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**Keiding, Villads; Gish, Liv**

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# Collaboration between two innovation courses enhances students' understanding of organisational context

**Villads Keiding**

Technical University of Denmark, Denmark, vkei@dtu.dk

**Liv Gish**

Technical University of Denmark, Denmark, ligi@dtu.dk

## ABSTRACT

The present paper presents the results of an experiment of close collaboration between two courses at the fourth semester at the bachelor programme 'Process and Innovation' at Technical University of Denmark. The two courses are Innovation and Knowledge Management (IKM) and Innovation in an Organisation Context (IOC). Design-based learning had been used as a learning philosophy in both courses. The aim of the collaboration was to prevent *premature closure* of the problem definition, when engineering students engage in innovation and design processes. The two courses shared six hospital cases, and the students did initially conduct an in-depth organisational analysis of a hospital department in the IKM course, followed by problem definition and an innovative process in the IOC course. The case partners answered with some variation that the students had understood their organisational context and that the solution they proposed had taken the context into consideration e.g. economic issues and understanding of the problem they solved. For some of the case partners it was not only the final solution that made value, also the initial analysis and the discussions about the organisational context and problems gave inspiration for the case partners.

*Keywords* – Design-based learning, innovation and design process, problem and context analysis, premature closure

*Type of contribution:* Explore

*Questions for plenum:*

1. Premature closure is a well-known concept in medicine and also mentioned in literature about creativity (e.g. the Torrance test). How do you experience the concept of premature closure when teaching innovation? How do you work with the 'opposite concept' articulated in phrases like 'don't jump to the conclusion' or 'keep the process open'?
2. We argue that a deep understanding of the context is important for identifying the right problem and developing relevant solutions. How do you teach students about a context (user and/or organisational context)? To what extent do you equip students with theoretical concepts prior to their work in the organization?

## I INTRODUCTION

In Open Innovation (Chesbrough 2006), it is widely accepted that the stakeholder's adoption of a new solution or a new value-offer is deeply dependent of the adoption to the actual context (Dopson et.al. 2008, Autio et.al. 2014). For the design engineer, getting the full picture not only from the perspective of users (von Hippel 2005) but also from multiple perspectives from other actors and stakeholders, analysing the organisational culture and ecosystem as a whole, is mandatory and maybe even a prerequisite for a value creating solution. The more complex the case, the more the need of context understanding is

emphasized. At the bachelor-program Process and Innovation (PI) at Technical University of Denmark, it is a cornerstone of the education is to teach the students how to conceive problems in their context, hence postponing the problem definition. Conceive is also the first step of the CDIO framework (Crawley et al 2007).

Engineers are often viewed as technical problem solvers (Downey 2005) and it is a challenge for some students to leave their aim to solve problems, and just immerse themselves into the organisational ecosystem characterized by interaction by many professions, intense activity, demands of high performance, power play, politics, human emotions and technology. Sometimes we see students and project groups closing their eyes for an ambiguous context, avoiding the complexity of the process, just jumping to the safe zone of solving a given problem. As Hansen and Jørgensen (2011) coins it “Problem identification is not a simple desk research task as it often involves a multitude of actors having different or even not very well established ideas of what might be a good design result”.

In the field of medicine, the phenomenon of jumping to conclusion too early, before all facts have been taken into consideration is labelled premature closure. Premature closure is also known from creative thinking, where it is mentioned in the Torrance Test (Almeida et al 2008) as a pitfall in creative thinking. Although, the label premature closure is not used in engineering design or innovation literature, we use it in this paper to denote the phenomenon of engineering students not placing the necessary effort in investigating the context. Thus, they arrive at a premature problem definition that consequently leads to a solution that might not accommodate the need of the user’s or other stakeholders.

To emphasize the importance of an understanding of the wider context and to the overcome the risk of premature closure, we have at Process and Innovation made an experiment, and re-designed and integrated two fourth-semester courses. By the re-design and integration, we support the students’ exploration of the context of the particular case, before they define a problem and later develop solutions in an open design oriented innovation process.

The courses in the experiment are ‘Innovation and Knowledge Management’ (IKM) and ‘Innovation in an Organisational Context’ (P4). Prior to the experiment the two courses were conducted in parallel throughout a semester, each with their own set of cases. Now IKM is executed in the first half of the semester, followed by P4. In the new design the courses share six hospital-cases, acquired through participation in the project CHI; Copenhagen Health Innovation (Link 2).

In IKM (5 ECTS) the students’ objective is to make a cultural analysis of the case’s organisational context. In the following course P4 (10 ECTS), the students must define a problem to solve and develop an innovative solution. In both courses, active learning is an integrated part that invites the students to learn and engage in theory, analysis and developing solutions.

