MANAGEMENT OF CHANGE

Management of Change

Implementation of Problem-Based and Project-Based Learning in Engineering

Edited by

Erik de Graaff
Delft University of Technology, The Netherlands

and

Anette Kolmos
Aalborg University, Denmark

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PREFACE

Higher engineering education is a field with strong traditions. Therefore, the transition from traditional approaches in engineering education to innovative curricula based on Problem-Based and Project-Based Learning represents a major challenge. Currently, many engineering institutions in different countries all over the world are involved in such a change process. Over the past decades, many papers and books have been published, highlighting PBL from many angles. Yet we feel there is still a need to focus on the aspect of implementation, in particular in relation to the transition process in existing engineering schools.

The book "Management of Change: Implementation of Problem-Based and Project-Based Learning in Engineering" aims to put together an overview of examples of the introduction of PBL formats in Engineering. The authors of the chapters – experts in their field - describe their experiences in changing to a new pedagogical model. Concrete case histories serve as a basis for inspiration for further development but also deeper insight in the understanding of implementing change.

There are four sections in the book. The *first section* aims to set the scene for the understanding of PBL. The contributions in the *second* section deal with management of change. In the *third* section, we have collected a series of research studies providing evidence on the effects of a PBL curriculum. The *fourth* section, at the end of the book consists of a collection of case studies on various aspects of PBL. Below, we give a brief description of each chapter.

Section 1: Setting the PBL Scene

In the opening chapter, the editors of this book, Erik de Graaff and Anette Kolmos, present the unique approach of this book: considering PBL to include both problem-based learning and project-based learning. The two pedagogical models are actually based on the same pedagogic principles. New institutions can be observed to mix principles, modelling them in a way to fit a particular culture and organizational pattern.

The second chapter offers an alternative. Maggie Savin-Baden represents another approach to PBL. She argues that problem-based and project-based learning are different models and introduces several other models that are practised all over the world together with an analytical framework for analyzing institutional models.

Section 2: Management of Change

In chapter 3, Anette Kolmos and Erik de Graaff start by addressing the transformation processes in Higher Education (HE) and by presenting models for institutional change. There is not much research and literature in this area of the

implementation of PBL in engineering education. Consequently, this book aims to fill out a gap on establishing innovation and change in higher education.

Myths about PBL tend to surface in discussions prior to the implementation of an educational innovation. In chapter 4, Rob Cowdroy, Arthur Kingsland and Anthony Williams dispel eight myths about PBL and argue that PBL is cost-effective. These myths are normally used as arguments against PBL and to prevent change of traditional teaching systems.

In chapter 5, Isabel Alarcão, University of Aveiro, Portugal, analyzes the institutional change process from a top-down perspective, emphasizing the phase of incubation from the presentation of the very first ideas at the institution until the active staff participation in the process. But also the alignment among institutional strategy, curriculum development, and staff development is underpinned as one of the lessons learned.

A different perspective on the management of change is presented by Brian Bowe in Chapter 6. He analyzes a case study detailing how PBL was designed, implemented, and evaluated from a students' and learner's perspective, aiming to discuss the management strategies of both the development and implementation phases. The strategies concern the overcoming of obstacles formulated by colleagues.

Section 3: Research on the Implementation of PBL

The third section highlights research-based evidence related to the implementation of PBL. The studies presented in this section are crucial to any further development and dissemination of PBL.

Chapter 7 by Mariane Frenay, Benoît Galand, Elie Milgrom, and Benoît Raucent describes the history of adopting project- and problem-based learning at University of Louvain-la-Neuve, the process for implementation and the main results of a comprehensive study evaluating students' and staff perceptions and students' learning performance. A conclusion of this study is that students in a PBL curriculum do not learn less – and that they do get motivated for learning through working with problems.

A similar study is presented by Denis Bédard, Roland Louis, Marilou Bélisle, and Rolland Viau from University of Sherbrooke, Canada, in chapter 8. They describe the background of the implementation of different PBL models, which gives the opportunity to compare and report on the results of students' and teachers' perceptions of these programmes. Results show that PBL is highly appreciated by students and staff.

In chapter 9, Caroline Baillie addresses the gender perspective in PBL. She reports on gender studies indicating that women get motivated for learning by open problems and the possibility of analyzing problems instead of solving problems. Especially, the social context of problems might be the key to recruit more women into engineering.

In chapter 10, Josée Bouchard and Alenoush Saroyan recount a study on the cognitive processes of PBL with undergraduate physics students, and they present a model for adopting PBL in a single course without changing the entire

programme or institution. Results from the study show that these PBL students achieve cognitive skills such as meta-cognition, critical thinking, and problem solving.

Section 4: Case Studies, and Good Practices

The fourth section of the book highlights some case studies on PBL.

In chapter 11, James L. Mason and James D. McCowan of Queen's University, Canada, describe how PBL is used as part of the first-year programme where a major part of laboratories were switched into PBL. This has caused a change in faculty and student's attitudes and created motivation for learning.

In chapter 12, José Manuel Nunes Oliveira presents a study analyzing the change process at University of Aveiro in Portugal. He describes the bottom-up experiences from the change process. From this point of view, support from the top is needed, the staff involved is mainly younger staff members, and the motivation for the staff was to create meaningfulness in a contextualised paradigm.

Going back to the roots of PBL, Donald Woods analyzes the experience of students in a PBL environment in chapter 13. Based on his extensive experience, he presents a series of tips and tricks to help students make the most of PBL. This information is priceless for curriculum developers, since it helps them to focus on the students' values.

Finally, chapter 14 presents a case involving the application of PBL to a different setting. Kevin Freiert and Sheella Mierson discuss the advantages of working with authentic problems in a workplace environment which underpin the fact that PBL is closely connected to the approach of work-based learning.

We hope that you will enjoy reading this book.

August, 2006
Erik de Graaff and Anette Kolmos

ERIK DE GRAAFF AND ANETTE KOLMOS

HISTORY OF PROBLEM-BASED AND PROJECT-BASED LEARNING

INTRODUCTION

Problem-Based Learning is an educational strategy. A method to organize the learning process in such a manner that the students are actively engaged in finding answers by themselves. Throughout time, great teachers and pedagogues have always understood the effectiveness of these principles. Socrates made a point of questioning the student in order to activate latent knowledge, and the Chinese philosopher Confucius stressed the importance of involvement with a few often quoted lines:

Talk to me.... and I will forget
Show me.... and I will remember
Involve me.... and I will understand
Step back.... and I will act

In more recent times, pedagogues like Fröbel and Montessori sought to enforce intrinsic motivation through engaging the learners in all sorts of appealing activities. The motto for the Montessori child is: '*my playing is my learning'*. The ideas of the American teacher Killpatrick are another example. Working in the early parts of the last century, he is considered to be the originator of the project method in education. Among other things he observed that the enthusiasm of the students for project work varied with the degree of freedom to make their own choices. Thus, we can understand Killpatrick's statement that the effectiveness of projects depends on: *"learning as wholehearted doing"* (Heitmann, 1993).

How to engage students of course depends on the particular situation and the age of the students. Nevertheless, educational concepts like '*discovery learning*', '*learning-by-doing*', *'experiential learning',* and *'student-centred learning'* clearly suggest exploiting human traits like curiosity and the sense of mastery and self-determination (Rogers, 1961; Kolb, 1984; Schmidt, 1983).

For a long time, pedagogy in the field of higher education has been grossly neglected. Teaching at the university was generally left to the professors. In fact, the issue of university teaching did not attract attention before the massive increase in student numbers in the 1960s. At that time, innovations sprouted everywhere. In many places, alternatives were proposed to the mass lectures attended by several hundreds of students. For instance, methods like Case-based learning and project education aimed at bringing practical experiences into the classroom (Van Woerden, 1991).

Erik de Graaff and Anette Kolmos (eds), Management of Change, 1–8.

Among these educational innovations, the one labelled Problem-Based Learning (PBL) eventually became quite well-known and successful. The term Problem-Based Learning was originally coined by Don Woods, based on his work with Chemistry students in McMaster's University in Canada. However, the popularity and subsequent world-wide spread of PBL is mostly linked to the introduction of this educational method at the medical school of McMaster University.

PBL in Medicine

At the end of the 1960s, a new medical school was established at McMaster. Starting from scratch, a completely new medical curriculum was designed. The new curriculum was soundly based on a "basic philosophy" containing three visions (Spaulding, 1969):

- A vision on mankind and society.
- A vision on the medical profession and its role in society.
- A vision on education.

The core philosophy consists of a holistic vision on humanity and a critical vision on the medical profession. The team working on building the new curriculum recognized that the process of ongoing specialization had gone too far, in particular in the medical profession. Medical science had evolved into a finely branched network of highly specialized fields. Physicians were treating symptoms and were losing sight of the patient. Medical curricula reflected the trend of specialization. In the first years, the foundation of 'basic disciplines' was laid. Next, the typical programme consisted of a series unrelated discipline-related courses and specialty courses preparing for a series of practice training periods in the hospital.

The McMaster medical curriculum aimed primarily at training general practitioners. PBL was embraced as the educational approach that was to compliment the holistic vision (Neufeld and Barrows, 1974; Fraenkel, 1978). Application in practice was seen as more important than storing facts by rote learning. In the context of medical education, this implies that learning should focus on the patient and his/her complaint. By systematically analyzing patient problems, students formulate questions with respect to the information they lack to solve a problem and so select their own learning-goals. Right from the start, students learn to integrate knowledge from different disciplines, related to the same medical problem. At the same time, they acquaint themselves with the problem-solving process of a physician. In this way, the relevance of the material studied is assured, but also the experience of learning becomes more exciting and more meaningful (Barrows and Tamblyn, 1980).

The success of the McMaster medical curriculum inspired other medical schools to implement similar educational programmes. Among the first to embrace PBL were the medical schools of Maastricht in the Netherlands and Newcastle in Australia (Graaff and Bouhuijs, 1993). In New Mexico, a programme in health sciences was started (Kaufman, 1985). These were all newly established institutes, who identified with the professional objectives first and adapted the educational model as part of the package.

Typically, in a PBL curriculum, the learning process is stimulated by means of small group work. This provides students with the opportunity to learn to work together like the members of a small medical team. Trained as independent learners, PBL students may be expected to be able to identify and fill the gaps in their knowledge. Experiments in Maastricht indicated that learning in a PBL curriculum was more effective than in a traditional classroom setting, because of activation of 'prior knowledge' (Schmidt, 1983). The observation that graduates from a PBL curriculum adapt easier to medical practice is explained by the fact that the learning takes place within a relevant context (Post *et al*., 1988).

