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THE PROBLEM REVISITED: TEACHING THE PBL APPROACH TO DESIGN STUDENTS

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ABSTRACT
Problem-based learning (PBL) is becoming increasingly popular in design educations, but how is it taught and practiced? This paper presents a case study of a three-day workshop that has the purpose of introducing PBL to design students. A theoretical background on PBL and problems in design is established and is backing up the case study. The study shows that design engineering and architectural students without experience in PBL in general finds the approach to be beneficial when working on a design challenge in a student team.

Keywords: PBL, problem statement, case study, foreign students.

1 INTRODUCTION

Design is taught in a wide span of educational environments across the world, and the pedagogical setting in which it is taught most probably differs just as much. At [university X], the problem-based learning approach [1] is a deeply rooted part of the educational tradition and it is, hence this, implemented across all educational departments, including all design-oriented department at the university.

Throughout the bachelor level at the university's design educations, students slowly gain confidence in handling design challenges in this problem-based and project-organised setting in teams of 4 to 6 students. However, at the Masters level at [X university], a high number of foreign students each year come to study without prior knowledge or experience with the problem-based learning used in this specific educational environment. As the various study activities are also most often carried out in groups with fellow students, it is important that these new students from abroad quickly learn and experience the problem-based approach. Therefore, a three-day workshop is held each year as part of their introduction to the specific study form of project-organised PBL.

The PBL-workshop takes the students through an intensive concept development process. In this process, the focus is on working in teams on a predefined design challenge and on explicating the continuous evolution of the problem, they try to solve.

This paper presents the structure of the workshop, which is build around framing and reframing problems that the students try to solve in relation to a given theme. During the workshop a series of pin-up sessions are conducted, and at each session, the student groups present their progress and revised versions of the questions they are trying to answer with their design proposals. The series of questions that a single group develop by iterating on the design task throughout the workshop shows how the focus converges from being broad and often unclear to being narrow and specific. The aim of this explicit workshop rhythm and setup is to show each student that working with a design challenge can often be seen as an on-going dialogue between problem and solution where both parts are continuously visited and revisited [2].

Besides from the workshop setup, the paper also presents an evaluation of the format from the involved students. The evaluation is primarily based on written student reports, and the result from the evaluation is furthermore discussed and analysed in relation to existing theory on design thinking and problem-based learning. The driving question of the paper is: *How is PBL effectively taught to students on master level in the field of design?*

The rest of the paper is composed as follows: Section 2 presents a theoretical background on PBL, problems and solutions in design and certain perspectives on contrasting process management models. Section 3 describes the case included in this research and the related data. The results are found in the

fourth section of the paper, and finally, the paper is concluded with a fifth section that discusses the results with certain perspectives on further research.

2 THEORETICAL BACKGROUND

In many ways the fundamental concepts and structures of problem-based learning resemble the ideas of several well-known planning- and design process-models. In this section some of the pertinent concepts and models are presented and related to each other.

2.1 Problem-based Learning in General Education

Problem-based learning is a relatively new pedagogical approach that started to gain footing in the 1960's and 70's. Barrows and Tamblyn published their research on the reasoning abilities of medical students after experimenting with new learning styles. From the traditional approach, where students answer questions from information supplied by a lecturer, the problem-based approach propose problem scenarios that encourage the students to engage themselves in the learning process by independently realising what knowledge they need to acquire in order to understand and solve the problem [3][4].

The following list in Savin-Baden and Major [4] sums up the classic understanding of problem-based learning based on the findings of Barrows and Tamblyn [3]:

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

The list of PBL characteristics includes self-directed learning, meaning that the students themselves define the problem in focus and the knowledge gabs they need to overcome. The problem formulation – despite its volatile nature – then drives the learning activities towards a further elaboration of the problem and its possible solutions. Typically, students work together in small teams, and together they establish their strategy on how to gain the needed knowledge in order to move forward on problem they set out with. Lecturers and teachers act as supervisors to the student teams. Not by dictating certain literature or investigations, but instead by gently pushing the teams in the right direction.

