

# PROBLEM BASED LEARNING VERSUS DESIGN THINKING IN TEAM BASED PROJECT WORK

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## ABSTRACT

All educations at Aalborg University has since 1974 been rooted in Problem Based Learning (PBL). In 1999 a new education in Industrial design was set up, introducing Design Based Learning (DBL).

Even though the two approaches have a lot in common they also hold different understandings of core project based learning issues, which has caused a need to describe and compare the two models; in specific the understandings, approaches and organization of learning in project work.

The PBL model viewing the process as 3 separate project stages including; problem analysis, problem solving and project report, with focus on problem solving through analysis. Design Based Learning viewing the process as series of integrated design spaces including; alignment, research, mission, vision, concept, product and process report, with focus on innovative ideation though integration.

There is a need of renewing the PBL to update the educations to meet today's competitive global society. In order to create an informed basis for discussing and updating the historic approach to project work at Aalborg University, this paper will try to unfold and compare PBL and DBL and the competences they create through team based project work

The paper will exemplify how projects work is organized, supervised, staged and reported. It will investigate the practical organization of the teamwork and process as well as the dominating mindsets and methods used during the process. Comparing the two models concerning the learning aims the competence they create.

*Keywords: Problem Based Learning, Design Based Learning, Design Thinking, Project models, Teamwork*

## 1 INTRODUCTION

All educations at Aalborg University has since 1974 been rooted in Project and Problem Based Learning (PBL) model. In 1999 a new cross disciplinary design-engineering education in Industrial design was set up. This education program introduced Design Based Learning (DBL), which extended the approach to both project work and learning. The new education program still had to satisfy the overall academic standards at Aalborg University.

The first reactions to the new design thinking based approach were statements like “these people have no process”, “it looks pretty messy”, “it is not research based” and “how do you define design?”

A big but welcoming challenge when you need to collaborate with colleges from different teaching cultures on developing a new educational and research field. Anyway as a design thinker yourself you are aware of the importance of good communication and the strengths of visualizations as media to facilitate it.

A visual model named Design Navigator gradually evolved through two streams of thought: design and learning. The model became a tool supporting a common understanding of design and was used many collaboration contexts. Lately there has been a more formal discussion concerning the updating of the PBL model at Aalborg University. For this purpose attempts to clarify the differences and similarities between PBL and DBL has been made.

## 2 PROJECT BASED LEARNING

Drawing upon the article by Helle et al (1) on Project Based Learning the following definitions are selected for this section as useful to build a basis for the topic of this paper.

Project Based Learning is widely used in higher education. The term project-based learning subsumes different activities with varying purposes (1).

Helle et al (1) states that according to Adderly et al, (1975) project method is defined as: 1) Involve the solution of a problem; often, though not necessarily, set by the student himself; 2) Involve initiative by the student or group of students, and necessitate a variety of educational activities; 3) Commonly result is an end product (e.g., thesis, report, design plans, computer program and model); 4) Work often goes on for a considerable length of time; 5) Teaching staff are involved in an advisory, rather than authoritarian role at any or all of the stages – initiation, conduct and conclusion.

### **2.1 Project based learning versus problem based learning**

Helle et al (1) refer to Blumenfeld (1991) saying that “the essence of project-based learning is that a question or problem serves to organize and drive activities and these activities culminate in a final product that addresses the driving question” Stating that the most distinctive feature of project-based learning is problem orientation. This was according to Dewey (1933) at the core of “scientific” or “reflective” thinking, which in his view, should have constituted the goal of the education. Concerning the relationship between project-based learning and problem-based learning (incidentally both abbreviated “pbl”); the starting point in both approaches is a problem but in problem based learning, students’ activity is directed to “studying”, whereas in project-based learning, students’ activity is directed to constructing the product. (1)

### **2.2 Project based learning versus experiential based learning**

Experiential learning as learning from experience bears a resemblance to the original model of project-based learning Kilpatrick (1921). He distinguished four types of projects. The first type represented those experiences in which the dominating purpose was to do, to make, or to effect: to embody an idea in material form (compose or design). The second type involved purposeful enjoyment or appropriation of an experience. The third type of project the dominating purpose was to solve a problem. The fourth type, the learning project, included experiences in which the purpose was to acquire some item or degree of knowledge or skill. (1)

### **2.3 Collaborative or cooperative learning**

The distinction between these two terms is often defined on the basis of the extent of shared activity: characteristic of cooperation is the effective division of labour while collaboration requires participants to solve a problem or perform a task together Teasley and Roschelle (1993). Project work is usually divided among participants but, at the same time, the aim is to construct a shared outcome. Thus, project-based learning involves both cooperative and collaborative elements.