A typical issue that often surfaces in the course of implementing PBL is the question: what is a problem? According to the dictionary, a problem could refer to a difficulty or even a riddle; in short, something you would want to get rid of as soon as possible. Of course, this is not the kind of problem we are talking about in PBL. As was pointed out years ago, a 'problem' in PBL is an incentive for students, a challenge to start them off on their learning process (Norman, 1986). Implementing a PBL curriculum involves a process of gradual adaptation to local conditions. Furthermore, each curriculum has its own evolution, adding specific elements to the characteristics of PBL. A good example is the Maastricht invention of the 'seven jumps' (Schmidt, 1993). As a consequence of these ongoing processes, the format of PBL curricula diverged widely. In fact, no more than 15 years after the initial introduction of a PBL curriculum, a need was felt to arrange the different varieties into a classification system (Barrows, 1986). Since then, PBL has definitely conquered a prominent place in medicine and health sciences all over the world as well as spread to other professional studies in higher education such as law, psychology, education, economics, and architecture, to mention just a few (Albanese and Mitchell, 1992; Ryan, 1993; Ostwald and Kingsland, 1994; Little, Ostwald and Ryan, 1995).

PROJECT WORK IN DENMARK

Parallel to the development of PBL and for a long time almost independently, a tradition of project pedagogy in engineering education emerged in Denmark. During the 70s, two new universities were founded: Roskilde University Centre in 1972 and Aalborg University in 1974. This occurred due to a very strong student movement and, in the case of Aalborg University, an industry that wanted new competence profiles for engineers. Learning by doing and experiential learning were two of the principles that dominated the development of this particular system. Following the student revolts in the late 60s, a strong moment arose in social sciences during the 70s regarding project work as a possible factor contributing to change in society. In particular, this was true in North European countries like Denmark, Germany, and the Netherlands (Negt and Kluge, 1972; Negt, 1968; Jansen and van Kammen, 1976), however, the advantages turned out to be learning and achievement of new skills.

In Denmark, several authors were formulating these new ideas (Holten-Andersen *et al.*, 1983; Berthelsen *et al.,* 1977; Algreen-Ussing and Fruensgaard,

1990). Especially Knud Illeris is known for the principles of the project pedagogy as it was called at that time. In one of the basic references from 1977, it says:

> .. a form of teaching in which students - in collaboration with teachers and others - explore and work with a problem in close relation to the social reality in which it exists. This entails that the work is to continually increase perspectives and deepen the awareness that the problem is to be approached from different angles across traditional professional boundaries, and that the selection of theories, methods, and tools is to be based on the chosen problem. The role of the teacher is not only to communicate knowledge, but in particular to act as initiator, inspiration, frame-builder, and consultant. The work is to result in a concrete product, be it an oral presentation, a written report, or expressed in other media or actions. (Berthelsen *et al.*, 1977)

Berthelsen *et al.* (1977) identified five central principles: problem orientation, project-organization, interdisciplinary considerations, participant control, and the exemplary function. In the 70s, problem orientation was defined as recognizing and experiencing a concrete problem or other social groups in society. During the following years, the meaning of the term 'problem' changed into the connotation of wondering about something. Several tools were developed to help the students carry out a problem analysis and state their arguments as to why an issue presented a problem.

The *project* aspect was defined as follows:

> A project is a complex effort that necessitates an analysis of the target (problem analysis) and that must be planned and managed, because of desired changes that are to be carried out in people's surroundings, organization, knowledge, and attitude to life; it involves a new, not previously solved task or problem; it requires resources across traditional organizations and knowledge; it must be completed at a point in time determined in advance. (Algreen-Ussing, 1990).

Since individuals cannot be expected to solve such complex tasks by themselves, group efforts are involved. *Interdisciplinarity* involves the crossing of professional discipline borders – hence, the problem analysis and the solutions considered are not confined to traditional professional boundaries.

Participant control means that the participants themselves make the relevant decisions and control the progress of the process. Because they choose and define the problem themselves, the ensuing learning is experienced as meaningful. *The exemplary principle* guarantees that the students learn not just isolated elements. They also have to learn to link theory and practice. The things they learn should provide examples of central aspects within the overall professional goals.

At the Universities of Roskilde and Aalborg, these principles were implemented and fully institutionalized. The principles permeated the entire construction phase, organizationally, culturally, as well as physically, for instance, in the sense that group rooms were built for the students. Both schools proved to be viable models and each has known its own history of development and adaptation of the project model. Project-organized learning has not lived up to the expectation of bringing

about changes in society. However, project work turned out to be an excellent method for developing new types of competencies (Kolmos *et al.*, 2004).

MERGING MODELS

Today, many authors continue to differentiate between problem-based and project-based learning (Prince and Felder, 2006; Savin-Baden, 2000). In most cases, the distinction is based on the understanding that problem-based learning is defined by open-ended and ill-structured problems that provide a context for learning. By contrast, project-based learning is interpreted in terms of an assignment or task that the students have to perform. In the previous, a project was defined as a unique and complex task requiring more resources than a single person is able to deliver (Algreen-Ussing, 1990). This implies that a project is more than just one task or one assignment. In fact, the complex problems triggering the learning process in project-organized learning are more authentic than most of the artificial cases used in PBL (Van Woerden, 1991). The point is that it is not just the 'problem' that decides the learning process. Much depends on the context in which the assignment is presented to the students.

Based on the historical development of both problem-based learning and project-based learning, the various models are based on the same type of principles of learning. Merging the characteristics of PBL and project learning, the authors suggested in an earlier publication to make a distinction based on varying degrees of self-direction by the students (Graaff and Kolmos, 2003; Kolmos, 1996).

- The Task project is characterized by a very high degree of planning and direction on the part of the teacher (teaching objectives) to the point where this most of all resembles a large task to be solved. Both the problem and the subject-oriented methods are chosen in advance, so that the students' primary concern is to complete the project according to the guidelines provided.
- The Discipline project is usually, though not necessarily, characterized by a rather high degree of direction from the teacher's side (study programme requirements), in that the disciplines and the subject area methods are chosen in advance. It may, however, still be dependent on the groups to identify and define the problem formulations within the guidelines of the described disciplines. These subject guidelines are described in the theme descriptions.
- The Problem project, finally, is a full-scale project, for which the course of action is not planned in detail by the teachers. The problem formulation directs the choice of disciplines and subject area methods, and the problem formulation arises from the problem-oriented theme. In other words, based on one work environment theme, the group can, for instance, actually work with widely different disciplines and subject methods.

Another approach to distinguish different modes of PBL has been developed by Savin-Baden. She operates with five models of problem-based learning (Savin-Baden, 2000).

- Model 1: PBL for Epistemological Competence, where knowledge is more or less propositional with a narrow problem scenario.

- Model 2: PBL for Professional Action, where knowledge is practical and performance-oriented and the problem scenario is characterized by real life situations.
- Model 3: PBL for Interdisciplinary Understanding where knowledge is both propositional, performance-oriented, and practical, and the problem scenario is centred on a situation in which a combination of theory and practice occurs.
- Model 4: PBL for Trans-disciplinary learning, where the aim is to test given knowledge and the problem scenario is characterized by dilemmas of different kind.
- Model 5: PBL for Critical Contestability, where knowledge might be contingent, contextual, and constructed by the learner for given situations, and the problem scenario is open and offers multidimensional possibilities.

The five models of Savin-Baden focus on learning objectives, ranging from narrow subject objectives to an open landscape of interdisciplinary knowledge necessary to analyze and solve problems. The scale goes from limited sets of right solutions to open-ended ill-structured problem domains. The five basic models represent the differences that exist in the landscape of PBL, and open up the possibility of merging the understanding of diverse problem-based practices with diverse practices of project-based learning or, using the original Danish term, project-organized learning.

All models epitomize the fact that problem-based and project-based learning may vary to a certain degree, inviting people to develop mixed models such as they are practised around the world. The common element in problem and project-based learning is that in both cases, learning is organized around problems. A problem as incentive for the learning processes is a central principle to enhance students' motivation. Therefore, it is important which problems the students are attracted to on the basis of their own experiences and interests. It could be any type of problem, for instance, a concrete and realistic problem, or a theoretical problem.

Most important is that the problem reflects the conditions of professional practice. Therefore, it makes sense that in some instances cases are relatively short, providing study materials for half a week and in other instances a project could last half a year.

For instance, in a medical curriculum, the typical problem is a patient case. The challenge to come up with a diagnosis and a treatment plan takes the average family physician less than 10 minutes. The bigger engineering projects involve many years and thousands of men. Another important difference between education programmes based on problem-based or project-organized learning lies in the nature of the product that the students are required to turn in at the end of the period. With projects, this usually consists of a finished product, a design, or a report. As such, a product is often at the centre of a rating system, and also the assessment formats differ markedly.

PBL PRINCIPLES OF LEARNING

Based on the historical development of both problem-based learning and project-based learning, the various models are based on the same type of principles of

learning (Boud and Feletti, 1991). In fact, there is substantial evidence supporting the psychological mechanisms explaining how PBL works (Norman and Schmidt, 1992). Graaff and Kolmos (2003) have summarized the main learning principles in three approaches: learning – contents - social.

The **learning approach** as problem and project-based learning means that *learning is organized around problems*. It is a central principle for the development of motivation. A problem makes up the starting point for the learning processes and places *learning in context* and base learning on the learner's experience.

The **contents approach** concerns especially *interdisciplinary learning*, which may span across traditional subject-related boundaries and methods. *Exemplary practice in the sense* that learning outcome is exemplary to the overall objectives.

The **social approach** is team-based learning. The *team learning aspect* underpins the learning process as a social act where learning takes place through dialogue and communication. But the students are not only learning from each other – they also learn to share knowledge and organize the process of collaborative learning. The social approach also covers the concept of *participant-directed learning,* which indicates who has the ownership of the learning process and, especially, the formulation of the problem.

The conclusion of this chapter is that there is a wealth of different PBL formats out there. Hence, it is easy to find inspiration to start developing your own particular brand, fitted to the particular conditions of your situation. We hope the contents of this book contribute to this purpose.

Erik de Graaff
Ph.D., Associate Professor, Institute of Technology and Communication
Delft University of Technology, Holland

Anette Kolmos
Ph.D., Professor in PBL and Engineering Education and Vice director of UCPBL
Aalborg University, Denmark.