## **II HYPOTHESIS**

We argue that when the courses aim at providing the students with a deep understanding of a complex organisational context, premature closure is avoided and it is more likely that the outcome of the innovation process can be implemented and will create value for the stakeholders in the case. We also argue that the exposure of the students to a complex reality in the setting of design-based learning, where students takes almost full responsibility for the interaction with the organization, supported by relevant theoretical concepts, do facilitate deep learning about innovation and the importance of adoption to context, theoretically and practically.

### III THEORETICAL TEACHING FRAMEWORK

The theme of this year's Etalee conference is active learning. In the two courses discussed in this paper, we use design-based learning to actively involve the students in their own learning process. Each of the two courses apply a different span of specific methods to support active learning. However, they do share the same case and the same student-teams throughout the semester. We define active learning as the students' active involvement with the organisational context and its actors and a design-based learning process that is also a design oriented innovation process, driven by students.

#### **Design-based learning**

The rationale for choosing a design-based learning framework is that it nurtures intrinsic motivation in the students and that it reminds very much of what the students will meet in real life when they graduate as Process and Innovation engineers. Design-based learning grows from problem-based and project-based learning, however different emphasis is put on its content. Gómez Puente et al (2011) argue that the design of artefacts, systems and solutions in project-based settings are central, whereas Richard K. Miller (2014) (Link 1) argue that in design-based learning the problem have not been defined yet, thus the student needs to define the problem. Moreover, framing the problem is one of the most overlooked aspects of education according to Miller, which also corresponds to the claims of Hansen and Jørgensen (2011). It has therefore also been difficult to find papers exploring the problem definition aspect of design-based learning. Consequently, we do not follow a predefined design-based learning framework in our two courses, but apply four central elements. These are: 1) Authentic cases, 2) Students work in project-teams, 3) Students follow a design based innovation process i.e. they iteratively investigate the context, define a problem and materialise a solution, 4) The teachers' dominant role is to act as facilitators and provide formative feedback. We will elaborate on the elements in the following.

#### *1) Authentic cases*

The concept of authentic learning was proposed by Herrington et al (2006) and relates to real-world situations involving complex problems and their solutions. Whittington et al (2017) argue that assignments with real-life relevance make students more motivated to learn and give them a more positive approach to their study. Working with authentic cases expose the students for real-world situations, it becomes meaningful for them to engage in the case, and it prepares them for their later professional careers.

#### *2) Students work in project-teams*

Design-based learning does not necessarily prescribe that the design process is conducted in a project-team, however, most design processes involve more actors. Working in project-teams also reassembles real life situations because this way of organising innovation in both the private and the public sector is widespread. In a project team, the members get familiar with the different development phases of a project team (Tuckman 1965). Furthermore, they need to cooperate, divide tasks between them and develop project management skills.

### 3) *Students follow a design process*

The students' objective of the P4 course is to conduct an innovation process. The students must “*analyse the company context, [...] identify and define a relevant problem [and] develop a solution*” as the course description explains (Link 4). At fourth semester students have experience with various innovation models presented at previous semesters. In P4, a merge of Design Thinking (Doorley et al 2018) and Double Diamond (The Design Councils 2005) serve as a framework for the course-design and as a recommendation to the students, who have a lot of freedom to design a process appropriate for their particular case. However, we do request that a problem is defined no later than three weeks before the final submission.

#### *Closure in the design process*

Since the general learning strategy of the two courses is design-based learning, and the two innovation models both exemplify innovation processes *based on design*, we find it relevant briefly to discuss the concept of design and the design process in relation to *premature closure*, as mentioned above.

Design thinking as well as the double diamond model emphasize the importance of knowledge creation early in the process. The first phase of design thinking is named ‘empathize’ and in double diamond the process starts out with a ‘discover’-phase, similar to the ‘conceive’ phase from the CDIO standards for engineering education (Crawley 2007). Unfortunately, this do not necessarily prevent premature closure. Both in the case of design thinking and the double diamond, the second phase is named ‘define’, a term that can lead the less experienced student to the misconception that ‘define’ means closure and that exploration of the context thereby has been sufficient.

