A framework for teaching educators to teach innovation

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INTRODUCTION

There is a building consensus among policymakers and industry stakeholders that the future economic wellbeing of European societies relies on peoples' innovative skills. Indeed, facilitating future innovation is one of the key areas of concern in the EU commission's 'Europe 2020' strategy [1]. The OECD recently emphasised the role of education in this regard: "The need to empower people to innovate […] calls for high-quality and relevant education as well as the development of wide-ranging skills that complement formal education" [2]. These policies and also the increasing

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global competition has put pressure on universities to develop their educational programmes to ensure that graduates have the capabilities to be innovative and entrepreneurial. More importantly, perhaps, the educational potential of using innovative processes in university teaching is considerable. First, as will be elaborated below, this can improve student learning in the disciplines, second, it has a critical educational (German: Bildung) potential, which support graduates developing the broader capabilities need in the 21st century.

As an answer to these challenges, three Danish universities in the Copenhagen area have formed the EU-supported Copenhagen Innovation and Entrepreneurship Lab (CIEL) to among other things develop and support initiatives within innovation and entrepreneurship for the benefit of students". One of the most prospective initiatives is to develop a course for educators at the three institutions that will provide the necessary skills to teach innovation and entrepreneurship (I&E) to their students. In this paper, we present a framework for the course in the form of a possible conceptual basis for teachers of I&E, that will enable them to interpret the meaning of I&E in their own discipline, and design teaching and learning activities that will support student development of I&E capabilities.

Until recently, 'entrepreneurship' has been much in focus in business and management education, whereas 'design' and 'innovation' have been in focus in engineering education. For instance, an attempt to make I&E more explicit in engineering education is the CDIO initiative which promotes structuring education by building on a model of the engineering working process: Conceive-Design-Implement-Operate [3]. However, we are witnessing, in the Danish context at least, these terms becoming central in most other educational domains in higher education [4]. Also the realization, that developing new technologies to meet the challenges of tomorrow often requires a trans-disciplinary effort, have put pressure on universities, faculties, and departments to collaborate across the traditional borders to make sure that students are able to collaborate in trans-disciplinary teams in innovation processes. Our framework is thus developed to provide a common framework across disciplines about what 'innovation' and 'entrepreneurship' could mean in an educational setting.

1 THEORETICAL BACKGROUND

1.1 The terms 'creativity', 'design', 'innovation', and 'entrepreneurship'

Terms such as 'creativity', 'design', 'innovation', and 'entrepreneurship' are often used interchangeably in both research (see e.g. [5]) and practice. 'Innovation' in particular has been used in many different ways. Such a conceptual obscurity is unfortunate (but understandable in an emerging field).

Now, clearly innovation has something to do with the introduction of something *new* (e.g. a new product, procedure, organisational structure etc.). Beyond the aspect of novelty, the term 'innovation' connotes something *valuable*. The multifarious present usages of the term 'innovation' all in some way stem from Joseph Schumpeter's definition [6], according to which innovation is either the process or product of introducing a new element (or a combination of old elements) that has an economic value. Many scholars and practitioners still adhere to this economically framed conceptualisation. For example, Tidd and Bessant defined innovation as "the *process* of turning ideas into reality and capturing value from them" [7]. But it seems that there can be 'innovations' (processes as well as products) that have other values than a pure economical value. Indeed, Drucker argued that some 'innovations' – "social innovations" in the form of new solutions to e.g. a social need in a workplace or in a

community – create value in a way which may not directly affect the fiscal bottom line (but in a way that may, of course have indirect economic effects) [8]. So we will argue that while innovation must minimally create value, that value creation can be taken in the broadest possible sense.

In this paper we will pursue a pragmatic definition of innovation, according to which (from an education perspective), innovation is *the implementation of something new which works and which has a value (in the broadest possible sense) for someone (e.g. a user group)* (cf. e.g. Lotte Darsøe [9]). An archetypical (yet hypothetical) example could be a group of students that have created environmental (and possibly economic) value by helping a local company find a new way to degrade and recycle plastic waste.