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MAGGI SAVIN-BADEN

CHALLENGING MODELS AND PERSPECTIVES OF PROBLEM-BASED LEARNING

INTRODUCTION

The notion of learning through solving problems is not new, and the emergence and development of problem-based learning (and project-based learning) reflect a number of historic changes in understandings of learning and the shaping of higher education worldwide. For example, in the 1960s, educators began to question traditional teaching methods where the staff member acts as the primary vehicle of information. The negotiation of meaning, the focus on experience, and the development of sound social practices and ideologies began to be viewed as central to the exploration of the nature of knowledge. As these ideas converged with other contextual forces, space opened for change, and problem-based learning emerged as an innovative approach to education.

This chapter will introduce the problem-based learning approach and identify some of the leading debates that surround it. It will also explore the history of problem-based learning in the context of the changing terrain of higher education. Finally, a number of suggestions for implementation will be offered, from the early approaches through to more recent diverse approaches, including models of problem-based learning online.

UNDERSTANDING PROBLEM-BASED LEARNING

Problem-based learning is an approach to learning where the curricula are designed with the problem scenarios as central to student learning in each component of the curriculum (modules/units), as in Figure 1. The lectures, seminars, workshops or laboratories support the inquiry process rather than transmitting subject-based knowledge. Whether it is a module or a whole programme that is being designed, the starting point should be a set of problem scenarios that enable students to become independent inquirers and help them to see learning and knowledge as flexible entities.

Erik de Graaff and Anette Kolmos (eds), Management of Change, 9–29.

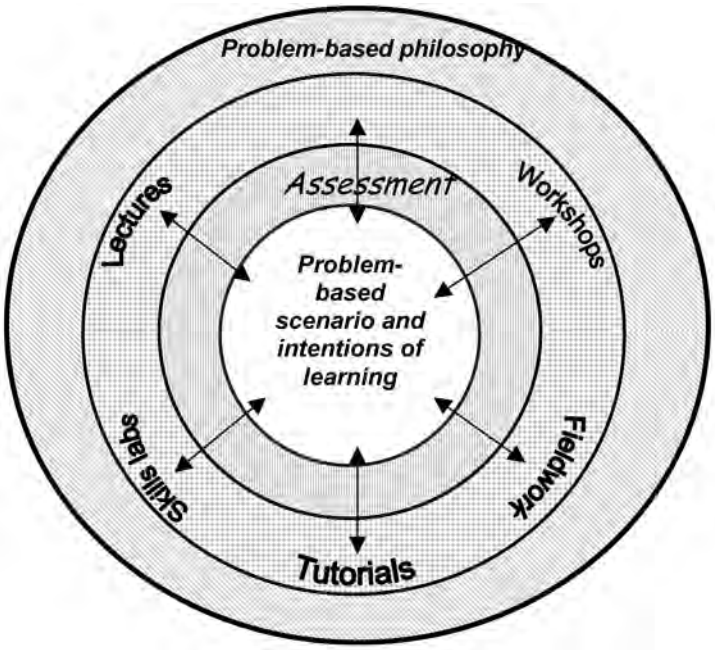

Figure 1. Problem-based curricula are suffused with an explicit educational philosophy and designed with problem scenarios central to student learning and to each component of the curriculum. Teaching and assessment methods support and inform student inquiry.

A SHORT HISTORY

The emergence and development of problem-based learning is marked by change. Compared with many pedagogical approaches problem-based learning has emerged relatively recently, being popularised by Barrows and Tamblyn (1980) following their research into the reasoning abilities of medical students at McMaster Medical School in Canada. Barrows and Tamblyn's study and the approach adopted at McMaster marked a clear move away from problem-solving learning in which individual students answer a series of questions from information supplied by a lecturer. Rather, this new method they proposed involved learning in ways that used problem scenarios to encourage students to engage themselves in the learning process, a method to become known as *problem-based learning.*

In this early version of problem-based learning, certain key characteristics were essential. Students in small teams[1] would explore a problem situation and through this exploration were expected to examine the gaps in their own knowledge and skills in order to decide what information they needed to acquire in order to resolve or manage the situation with which they were presented. Thus, early definitions of problem-based learning identify the classic model as one that has the following characteristics (Barrows and Tamblyn, 1980):

- Complex, real world situations that have no one 'right' answer are the organising focus for learning.
- Students work in teams to confront the problem, to identify learning gaps, and to develop viable solutions.
- Students gain new information though self-directed learning.
- Staff members act as facilitators.
- Problems lead to the development of clinical problem-solving capabilities.

Problem-based learning has expanded world-wide since the 1960s, and as it has spread the concepts associated with it have changed and become more flexible and fluid than in former years. In an attempt to move beyond narrow and prescriptive definitions, Boud (1985) and Barrows (1986), two of the stronger proponents of the approach, have outlined broader characteristics of problem-based learning. Both have argued that problem-based learning is not to be seen as a particular way or method of learning; rather it is to be seen as learning that has a number of differing forms.

Soon after McMaster began its problem-based learning curriculum, two other new medical schools, at the University of Limburg at Maastricht in the Netherlands and at the University of Newcastle in Australia, adapted the McMaster model of problem-based learning and in so doing developed their own spheres of influence. The then University of Limburg, now Maastricht, began a new medical school in 1975, which saw problem-based learning as the primary strategy for the first four study years. The institution also developed a new library consistent with the problem-based learning approach in 1992 (Ebenezer, 1993). Interest in the impact of problem-based learning on students was an area of interest for tutors at Maastricht from the outset. Early studies tested the extent to which problem-based learning helped students with problem-solving. In particular, Schmidt (1983) found that by examining the role of prior learning, evaluating students' retrieval of information and exploring the extent to which students were able to elaborate knowledge that is was possible to map the potential qualities of problem-based learning. Later work at Maastricht (Schmidt and Moust, 1995) explored the influence of tutors' behaviour on student achievement. This important study found

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[1] *The word team is used throughout the chapter to denote a group of people who work together with a common purpose, a limited membership and the power to make decisions. Teams have a focus, a set of team rules and are time limited. The term team is more appropriate than group to denote what occurs in most problem-based learning seminars because there is a focus, a remit and much of the learning that occurs evolves through the ways in which the team make decisions about what and how they learn within agreed or contracted deadlines.*

that effective tutoring for problem-based learning required that tutors had: a suitable level of knowledge; a willingness to engage with students in an authentic way and an ability to express themselves in a way understood by students.

As problem-based learning was flourishing at Maastricht, Linkoping University was also developing its own approach. Important studies undertaken at Linkoping emerged from interest in exploring the relationship between research and undergraduate education, for example Abrandt *et al*. (1995) (more recently termed research-led learning in the UK in 2006). An examination of problem-based learning from the teachers' perspective was one of the early qualitative studies in the field. This study (Abrandt *et al*., 1998) found that whilst tutors valued problem-based learning they experienced conflict about whether their role should have a teaching or learning focus and a supportive or directive function.

Problem-based learning also became popular in Australia, perhaps spurred in part by the Karmel Report in 1973 that concluded that Australian medical school curricula were too science-oriented (Report on the Committee for Medical Schools 1973). In addition to influencing medical education worldwide, McMaster, Maastricht and Newcastle had considerable influence upon each other as well. According to Barrows (2000), many of the educators at Maastricht and Newcastle spent considerable time at McMaster while working to develop their new curricula. Fertilization and cross-pollination of ideas allowed the model to grow and also kept the three universities fairly congruent in their approaches. However, there have also been differences in the way in which problem-based learning has been adopted in other disciplines. For example, other health-related programmes began to use problem-based learning from the 1980s onwards. These included programmes such as veterinary medicine at Mississippi State University, USA, pharmacy at Samford University, USA, and nursing at the universities of North Carolina, USA, and Newcastle, Australia. In the UK during the 1980s, problem-based learning was adopted in occupational therapy at the then West London Institute of Higher Education and The London Hospital Medical School, and in social work education at the University of Bristol.

Problem-based learning soon began to move beyond its origins to other professional preparation programmes such as engineering at McMaster, Coventry University and Imperial College, London in the UK; business at Maastricht University and education at Stanford University, USA (Bridges and Hallinger, 1996; Casey and Howson, 1993; Major, 1999). Other disciplines in which problem-based learning is used around the world include architecture, economics, educational administration, law, forestry, optometry, police science and social work, (Boud and Feletti, 1997; Cordeiro and Campbell, 1996, Bridges and Hallinger, 1996). Problem-based learning in education for the professions has also been adopted at universities in Denmark, Finland, France, South Africa, and Sweden.

There has been some movement of problem-based learning courses into traditional arts curricula. Samford University in Birmingham, Alabama began to experiment with problem-based learning across its general and liberal education curriculum in the late 1990s. The increased use of problem-based learning has arguably been slower in these areas, perhaps because of the challenges of adapting

the classical model to these subjects. Certainly Hutchings and O'Rourke's work in the UK (Hutchings and O'Rourke, 2004: 181) has suggested that 'literary studies is essentially a discursive, open-ended, critically contested, responsive and creative subject that challenges students and encourages them to find their own intellectual pathways.' Hutchings and O'Rourke found that any imposition of a rigid structure in terms of specific responsibilities within the groups was counter-productive to the nature of learning within the discipline.

Three institutions are notable for 'across the curriculum problem-based learning' extending into the areas of arts and humanities. Firstly, Maastricht, founded in 1976 and built from the ground up on a problem-based model. All of its faculties, including the faculty of arts and cultures, rely on problem-based learning methods. Secondly, Aalborg, Denmark, founded in 1974; Aalborg is problem-oriented and project-based, which many distinguish from the problem-based approach. For further discussion on these different approaches, see Graaff and Kolmos (2003). Thirdly Samford, with perhaps its most unique feature being its efforts to adopt a problem-based model for humanities. Samford and Maastricht have received a grant from the Fund for the Improvement of Secondary Education (FIPSE) to form a transatlantic co-operation for problem-based learning in the humanities.

LEADING DEBATES

There are a number of leading debates in the field of problem-based learning. One relates to the extent to which a course, module or programme is deemed to be problem-based or not. To date there has been little in-depth discussion about the design of problem-based curricula. Instead the discussions have tended to centre on what counts as problem-based learning, ways of implementing it and types of problem-based learning (for example, Boud, 1985; Barrows, 1986). More recently, Conway and Little (2000) have suggested that problem-based learning tends to be utilised as either an instructional strategy or as a curriculum design. Instructional strategy is where problem-based learning is largely seen as another teaching approach that can be mixed in with other approaches. Thus, it tends to be used within a subject or as a component of a programme or module, where other subjects may be delivered through lectures. In an integrated problem-based learning curriculum, there is a sense of problem-based learning being a philosophy of curriculum design that promotes an integrated approach to both curriculum design and learning. Here students encounter one problem at a time and each problem drives the learning.