Looking back in literature to understand the design process, reveals that learning theory and design theory are intertwined. In 1984, Kolb published his model for experiential learning; the hermeneutic learning circle. The year before, in 1983, Donald Schön published the book ‘The Reflective Practitioner’. Both are influential to modern learning theory, also experience-based learning and in particularly design-based learning. Both are dealing with the same matter, that is, the emergence of *something*; knowledge, skills, concepts or ‘solutions’ in a process of experimenting or ‘making’, altering with reflection. In the perspective of Kolb and Schön the design process could be understood as a situated knowledge-producing hermeneutic practice (Jahnke 2013). Bryan Lawson, architect and design theorist, published in 2005 a hermeneutic model for the design process suggesting three actions; analysis, synthesis and evaluation, altering repeatedly with the duality of ‘problem’ and ‘solution’ as the pivot. According to Schön and consistent with the concept of design-based learning; “there are no problems to be solved, only problematic situations to engage in, characterized by uncertainty, disorder and indeterminacy” (Schön 1983 p 15), because, as Lawson adds; “Problem and solution emerge together” (Lawson 2006). A suggested solution are no more than temporarily stabilized - or closed - state, action, routine or artefact.

### 4) *The teachers' dominant role is to act as facilitators and provide formative feedback*

Puente et al (2015) argue, “The role of the teacher is to facilitate the learning process and coach and supervise students in DBL assignments”. The teacher’s task as a facilitator is also to take design for granted in design-based learning, to prevent premature closure, achieve a deep adoption to the context and to keep the wheel of the design-process spinning to gain knowledge all the way, until times is up.

As teachers, we need to prepare and support the students’ entrance into the arena of the case. We must consider what is an appropriate theoretical toolbox, what process models should be suggested, and what deliveries or explications could facilitate the process. Furthermore, we need to manage the initial contact with the involved case-owners in the companies and set up and align expectations. Sometimes company management expect students to solve given problems from day one, so the case-owners also need to understand the importance of exploring the context and let the students take responsibility for the project.

## **IV THE CONDUCTED EXPERIMENT**

### **Access to authentic cases**

Access to the cases has been provided through the teachers' participation in CHI (Copenhagen Health Innovation), a project that aims to create collaboration between the healthcare sector and university. Before semester start, CHI provided us access to hospital management at Herlev/Gentofte Hospital. We were allowed to contact all departments with an introduction letter sent by email. Six departments of 16 possible agreed to participate as case-partners.

### **Learning design**

The IKM course follows a strict lecture structure where the students at each class apply a theory (selected by the teacher) to analyse the case. Each lecture is structured as a workshop with a number of activities supporting active learning: Student presentation of curriculum, facilitated dialogue in class, team exercises and group presentation. After each lecture, the groups documented and collected their work in a portfolio. After six and a half weeks, all groups summarized their findings in a poster session, showing "a comprehensive image of the organisation". A report reflecting on the impact of the theoretical concepts on the innovation process were submitted after 13 weeks and presented and defended at an individual oral exam.

Innovation in an Organisational Context is organised as a project's course that alternates between pitches made by the student-teams and supervision. The starting point for Innovation in an Organisational Context (after 6.5 weeks) was the descriptions and analysis of the group's case made in Managing Innovation and Knowledge Management. For the final assessment the students handed in a report, an as-is map, a storyboard, and a two-page executive summary. At the final oral group exam, they also presented a prototype.

## **V DATA COLLECTION AND ANALYSIS**

To answer our initial assumption, that a deep understanding of the organisational context make it more likely that the outcome of the development process can be implemented and create value for the stakeholders, we did five qualitative interviews, asking the case owners about their experience of the students final results and work methods. The interviews were conducted two month after both courses have ended, were audio-recorded and transcribed. For analysis, both authors read the interviews twice and looked for three categories of coding: 1) The interviewees' perception of the students, 2) the interviewees' perception students investigating the organisational context, 3) the interviewees' perception of the proposed solutions and value creation.

## **VI DISCUSSION**

Reflecting the hypothesis we will, based on our empirical studies, discuss to what extend the design-based learning strategy and the integration of the two courses really facilitated the students' interaction with the

department in the innovation process: Were the students seen as relevant actors by the organization? Were the students, from the perspective of the organisation, able to adapt to the actual context? Did the proposed solutions consider the context, and how did it affect the perceived value creation?

### **The students as actors**

First of all, the students behaved themselves, acted in general polite and respectful to everyone. They paid very well attention to the fact, that they are invited into a world of strangers, and conscious about not to disturb more than necessary. They are “good ambassadors”, as one stated, and with “a good approach to inquiring without being judgmental”. We as teachers will not take the credit of our students’ good behaviour, but just note that it seems that the students have acted appropriate facing the sudden experience of being in the intense and complex world of a hospital. We will not further discuss to what extend the initial introduction to healthcare at IKM and P4 have supported this.