## **3 DESIGN BASED LEARNING**

Design is a complex interactive and dynamic process of transformation and so is learning; design in order to conduct ideas that create values through transformation of information and knowledge; learning in order to create knowledge, skills and competences.

### **3.1 Design Thinking**

According to Brown (3) design thinking “begins with the skills designers have learned over many decades; put design tools into the hands of people who have never thought of themselves as designers and apply them to a vastly greater range of problems relies on our ability to be intuitive, to reorganize patterns, to construct ideas that have emotional meanings as well as functionality, to express ourselves in media others than words and symbols and taps into capacities we all have but that are overlooked by more conventional problem solving practices”

### **3.2 Design as process**

Drawing upon the article by Beckman and Barry (2) on innovation as a learning process, the following information is selected as useful in building a reference for the topic of this paper.

“The history of academic understanding of the design process displays both a need to make design thinking explicit and a need to embrace the many disciplines engaged in design. Designers determine that their trial-and-error methods of design, in which they identified flaws and fixed them in a process of successive approximation to a final solution, need more predictive and evaluative methods for

determine the suitability of a design”. “Looking at design as a social process design has further shifted from a clear-cut problem-solving process to a problem-formulating process in which getting to a collectively acceptable starting point become the core of the effort” (2)

### **3.3 Design as a process of knowledge creation**

According to Owen (1997) the design process has “recognizable phases, and these, while not always in the same order, nearly always begin with analytic phases of search and understanding, and end with synthetic phases of experimentation and invention” and views design as a “process of knowledge development” suggesting that “the design process has both analytic and synthetic elements, and that it operates in both the theoretical and practical realms”. In the analytic phases of design, one focuses on finding and discovery, while in the synthetic phases of design, one focuses on invention and making (2).

### **3.4 Learning as a process of reconstruction of experience**

Dewey (1938/97), propose that learning is an ongoing “reconstruction of experience that reconciles new experiences with old ones in a continuous learning process”. According to Kolb’ (1984) Experiential Learning Theory learning is defined as “the process whereby knowledge is created through the transformation of experience” He defined the learning process as applying the four steps of experiencing, reflecting, thinking, and acting in a highly iterative fashion. His experiential learning theory model juxtaposes two approaches to grasping experience including; concrete experience and abstract conceptualization and two approaches to transforming experience including; reflective observation and active experimentation (2).

### **3.5 Learning styles and experiential learning**

Beckman and Barry (2) suggest that the experiential learning theory model with its dualistic approaches to respectively experience grasping and experience transformation placed in a matrix “define four learning styles and individual learning preferences; diverging (idea generation activities); converging (technical tasks and tasks dealing with social interpersonal issues); assimilating (take in a lot of information and logically ordering it); accommodating (hands-on experience and action)”. Barry further state that learning style is not a fixed trait in an individual, but according to Kolb “arises from consistent patterns of transaction between the individual and his or her environment”.

## **4 PROBLEM BASED PROJECT IN AAU CONTEXT**

The PBL introduced at Aalborg University in 1974 as a studying model which include; Project and Problem Based Learning, project organized education, inter disciplinary studies and group work (mono disciplinary). The PBL process model holds the 3 stages; Problem Analysis, Problem Solving and Project Report. The model is a linear stage-gate model embedding discursive thinking.

### **4.1 PBL and project work**

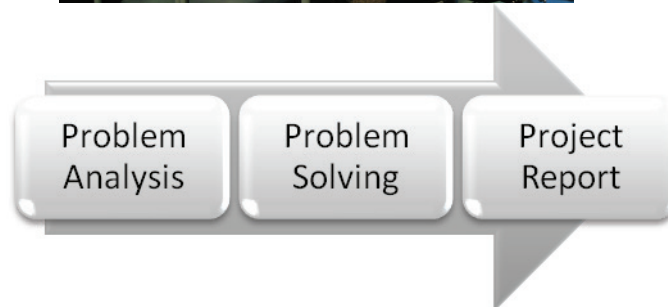
The duration of a project work is 4 month. The project groups between 3-7 students. Lectures on related topics and supervision are provided throughout the project period. Problem area is given but stated in a problem formulation by the students groups based on Problem Analysis. Problem Solving includes literature studies, group studies, field work and experiments. Project output is a Project Report including results of analysis and problem solving as well as the applied theories, methods and references.