A number of other discussions have emerged about types of problem-based learning, the most basic being that there are two types: the pure model and the hybrid model. The argument here is that either the whole curriculum is problem-based and is modelled on the McMaster version of problem-based learning, whereby students meet in small teams and do not receive lectures or tutorials, or it is the hybrid model, which is usually defined by the inclusion of fixed resource sessions such as lectures and tutorials which are designed to support students. Lectures may be timetabled in advance or may be requested by the students at

various points in the module or programme. The so-called pure model is also often termed the Medical School Model, and is invariably defined as having a dedicated facilitator for small teams of students, being student centred and being seen to be a good choice for highly motivated, experienced learners in small cohorts (see for example Duch *et al.,* 2001). The difficulty with this notion of there only being two types: a pure model and a hybrid model, is that in reality given the current number of forms of problem-based learning in existence, most models would be classed as being hybrid. I would therefore suggest that:

> Problem-based learning is thus an approach to learning that is characterized by flexibility and diversity in the sense that it can be implemented in a variety of ways in and across different subjects and disciplines in diverse contexts. As such it can therefore look very different to different people at different moments in time depending on the staff and students involved in the programmes utilizing it. However what will be similar will be the focus of learning around problem scenarios rather than discrete subjects. (Savin-Baden, 2000: 3)

One of the other main debates centres around the relationship between problem-based learning and other forms of learning. It is possible, in many conventional curricula, to add on project-based learning, games and simulations and work-based learning in a whole variety of ways. However, bolting on problem-based learning is usually quite difficult because of the need for inquiry and student-centred practices to be central to the whole learning approach.

Problem-based learning does differ from other teaching methods, some of these, such as project-based learning, have been used extensively for many years, whilst others, such as work-based learning, are relatively recent developments.

Problem Solving

Problem solving has been studied by psychologists over the past hundred years. However, in the 1970s, researchers became increasingly convinced that empirical findings and theoretical concepts derived from simple laboratory tasks did not necessarily generalize to more complex, real-life problems. However a critical aspect of understanding problem solving is seen as problem analysis. The most famous approach is that of Newell and Simon (1972) and a state-space analysis. The idea is that a problem solver searches through a problem space until she finds a solution, or fails to find one and gives up. In terms of problem-based learning, problem-solving is a component of the problem-based approach and some universities put more emphasis on the problem-solving components of it than others. For example, the seven steps to problem-solving developed by University of Maastricht mirror problem steps often used in cognitive science:

Table 1. Comparison of ways of solving problems.

Components of problems:	Maastricht. Seven steps
1. Problem space: The problem situation to be comprehended by the problem solver 2. Initial state: What the solver has at her disposal when the problem commences 3. Intermediate states: The state of the situation at times after the task has begun 4. Goal state: The state of the situation when the problem has been solved. 5. Moves, transformations, or operations, procedures that transform the situation from one state to another.	1. Clarify and agree working definitions, unclear terms and concepts 2. Define the problem and agree which phenomena require explanation 3. Analyse the problems (brainstorm) 4. Arrange explanations into a tentative solution 5. Generate and prioritise learning objectives 6. Research the objectives through private study 7. Report back, synthesize explanations and apply new information to the original problems

There have been many debates about the relationship between problem-solving and problem-based learning and much of the recent discussion has centred on the possibility of transferring information form one context to another. However, Eva *et al.* (1998) have suggested that the problem-solving theories concerning ways in which students transfer knowledge from one context to another fall into two broad areas:

– Abstract induction: which presumes that students learn principles or concepts from exposure to multiple problems by abstracting a general rule, thus it is independent of context.
– Conservative induction: which assumes that the rule is not separated from the problem context, but that expertise emerges from having the same principle available in multiple problem contexts.

Thus some lecturers in the field of cognitive science would take the view that by teaching principles of problems, students will then use these principles to solve other similar problems. Inevitably, this raises questions about the extent to which problem-solving can be classed as a generalizable skill and whether some knowledge is necessarily foundational to other knowledge.

Problem-Solving Learning

Problem-solving learning is more than just finding a solution to a given problem, indeed it is the type of teaching many staff have been using for years. The focus is upon giving students a lecture or an article to read and then a set of questions based upon the information given. Students are expected to find the solutions to these answers and bring them to a seminar as a focus for discussion. Problem scenarios here are set within and bounded by a discrete subject or disciplinary area. In some curricula students are given specific training in problem-solving techniques, but in many cases they are not. The focus in this kind of learning is largely upon

acquiring the answers expected by the lecturer, answers that are rooted in the information supplied in some way to the students. Thus the solutions are always linked to a specific curricula content, which is seen as vital for students to cover in order for them to be competent and effective practitioners. The solutions are therefore bounded by the content and students are expected to explore little extra material other than that provided, in order to discover the solutions.

Scenario-Based Learning

This form of learning is increasing used as a 'catch-all' for a number of active forms of learning, which include problem-based learning, case studies, project based learning, problem-solving and using scenarios in electronic-learning (e-learning). In e-learning a sequence of concrete problems is described, and behavioural choices are presented that enable the learner to reach a satisfactory outcome. Scenario-based learning in e-learning is thus more about particular discrete behaviours than learners constructing their own knowledge. It is based on the concept of situated cognition, which is the idea that knowledge cannot be known and fully understood independent of its context. A scenario represents a realistic work situation and requires the learner to work through it. Furthermore it tends to focus on performance improvement rather than correct answers, supplies information only as needed, and promotes student engagement by using images and sound.

There has also been a shift towards scenario-based learning and games. This has largely resulted because of the increasing use of game and gaming and society research into gaming and the increasing use of games in higher education. Games in the past were usually described as exercises in which individuals cooperate or compete within a given set of rules (Jaques, 2000), such as charades, tiddlywinks or hockey, thus players act as themselves. However games and gaming is being reconceptualised through the computer gaming industry. Simulations are also part of what is being termed scenario-based learning. A simulation is when a scenario is provided that in some way represents real life. The confusions that occur between problem-based learning and simulations relate to the use of real-life situations. In problem-based learning students are (usually) provided with real-life scenarios, they are expected to act as themselves and the situations with which they are presented are tailored according to the level of the course. Whereas in simulations individuals are ascribed roles related to the simulations, such as 'you are the manager of an engineering firm', or 'your aim in this simulation is to win the most money,' with the tutor acting as a referee.

Inquiry-Based Learning and Enquiry-Based Learning

These two forms of learning are often seen the same as both each other and problem-based learning. In such cases they have emerged as descriptors of problem-based learning that are used in areas such as social care and humanities where the notion of a 'problem' is seen as negative or unhelpful. For example, being pregnant is not a 'problem' it is a normal process. However, there are other

examples, such as The University of Manchester, UK where enquiry-based learning is seen as a broader philosophy. Here the term enquiry-based learning refers to forms of learning in which learners engage with a self-determined process of enquiry. The approach is intended to foster collaborative learning and deep engagement, through enquiry, with complex, often fuzzy, problems and issues. The examples they offer illustrate a clear overlap with problem-based learning but enquiry-based learning is as a broader spectrum of approaches, such as

- Project-based activities.
- Problem-based learning.
- Product design projects in engineering.
- Case-study projects in Business Studies drawn from real life, with students playing the role of consultants.
- Creative projects in the arts, such as a film production project in Media studies.
- Field mapping excursions in Geography and Geology.
- Programme-long design projects in Architecture.

Inquiry-based learning is seen as a form of learning that focuses on high order thinking in the context of managing problems. It is also often used to describe a form of learning where the students decide on their own problems about issues that emerged during a practice or fieldwork component of their course and they set their own objectives as to what they want to learn.

However, these terms have been used for forms of learning that are a distortion of problem-based learning where the philosophy of the approach has been distilled in to a learning technique where students learning in large groups (15-20 people) and in many ways what is practised would seem to be little more than what used to be seen as 'small group teaching' (see, for example, Jaques, 2000). The confusion about whether inquiry is written as inquiry or enquiry is invariably insufficiently deliberated. For example the notion of inquiry centres on the idea of undertaking research of some kind, whereas enquiry is generally used as much broader idea of trying to find something out. This it would seem the term 'inquiry' would be more appropriate than enquiry.

Problem-Orientated Learning

The arguments for problem-oriented learning (rather than problem-*based* learning) have largely stemmed from Margetson's suggestions about the nature of knowledge and in particular his belief that some knowledge is not necessarily foundational to other. Margetson (1991) has suggested that the assumption that 'knowledge is certain' persists in higher education and that the assumed link between certainty and knowledge is used to justify didactic teaching. Margetson suggests that in order to move away from problems being 'based' on knowledge we need to move away from the idea that knowledge is certain and thus use the term 'problem-oriented learning' as it allows for the use of open ended problems; real problems, those to which solutions are *not known.*

Work-Based Learning

Work-based learning is used to describe learning through work so that learning occurs through engaging in a work role. The formulation of partnership is seen to have a central place in the discourses of work-based learning, and partnership as a concept operates in a variety of ways. For example, the founders of work-based learning are 'in partnership' with higher education institutions or alternatively alliance takes the form of a partnership between university and learner. Work-based learning is an important development in many professions but one of the key shifts it has prompted is a move away from higher education as front end education that equips people for work. Instead, initiatives such as work-based learning have promoted ongoing learning, regular updating and continuing professional development, which in many ways have meant that higher education institutions have had to become more responsive to the needs of the learner. Work-based learning is not usually perceived as a problem-based approach to learning because it centres on learning through work and tends to be individually guided and focussed on solving problems in the immediate work environment. The difference between work-based learning and problem-based learning is that in work-based learning the learning is derived from utilising opportunities, resources and experience in the workplace and therefore the outcomes will relate to the purposes of the workplace. Work-based learning is perceived to be located at the work place with support from the employer and university.

Project-Based Learning

Project-based learning would be seen by many to be synonymous with problem-based learning because both are perceived to be student-centred approaches to learning. Indeed some have argued that they are the same (Boud, 1985). There are others too, who would suggest that problem-based learning can only be undertaken in small groups (Barrows and Tamblyn, 1980) whereas many believe that project-based learning can be undertaken individually, as well as in small groups. Arguably research projects, particularly PhDs, could be said to be the ultimate problem-based approach. However, there are distinct differences between the two approaches and these are most marked when considering curriculum design rather than in terms of one approach necessarily being more effective than the other. Project-based learning is predominately task orientated and the project is often set by the tutor. Even if the task or topic is not set, then the parameters and criteria for submission usually are. The differences between the two approaches is that in project-based learning

- Students are required to produce an outcome in the form of a report or design. In problem-based learning, the focus is not on this kind of outcome.
- The tutor supervises (rather than facilitates) the project.
- Students are required to produce a solution or strategy to solve the problem, whereas in problem-based learning, solving the problem may be part of the process, but the focus is on problem-management, not on a clear and bounded solution.