Problem-based learning has a resemblance to experiential learning and the work of Dewey [5]. According to Dewey, education is a process of continuous reconstruction and growth of experience. To sum up, the problem-based learning process is a process that takes its departure in a given – and often ill-defined – problem. The student team then searches for knowledge and insights that can help the team cast new light on the problem and create a basis for a further elaboration of the problem and possible solutions. As Dewey suggest, this process is a continuous process of learning and gaining new experiences.

2.2 Problems and Solutions in Design

From the PBL definition by Savin-Baden and Major, we have learned that real world situations have no one right answer, and according to Rittel [6] and Buchanan [2] similar conditions exists in regard to design problems. Rittel defines design problems (and planning problems in general) as *wicked problems*, which are characterised by being:

- Difficult to define
- Perceived differently from person to person
- Without a clear set of criteria for whether a solution is right or wrong
- Symptoms of other problems

From this we may derive that problem-based learning activities carried out in design educations revolves around problems with these characteristics, and also that these problems to a large extent fit well with PBL as defined by Savin-Baden and Major [4]. But how do design students tackle the ambiguity of the wicked problems that they are exposed to? An answer to this question is suggested by Lawson [7] in his classic study of two groups of students: final year students of architecture and postgraduate science students. In this study, Lawson experiences a difference in solution strategies:

"… they learn about the nature of the problem largely as a result of trying our solutions, whereas the scientists set out specifically to study the problem." [8]
What Lawson suggests is that experienced architectural students are not only analyzing the problem at hand, but also synthesizing solutions in order to achieve a better understanding of the problem. This oscillating movement between analysis and synthesis is depicted in several design process models. Two models are shown in figure 1 below.

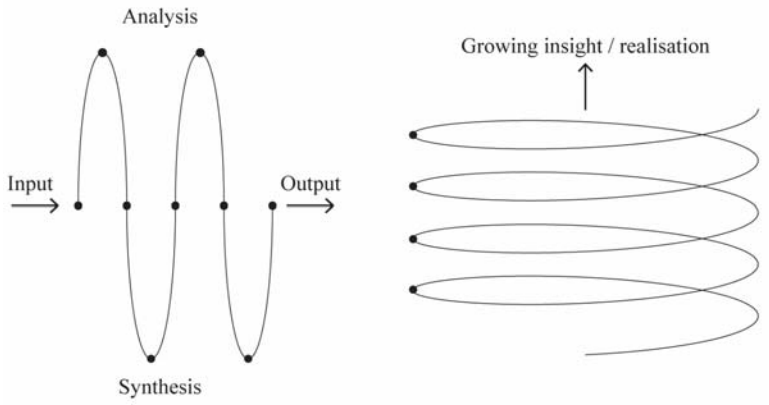

Figure 1. The two models present the design process in each their way. The model to the left shows the oscillation between synthesis and analysis, whereas the right model depicts the realisation process as a hermeneutic circle with growing insight in a cyclic process.

From the two models in figure 1, it looks like the design process could be never-ending, but according to Cross [9], the overall process must converge:

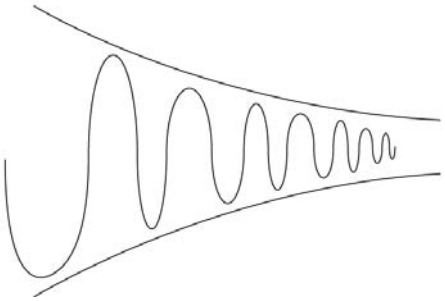

Figure 2. According to Cross [8] the oscillating process between synthesis and analysis – or as some denotes it: the process of divergence and convergence – must converge in the long run.

As it will be shown in a later section of the paper, the workshop carried out with foreign students was based on this same assumption of an overall converging problem statement.

2.3 The Strength of PBL in Design Education

Returning to the problem-based learning approach, one could ask what value PBL adds to design education when the fundamental process of design already holds similar ingredients, such as an ill-defined problem as starting point and continuous iteration between problem and solution? At University X, emphasis is on methodological solidity and clear rationales in the design engineering process. This is achieved through PBL elements such as a clear problem statement to bounce up against; and PBL thereby offers student teams an important explicitness and transparency in the design process. Stolterman [10] distinguish between to fundamental approaches to design education: the guideline approach and the aesthetic approach. Whereas both approaches are recognised as important qualities in design at University X, PBL helps to facilitate a learning approach closest to the engineering-like guideline approach.