Instructions concerning project work delivery include; problem formulation, synopsis, report structure and citations are provided when students enters an education

### **4.2 Project types and group formation**

Project types include; Problem projects, Discipline projects and Task projects. Problem and discipline projects can both be analysis, construction and design projects whereas Task projects can only be analysis or construction projects. Project often include cooperation with companies or public organizations. Master students are responsible of finding and framing the problem. Interdisciplinary studies include; integration of theory and practice, learn to learn and scientific methodological skills. Analysis represents the main part of the project. Students tend to focus on the project report as the

purpose of the project work. They are responsible for creating the project groups without any facilitation.



*Figure1. Staging PBL based project work*

#### **4.3 Project supervision and staging**

Supervision is linked to the Problem Solving phase and includes; lectures and tutorials. Each group has two supervisors of which one is a main supervisor from the specific education and the other either from the PBL institute or a relevant related education. The supervision format includes meetings and mail correspondence.

PBL project work is staged in group rooms with a meeting lay out. Students are responsible for both project and team management, but are not provided with any methods or tools for the purposes.

### **5 DESIGN BASED PROJECT IN AAU CONTEXT**

The DBL introduced at Aalborg University in 1999 is extending the studying model to design thinking model which include; Project Based Learning, project and workshop organized education, interdisciplinary and process studies and group work (mono and multi disciplinary).

The DBL process model holds the 6 platforms; Alignment, Research, Mission, Vision and Product. This interactive model is embedding both intuitive and discursive thinking.

#### **5.1 DBL and project work**

A project period can be 6 or 12 weeks. The project groups between 3-5 students. Lectures on related topics are an integral part of separate workshops including a minor 3 week individual project. Project supervision includes facilitation of teamwork, project organization and management. The clear-cut problem solving process is replaced by a problem and potential finding process as a core element of designing innovative solutions. Project output is a Product Report and a Process Report; the first holding a description of the design proposal and the second holding a description and reflection on the design process.

Instructions concerning project delivery content and format; product report, process report, slide presentation, physical models, boards and working papers are specified for each project in a study guide.

#### **5.2 Project type and group formation**

Project types include; Minor Discipline and Experimental projects, Major Problem and Potential based design project. Projects work in general focus on and “designing to learn” and “learning to design”; the ability to navigate the process and master design methods and tools. Analysis and synthesis are

seen as a mutual interactive process. Major projects include cooperation with companies or public organizations. Interdisciplinary studies include; integration of theory & practice and scientific & artistic skills. Synthesis represents the main part of the project. The students use the process report to scale the progression in their design competences. The groups are facilitated on team creation and collaboration.

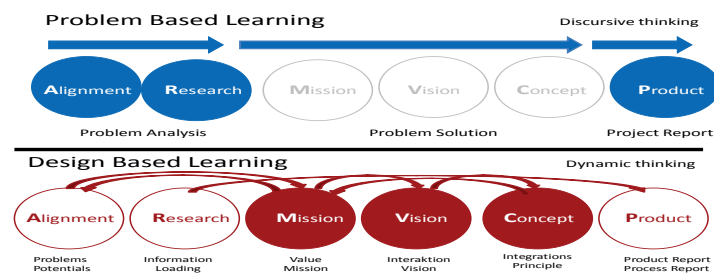
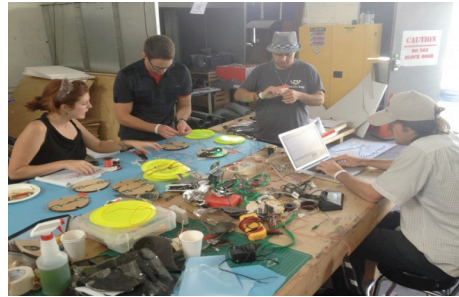


Figure 2. Staging Design based project work in the context of PBL

### 5.3 Project supervision and staging

Each group has a design and an engineer supervisor. Supervision includes all process platforms. To facilitate design thinking a Design Navigator (4) is used. It provides a framework including a set of parameters for what you are working with– the product and a set of levels for how you are working – the process and integrates the two systems. The product dimensions state 8 basic parameters. The process dimensions define 4 levels each framing a certain way of working concerning your thinking mode and communication form.



Figure 3. Design Navigator for co-creation process facilitation

The firm and simple structure allow the group to move freely among the parameters and levels while at the same time securing attention and supporting communication. The tool works as design arena and together with intensive use of the floor and walls it create a flexible and facilitating project space for collaborative design thinking, actions and reflection. Supervision mainly takes place within the project space.