– An input from the tutor occurs, in the form of some type of teaching, during the lifespan of the project. The focus in problem-based learning is on students working out their own learning requirements. Some problem-based learning programmes use lectures as a means of supporting the students rather than to directing the learning.
– Project-based learning often occurs towards the end of a degree programme after a given body of knowledge has been covered that will equip the students to undertake the project. Problem-based learning is normally used on the basis that students have already covered required propositional knowledge, rather, students themselves are expected to decide what it is they need to learn.
– Project-based learning is often seen as a mechanism for bringing together several subject areas under one overall activity at the end of a course. Problem-based learning works from the premise that learning necessarily will occur across disciplinary boundaries, even at the beginning of a course.

Therefore, project-based learning is more often seen as a teaching technique in a given area of the curriculum rather than an overall educational strategy such as problem-based learning.

Action Learning

Action learning is based on the idea that through the process of reflection and action is possible to solve problems. The idea is that a group of people come together to form an action learning set. The set work together over a stated period of time with the aim of 'getting things done' (McGill and Beaty, 2001: 1). In practice this means that the set is formed and each member brings a real life problem they want help in solving. Action learning is a form of learning based on the interrelationship of learning and action and thus the learning occurs through a continuous process of reflecting and acting by the individual on their problem. The difference between problem-based learning and action learning is that the essence of an action learning set is its focus on the individual and their future action. (McGill and Beaty, 2001: 14-15). In problem-based learning the group functions as a team who seek to achieve the tasks collaboratively, the lifespan is generally determined by the length of the module or curriculum and there is usually a facilitator who is a member of staff. Thus in action learning the members have more control over the group than many students would do in a problem-based learning team where the facilitator may influence the learning agenda and in some curricula the problem-based session may seem to contain components of a seminar where presentations are made and pre-prepared material is discussed. Action learning sets are more individualized, freer flowing and centred upon personal learning and reflection in order to achieve effective action.

WAYS OF IMPLEMENTATION: THE OLD AND THE NEW

There are several blueprints for problem-based learning but relatively little information exists to guide those who want to consider how to use it in terms of actually designing the curriculum in a practical way. Cultural and institutional

constraints affect the design of problem-based curricula, as do issues that tend to differ across disciplines, such as the way an essay is constructed or the way that knowledge is seen. However, I have suggested elsewhere, a number of models (Appendix 1) and more recently eight *modes of curriculum practice* (Appendix 2). These models and modes are not meant be an exhaustive list but rather are a means of considering what occurs in some programmes as well as the impact of opting for a particular design.

Curricula where problem-based learning is central to the learning are in fact largely constructivist in nature because students make decisions about what counts as knowledge and knowing. What is problematic here is how such a constructivist stance can be married with benchmarking statements and the emerging audit culture in higher education. In recent years, we have seen such a significant shift towards accountability and transparency that the focus in many curricula is more upon outcomes and less upon learning. For example, if the assumption is that the students must cover a given amount of knowledge in a given time, the focus of the curriculum is likely to be on knowledge acquisition rather than learning. In a programme that is centred on skills acquisition, the focus will be on the way in which knowledge is necessarily useful for practice. When adopting problem-based learning, the extent to which the curriculum is designed as a whole entity is an important concern. For example, in the UK, degree courses in health and social care are constructed as integrated modular programmes; they are designed as a whole. Whereas a course in history may just be a collection of modules, with little if any integration, that students just take in order to gain a degree. Curriculum design thus impinges upon tutors' and students' roles and responsibilities and the ways in which learning and knowledge are perceived. However, new and different forms of problem-based continue to emerge and with them an increasing interest in the kinds of discipline-based pedagogies that affect curriculum design.

NEW FORMS AND VARIATIONS ON A THEME

As with most innovations, change is rapid and we have seen this already in the overlap between forms of learning such as scenario-based learning and inquiry-based learning; change is a constant in the field of problem-based learning. Change is not just about the pedagogy but also the discipline, arena and practice. Here are three examples of recent change.

A Problem a Day

This approach was developed at Republic Polytechnic, Singapore (O'Grady and Alwis, 2002) and is termed the 'one-day one-problem approach'. Students thus spend one whole day working on a single problem. Over the course of a week, students will work on five different, but related, problems. The day occurs as follows:

– In the morning students receive a problem scenario

- Students with the help of a tutor in five groups of five (total of 25 students in a class) examine the problem and clarify what it is they do and do not know formulate possible hypotheses.
- Groups identify learning issues they will investigate and employ research strategies to collect relevant information.
- During the middle of the day the groups of five meet individually with tutor to discuss their progress.
- The groups develop an outcome for the problem and present their findings to the other four groups of five and the tutor for evaluation.
- Groups discuss, defend and justify their outcomes and reflect on the way they have learnt in their groups.
- Students are assessed individually for their learning and record key learning milestones in their learning journal.

This mirrors many formats adopted by other tutors in the problem-based learning community, but it is condensed into one day. The authors argue that this approach has been adopted so that

> students would learn highly technical skills and subject matter so they can immediately enter into specific professional occupations and apply these skills with very little additional training, but at the same time be able to adapt to the quickly changing technological landscape (O'Grady and Alwis, 2002).

Whilst this is a relatively new approach, it will be interesting to see if it is adopted elsewhere and whether the students at Republic Polytechnic tire of this approach more quickly than in programmes that use more flexible forms of problem-based learning.

Problem-Based Learning Online

The combined use of online learning and problem-based learning is a complex activity since on their own, problem-based learning and interactive media both demand that staff and students have a complex array of different teaching and learning capabilities, whilst together they could be seen as a formidable combination. However, it is not yet clear as to whether they are approaches to learning that collide. The nature and process of interactive media has changed considerably over the last few years. Britain and Liber have noted that considerable effort has been expended on the development of managed learning environments rather than the pedagogy of such development (Britain and Liber, 2004:8). The objective of combining problem-based learning and interactive media is in itself complex. Terms such as 'computer mediated problem-based learning' and 'online problem-based learning' have been used to define forms of problem-based learning that utilize computers in some way. However, this is problematic since it offers little indication about the ways in which computers are being used, the areas of interaction of the students, the quality of the learning materials or the extent to which any of these fit with problem-based learning (see for example Barrow's (2002) discussion of distributed problem-based learning). Furthermore, there are other issues which need to be addressed, such as developing tutors' online

facilitation capabilities, providing some synchronous events to support students, encouraging collaborative interactive participation and finding ways of engaging students who seldom participate in the online problem-based learning team.

There is a further concern, that of the positioning of the 'problem' in the learning. In some forms (for example the SONIC project, Savin-Baden and Gibbon, 2005) what is on offer is a form of 'problem-based learning' that has many of the hallmarks of the original models developed in the 1960s. However, in the online community, problem-based learning (without the hyphen) is seen as being where the problem is defined as a discrete learning object. Essentially this would seem to be an acknowledgment that online education needs to be more creatively situated and thus 'problems' are a means of providing students with more creative ways of learning, whilst also being a means of preventing virtual learning environments (VLE) from becoming information repositories. This distinction is important:

– Problem-based learning (with the hyphen) is an approach to learning in which students engage with complex, real world situations that have no one 'right' answer, and are the organising focus for learning. Students work in teams to confront the problem, to identify learning gaps, and to develop viable solutions and gain new information through self-directed learning.
– Problem-based learning (without the hyphen) is where problems are used as prompts for learning in online environments. The problems often have a correct answer and often demand little of the students other than linear problem-solving skills.

There has been much criticism, in the last five years, about interactive media environments that fail to create effective settings for learning (Noble, 2001; Reeves, 2002; Oliver and Herrington, 2003). One of the reasons for this has been because the focus in interactive media environments has been on technological rather than pedagogical design and there have been suggestions that there is a need for a re-engineering of the concept of learning design rather than just a simplistic repackaging of the course content into interactive media formats (see, for example, Collis, 1997). Further, as Oliver and Herrington (2003) argue:

> In learning environments that support knowledge construction learners need to be exposed to a variety of resources and to have choices in the resources that they use and how they use them. An important aspect of resource development is to provide content that provides them with perspectives from a multitude of sources... The materials need not all be on-line. (Oliver and Herrington, 2003: 15)

In the context of problem-based learning, there needs to be clarity about how scenarios are created so that they produce robust educational discussion but perhaps different types of scenarios need to be used in online learning than in face-to-face problem-based learning. At one level, the inter-linking of problem-based learning with virtual learning environments has brought creativity to problem-based learning and the development of innovative multimedia materials. Yet, it is clear from much of the literature that this is not always the case, and the focus on the achievement of outcomes and tasks is causing instead a narrowing of the

definition of problem-based learning and a certain boundedness about the types of problem scenarios being adopted, and the way that problem-based learning is being used.

However, the most effective option would seem to be to develop materials towards computer-mediated collaborative problem-based learning (CMCPBL). This conception of problem-based learning places it pedagogically in a collaborative online environment. Whilst many of the current models of online education focus on teacher centred learning, CMCPBL needs to be focussed on a team-orientated knowledge building discourse. Scardemalia and Bereiter (1994) have defined three characteristics of this discourse:

- A focus on problem scenarios and depth of understanding.
- Open knowledge building that focuses on collective knowledge so that inquiry is driven by a quest for understanding.
- An inclusion of all participants in the broader knowledge community, thus learning involves students, teachers, administrators, researchers, curriculum designers and assessors. This brings a wide range of perspectives and an acknowledgment that anything done by one person means that others must adapt.

The impact of the inclusion of these three characteristics means that learners and facilitators may take on different roles in the course of a collaborative learning situation, which again brings online education of this sort into line with the dialogic nature of problem-based learning. Facilitation occurs through the tutor having access to the ongoing discussions without necessarily participating in them. Tutors also plan real-time sessions with the CMCPBL team in order to engage with the discussion and facilitate the learning.

Problem-Based Learning in Early Years Education

Whilst it is possible to suggest that much early years education was formally predominantly problem-based, following the work of Dewey in recent years, there have been many government initiatives worldwide, that have encouraged more formal approaches to learning in the early years. Whilst such change does reflect the ebb and flow of government initiatives there are a number of emerging models of problem-based learning in the early years that focus particularly on collaborative group learning. Such projects reflect many of the ideas implicit in problem-based learning for critical contestability, models that are used in arenas such as literary studies. The emergence of these freer forms of problem-based learning is exemplified in work by infant/toddler and preschool programs in Reggio Emilia, Italy. A key value in these schools is that of seeing the children as competent learners and researchers and reflects the values of a pedagogy of listening. Thus, respect for the children's needs and work drives the development of the theories about education that best serve the children. The teacher/researcher's work

> not only produces daily experience and action, but can become the object of critical reappraisal and theory building … practice is not only a field of action

> necessary for the success of the theory, but is an active part of the theory itself: it contains it, generates it, and is generated by it (Rinaldi, 2001: 342).