2.4 Suitable Process Management Models for PBL in Design Education

As the models and definitions shown earlier suggest, the fundamental principles of problem-based learning in a design context, must be an empirical approach. Simply put, an assumption of students or teams knowing how to solve a given design task and with a steady hand prepare a perfect project plan at day one, would be false. Instead, student teams typically navigate into unknown terrain (the ill-defined problem) with no clear picture of what resources or insights are needed in the beginning of a design project. The choice of process management tools should reflect this ambiguity and openness in the design project.

In the case to be presented in the next section, time boxing and early feedback loops has been used as tools for managing and guiding the process. In contrast to practical tools such as Gantt charts [11] that have the purpose of planning far ahead and create an overview in given project, time boxing [12] solely offers a steady tact and frequent inspection and revision of the project's current state. Depending on the extent of the project, a time box can last from as little as a few hours to a couple of weeks. At the end of each time box, the project status is reviewed and discussed, and eventually an updated problem statement is formulated. The concept of time boxing derives from Agile Development [13] in the domain of software development and is perhaps best known as Sprints from the process management framework called Scrum [14]. The "fail early, succeed sooner" mentality of frequent project reviews fits well with the problem-based learning format as it promotes an active discussion and revision of the current-state problem formulation.

3 CASE DESCRIPTION

The case presented in this paper is a specific PBL workshop that serves as an introduction to the educational environment at University X. The workshop is placed in the beginning of the first master semester and is aimed at the foreign architectural and industrial design master students that come to study at the university without prior experience with the PBL. The workshop runs over three intensive days with several time boxes and project review sessions. All groups were asked to develop a new concept for a specific square in the city, leaving the decision to the group about what problems related to the square to work on. The overall structure of the workshop is shown in figure 3 below.

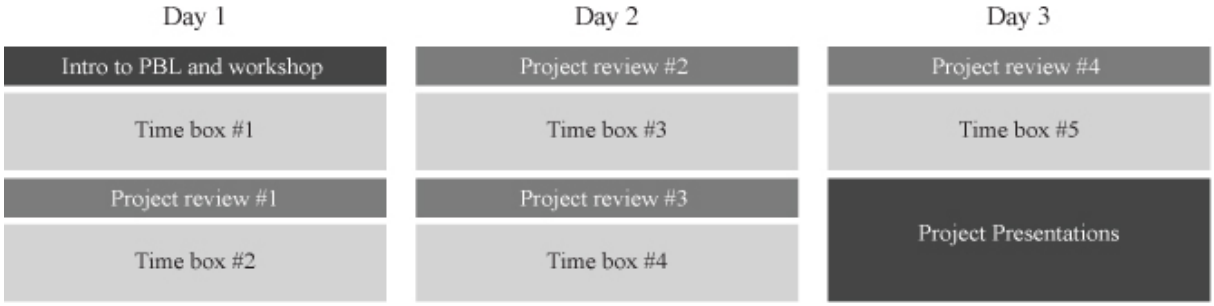

Figure 3. The workshop is structured as short time boxes approximately three hours each. In-between the time boxes, the projects are collectively discussed through rather fast-paced project previews.

The workshop was conducted with groups of four or five students, and at each project review, the groups were asked to present a revised version of their problem formulation. An example of the continuous elaboration of the problem formulation from one group is shown in the list below:
How can two different characters coexist?

1. How can pedestrians and cars coexist on the square?
2. How can we design the public square according to flows?
3. How can we maintain the flows of cars and pedestrians on and around the public square while improving the experience of people temporarily staying on the square?

