

## **The Transformation Process from a Traditional Curriculum to Problem-Based and Project-Based Learning**

**E. de Graaff**  
Professor  
Aalborg University,  
Aalborg, Denmark  
degraaff@plan.aau.dk

Conference Key Areas: Curriculum development, Engineering Education Research, Integration of, New learning concepts for engineering education

Keywords: Curriculum development; PBL; Management of change;

### **INTRODUCTION**

Over the past decades Problem-Based learning (PBL) established a worldwide reputation as a highly successful method to organize a curriculum for medicine, engineering and other professions [1, 2, 3]. Repeatedly PBL curricula have been demonstrated to be more efficient in terms of lower dropout rates and shorter study duration [4,5,6]. Also, employers consistently prefer PBL-graduates to traditionally trained students. Aiming to profit from these advantages, the past decades many existing engineering schools have started to implement one or another format of PBL. However, it turns out that the transition to PBL in an existing institute with its own traditions on teaching and learning presents serious challenges [7].

Successful implementations of PBL that are frequently cited in the literature, like McMaster's university and Maastricht had the advantage of starting from scratch. At Aalborg University the PBL model was used to enforce a unifying principle joining different schools in the establishment of the University [8]. Currently, many engineering institutions in different countries all over the world are involved in a change process involving transition to PBL.

This paper focuses on the transition process in existing engineering schools, dealing with questions like:

- What variety of PBL is most suited?
- How to prepare the staff for their new tasks
- How to adapt the organization to the new situation?

Rather than providing cookbook answers the paper will present some tools that can help people deal with these questions in their own situation.

---

## 1. Why change and to what type of PBL?

Without a doubt the power to innovate is one of the supreme qualities of mankind. Yet people are also creatures of habit. Most of us are reluctant to change. As an old engineering motto says: 'if it works do not change'. So before you start a change process you will have to be convinced that the change will be profitable. And your arguments will have to be good enough to convince others as well. Basically this means that a change process takes off from a negative starting point of criticism on the status quo. If you say we need to change the education of university X, you say in so many words that the education of this university is not good enough as it is.

Criticism on education can take many forms. Someone could point out that the graduates are not sufficiently competent when they enter practice, or that not enough students graduate on time, or that it is too costly. Depending on the actual cause, different types of change will ensue. The arguments for instance derived from a high dropout rate, are different than those related to a lack of practical competences. In both cases you could opt for a PBL solution. However, in the first case you would argue that projects have a positive effect on study results. In the second case you would tend to emphasize the development of practical competences as a result of working in a project. In any case it is highly important to identify the relevant causes with respect to the case at hand, because this will determine the direction of the change process.

In the introduction several clear advantages of PBL are cited. However, to what degree these advantages can be realized depends on the type of PBL in question. There are different types of PBL, varying in attributes like the way the problem is presented to the students, the role of the teachers, the timespan allotted for working on the problem, etc. [9,10,11]. A major differentiation is the distinction between Case and phenomenon based PBL as it was disseminated from McMaster's and Maastricht on the one side and the Problem Based Project Organized Learning that was developed in engineering education in Aalborg on the other side. The first model works with paper cases that are used to trigger a discussion allowing groups of students to formulate their own learning goals. There is no expectation that any problem will be solved. The second model is based on problem from practice requiring students to work together to produce a solution. In the last case 'authenticity' of the problem situation is crucial for the learning.

Also, it makes a difference whether PBL is concentrated in isolated projects or it is considered a leading principle throughout the curriculum. As a result there is a multitude of more or less differentiated PBL formats, mixing characteristics of case based and project organized PBL and integrating more or less elements from the traditional curriculum. Some schools even opt explicitly for marking their own brand of PBL. Based on the main resources the following key PBL characteristics can be identified as checkpoints:

1. Learning starts with a problem.
2. The problem can be a case, a phenomenon or a project.
3. The problem integrates knowledge and skills from different disciplines.
4. Teachers design learning situations and facilitate the learning process.
5. Students are active participants, directing their own learning process and formulating their own learning objectives.
6. Students collaborate in teams, stimulating prior knowledge
7. Students reflect systematically on their own learning.
8. Teachers provide continuous feedback on the learning.
9. Assessment procedures are designed to stimulate the learning.
10. Students are stimulated to learn from their failures.