The idea is that the curriculum is not child-centred nor teacher-directed, but child-originated and teacher-framed. This approached is based on the following ideas:

- Emergent Curriculum: An emergent curriculum is one that builds upon the interests of children, and team planning is an essential component of the emergent curriculum.
- Collaboration: Collaborative group work, both large and small, is considered valuable and necessary to advance cognitive development. Children are encouraged to talk, critique, compare, negotiate, hypothesize, and problem solve through group work.
- Teachers as Researchers: The role of the teacher is first and foremost to be that of a learner alongside the children, very much like the role of a facilitator in problem-based learning in higher education.
- Environment**:** Great attention is given to the look and feel of the classroom. Environment is considered the "third teacher". Common space available to all children in the school includes dramatic play areas and work tables for children from different classrooms to come together. This is different from most forms of problem-based learning but is perhaps an area which could be developed further in higher education.

CONCLUSION

Problem-based learning is an approach to learning that continues to grow and develop and the variations in its use still tend to cause much debate in higher education. However, what seems to be important in the debates, beyond the arguments about type, use and approach, is a belief in the essential principles of problem-based learning rather than a belief that the content should drive the learning. Problem-based learning is often a difficult approach for staff and students to grasp because it challenges them to see learning and knowledge in new ways and it is often a space and a place where everything is brought together with a view that blurred boundaries and transitions are part of the way life and learning is managed. Yet it is a challenging way of learning because it generates disjunction and 'stuckness' in peoples' lives. Engaging with problem-based learning can be costly personally and pedagogically but it also a powerful transitional process.

Maggi Savin-Baden
Professor of Higher Education Research
Coventry University, United Kingdom

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APPENDIX 1

Models of PBL

(Savin-Baden, 2000)

Model I Problem-based learning for epistemological competence
Model I is characterized by a view of knowledge that is essentially propositional, with students being expected to become competent in applying knowledge in the context of solving, and possibly managing, problems.

Model II Problem-based learning for professional action
This model of problem-based learning has, as its overarching concept, the notion of 'know-how'. Action is seen here as the defining principle of the curriculum whereby learning is both around what it will enable students to be able to do, and around mechanisms that are perceived to enable students to become competent to practice.

Model III Problem-based learning for interdisciplinary understanding
In this model there is a shift away from a demand for mere know-how and propositional knowledge. Instead, problem-based learning becomes a vehicle to bridge the gap between the know-how and know-that and between the different forms of disciplinary knowledge in the curriculum.

Model IV Problem-based learning for transdisciplinary learning
In this model problem-based learning operates in a way that enables the students to recognize that disciplinary boundaries exist but that they are also somewhat illusory, that they have been erected. The student might transcend boundaries but he is not likely to challenge the frameworks into which disciplinary knowledge is placed.

Model V Problem-based learning for critical contestability
This form of problem-based learning is one that seeks to provide for the students a kind of higher education which offers, within the curriculum, multiple models of action, knowledge, reasoning and reflection, along with opportunities for the students to challenge, evaluate and interrogate them. Students will therefore examine the underlying structures and belief systems implicit within a discipline or profession itself, in order to not only understand the disciplinary area but also its credence. They will transcend and interrogate disciplinary boundaries through a commitment to exploring the subtext of those disciplines.

APPENDIX 2

Curriculum Modes in Problem-based Learning

(from Savin-Baden and Major, 2004)

Mode 1 Single module approach
This is where problem-based learning is implemented in one module (possibly two) in the third year of a programme.

Mode 2 Problem-based learning on a shoestring
This tends to be implemented in modules run by staff interested in it and avoided by those who disagree with it. The result is that problem-based learning may be used in many modules throughout the curriculum but there is little real rationale for its implementation in particular areas.

Mode 3 The Funnel approach
In this mode the decision has been to design the curriculum in a way that enables students to be funnelled from a lecture-based approach that may be more familiar to them than problem-based learning, move on to problem-solving learning in the second year and then problem-based learning in the final year.

Mode 4 The foundational approach
Here the assumption that some knowledge is necessarily foundational to another and therefore it need to be taught to the students before they can begin to solve problems. Thus in the first year of the programme the focus is on providing students with lectures, tutorial and laboratory time that will enable them to understand the required knowledge and concepts. In the second and third year students then utilise problem-based learning. One of the underlying principles of this in many curricula is the assumption is that if basic concepts are taught first then the knowledge will be decontextualised and will therefore be available in the students' memory for use in solving new problems.

Mode 5 The two-strand approach
In the two-strand approach problem-based learning is seen to be a vital component of the curriculum that has been designed to maximise the use of both problem-based learning and other learning methods simultaneously. In the two-strand approach the curriculum is seen to have clear strands running alongside one another. The problem-based modules are designed to build on each other but also to draw from the modules in the mixed approach strand. What tends to happen is that modules in each strand are designed with interlocking themes so that the knowledge and capabilities in the mixed approach feed in to support problem-based learning rather than working against it.

Mode 6 Patchwork problem-based learning
The patchwork approach is a complex mode that is often experienced as difficult and confusing for students. Here the whole curriculum is designed using problem-based learning but due to intuitional requirement the modules so not run consecutively but concurrently. Students undertake 2 or 3 problems simultaneously in different but not necessarily related subject areas. Furthermore modules are unlikely to be the same length so that students may do one problem over a period of 4 weeks, another over two weeks and another within a week.

Mode 7 The integrated approach
The integrated is based on the principle that problem-based learning is not merely a strategy but as a curriculum philosophy. The curriculum is designed in an integrated fashion so that all the problems are sequential, are linked both to one another and across discipline boundaries. Students are equipped for the programme through explanations of the approach and team building activities.

Mode 8 The complexity model (following Barnett and Coate 2002)
Barnett and Coates argue curricula should be seen as forming identities founded in three domains: knowledge, action and self. Mode 8 takes this notion of curriculum a stage further by arguing for a curriculum that reflects the fragmented world of both the learners and the curriculum designers. The curriculum then is about the management and development of knowledges and capabilities.

ANETTE KOLMOS AND ERIK DE GRAAFF

PROCESS OF CHANGING TO PBL

INTRODUCTION

The change processes discussed in this book aim to apply PBL learning principles in the course of curriculum development. This does not mean we favour one particular PBL model. Different institutions utilize the PBL principles in many different ways. These PBL learning principles are based on the history of learning theories and the new pedagogic experiences obtained and learned during the late 60s and early 70s during the foundation of several new institutions based on PBL and project pedagogy such as McMaster, Maastricht, Aalborg, Roskilde, Linköping, and Newcastle.

However, the institutions mentioned above all started PBL with a blank slate. These are young universities that were able to develop an entire curriculum without the burden of traditions and habits. This book addresses the much more complicated transformation process from traditional teaching and learning systems with ordinary lectures to PBL systems based on PBL learning principles including problem-based, team-based, interdisciplinary, and contextual learning.

The transformation from traditional to more student-centred learning is a widespread global process caused by new demands for process and lifelong learning skills. But even if this is a global process, each programme utilizing PBL principles has its own history. In many cases, the shift to PBL was caused by more or less similar wishes:

- To decrease drop-out rates,
- To stimulate motivation for learning,
- To accentuate institutional profile,
- To support development of new competences.

Change can be observed from many different angles. Some changes manifest at an institutional level when a faculty, a department, or a programme opts for a total curriculum change. In other cases, the subject is a single course sought infused with innovation by a teacher. This article deals primarily with the institutional change – the more holistic transformation of a system. These types of transformation processes are complex and each institution that has undergone such a transformation process has a unique story to tell. However, these stories also share a lot of similarities, revealing a pattern for transformation processes in Higher Education.

The purpose of this book is both to tell the stories - as the stories are the concrete evidence of it being possible - but also to analyze the transformation pattern across institutional and national borders, for which this chapter sets the stage.

Erik de Graaff and Anette Kolmos (eds), Management of Change, 31–43.

EDUCATIONAL CHANGE

Regardless of the strategy involved, there is a need for a concept of change in education. The intention with this chapter is to provide an understanding of the concept of change in education. Normally in the organizational literature, the objective of a change process is to develop a new product – or to decrease costs in product manufacturing. Relating these terms to Higher Education, the product is not a tangible, material product, but the students' knowledge and competencies. In other words, it is about changing students' learning.

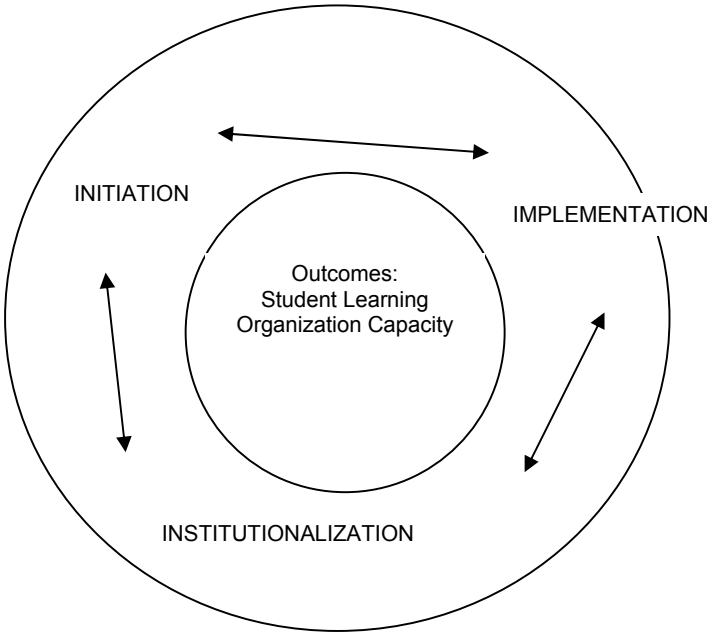

Figure 1. A simplified overview of the change process (Fullan, 2001)

Fullan (2001) is one of the few educational researchers working with change in education at a practical level and at the same time contributing to the theoretical knowledge within the field. Fullan emphasizes that the outcome of an educational change process is not only a change in student learning, but also the organizational capacity. Students leave the education – the sustainable factor is that the staff has changed in order to constantly develop students' learning and the learning outcomes.