The above definition of innovation is, of course, just one candidate among many in the literature. We have settled on this particular one for pragmatic purposes: It is through this definition that it can become clear to educators that teaching innovation can make sense from the perspective of student learning. Further, we believe the above definition of innovation affords a much-needed conceptual distinction between the terms 'creativity', 'design', 'innovation', and 'entrepreneurship' (see *Table 1*).

In order to guide the distinction, we have made a categorisation with regards to the modality of the end product – this categorisation is inspired by C.S. Peirce's phenomenological categories [10]. Many ideas never leave the drawing board or their owner's mind. The modality of such ideas is as mere 'possibilities' in Peirce's terminology – they are *potential* products or processes, but nothing more. However, some ideas are carried out, and in being carried out they collide with reality (and some fare better than others in this collision). This is the level of the *actualised* products or processes. In Peirce's terminology, this second level comprises a 'relation' (or a 'reference to a correlate') between the idea for a product or process and the reality in which that product or process is thought to enter into. Finally, some actualised products or processes are *generalised* in the sense of being marketed. This corresponds to Peirce's idea that the third level of being comprises complexes such as 'laws' or 'habits'.

Table 1: A schematic overview of key terms

<table>
<tr><th>Modality</th><th>Creativity</th><th>Design</th><th>Innovation</th><th>Entrepreneurship</th></tr>
<tr><td>The end product is potential (not actualised).</td><td>(The ability) to create something new that works (is useable) [11]</td><td rowspan="2">To create and/or represent something new that works and which has a value for someone (e.g. a user group) [12]</td><td></td><td rowspan="3"></td></tr>
<tr><td rowspan="2">The end product is actualised (but not yet generalised).</td><td rowspan="3"></td><td rowspan="2">To implement something new which works, and which has a value for someone (e.g. a user group)</td></tr>
<tr><td rowspan="2"></td></tr>
<tr><td>The end product has become general.</td><td></td><td>To transform an innovation to an economic value (e.g. [13])</td></tr>
</table>

1.2 Three different educational conceptualizations I&E

In their analysis of the role of I&E in engineering education, Jørgensen and Andres point to three different ways of including I&E in the curriculum, each of which reflects different conceptualizations[2] of what innovation and entrepreneurship is about [5].

The technology-driven conceptualization is based on the belief that the training of engineering students in the fundamentals of science will produce skills and knowledge that lead to the innovation of new artefacts and systems. The business selection conceptualization is about engineering students complementing their education with business competencies. It is mainly about business innovation and the ability to be successful start-up business men and women. In these two conceptualizations, the core curriculum is science and technology, whereas design courses, let alone I&E courses, and business courses are all pushed to the margin of the curriculum.

The design intervention conceptualization relates to a more complex conception of science and technology. Innovation in this response strategy is about understanding and bringing together the sociotechnical complexities of any given system [14]. It is about making new sociotechnical network connections to make new systems work, and entrepreneurship is not about taking a given technology and commercializing it, it is about re-designing a new system as it grows in society. Here, I&E are placed at the core of the curriculum.

When designing units, courses, or educational programs which aim at providing students with competencies in I&E, these conceptions are worth considering. We would of course not argue, that it is universally conducive to place I&E at the core of the curriculum in any university program. However, we would argue, that the more concurrent, research based view on technology and sociotechnical systems which is promoted in the design intervention conceptualization is worth promoting, even in smaller educational units on I&E.

2 INNOVATION AND LEARNING

2.1 Relevance for students

Teaching activities that are designed to facilitate innovative processes on the side of the students can, from our perspective, be useful for a number of reasons. The very idea, that teaching activities can lead to some concrete new creations that should be valuable to someone, has immense potential. Clearly, working on issues that are real to some group has the potential to make the related disciplinary learning relevant for the students. Further, the notion that students work on real issues and that their solutions should have an actual value for someone could be seen as exemplary versions of types of student centred learning that are presently heralded – e.g. inquiry learning, case-based learning, project or problem based learning. For, ideally, education for innovation should not just foster students' creativity, it should also foster analytical competences needed for analysing the needs of the user groups for which the students' product/solution has a value, and the disciplinary competences needed to implement the idea. At the same time, real issues are likely to transcend disciplinary borders, requiring students to address reflect on disciplinary knowledge in relation to other disciplines, the limits, assumptions and conditions for using disciplinary knowledge. These are higher order competences that are also highly

