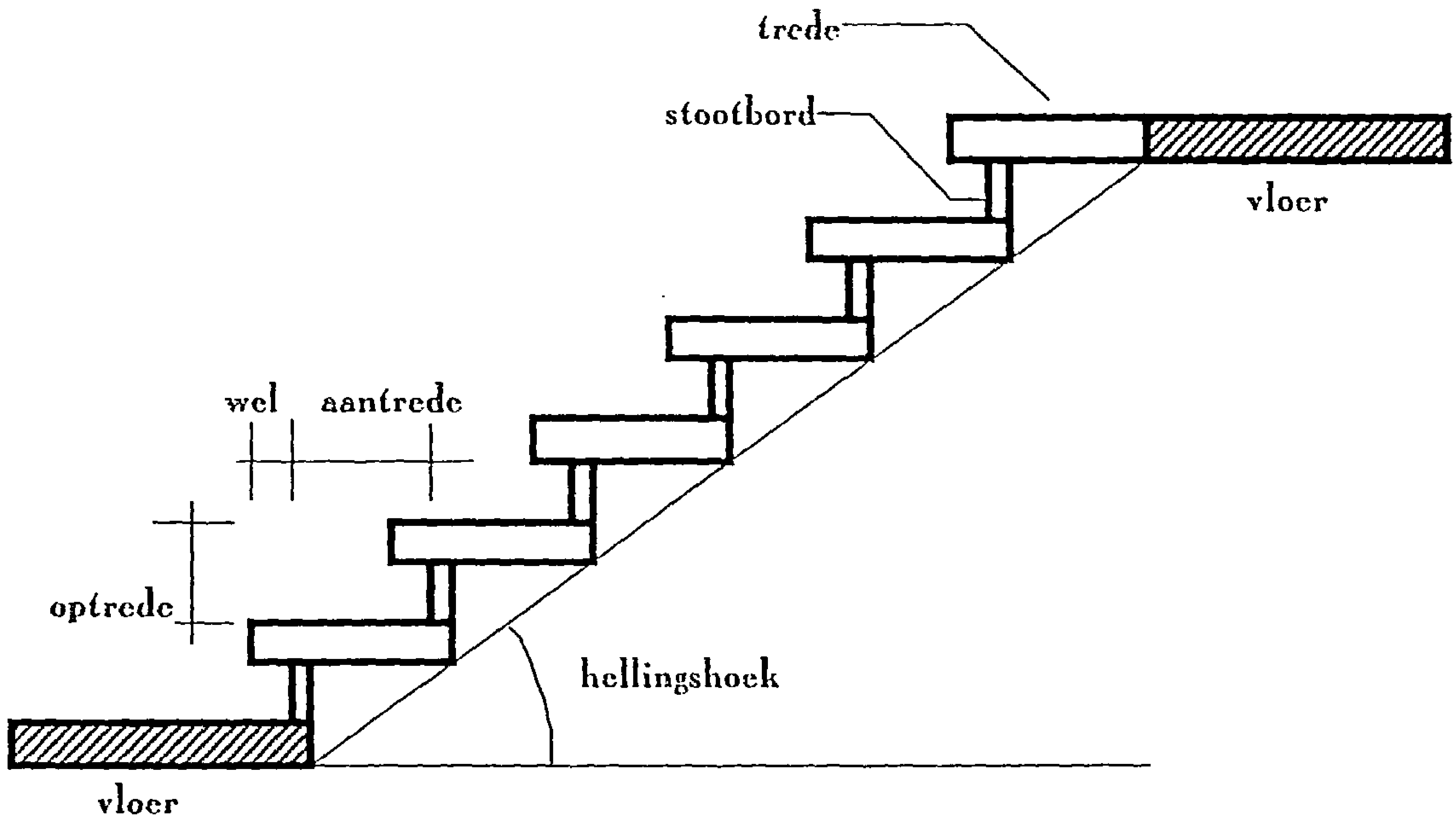
De afmetingen van een trap hangen af van functionele eisen gesteld door de ergonomie en veiligheid van menselijk verkeer in gebouwen. De traphelling, de aan- en optrede en de breedte van een trap bepalen of een trap gemakkelijk en veilig beloopbaar is.