Fullan stresses that change is a process, not an event (Fullan, 2001), entailing that change does not occur overnight. It takes time and it has deep impact.

Henriksen *et al.* (2004) maintain that in order to understand organizational change, we need to understand the concept of reality – since change in organizations is change of reality. He emphasizes that to obtain an understanding

of reality, it is necessary to look into at least four elements; fact (documentation), logic (core part of the constitution process), values (to describe the importance), and communication (as being a member of society and interpretation).

So change should be analyzed and interpreted in a broader context, and values are an important part of educational change as change processes entail both a systemic and value-oriented change if superficial change is to be avoided. Henriksen makes another important point, namely that change happens in contexts – and that it might be difficult to develop one overall model for analyzing these very complex processes as there is always a story to tell - like the stories that are told in this book. Some of the changes occur within a course, whereas others address the overall systemic level.

Applying this to a curriculum perspective requires a concept of a more holistic and systemic approach to curriculum development. Biggs (1999) has developed the 3P model describing presage (students' prior knowledge and teaching context such as objectives, assessment, climate, and institutional procedures), process (learning-focused activates), and product (learning outcome), see figure 2. This 3P model describes a balanced system where the components are aligned to each other. Consequently, the principles of holism and alignment are key in this approach.

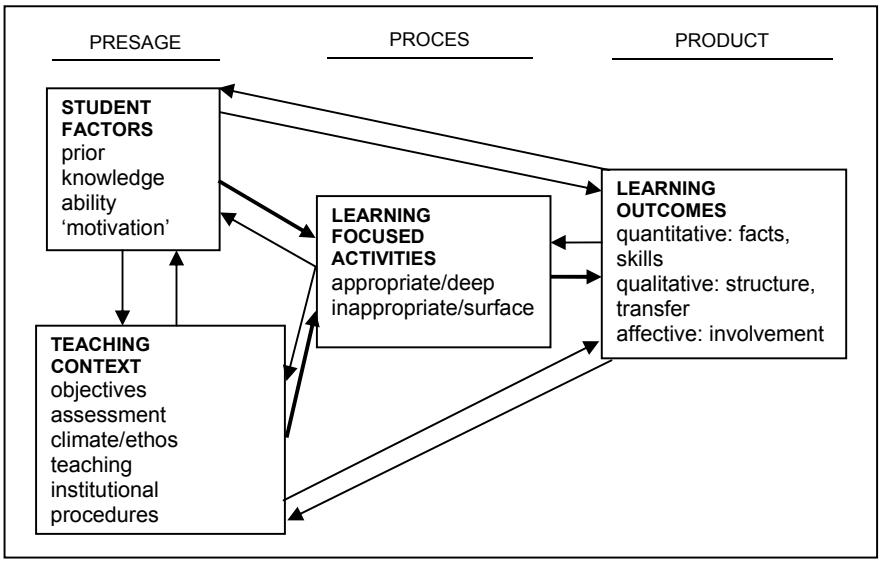

Figure 2. The 3P model of teaching and learning (Biggs, 1999:18)

The principles of alignment entail the existence of consistency and logic among all the elements and mutual support between the elements:

- The curriculum that we teach.
- The teaching methods that we use.
- The assessment procedures that we use, and the methods of reporting results.

– The climate that we create in interaction with the students.
– The institutional climate, the rules and procedures we have to follow (Biggs, 2003:26).

The model is not developed for the purpose of analyzing change in an organization, but for analyzing curricula. Any change in the teaching context will affect the student factors, the learning activities, and the outcomes and one has to consider the entire curriculum as an aligned system.

However, for analyzing the processes of changing to PBL, we need a model that is more comprehensive and covers not only institutional procedures but also the relation to society, organization, culture, and values. The Scandinavian approach to curriculum development (in continental Europe called didactics) covers these elements. The interrelation between educational politics and curriculum development has been emphasized, so in order to understand curriculum change, the understanding of the societal framework is crucial. Him and Hippe (1997) have developed a model for relationship didactics, the aim of which is to critically analyze and understand teaching and learning. They operate with six factors, which make up the most important elements in teaching and learning analysis:

– The student's social, cultural, psychological, and physical prerequisites for learning.
– Cultural, social, and physical factors of frame (including the prerequisites of the teacher).
– Goals for learning.
– Contents.
– Process of learning.
– Assessment.

The curriculum model below, see figure 3, builds on the relationship didactics (Him and Hippe, 1993; Kolmos, 2002). We have developed it further according to the importance of organization, culture, and values, which must be considered when dealing with a change process. According to this model, all of the educational elements must be included in the curriculum change processes in order to achieve change. Thus, the model helps explain why changes in teaching methods within a traditional educational framework would not result in a changed educational model, if the way of assessment and/or the principles for material selection were not changed concurrently.

The model features two layers – the curriculum layer, and the organizational and values layer. The first layer is the curriculum covering six elements: students, teachers, goals, selection of contents, teaching and learning methods, and assessment, see figure 3. Changing over to PBL also entails changes in all six elements: students' prerequisites concerning their previous PBL experience have to be reconsidered. Teachers' qualifications have to be developed. New types of objectives, new competences will emerge. The contents will be reselected in a new manner. The teaching and learning methods will be based on PBL methods and new forms of assessment methods will arise.

The second layer is the organizational aspect, which is crucial as the contents layer is not sufficient to explain curriculum change. All these elements form the frame for curriculum development – and beyond these elements and their

interrelation is the very core change of knowledge construction consisting of values, conceptual change, and the use of new learning principles.

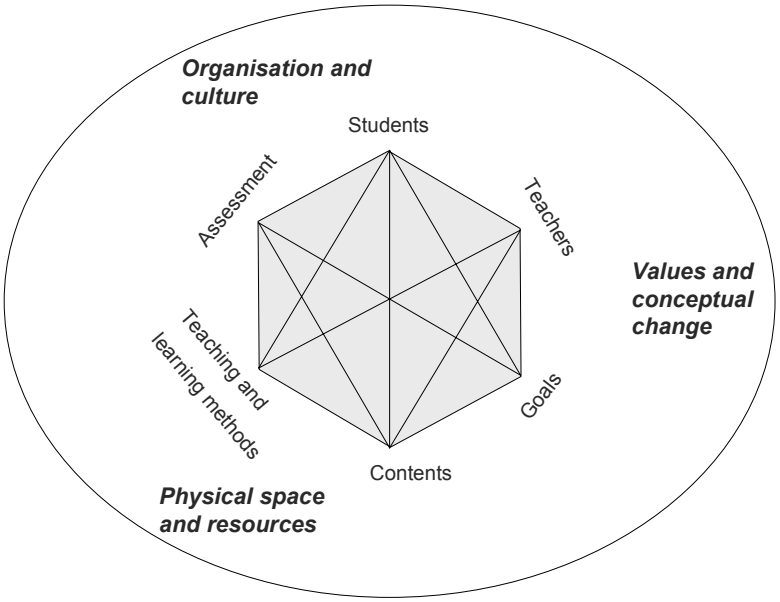

Figure 3. Curriculum model for change

This model depicts a total system change, pointing out the relevant elements – however, it does not give any understanding of the process of change.

STRATEGIES FOR CHANGE

Managing a large institute like a university faculty is at times compared with the navigation of a super tanker. The inertia of the mass precludes any abrupt change of course. In other words, the operation of changing an organization involves strategic planning, with short-term and long-term goals. Chin and Benne (1985) distinguish three types of strategies that can be applied when changing an organization:

– Empirical-rational strategies.
– Normative-re-educative strategies.
– Power-coercive strategies.

Each strategy rests on implicit beliefs about human nature. The first strategy treats man as a rational being. In the end, everyone is interested in personal gain, so in order to effect change, the advantages should be pointed out. The second strategy recognizes that man is conservative in nature. This strategy also emphasizes the social aspects of human behaviour and the ability to learn new behaviour. Consequently, to change an organization, you will have to change the value system of the people within the organization - what we call cultural change

today. Power-coercive strategies depart from the assumption that man primarily identifies with his personal profit, and that most men do not care for the advantages or risks of the organization as a whole. Top-down management is therefore necessary to protect the larger interest at stake.

Each type of strategy has its advantages and drawbacks. Empirical-rational strategies are the approach of choice in an academic environment and, in particular, in Engineering Education. The simplicity is appealing. Once we explain why a certain innovation will result in better learning and all other implied advantages are laid out, all sensible persons will agree that this is the way to go. However, as indicated in the section on power-coercive strategies, an advantage for the organization as a whole is not necessarily perceived as an advantage by the individual teacher. In particular with the introduction of PBL, new teaching tasks could even threaten to diminish the job satisfaction of the old-fashioned teacher (Graaff and Mierson, 2005). When applying rational strategies, one should take into consideration the limitations of human rationality.

A normative-re-educative strategy is best suited for long-term effectiveness, aiming at creating conditions for growth rather than immediate results. This strategy recognizes the importance of patterns of values and attitudes as the basis of human behaviour. As an approach to educational change, this takes much more time and the outcomes are uncertain at the start. On the other hand, the acceptability of the ideas generated from within the system will be much higher. In order to have people accept the consequences of introducing PBL, such a strategy might be an essential element of the overall strategy.

Power-coercive approach strategies, to start at the bottom, primarily serve the immediate needs of quick visible results. Although this strategy may be successful in solving the most urgent problems, it is recognized that it results in few long-term effects. In particular in (higher) education, the willing collaboration of the professional staff is required for successful implementation. Another major drawback of the power-coercive strategy is that the initiative rests with a rather small group that can easily become isolated. This group may serve well to get the train in motion, but in order to sustain that motion, broad support among the staff is necessary.

In order to change to problem-based learning, it is necessary to constitute a bridge between different strategies of organizational chance and, not at least, a bridge between organizational learning and education.

PHASES IN THE PROCESS

The change process itself is left in the dark, and organizational literature must be consulted in order to find more developed models for change. Kotter's (1995) model for change is often used to illustrate phases at a more specific level. It was developed in the context of companies, but has been used as an analytical model for education processes as well (Morgan and Roberts, 2002). Kotter (1995) works with eight phases, see figure 4.

Kotter is often criticized for being too rational and logical as the point with his phases is to go from one phase to the other. As already mentioned, change

processes are complex and unique; however, the important aspect of Kotter's eight phases is the emphasis placed on urgency and creation of visions. In our experience as faculty developers who often attend workshops on various education topics aimed at increasing staff motivation, staffs do not possess such sense of urgency nor feel that they have a part in formulating visions.