We also got the feedback that the students appeared structured, were good at communicating with their contact-persons at the hospital as well as other employers, and good at presenting for the stakeholders during the process. The interviewees mentioned the inquiring attitude several times as a sign of real interest in understanding what was really going on. Although we and the contacts at the hospital were aware that the experiment would somehow be time consuming, the students were pushing the limits. Asked whether the time consumption was acceptable one answered; “That was okay, but you could not have asked for more”.

Educating trainees from many medical professions is an integrated part of the daily work at hospitals, and working with students is a well-known part of the daily routines. Having non-healthcare professionals like engineer-students or business school students in the department is somehow different: They do not take part in the daily routines, instead they observe, analyse and eventually propose solutions. Asked what can be expected from an engineer, one answered “a practical structured approach”. Answers to the question what could be expected from our students and from their participating as a case in the courses came out more differently: Some departments tried to prompt the students to work on a particular problems, others just wanted “a glance from outside” and apprised the explorative approach. In short: The students acted differently from what the departments are used to. They are perceived interdisciplinary, serious, explorative and structured. To let engineer students into the department takes resources, but in general, the effort pays off all right.

### **Adaption to the actual context**

We were curious how the departments perceived the process. What was it like to be under the analytic lens? What was it like to participate in an innovation process with the design process characteristics and as open as described above?

In most of the departments, the analytic part was recognized as relevant and necessary. One department; the “Patient-journey and Organization” (P&O) does not have direct interaction with patients, but are instead supporting the rest of the hospital, and facilitating processes across the organization. Employees here are familiar with the organisational perspective, and found the students “analytic approach” and the initial “cultural screening” obvious. In contradiction to what we experienced in the other departments, the cross disciplinary perspective brought in by the students were not perceived as something that created new value, but although acknowledged as something of great importance in order to facilitate changes and innovation in the hospital. Only, most of the matters of interest suggested by the students were rejected as something of a larger complexity that could be dealt with within the limited span of time. “We ourselves had been around a lot of it”, as one said, and later when the students’ value creation was discussed, it was stated that “basically, there was not much of a result”. But, to deeper understand the culture and cross

organisational praxis of the department, the students were assigned to two particular employees, former nurses, now consultants, and joined them at two minor change management projects, where the aim was to implement new tools and procedures. For the students it was an eye opener to experience how the consultants worked, how they were perceived in the departments where the implementation were meant to take place, and all the difficulties they met. The students ended up suggesting a very simple solution to notify the health care professionals prior to a specific kind of patient dialogue meetings. Both in P&O and in the department where it was meant to be implemented, it was appraised as simple and relevant, as "They had some really nice ideas", but hence conceptual strong, the proposal was also "rather unrealistic". Unfortunately, it conflicted with IT protocols and regulation. Although the students did not match the level of understanding of the context in the department, some organisational learning took place; "...we became even more aware of the importance of the fact that there is a professional knowledge and how the network is important"

In another department, one manager was surprised to be object for an organisational analysis. "We do a lot of work with employee satisfaction and management assessment. If more analysis should be done, I would prefer to be in charge", the manager said. The perception is that "one cannot do a proper analysis in such a short time". But later in the same interview a bad experience with students from a business school were revealed, where the students "not at all grasped what's going on", apparently, "because they have not spent enough time on it". We have no detailed knowledge about the particular example, or the methods and theory applied, but much later in the interview, the manager indicated that our students' observations and application of theoretical concepts actual did build a sufficient understanding of the organisational context: "They tried to go beyond, to talk about economics and costs while developing a device". Also, the manager elaborated on a situation in the process where the students proposed several matters to choose from and noticed that "both the hospital porters and I chose the same solution as such, so it was very good. Then they have somehow hit it".

### **Solutions and value creation**

"The solution was very simple" one said during one of the interviews. This could be true to most of the feedback we got on the suggested solutions.

One of the solutions is already mentioned: A way to notify prior dialogue meetings with patients. A solution that explicate a deep and focused understanding of practice in the particular department, but meet its limitation in the adoption to another context, the IT-infrastructure of the hospital.

In another department, acting as an internal production unit, producing gel for diverse biological tests, the production management was conducted manually on paper. The students suggested digitalization and presented a prototype. It was very well received when presented in the department: "People were amazed when the students presented the program they had made where the employees themselves were allowed to scan the things with these barcodes, and they could see how it just came online. There they were very excited". The project continues with the students as suppliers to the department, as they have formed a start-up.