Deze afmetingen en hun onderlinge relaties vormen een *constraint propagation*-netwerk gebaseerd op Blondels formule

$$2 \text{ x optrede} + \text{aantrede} = \text{paslengte}$$

Dit netwerk krijg je in twee hoofdvarianten, een voor rechte steektrappen en een voor ronde trappen (in principe Engelse trappen). Deze vind je als spreadsheet bestanden in de sub-directory Trappen op de harddisks van het CAD-Atelier.

De trappen die je berekent moeten veilig en gemakkelijk beloopbaar zijn. Dit bereik je door aandacht te besteden op de volgende:



- *Trede*
  De trede is het horizontale gedeelte, waarop wordt gelopen. De lengte van een trede is gelijk aan de aantrede plus de overstekende wel.

- *Stootbord*
  Het stootboord is het verticale gedeelte tussen treden.

- *Wel*
  De wel is het overstekende stuk vóór het stootbord. Deze wel is bedoeld om meer ruimte te maken voor de plaatsing van de voeten. Daardoor wordt tevens voorkomen dat men steeds tegen het stootbord schopt. De wel bevordert dus de beloopbaarheid van een trap, vooral bij het afdalen. De gebruikelijke lengte van een wel is 2–5 cm.

- *Aantrede*
  De aantrede moet 27 cm of groter zijn.

- *Optrede*
  Onder optrede verstaat men de verticale afstand tussen treden. De optrede moet 16–19 cm zijn.

- *Paslengte*
  De paslengte van een volwassene is 60–65 cm.

- *Helling*
  De helling van een trap moet 20–45° zijn. Voor hellingen steiler dan 45° gebruik je ladders en voor lager dan 20° hellingbanen.

Berekening van een rechte steektrap

Input

A. Vloerniveau A	300
B. Vloerniveau B	100
C. Paslengte	60
D. Maximale optrede	19
E. Minimale optrede	16
F. Maximale aantrede	35
G. Minimale aantrede	26
H. Gewenste optrede	17
I. Gewenste aantrede	33

Output

J. Traphoogte (A-B)	200

Op basis van gewenste optrede (H)		Op basis van geweste aantrede (I)	
K. Optrede (D, E of H)	17	K. Optrede (|C-L|/2)	13,5
L. Aantrede (C-2*K)	26	L. Aantrede (F, G of I)	33
M. Aantal optreden (J/K afgerond)	12	M. Aantal optreden (J/K afgerond)	15
N. Precieze optrede (J/M)	16,67	N. Precieze optrede (J/M)	13,33
O. Aantal aantreden (M-1)	11	O. Aantal aantreden (M-1)	14
P. Traplengte (O*L)	286	P. Traplengte (O*L)	462

Berekening van een trap in een spreadsheet

- *Traphoogte*
  Dit is de hoogte die door elk gedeelte van de trap overbrugd moet worden. Het kan het verschil tussen twee verdiepingen, bordessen of (bij composiete trappen) het beginpunt van trapgedeelten zijn.