[2] Since the authors argue that the conceptualizations are responses to societal demands on engineering education, the term the conceptualizations 'response strategies' [5]. For clarity, we stick to the term 'conceptualization' here.

demanded graduate attributes. We thus argue that going through innovative processes in itself fosters learning of several valuable kinds for the students.

2.2 *For* and *through* innovation

Students can learn how to innovate, how to be innovative, to be able to 'implement something new which works and has value for somebody (a user group)', which can be an educational objective in itself. This can be termed 'teaching *for* innovation'. But students can also learn the disciplinary content through innovative processes, as argued above. Innovative processes are to a high degree also learning processes. This can be termed 'teaching *through* innovation'.

The difference is that when you teach through innovation, the students do not necessarily know that it is innovation which is going on; that they obtain innovation competences. It remains an open question whether you get innovation competences by being taught through innovation. We would hypothesize: not necessarily. Something extra is needed, in order to get innovation competences, e.g. reflection, emphasis, and student ownership in the process. However, we find it obvious, that teaching *for* innovation can only be successful if teaching *through* innovation. Students can only learn to be innovative if they practice innovation.

2.3 Critical educational potential - bildung

The critical educational (German: Bildung) potential of learning through I&E lies in students experiencing how their academic knowledge and competence can be brought into play in relation to a user group, e.g. an non-governmental organization (NGO) or a company, and how they then need to consider how their 'product' (be it material or immaterial) can and will be interpreted and used by the users. How does the product interact or interfere with the users' everyday life? The organization? The society? The environment? The climate?... Here the sociotechnical view on technology can advantageously be brought in to play. As is indicated in *Table 1*, this potential lies particularly in innovation – rather than entrepreneurship, although, as also indicated in the figure, entrepreneurial processes sometimes include some innovation, and also considerations of users' possible use.

We have argued above, that the academic potential in terms of student learning, as well as the potential for bildung, lies by far the most in the design and implementation phases. Thus we allow for the conclusion that teaching, or curricular activities, should focus mainly on innovation, whereas entrepreneurship activities are in general better placed at the margin of the curriculum, if not, for instance when it comes to student incubators etc., as extra-curricular activities. Maybe sometimes less so for engineering or business education.

2.4 Innovation and entrepreneurship in the disciplines

When innovation policies for higher education are promoted, it seems to be understood that the aim is for the students to be able to be innovative within their own field, and thereby contribute with fore-front research knowledge to technological, business, and/or social development. Even though the terms 'innovation' and 'entrepreneurship' are used as general terms across disciplines, what actual goes on might be very different things. Thus the students must learn to be, and what it means to be, innovative and entrepreneurial in within their own field. On the other hand, when they learn to be innovative, they will also learn 'in' their discipline, as argued above.

Real-world problems are characterized by being complex and transcending disciplinary borders. Therefore, innovation in a real-world setting is likely to require

knowledge beyond a specific discipline, and hence innovation in interdisciplinary teams is an issue that must be addressed. In the course, we will ensure that the participants have diverse disciplinary backgrounds, and are given opportunities to reflect on learning in interdisciplinary settings, how to facilitate learning in interdisciplinary settings, and how to assess innovation in interdisciplinary settings.

We will argue that the ability to use innovation in teaching, be it 'for' or 'through' is a desired competence for all university teachers. This is the main assumption underlying the course: That teaching through and for innovation leads to better learning and more future-proof graduates.

3 A COURSE IN TEACHING THROUGH AND FOR I&E

3.1 *Through* or *for* innovation?

As argued above, a course on I&E for university teachers should focus mainly on innovation, and focus on teaching for innovation, since this entails teaching through innovation.