## 6 DISCUSION ON PBL VERSUS DBL

Here I will try to examine differences and similarities in PBL and DBL as it comes through in team based project work in specific concerning; 1) Project model and process approach; 2) Project driver, support and staging; 3) Learning and working modes 4) Competence creation.

Project model - process approach	Process driver, -support -staging	Learning and working modes	Competence creation
<b>Problem Based Learning-PBL</b> Stage-gate model Analytic approach Problem solving	Problems Analysis and construction Tutorials, lectures and literature Cooperation Meeting space	Assimilating (logic info ordering) Converging (technical tasks)	Scientific competence Discursive thinking Subject management Project report
<b>Design Based Learning-DBL</b> Systemic model Interactive approach Potential exploration	Potentials and problem Synthesis and innovation Facilitation and tool provision Collaboration Workshop space	Diverging (idea generation) Accommodating(hands on action) Converging (technical tasks) Assimilating (logic info ordering)	Innovation competence Design thinking Process management Product report & Process report

Figure 4. Comparing PBL and DBL

### 6.1 Project model and process approach

Project models traditionally represent a procedure of how to progress and thereby create a specific way of working initiated by a problem or purpose. Furthermore they also affect the mindset; embedding discursive thinking. Stage-gate models like the PBL model are well-entrenched in contexts dealing with traditional problem solving. However struggling with increasingly broad and complex challenges this model is inadequate and causes a need of system models and to seek understanding of fundamental principles of interactions between problems and potentials and between analytic, synthetic and reflective thinking.

### 6.2 Process driver, support and staging

Projects serve to organize and drive constructions activities. Problems serve to organize and drive studying activities. Lectures, literature and tutorial might be suited for academic projects dealing with the past and present but is not adequately when dealing with the future like you do in design and innovation.

Design is a highly dynamic and complex process which involves navigating both what you are working with and how you are working. When project group enters discussion, negotiation and decision making on design matter, they need interactive facilitation to support their thinking, actions in the process of co-creation.

Collaborative project work do not work out in the context of a conventional auditorium or meeting room as it implies interactions of thinking and emotions involving both mind and body. Communication in design should be staged in a way to actively support expression, sharing and interaction. A flexible project space, which allows a diversity of action and interaction, will act as a facilitating partner in the project work.

### 6.3 Learning and working modes

Designing and learning are both complex interactive and dynamic transformation process`; designing in order to conducts ideas that create values through transformation of information and learning in order to create knowledge, skills and competences through experience.

The PBL process presents a clear differentiation between analysis (assimilating) and synthesis (converging) as separated project stages, which leads to the misunderstanding that solutions with occur on the basis of thoroughly amount and quality of analysis, which is obvious not the case. In the DBL process the participant moves between concrete and abstract modes. It alternately uses analysis and synthesis to generate new designs. In moving among those extremes, in essence requires participants to engage in concrete experience and abstract conceptualization, reflective observation and active experimentation thus exercising all four learning styles; diverging, assimilating, converging and accommodating.

## 6.4 Competence creation

PBL primarily create competences in scientific theories, methods and reporting and knowledge management within a specialized field as well as promoting a culture of discursive thinking and an analytical oriented working mode in relating practice to specific theories. DBL primarily create competences in design and innovation theories, methods and tools and knowledge management within an integrated field of subjects as well as a culture of systemic thinking and a synthetic oriented working mode relating new concepts to future practice; to take holistic approach to design and work in the cross field of science - innovation and conduct ideation and product development carried out by cross disciplinary teams.

## REFERENCES

- [1] Helle L. Project based learning in post-secondary education –theory. Practice and robber sling shots, *Higher Education*, 2006, vol. 51 pp. 287-314.
- [2] Beckman, S.L. and Barry, M, Innovation as a Learning Process: Embedding Design Thinking. *California Review Management*, 2007, vol. 50 no.1 pp. 25-56.
- [3] Brown T. Change by Design. How Design Thinking Transform Organizations and Inspires Innovation, *Harper Business*, 2009.
- [4] Stockholm, M. A Holistic Approach to Interdisciplinary Innovation Supported by a Simple Tool. In *The 9<sup>th</sup> International Symposium of Human Factors in Organizational Design and Management*, Sao Paulo 2008, pp. 143-149. EIA Press, Santa Monica.
- [5] Stockholm, M. Team designing-facilitation of design learning using a systemic model of design. in *The 14<sup>th</sup> International Conference on Engineering and Product Design Education E&PDE12*, Antwerpen 2012, pp. 64-70.