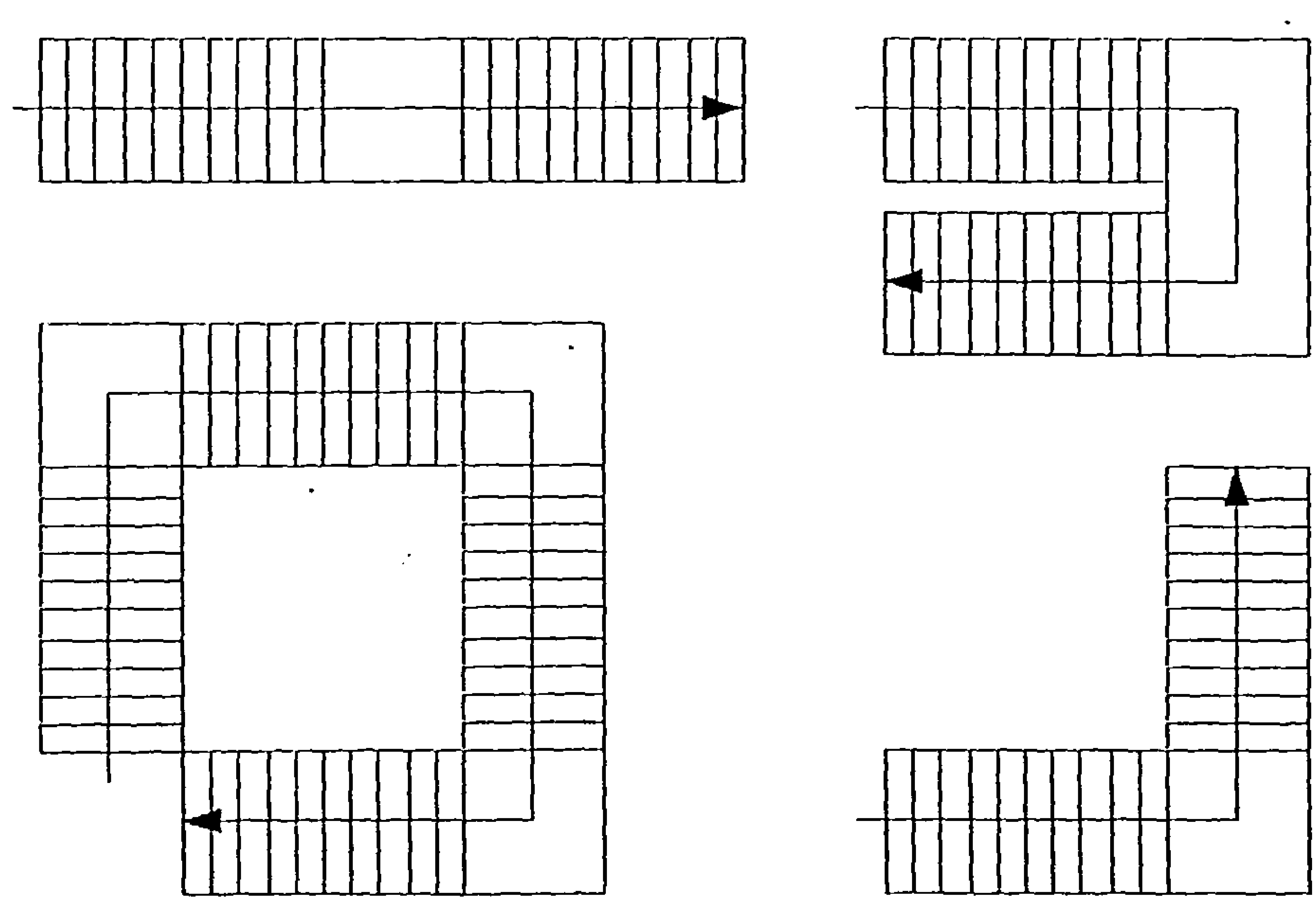
- *Looplijn*
  Bij een rechte trap zullen we meestal in het midden lopen. Daarom tekenen we hier de looplijn (of klimlijn). De looplijn wordt aangegeven met een pijl die de opwaartse richting van het belopen aangeeft.

  Bij een ronde trap neem je voor de looplijn een cirkelboog. Deze boog ligt in het midden van de trapbreedte. Dit is niet van toepassing op spiltrappen. Bij de ronde trappen van dit praktikum gebruik je daarom een lange straal.