The list above shows an increasing level of detail in the different versions of the formulated problem. The group from this example started out with a rather vague problem formulation, but during workshop time boxes, the students immersed into the problem by researching the location, observing traffic flows, interviewing users, looking into legislation and city regulations while also proposing sketchy and conceptual ideas for possible solutions. At the project reviews, the group presented their progress and deeper understanding of the problem through a revised problem formulation. Step by step

they thereby achieved an increasingly articulated idea of what basic problem they really needed to solve.
Similar examples exist from the other six groups in the workshop. In general, the lists of problem formulations from the seven groups show a pattern of increasing detail and awareness of the problem in focus. Most of them converge from being rather broadly defined to becoming increasingly narrower and goal oriented. However, the problem formulations also shows a couple of instances of totally reframing the question in the problem formulation and leaping backwards in order to pursue a completely other direction in the project.

4 RESULTS

This section is based primarily on the students' reflections about the course of the workshop and their personal learning outcome, but also on the teachers' experiences of the workshop.
From a teachers' point of view, it seems clear that students without prior knowledge or experience in working this actively with the formulation and re-formulation of a driving question initially have a certain difficulty in actively using the problem formulation as a primary driver of the project. However, during the workshop it was also observed that students were starting to use the current state problem formulations as a basis for an ongoing discussion about the course of their projects. One student elaborate on the strength of the problem-focused approach to working on design projects in groups:
"The [PBL] model was successful during the problem orientation stage; the opportunity to be able to bounce ideas between group members was highly effective as individual members were able to provide different perceptions of the site. As such we had a richer selection of potential problems, which would later formulate the basis for our design."
As it is indicated in the quote above, the problem formulation assists the students in explicating their respective understandings of the project outset. However, several students found the collaborative project proposal activities in the groups difficult, as they were not used to work on design tasks collectively as a team, but only as individuals. Despite this, most students found the method fruitful and emphasised the benefits and precision of using the problem formulation as driver in the projects. Another student's reflects upon this:
Asking a question is for me a totally new technique to start a project and it may lead to a completely different result but it is probably also more precise. By asking a question you have to get the deeper sense of the project. You become more are aware of what, why and how you are creating a piece of architecture.
The latter quote indicates that the PBL approach raises the students' level of awareness towards why and what they are doing. This is very much in line with the general aim of PBL and the thoughts of Dewey about experiential learning: Learning activities should build on the previous experiences of the students and direct them to new experiences that further their growth [4].

5 DISCUSSION AND FURTHER PERSPECTIVES

This paper presents a case study of a three-day workshop on PBL within the domain of design education. In order to back up the case, a brief theoretical background that relates PBL and design problems to each other has been presented.
From the case it has been investigated how the PBL approach is implemented as an introductory workshop for new students at the master level of the design education at University X. It shows that the foreign students – despite their cultural differences and educational backgrounds – found that the PBL approach was a practical and efficient tool in strengthening the awareness of what activities the student groups were carrying out and needed to carry out in order to progress. From the lists of problem statements developed throughout the workshop, it was seen that the student groups increasingly narrowed down the project focus in each new version of the problem statements. However, it also showed some cases of students that had to return to their starting point and pursue a new direction of the project. The task of explicating the problem formulation continuously in a workshop format this intensive had not been done before, and the study showed that its transparency helped the students as well as the teachers in aligning the project and the supervision.
It is clear that a short and intensive workshop with the purpose of introducing a new learning approach also has some shortcomings. The limited time and the fact that the students did not know each other occupied a large part of the metal resources on the student level, and given another setup, these

resources could have been allocated to learning and understanding the PBL approach. The case presented in this paper is also an example on how strict time boxing can be carried out in a rather fast pace and support faster project review loops. On the fourth industrial design bachelor semester at University X, students work in a similar way, but in slower pace. This allows for the pursuit of another depth in the project and for the students to work in practice with synthesising new solutions for the design problems.

From the experiences with the case in this paper, it is clear that several directions for further research could be followed. The case represents a face-paced time boxing tact that directs the learning activities in a certain way. It may be fruitful to pursue a more flexible combination of various-length time boxes that adapts to the specific project activity. A deeper look into the framing and reframing of the problem formulations could also prove interesting. Hopefully the case presented in this paper will initiate a discussion about how PBL is taught and could be taught in general design educations.

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