## **2. Initiating the change process**

Awareness of the need for change has to arise before the transition process can start. First, at a preliminary stage the person that aims to initiate the change process needs to identify allies that support the initiative. With this small group the first step is to make a preliminary inventory of the main stakeholders. For key stakeholders like the university administrators, the teaching staff, the support staff, the students, alumni, employers, parents, and politicians representing the interest of society the level of interest needs to be assessed [12]. Based on this assessment a strategy for change can be formulated. If your assessment is that the students will profit in the long run from a change in their curriculum, but it will be hard on the teachers at short term, your strategy will need to consider how to win over the support from these parties. In quite a number of occasions the innovation process is frustrated because the teaching staff suspects that the administration wants to use the change in order to reduce cost by increasing the teaching load (correctly or imagined).

Strategies for changing build on implicit beliefs about human nature. Chin and Benne distinguish three types of strategies that can be applied when changing an organization [13]:

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

The first strategy acts on the assumption that man is a rational being. In the end, everyone is interested in personal gain, so in order to promote change, the advantages should be pointed out. The second strategy 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. Power-coercive strategies depend on 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 a necessity to protect the larger interest at stake.

In practice the initiating team will have to operate flexible, switching between different strategies as the need arises. They need to be aware of the characteristics of different strategy types in order to adjust their plans. It may be a good idea to start with providing information on the advantages of the change, for instance by inviting a guest speaker representing an institute where the innovation has been implemented successfully. Next, the strategy can shift to a re-educative strategy, involving the staff in a programme of workshops courses. Finally, in the long run at some stage it may be necessary to impose some aspects change by means of an overriding decision. In an academic organisation hierarchical decisions are often not accepted easily, therefore this should be done with utmost care. However, there may come a stage where the implementation is hampered by one or two professors who refuse to go along and taking away their prerogatives may be the only way to continue the change process.

## **4. Stages in the change process**

Setting up a strategy requires awareness of the different stages of the change process. Organisation literature provides many models for organizational change, dividing the process in successive stages [14]. The approach proposed by Kotter's includes the most common phases. Although this model was developed in the

context of organisational change in companies, it can also be used as an analytical model for education processes as well [15]. Kotter distinguishes the following eight phases, see table 1.

*Table 1.: Eight Steps to Transforming Your Organisation*

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	Institutionalising of the new approaches

An important aspect of Kotter's eight phase model is that he stresses the importance of urgency and creation of visions. Normally, teachers do 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. Strong educational leadership is necessary to trigger institutional change.

During the change process the initiating team needs to be aware of responses to the transition at all levels in order to be able to adapt their plans. In the course of an NF program aiming for dissemination of instructional innovations the following series of propositions was formulated that sum up the most important considerations concerning the change process, see table 2.

*Table 2.: Five propositions regarding organizational change in [16].*

- |    |  |
|----|--|
| 1. | Change takes time – it is a process, not an event.   |
| 2. | Awareness is only the first stage in adoption.   |
| 3. | Different types of changes require different strategies.   |
| 4. | Faculty beliefs and values may need to be modified in order for them to properly adopt/adapt the innovation. |
| 5. | Creating change requires taking a systems perspective.   |

Although it is implied in the fifth one, I would like to add a sixth proposition explicitly: 'The end point of the change process is not a steady state!' There will always be new challenges and new persons setting objectives for a new round of change.

#### **4. Sustainability of change**

Even if we accept the notion that the new situation will not be completely stable any particular change operation will have to be ended formally. A project has a beginning and an end. At the start of the process the initiating group has to specify objectives for the project. When the pre-defined criteria indicate that these objectives have been met sufficiently, the project is concluded successfully. The next question is what happens with the transition after the conclusion of the change project? Will the changes prevail, or will it degrade back to the old situation?

Fullan, the worldwide authority on management of educational change formulated eight elements that must be present in order to effect sustainable change [17]. With these eight elements Fullan clearly underlines the importance of commitment and ethical awareness as factors in the sustainability of change, highlighting aspects like,

a moral purpose, lateral capacity building, intelligent accountability, and vertical relationships. This involves the institutions undergoing processes of change, but also the contact to the society at large.

Table 3.: Eight crucial elements of sustainability [17]

---

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

---

Fullan recognizes the fact that change will not persist without stimuli. He advocates that recurrent energizers are organized to smooth the passing from a phase of change to continuous improvement. Fullan also points to leadership as a lever [18]. 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.

## 5. Conclusion

Summing up the following aspects that definitely should surely be taken into consideration in any change process:

- Look at the curriculum as a whole, including all curriculum elements.
- Think of the coherence between the curriculum and the organization culture.
- Employ a range of strategies for change, adapting to the situation.
- Create a general view of the total change process.
- Motivate staff and students.
- Develop visions for long-term goals without compromising short-term goals.
- Plan the development of teaching competences.
- Raise funds.
- Participate in network activities.
- Establish a staff development unit responsible for recurring energizers
- Provide proof of the development of students' learning outcome.
- Provide proof of the development of faculty' s capacity.