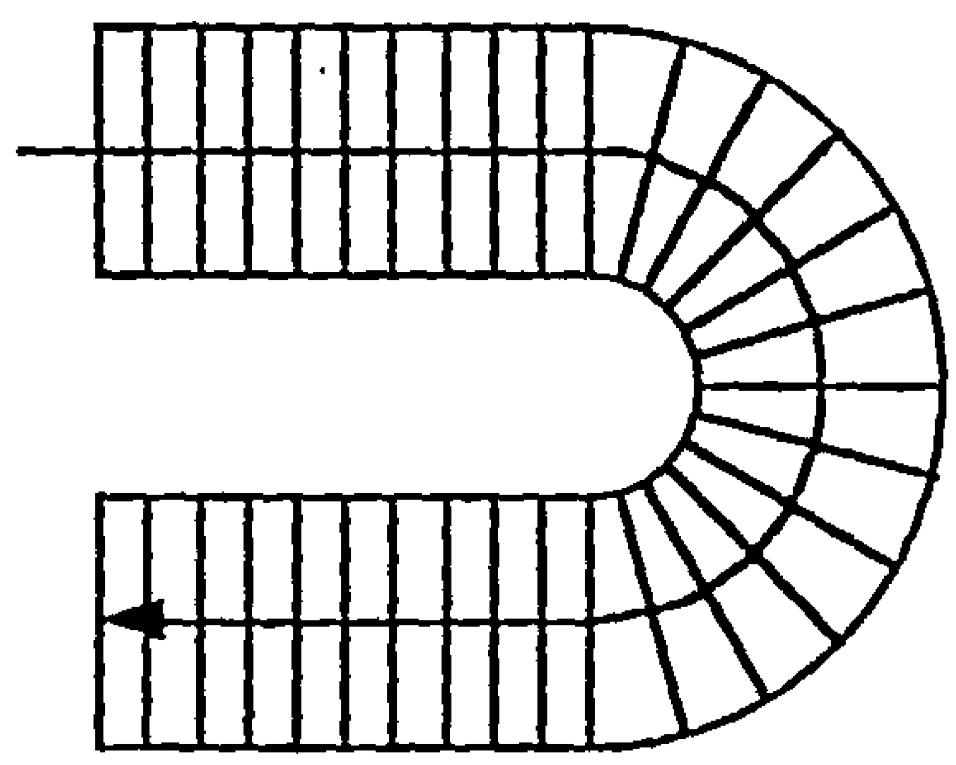
Door de juiste samenstelling van deze bestanden (inclusief de toevoeging van nieuwe elementen zoals bijvoorbeeld bordessen) maak je een parametrisch model waarmee je de afmetingen en positie van de trap berekent. Het instellen van de variabelen in het netwerk genereert alternatieve oplossingen voor de trap.

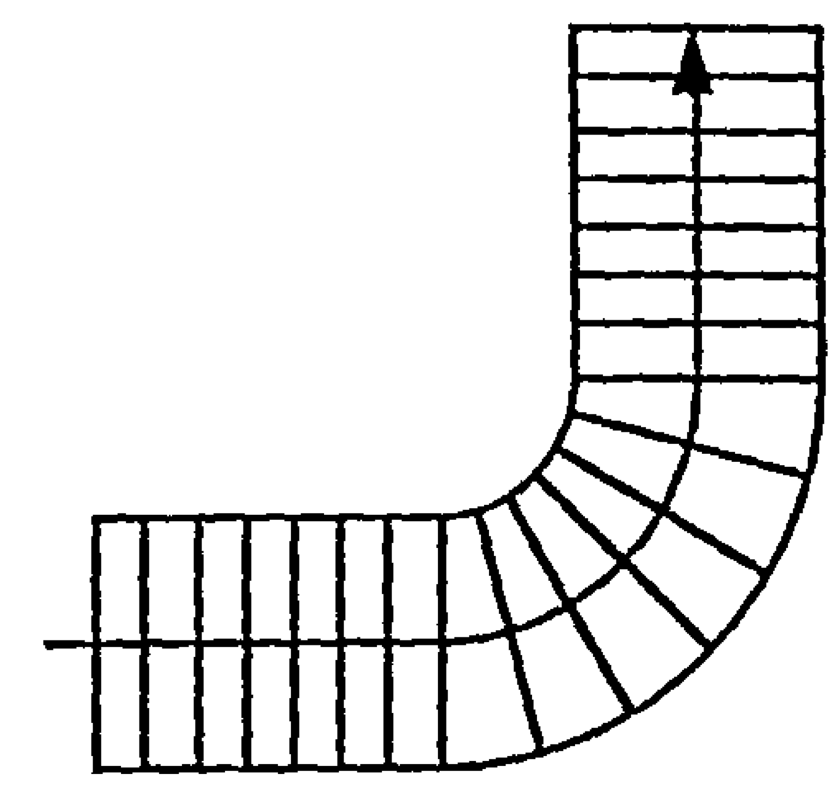
Naast rechte steektrappen en ronde trappen kun je de volgende trapvormen produceren:

- *Bordestrappen*
  Een bordestrap bestaat uit twee of meer trapgedeelten (de *traparmen*). Traparmen worden door bordessen onderbroken. De volgende illustratie bevat voorbeelden van bordestrappen met rechte traparmen.

