Science Education For Innovation: A new way of connecting science teaching with real societal needs
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Science Education For Innovation:  
A new way of connecting science teaching with real societal needs?

Background and purpose
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 (EU-Commision, 2010). 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” (OECD, 2010, p. 3). There can be no doubt that the focus on ‘education for innovation’ will come to the attention of the field of science education in the near future. In fact, the OECD mention that “[s]cience is vital to innovation, especially to generate ‘step changes’ such as the discovery of the transistor or vaccines” (ibid, p. 4). In this presentation, we present a possible conceptual basis for talking about science education for innovation in a way that is meaningful with regards to science learning.

So far, only very few contributions to science education have addressed this topic. The seminal ‘Science education in Europe’-report (Osborne & Dillon, 2008) briefly mentioned that there is a shift in society towards valuing “creativity and innovation more highly than have been the case in the past” (p. 17). And in a large Delphi study Osborne and colleagues found that many participants of the expert community think that it is important that science students have “opportunities to be genuinely creative” (Osborne, Collins, Ratcliffe, Millar, & Duschl, 2003, p. 706). It seems to us, that, until recently, the terms ‘innovation’ and ‘entrepreneurship’ have primarily found usage in relation to business and management education. But we are witnessing, in the Danish context at least, these terms becoming central in most other educational domains at both the university level (University of Copenhagen, 2012) as well as the secondary level. Unfortunately, policymakers and educational scholars often fail to define what they mean about ‘innovation’; terms like ‘innovation’ and ‘entrepreneurship’ are often used synonymously (see e.g. Mars & Rios-Aguilar, 2010).

Rationale
The aim of this presentation is to present a conceptual frame for talking meaningfully about science teaching for innovation. In the presentation, we will argue that there may be good science education research-based reasons for teachers and researchers to partake in teaching for innovation. We stress that teaching innovation in this context means teaching or educating for innovation – i.e. teaching or educating with the purpose of fostering a set of competencies that could be called ‘innovative competencies’.
Overview and Discussion
In the presentation, we will argue that innovation, from a (science) education perspective, should be defined as the implementation of something new which works and which has a value (in the broadest possible sense) for someone (e.g. a user group). An archetypical (yet hypothetical) example could be a group of secondary science students that have created environmental (and economic) value by helping a local company find a new way to degrade and recycle plastic waste. Specifically, in the presentation, we want to argue that the terms ‘creativity’, ‘design’, ‘innovation’, and ‘entrepreneurship’ can and should be distinguishable (see Table 1).

<table>
<thead>
<tr>
<th>Modality</th>
<th>Creativity</th>
<th>Design</th>
<th>Innovation</th>
<th>Entrepreneurship</th>
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<tbody>
<tr>
<td>The end product is <em>potential</em> (not actualised).</td>
<td><em>(The ability) to create something new that works (is useable)</em> (Amabile, 1988)</td>
<td>To create and/or represent something new that works and which has a value for someone (e.g. a user group) (Bucciarelli, 1994)</td>
<td>To implement something new which works, and which has a value for someone (e.g. a user group)</td>
<td>To transform an innovation to an economic value (e.g. Wennekers &amp; Thurik, 1999)</td>
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<tr>
<td>The end product is <em>actualised</em> (but not yet generalised).</td>
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<td>The end product has become <em>general</em>.</td>
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Table 1: A schematic overview of key terms. The categorisation with regards to the modality of the end product is inspired by C.S. Peirce’s (1995) phenomenological categories.

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 (1934) definition, according to which innovation is the either the process or product of introducing a new element (or a combination of old elements) that has an economic value. While many scholars and practitioners still adhere to this economically framed conceptualisation, it seems that there can be ‘innovations’ (processes as well as products) that have other values than a pure economical value. Indeed, Drucker (1999) 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). So we will argue that while innovation must minimally create value, that value creation can be taken in the broadest possible sense.

Science 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 science teaching activities can lead to some concrete new creations that are should be valuable to some one has immense potential. Clearly, working on issues that are real to some group has the potential to make the related science learning relevant for the students (a quality that is in high demand; e.g. EU-Commision, 2004). Further, the notion that students work on real issues and that their solutions should have an actual value for some one could be seen as a exemplary versions of...
types of learning that are presently heralded – e.g. discovery learning, inquiry learning, or, more generally, 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. There are some interesting ties here to Gibbons’ (1997) ideas of knowledge production in the 21st century: The idea that knowledge is increasingly “transdisciplinary” and that it is “worked out in the context of application” (p. 3). In the presentation we want to present in more detail which competences science education for innovation could foster.

References