However, you should remember that there is not one simple recipe for success in educational change. At all stages it is important to keep your purpose clearly in mind and be firm in your course. Yet you also will have to respond adequately to reactions from the environment and show flexibility when it is needed. You will have to realize that when you think you have everything taken care of, it may disappear magically from under your hands. I have visited schools were they had told me they practiced PBL, to be shown around in traditional looking classrooms with teacher in from of the class. Words are slippery and their meaning can be the reverse of what your thought it was, as expressed by the following quote from William S. Burroughs: *'Language is virus from outer space'*.

## REFERENCES

- [1] Albanese, M.A. (1993). Problem based learning: A review of literature on its outcomes and implementation issues. *Academic Medicine: Journal of the Association of American Medical Colleges*, 68 (1), 52-81.

- [2] Savin-Baden, M. (2000), *Problem-based Learning in Higher Education: Untold Stories*. SRHE and Open University Press, Buckingham.
- [3] Graaff, Erik de & Kolmos, Anette (2003) Characteristics of problem-based learning. *International Journal of Engineering Education*. 19, 5, p. 657-662.
- [4] Kolmos, A., Fink, F. and Krog L. (2004). The Aalborg Model: Problem Based and Project Organized Learning. In Kolmos, A., Fink, F. and Krog L. (Eds.) *The Aalborg PBL Model: Progress, Diversity and Challenges*. Aalborg: Aalborg University Press. 9-18
- [5] Post, G.J., De Graaff, E. and Drop, M. J. (1988) Efficiency of a Primary-Care Curriculum. *Annals of Community-Oriented Medical Education*, 1, 25-31.
- [6] Perrenet, J.C., Bouhuijs, P.A.J. & Smits, J.G.M.M. (2000), The Suitability of Problem-based Learning for Engineering Education. *Theory and Practice. Teaching in Higher Education*, 5(3), 345-358.
- [7] Schmidt, H.G. (1990) Onderwijskundige aspecten van probleemgestuurd onderwijs. In W.S. Jochems (red.), *Activerend Onderwijs, over onderwijsvormen die het leren bevorderen* [Activating Education, on educational formats that encourage learning]. Delft: Delft Universitaire pers.
- [8] Algreen-Ussing, H. and Fruensgaard, N.O., (1990) *Metode I Projektarbejde*, Aalborg University Press.
- [9] Wilkerson, L. and Gijsselaers, W. H. (Eds.), (1996), *Bringing Problem-Based Learning to Higher Education: Theory and Practice*, Jossey-Bass Publishers, San Francisco.
- [10] Graaff, Erik de & Anette Kolmos (2007). *Management of Change; Implementation of Problem-Based and Project-Based Learning in Engineering*. Rotterdam / Taipei: Sense Publishers. 221p.
- [11] Du, Xiangyun, Graaff, E. de & Kolmos, A. (Eds.). (2009). *Research on PBL Practice in Engineering Education*. Rotterdam: Sense Publishers.
- [12] Fullan, M., 2001, *The new meaning of educational change*, 3<sup>rd</sup> edition (New York: Teachers College Press).
- [13] Chin, R., and Benne, K. D. (1985). General strategies for effecting changes in human systems. In Bennis, W. G., Benne, K. D. and Chin, R., *The planning of change* (4<sup>th</sup> edition). New York: Holt, Rinehart & Winston.
- [14] Graaff, E de (2008). How to Implement active learning? Strategies for change. In Catlina. Ramirez Rafael Gomez (Ed.), *Designing and Implementing an active and equitable engineering education*. Proceedings of eighth international workshop ALE 2008 pp. 67-76. Bogota: Universidad de Los Andes. Facultad de

Ingenieria.

- [15] Kotter, J. B., 1995, *Why Transformation Efforts Fail*, Harvard Business Review, March-April 1995.
  
- [16] Henderson, C., et al. (2012). Five Claims about Effective Propagation: A White Paper prepared for the January 30-31, 2012 meetings with NSF TUES Program Directors. <http://homepages.wmich.edu/~chenders/Publications/Publications.htm>
  
- [17] Fullan, M., 2005. *Leadership & sustainability: system thinkers in action*. (Corwin Press, Thousand Oaks).
  
- [18] Fullan, M., 2004, *Leading in a culture of change : personal action guide and workbook* (San Francisco: Jossey-Bass, John Wiley).