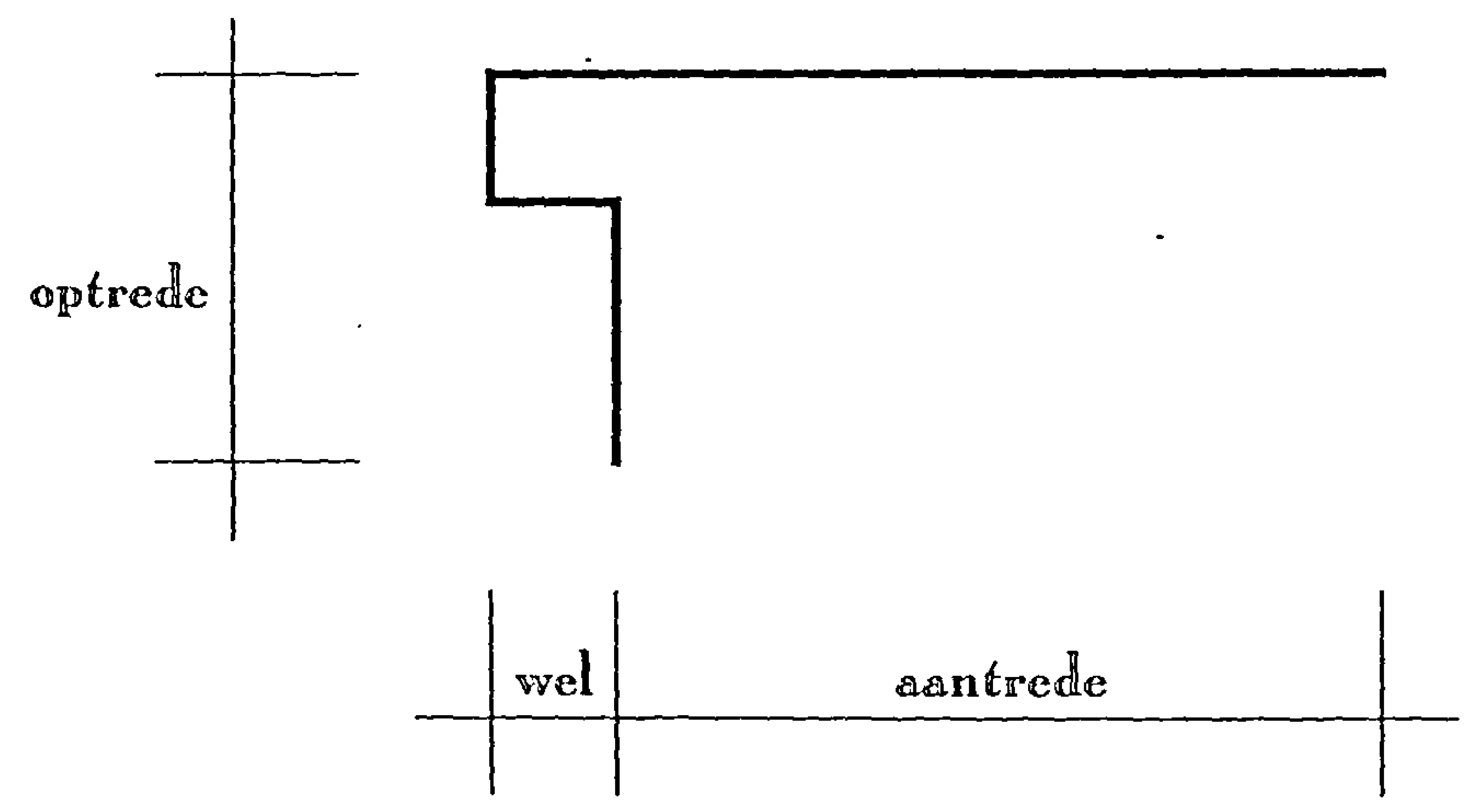


- *Komposiete trappen*
  Ook een komposiete trap bestaat uit twee of meer gedeelten. Het verschil met bordestrappen is dat deze gedeelten niet door bordessen worden onderbroken. In het kader van het praktikum maak je komposiete trappen uit combinaties van rechte en ronde gedeelten, zoals:



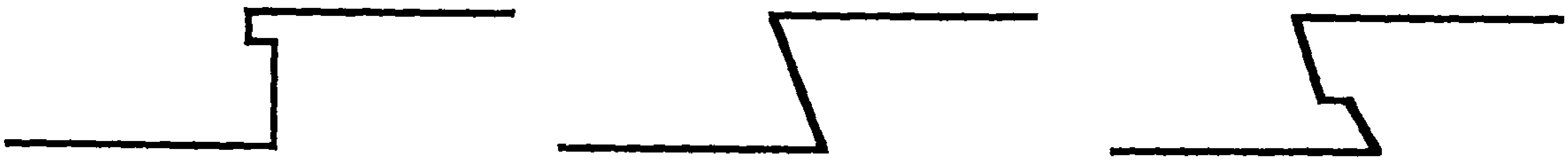


De berekende afmetingen van de trap kun je vervolgens naar een tekenprogramma exporteren. Op basis hiervan wordt de hoofdstructuur van de trap automatisch getekend. Deze hoofdstructuur bestaat uit gestandaardiseerde treden (*blocks*). Deze treden hebben in doorsnede de volgende vorm:



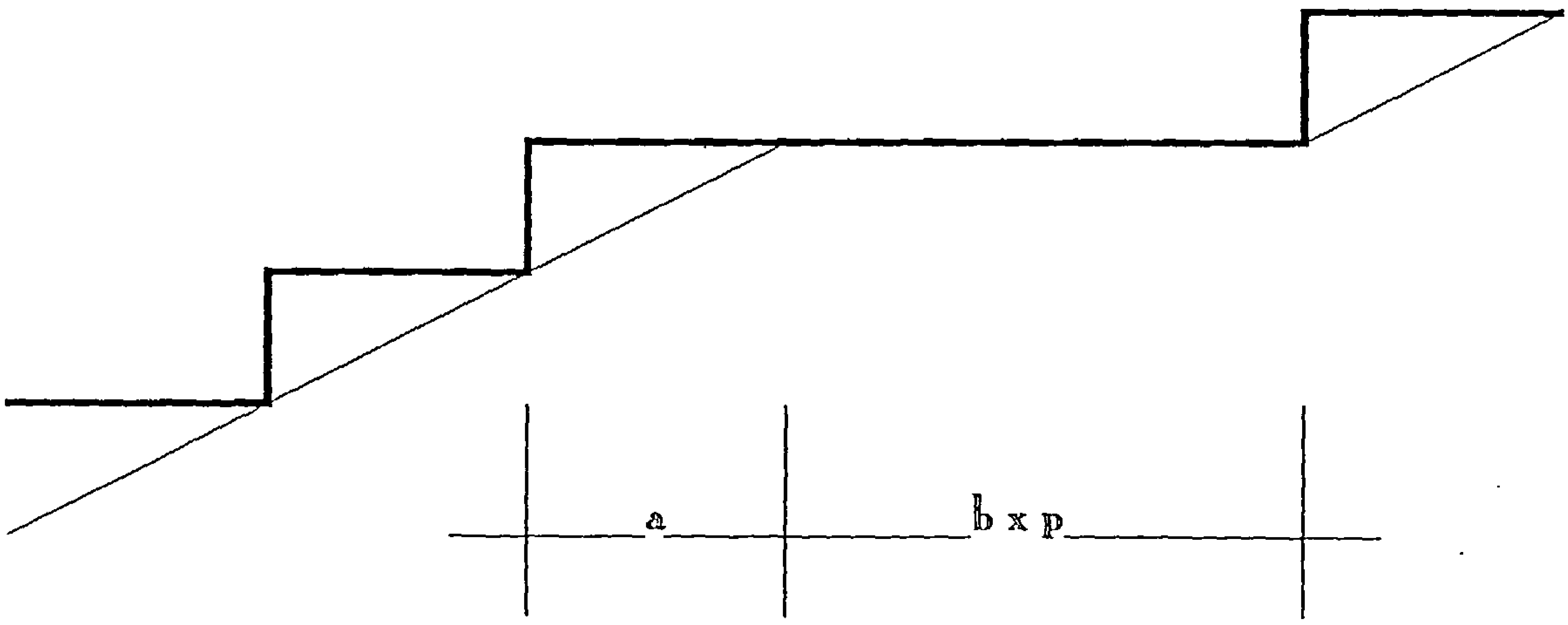
Deze vorm moet je verder bewerken in een concrete representatie van de trap. Dit doe je door de definitie van de trede-*blocks* te veranderen. Je mag balusters, leuningen en andere uitrusting aan de nieuwe *block*-definities toevoegen. Je moet echter aandacht besteden aan de volgende:

- *Wel*
  Je kan uit verschillende welvormen kiezen, zoals:



Treden zonder wel zijn niet toegestaan.