In order to learn to teach innovation you should learn innovation – through and for innovation. Thus the teachers should 'implement something new which works and has value for someone (a user group)'. The 'something new' of the innovation process for the participating teachers will be a sequence of teaching and learning activities, a unit, for their own students, the 'someones' for which the unit has value. The unit shall provide their students with both the relevant disciplinary knowledge and skills, and the broader skills needed to be innovative within the discipline. During the process, the participating teachers should reflect on the process, both in terms of learning to innovate in their own field, and in terms of learning to teach innovation.

3.2 Entrepreneurship, intrapreneurship and effectuation

Even though we argue that the notion of entrepreneurship should play a minor role within the curriculum, it must of course be addressed in the course. We propose that the notion of effectuation [15] will be best suited for this: Effectuation is a notion that covers the ways of thinking by expert entrepreneurs, and is thus a logic of entrepreneurial. It can be defined like this: Causation processes take a particular effect as given and focus on selecting between means to create that effect. Effectuation processes take a set of means as given and focus on selecting between possible effects that can be created with that set of means [15]. Thus, the entrepreneurs should focus on what they have: A network of people, who they know, what they have, financially and otherwise, and exploit their contingencies. And work within the boundaries of affordable losses.

In order to be entrepreneurial, students need firm self-efficacy beliefs in their ability to go beyond the unknown and handle resistance [17]. In order to build students' self-efficacy beliefs, they must experience to having gone successfully through innovation processes and overcome the frustration and resistance.

Intrapreneurship is the act of behaving like an entrepreneur while working within a large organization. It has not been given a separate focus in the paper so far, since we find that the 'behaviours of an entrepreneur' or, in other words, entrepreneurial competence, is covered by the notion of entrepreneurship and effectuation.

3.3 I&E competence and capabilities

Obviously, in order to teach innovation and entrepreneurship in a field, one will have to define a number of specific learning objectives relating to I&E within that field. In

order to do so, we will propose a number of general aspects of I&E competence that the participants can consider and interpret in relation to their own discipline.

We will adhere to the particular notion of competence: Professional competence as a result of university education is about seeing and conceiving the world as a professional, and acting in accordance. Thus competence is a whole, an integrated knowledge structure. What we describe here are thus *aspects* of innovation competence.

What does it mean to be able to be innovative? Or, in other words: What does it take to be able to go successfully through an innovation process? Usually the innovation process is divided into a number of phases, starting in the very broad idea generation and then narrowing down to implementation, testing, and some kind of delivery. Different forms of capabilities are necessary in the different phases. Also, there are capabilities related to the fact, that innovation processes involves group work in often trans- disciplinary teams. We suggest that the following minimum set of capabilities – more may be relevant:

- To be creative in one's own disciplinary field
- To be able to spot operational principles [16] in one's own disciplinary field. This is particular to the basic science disciplines where the disciplinary knowledge is often of a descriptive nature. A further elaboration is beyond the scope of this paper.
- To be able to handle uncertainty and frustration in the development process
- To be able to work effectively in trans-disciplinary/inter-disciplinary teams (both the trans/inter-disciplinarity and the team work)
- To be able to obtain knowledge of, analyse and understand users' needs
- To design artefacts (material or non-material (e.g. organizational)) that meet user's needs
- To be able to implement ideas/artefacts that meet users' needs
- To analyse and to some extend forecast possible negative or positive consequences of user's intended or unintended interpretation and use of the artefact

Particularly in relation to entrepreneurship, one should be able to be effectual:

- To be able to create and maintain strategic partnerships
- To be able to explore market opportunities within the limits of 'affordable losses'
- To be able to leverage contingencies – to turn the unexpected into the profitable

4 SUMMARY

In sum, we have described and justified a framework for teaching through and for innovation and sketched the basic ideas underlying a course for educators on how to teach innovation. The framework constitutes a conceptual base for teachers who wish to teach for or through innovation. The framework should be useful as model for the teachers to use to reflect on their own teaching and innovation practices, in order to develop both their own teaching and the framework further.

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