In the department mentioned above, where the managers claimed the right to control organisational explorations, time spend on archiving biological samples is an important matter. The students suggested a registration system that uses cameras to automatically log paraffin blocks with tissue samples when archived. Also mentioned before, the matter was suggested by the students on a backdrop of 10 weeks of presence at the department, and chosen by the manager as well as the porters in consensus an event where more optional matters were presented by the students. The suggested solution was very judged as relevant, realistic, and affordable: "They had an eye on the economy". Now after the termination of the project, the manager still consider the solution relevant and "has it on the list", only, it has to be postponed because of an already scheduled construction project.

In a logistic department the students presented a solution to optimize the complex matter of food supply and transportation at the hospital, suggesting a range of hands-on interventions, some approaching the matter with communication techniques and strategies, other with simple tracking technologies, addressing employees as well as visitors. During the process the students had to a wide extend, engaged with the organisation, not only by observing but also by doing experiments. At our interview, the top manager as well as four middle managers had decided to participate and spent time. They have had a good experience working with the students, and recognized that the students' work did create value. The students were perceived as an important resource to deal with problems, that was well known, but not taken care of because of lack of resources, and because "people has got a little exhausted [and] there were a sense of discouragement". Our respondents felt inspired by the methods and the mind-set of the students and one felt that "now, the organization is more mature". Some of the concepts suggested by the students are already implemented and the outcome can be measured: "There are fewer delays than there has been in December, so it's only on a fraction now, where there are delays". Dealing with delayed food supply has, as we were explained, a huge economical impact, since delayed food to patients causes delayed operations.

To summarize; in the particular experiment, involving six departments in Herlev/ Gentofte Hospital and six groups of engineer-students from the bachelor-program Process & Innovation, the Design-based learning process apparently have created value to the departments, in one case even quantifiable value. As one put it; "Never before I had anyone from outside looking at what's going on in the department from a technical, organisational or psychological perspective. That is new to us [and] it is my impression they had a very good understanding that is, whatever the case is, it doesn't take a quick-fix, it's more complex.". Another said that "There are many actors and many dependencies so it became a really complex task [...] but they had actually identified the complexity."

You could argue, that even in the case where the proposed solution did create the less value, the notification system, the focus on exploring and understanding the context was not the problem. Rather the case is that the global context of a hospital is overwhelming and constantly expanding, as you work your way in, so, if a value creating proposal should be developed, diving into the context of the IT-infrastructure is just the next step. Defining what problem to solve beforehand would be a premature closure.

## VII CONCLUSIONS

Our data shows that the majority of the students found it relevant to use the same case during the two courses. Using the same case made it possible to analyse the case from more perspectives and get an in-depth understanding of the organisational context. All of the case partners expressed satisfaction with how the students had engaged with the case and described among other things the students as "polite", "engaged", "structured" and "creative". To the question "how does the students' innovative solution fit your organisation?", all case partners answered with some variation that the students had understood the context and that the solution they proposed had taken the context into consideration e.g. economic issues and understanding of the problem they solved. For some of the case partners it was not only the final solution that made value, also the initial analysis and the discussions about the organisational context and problems gave inspiration for the case partners. Our analysis indicate that there is a close connection between the achieved results and the design-based learning strategy, with the students as autonomous actors, supported by theoretical concepts and facilitated by the course management.

With respect to the phenomenon of premature closure, our data indicate that the students are in the 'discover' phase for a longer period than before the course collaboration. However, an in-depth analysis of exam reports from earlier years should be conducted to make a more certain conclusion.

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## INTERNET RESOURCES

Link1: Richard K. Miller (2014), Olin College [https://www.youtube.com/watch?v=yzM9\\_DamVP0](https://www.youtube.com/watch?v=yzM9_DamVP0), accessed 2 Oct. 2018

Link 2: Copenhagen Health Innovation: <http://copenhagenhealthinnovation.dk/>, accessed 12 Oct. 2018

Link 3: Knowledge and Innovation Management: <http://kurser.dtu.dk/course/62L26> accessed 12 Oct. 2018

Link 4: Project 4: Innovation in an organisational context: <http://kurser.dtu.dk/course/62040> accessed 12 Oct. 2018

## **BIOGRAPHICAL INFORMATION**

Villads Keiding is associate professor at Center for Bachelor of Engineering Studies at Technical University of Denmark, teaching at the bachelor programme Process and innovation. He is involved in teaching and innovation projects within creativity, innovation and design processes.

Liv Gish is assistant professor at Center for Bachelor of Engineering Studies at Technical University of Denmark, teaching at the bachelor programme Process and innovation. She is involved in teaching and innovation projects within entrepreneurship, innovation and organisational analysis.