- *Bordessen*
  De bordeslengte moet zodanig gekozen worden, dat deze altijd een aantrede plus één of meer passen heeft.



a = aantrede
b = 1, 2, ...
p = paslengte

- *Leuningen en balusters*
  De leuningen zijn geplaatst op een doelmatige hoogte (85–90 cm) boven de treden, gemeten van de voorkant van de trede. De leuning wordt bevestigt op de muur met leuningdragers, -houders of smeltplanken. Tussen de muur en de leuning moet je tenminste 4 cm vrije ruimte hebben.

  Men kan voor de doorsnede van de leuning diverse vormen kiezen. Het profiel moet gemakkelijk met de hand te omvatten zijn. Scherpe kanten moeten worden vermeden.

Indien één van de zijden van de trap niet tegen een muur komt, dan bevestig je de leuning met *balusters* of een paneel aan de trap. De afstand tussen balusters moet zodanig worden gekozen, dat kinderen er niet tussendoor kunnen vallen. Deze afstand mag daarom nooit meer dan 15 cm bedragen.

- *Trapbreedte*
  De trapbreedte is de vrije ruimte tussen de leuningen. De breedte wordt mede bepaald door het aantal personen dat ervan gebruik moet maken. De aangewezen breedte voor één persoon is circa 70 cm, voor twee 130 cm en voor drie 190 cm.

- *Trapgat*
  Op de plaats waar een trap een verdieping doorbreekt, is het noodzakelijk een trapgat aan te brengen. De afmetingen van dit trapgat moeten zodanig zijn, dat men dit gat gemakkelijk kan passeren (vooral bij het afdalen).

DE MIDDELEN

Voor het ontwerpen van de trappen maak je gebruik van de volgende programmatuur:

- Excel 5 voor Windows (spreadsheet)

- AutoCAD 12 voor Windows (tekenprogramma)

DE STRUCTUUR VAN HET PRAKTIKUM

Het praktikum bestaat uit 6 sessies van 4 uur in het CAD-Atelier. Drie sessies zijn voorbereidend. Tijdens deze sessies maak je kennis met de middelen en de opdracht. In de andere drie sessies ontwerp je de trappen onder begeleiding van docenten en instrukteurs van de sector Bouwinformatica.

Elke sessie begint met een korte instruktie en eindigt met een rondvraag en presentatie van bereikte resultaten. Zorg daarom dat je op tijd komt en niet te vroeg vertrekt.

IN TE LEVEREN WERKSTUKKEN

De beoordeling van je resultaten in dit praktikum vindt plaats op basis van:

- de presentatie van de trappen op de computer tijdens de laatste sessie van het praktikum, en

- een rapportage / presentatie van de trappen door middel van afdrukken van:

    - het Excel-bestand met de berekening van de trappen (bestaande situatie en eigen alternatief),

    - de plattegrond(en) van de trappen in het AutoCAD-bestand (vergeet niet de looplijn, de nummering van de treden en de peilmaten van allen vloerniveaus, inclusief bordessen),

    - driedimensionale afbeeldingen van de trappen in het AutoCAD-bestand (minimaal drie van de bestaande situatie en drie van jouw alternatief),

    - eventuele andere documenten die een goed beeld van de trappen geven, zoals tekeningen van het gebouw met de bestaande situatie van de trappen.

De afdrukken, voorzien van naam, studie-, groep- en bloknummer, moeten ingeleverd worden in een A4-map bij het secretariaat van de sector Bouwinformatica (kabinet 11.02) in de laatste (zevende) week van de blokperiode. Samen met de afdrukken lever je in de map ook een kopie van het Excel- en het AutoCAD-bestand van de trappen (niet je eigen werk- of archiefkopie). De map moet een zelfstandige presentatie van de trappen vormen. De kwaliteit van deze presentatie speelt een rol in de beoordeling van je resultaten.

This example is a design course to be used in PBL environment of first year students.