Phases		
1	Establishing a Sense of Urgency	
2	Forming a Powerful Guiding Coalition	
3	Creating a Vision	
4	Communicating the Vision	
5	Empowering Others to Act on the Vision	
6	Planning for and Creating Short-Term Wins	
7	Consolidating Improvements and Producing Still More Change	
8	Institutionalizing New Approaches	

Figure 4. Eight steps to transforming your organization

Kotter underpins two important elements in the innovation process: urgency and visions. Normally, teachers might not experience any urgency – on the contrary, they feel confident and satisfied with existing teaching practices. Only few staff members feel the need for change as the trigger for internal institutional change most often is external.

Kotter's phases are part of a normative-re-educative strategy. The vision is vital for long-term change, even if it might be problematic that in this model, vision is formulated by the leaders, who communicate the vision to the staff. In educational settings, the role of the leader might be hard to define and fulfil as leaders often are good colleagues with "their" employees. So the formulation of visions has to be regarded as a common process among colleagues. The vision element is important since the process of visions may include both motivation and an overview of the total planning process.

Joining in Kotter's belief of the centrality of vision in curriculum development, Moesby (2004) has developed a model for implementation of change to PBL in higher education covering four phases:

– Investigation Phase: Pre-action activities.
– Adoption Phase: Formulation of Vision; Defining criteria of success; Communication of the results.
– Implementation Phase: Staff development programme, Evaluation programme.
– Institutional state which is the final state of the change process.

Instead of a phase of urgency, he speaks about creating motivation in an investigation phase with pre-action activities. So if change is established by the top management, the pre-phase is crucial to consider due to its motivational nature. Change never stops – it is an ongoing activity, and consequently, the formulation of a phase as the institutional state might be too static. Even after a period of institutionalization, an enormous need for further organizational reflection and development may be present.

Also Knoster emphasizes the importance of visions (in Thousand and Villa, 1995). Knoster do not work with phases, but necessary elements in the process: vision, consensus, skills, incentives, resources, and action plan. Relating them to Kotter, these elements are to be found on a more specific level for change and are as such more action-oriented. Knoster's point is that a change process has to cover all six elements in a proper way. If merely one element is missing, the result will be different attitudes among staff members like confusion, sabotage, anxiety, resistance, frustration, or the experience of a treadmill.

Vision +	Consensus +	Skills +	Incentives +	Resources +	Action Plan	= Change
	Consensus +	Skills +	Incentives +	Resources +	Action Plan	= Confusion
Vision +		Skills +	Incentives +	Resources +	Action Plan	= Sabotage
Vision +	Consensus +		Incentives +	Resources +	Action Plan	= Anxiety
Vision +	Consensus +	Skills +		Resources +	Action Plan	= Resistance
Vision +	Consensus +	Skills +	Incentives +		Action Plan	= Frustration
Vision +	Consensus +	Skills +	Incentives +	Resources +		= Treadmill

Figure 5. Factors in managing complex change (Thousand and Villa, 1995)

The consequences may be slightly dramatized to convey these points, but it provides a sense of the different feelings that occur during a change process and suggests that part of the resistance might be avoided by having a holistic and systemic approach to change where all elements form part of the change process. However, staff involved in change processes can easily recognize this analytical framework.

MANAGEMENT

Compared to change in private companies, change in higher education is far more complicated due to the organizational structures and, not least, the role of leadership. In private companies, leaders normally have the power to direct and control initiatives. In higher education in western countries, leaders are normally elected among colleagues and leadership tends to involve administration rather than mapping out future directions. New trends are emerging with appointed leaders in higher education; however, the impact on change is yet to be investigated.

Regardless of appointed or elected leaders, Kolmos, Gynnild and Roxå (2004) point to the fact that all organizational levels become involved if the organization enters a change process. Bottom-up strategies are not efficient since change at a system level requires a decision at top-level. Top-down strategies are not efficient as they create much resistance in the system. So the optimal situation is to establish change by using both top-down and bottom-up strategies. Top-down strategies are comparable to empirical-rational and normative-re-educative strategies whereas bottom-up is comparable to the power-coercive strategy.

Experiences made from the change processes in this book document that all strategies are needed. It may be so that change is initiated by the top, but is

successful only if there is support among the staff. The Aveiro experience clearly demonstrates this feature.

On the other hand, strategies relying only on bottom-up initiatives may result in frustration since the system does not support a change process. As long as staff members only effect changes within a single course and do not have further ambitions, support from the leading level may not be needed – but as soon as more courses are involved as well as a breakdown of the normal schedule and maybe the physical space, support from the top is a must.

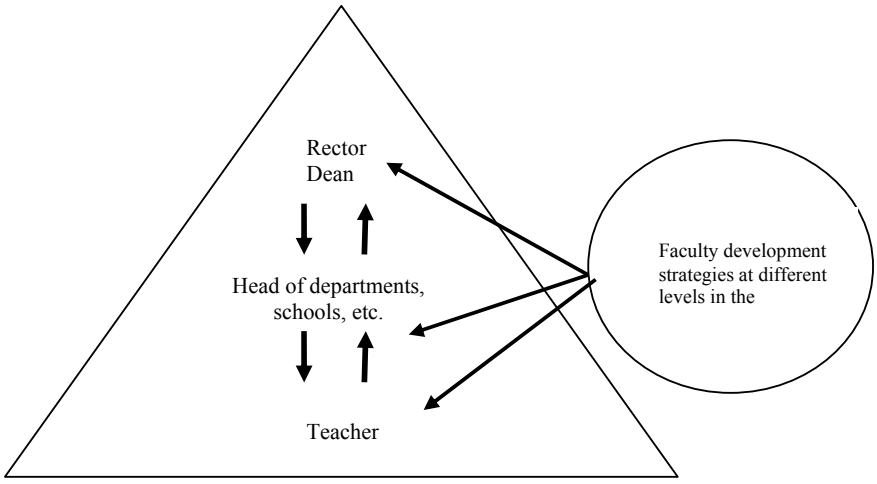

Figure 6. Relation between faculty development units and the university organization

Therefore, there is a need for change agents – if the change starts from the top, change agents must be found among involved staff members – if the change starts from the bottom, change agents must be found in the top. The role of change agents is to motivate staff and to lead the change process by pushing the whole time. Pushing for visions – pushing for exact plans– pushing for resources, strategies, etc. We do not propose that each individual change agent should cover all the responsibilities, but experience shows that drivers are necessary.

There is also a need for faculty development units – and for these units to relate to all levels in the organization - both the top, middle, and bottom levels. However, in order to develop that kind of practice, resources and awareness are needed and faculty developers might be core change agents.

Resources enable these units to act at all levels, e.g., to join meetings for heads of departments, study boards, deans, etc., and promote awareness of the roles of both the faculty development units and the leaders at all levels in the university organization. Based on an analysis of the situation in the Netherlands, Graaff and Sjoer (2006) argue that the most effective educational support centres are research-based.

SUSTAINABILITY OF CHANGE

As previously mentioned, change cannot take place overnight – it is not an event, rather an ongoing long, comprehensive, and energy-intensive process.

Fullan (2005) has stipulated eight elements that must be present in order to effect sustainable change. Elegantly, these eight elements cover a number of the previous conclusions. Moreover, they also transcend the previous since Fullan highlights, e.g., lateral capacity building through network, intelligent accountability, and vertical relationships not only between the institutions undergoing processes of change, but also the contact to the surrounding society.

1	Public service with a moral purpose
2	Commitment to changing context at all levels
3	Lateral capacity building through network
4	Intelligent accountability and vertical relationships
5	Deep learning
6	Dual commitment to short term and long term results
7	Cyclical energizing
8	The long lever of leadership

Figure 7: Eight elements of sustainability

Fullan develops his models on the basis of the primary and secondary lower school, so to apply them to higher education institutions, industry, unions, ministries, etc., should be included in the formation of networks surrounding the processes of change. Implementing ideas in a number of associated organizations only helps strengthen the internal sustainability of the institution in question.

The two additional elements that we will point to as complementation to our approach are cyclical energizing and the long lever of leadership. We have already touched upon the fact that change is a process and not something that takes place within a short period of time. However, change may come to a standstill after a while. Fullan makes a clear point here, advocating organization of recurrent energizers to pass from a phase of change to continuous improvement. This requires energizers - new inputs for reflection on and improvement of practice. Similarly, Fullan points to leadership as a lever, an element that has been called attention to, but Fullan's point is that leaders must be capable of implementing all eight elements in the organization and not least be capable of thinking in terms of systems and wholes.

PERSPECTIVES

The different models can help explain elements of the occurring change processes, and, not least, point out the areas that definitely should be taken into consideration previous to the implementation of the change processes, such as:

– Including all curriculum elements.

- Thinking of coherence between curriculum and organization/culture.
- Employing a range of strategies for change.
- Creating a general view of the total change process.
- Creating visions.
- Motivating staff and colleagues.
- Developing visions for long-term goals without compromising short-term goals.
- Planning development of staff qualifications.
- Raising resources.
- Developing specific plan of action.
- Establishing networks.
- Including and developing a staff development unit responsible for recurring energizers.
- Providing evidence of the development of students' learning outcome.
- Providing evidence of the development of faculty' s capacity.

The latter two points are decisive for the spread of change processes. Therefore, it is important to be able to provide evidence of a change in the students' learning along with a change in staff capacity. Students' learning should to a higher extent focus on deep learning rather than surface learning – and staff should develop an understanding of students' learning.

The success of curriculum innovation in the long run depends on the ability of the faculty to adapt the educational method to suit its own specific needs – and on the ability to constantly renew itself. In a comparison between two schools of Architecture both introducing PBL, Graaff and Cowdroy (1997) pointed out the importance of staff involvement. As a matter of fact, the one school where PBL was introduced top-down has in the meantime abandoned the method completely. As for a rational-coercive strategy, the advantages of a PBL curriculum can be explained, supported by research evidence form other institutes. An important advantage of the introduction of PBL is that it entails a new way of thinking about education and learning. In traditional organizations in higher education, little reflection on the task of teaching exists. The introduction of PBL curriculum can help to break down these traditional boundaries. In the course of the introduction process, the staff has to be trained and re-educated in order to learn to function effectively in the new situation. Finally, successful educational leadership assumes the responsibility of making decisions, including those decisions that will not be embraced by all parties involved, but that are necessary for the organization to survive in a competitive world.

Anette Kolmos
Ph.D., Professor in PBL and Engineering Education and Vice director of UCPBL
Aalborg University, Denmark.

Erik de Graaff
Ph.D., Associate Professor, Institute of Technology and Communication
Delft University of Technology, Holland

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