ARCH1120	**Architecture 1 (Part 2)**	**Units:40**
Course Availability:	Not Available 2006	
Faculty:	Faculty of Engineering and Built Environment	
School:	School of Architecture and Built Environment	
Teaching Methods:	Problem Based Learning Field Study Lecture Practical Student Projects Studio Tutorial	
Description:	Students will explore, investigate, research and resolve architectural problems while developing skills, knowledge and understanding in design integration, environmental studies, technical studies, communication skills, professional development and design studies.	
Course Objectives:	Design Integration: Introduction to the theoretical and practical concepts and terms of architecture; Develop an understanding of architectural design processes and related techniques and outcomes; Perceive and communicate existing and imagined architectural conditions; Work singly and within small groups on architectural design tasks; Develop an understanding of professional architectural roles, relationships and activities. Information Literacy: Investigate Problem Based Learning as a teaching method and summarise and verify the value of the literary evidence Collaborate within teams and contribute to team management Use available technology to assist in the preparation of the essay, for communication and management of teams Critically reflect on the learning process for the semester Basic Construction: Examine the history of materials used to construct simple buildings Differentiate between materials commonly used to construct simple buildings Contrast between different construction methods Define the principles of timber and steel framed construction Define the principles of monolithic construction Produce a scaled model of a framed building Communications Skills: Electronic Communication Develop techniques in the use of standard architectural 3D CAD to a basic level of competence Create a 3D CAD model of simple architectural design Select (and output) appropriate 3D views of a 3D CAD model to present the design of a building for critical appraisal	

Course Content:	Students undertake studio assisted architectural design processes to develop solutions to architectural projects. They concentrate on observation and analysis, be introduced to some design processes, develop graphical communication skills (diagramming, 2D and 3D drawing both mechanical and freehand and model-making) and develop an understanding of environmental studies (how to look at, measure and analyse architectural sites and begin to respond to climatic conditions). Design Integration: An introduction to the theoretical and practical concepts and terms of architecture; An understanding of architectural design processes and related techniques and outcomes; Perceive and communicate existing and imagined architectural conditions; Work singly and within small groups on architectural design tasks; An understanding of professional architectural roles, relationships and activities. Information Literacy: PBL - what is it? Endnote Training Working in Teams Academic Writing Skills How to Assess Creativity Reflective Writing Facilitation of Teams Presentation Styles Reflective Journals in Design Executive Summary of Reflection Basic Construction: Materials and Structural Principle Grounding of Structures and Floor Framing Wall Framing and Linings Concrete Slabs Masonry Walls Detailing of Opening in Walls Composite Construction Introduction to Detailing Architect in Focus Communication Skills: Electronic Communication CAD software 2D modelling 3D modelling CAD conventions CAD presentation skills Printing and Troubleshooting

This example is an architectural course designed for third year students.

ARCH3120	**Architecture 3 (Part 2)**	**Units:40**
Course Availability:	Not Available 2006	
Faculty:	Faculty of Engineering and Built Environment	
School:	School of Architecture and Built Environment	
Teaching Methods:	Problem Based Learning Field Study Lecture Integrated Learning Practical Student Projects Studio Tutorial	
Description:	Students will explore, investigate, research and resolve architectural problems while developing skills in design integration, environmental studies, technical studies, communication skills, professional development and design studies.	
Course Objectives:	Design Integration: Justify a design with reference to an urban site Develop design strategies for public buildings Identify the functional needs and uses of public buildings Prepare design solutions to support sustainable buildings Present ideas and designs graphically and verbally Historical Studies: 20th Century Movements in Architecture Environmental Studies: Architecture and the Environmental Context Develop informed processes of understanding and describing the civic architectural site; Develop an applied understanding of architectural science and technology concepts; Develop a knowledge of inter-related concepts of planning, ecology and landscape design; Inform and develop skills to enable detailed design following ESD principles Develop an integrated understanding of recent examples of ESD through case studies.	

Course Content:	Design Integration: Issues relating to public building types New scale of public, institutional clients and a wider diversity of building users Range of historical models from Australian and overseas relating to the formal and cultural issues present Presentation of technical information including lighting and acoustics Historical Studies: 20th Century Movements in Architecture Futurism Constructivism Functionalism Brutalism Rationalism Metabolism Eclecticism Classicism Regionalism High-Tech Deconstructionism Complexitism Environmental Studies: Architecture and the Environmental Context Understanding and describing the civic site Architectural science and technology Planning, ecology and landscape design Sustainable detail and materials Case studies In even numbered years (in conjunction with Architecture 2 Part 1) students study Introduction to Design Management. In odd numbered years (in conjunction with Architecture 2 Part 1) students study twentieth century architectural and design theory movements.

THESIS CONTAINS

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