The city is our lab

Smink, Carla Kornelia; Lehmann, Martin; Holgaard, Jette Egelund

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The city is our lab: Innolabs at Aalborg University

Carla K. Smink[1], Martin Lehmann[2] and Jette E. Holgaard[3]

Aalborg University
Department of Development and Planning
Skibbrogade 5
DK-9000 Aalborg
Denmark

1. Introduction

Smart and sustainable growth is one of the priorities of the European Union (EU) (EU Strategy 2020). Innovation is an essential part for reaching these priorities. Recently, more and more attention has been paid to bottom-up innovation: innovative new business and project development that is based on ventures from students at universities, polytechnics, as well as at art and business schools. The EU stresses and supports this by funding research, innovation and demonstration schemes. The Innolabs project has received EU funding through the Erasmus+ programme. The project focuses on student innovation labs as a way to sustainable and socially responsible growth.

The Innolabs project, that runs from September 2014 to August 2016, is based on the knowledge transfer idea from countries where there are established efficient, bottom-up innovation structures and platforms that address sustainable and social issues in cities or the region. The aim of the project was to raise bottom-up innovation capacity for the benefit of sustainable and socially responsible growth in Estonia, Latvia and Cyprus.

In this paper, we take point of departure in innovation and living laboratories as implemented throughout the years at Aalborg University (AAU) (Denmark).

Innovation
It is largely recognised that sustainable development requires innovative societies that are able to handle and solve problems of the past, and provide new products, services and jobs for future opportunities and generations. Lundvall (1985) and Freeman (1987) originally created the theoretical basics of innovative societies, which they labelled National Innovation Systems (NIS). Today, our understandings of the relationship between research, innovation and socio-economic development suggests that well-being of a society is based on a well-functioning National Innovation System in which not only the individual stakeholders but also the links between them perform well and gives rise to learning and new understandings.

[1] carla@plan.aau.dk; phone (+45) 99 40 98 05
[2] martinl@plan.aau.dk; phone (+45) 99 40 84 22
[3] jeh@plan.aau.dk; phone (+45) 99 40 98 11

"*In the modern economy learning has become increasingly endogenous. Learning processes have been institutionalised and feedback loops for knowledge accumulation have been built in so that the economy as a whole is learning by interaction in relation to both production and consumption. When economies learn how to learn the process tends to accelerate*." (Johnson & Gregersen, 1995).

Hansen & Lehmann (2006) coined such societies "auto-learning". The conception suggest that critical mass has been established in terms of stable and multidimensional relationships between stakeholders in the (national or regional) innovations system, and that both organisational and institutional settings, as well as an absorptive capacity (Cohen & Levinthal, 1990) in both theory (e.g. universities) and practice (e.g. business) are present. The notion, however, does not signify that learning and innovation happen automatically. On the contrary, it means that networking and collaborating between a theory-praxis dualism, e.g. companies, research institutions, universities and governmental organisations, is crucial for the innovation and learning processes to sustain development. Thus, to support the auto-learning, the innovation and developments, partners may create living labs:

"A Living Lab is a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values" Bergvall-Kåreborn et al. (2009: 3).

The environment referred to may be a city a region within a country, an industry, a supply chain or a whole country (Sifrer et al. 2012)

Innovation labs
In this paper, an Innovation Lab (InnoLab) is perceived as a Living Lab that focuses on technological innovation. The Innolabs as implemented at AAU serve as inspiration for Vidzeme University of Applied Sciences (Latvia), Estonian Academy of Arts (Estonia) and Cyprus University of Technology (Cyprus) and how these institutions can incorporate living labs in their respective curricula and thereby underpin the transition to auto-learning (and highly innovative societies).

We explore the possibilities of relating Innolabs to two platforms (see figure 1) – a *learning platform* that includes the pedagogical principles and approach and a *strategic platform* including the trajectories for universities, which can be more or less in alignment with the Innolab mind-set. We will illustrate the interconnectivity between the strategic platform, the learning platform and the Innolabs at AAU – when the city is our lab.

AAU has experiences with various Innolabs. In this article, we have chosen to focus on two Innolabs: 1) Wofie and 2) Solution Hubs. However, we will also provide an example of what we call "informal Innolabs". These informal Innolabs are based on thematic project work – in this case we have chosen to focus on students Media-technology, who are using the city as their Innolabs.

In order to understand how Innolabs works at AAU, section 1 will describe the strategic platform and discuss the alignment with the Living Lab definition as presented by Bergvall-Kåreborn et al. (2009). In section 2 we will describe the learning platform at AAU, which is based on principles of Problem Based Learning (PBL) and discuss how this pedagogical approach to learning supports

Living Lab activities. Finally, Living Labs activities at AAU are exemplified and related to the learning and strategic platform presented.

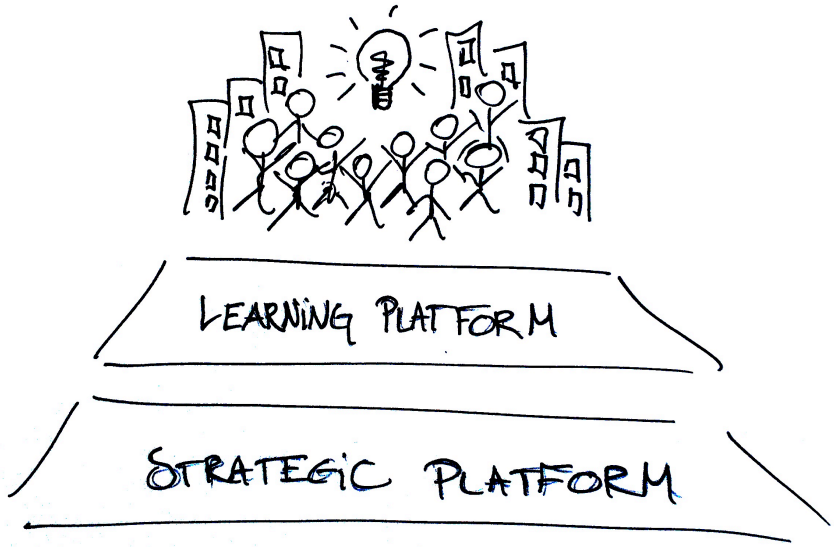

Figure 1: The living labs based on a learning platform of pedagogical principles and approached based on the broader strategic platform as defined by the institution.

2. Problem based learning as the learning platform for Innolabs

All university programmes at AAU have been based on problem based learning (PBL) since the university was established in 1974. AAU-students work in groups applying problem-oriented methods in preparing projects of a high academic standard, this study method is called problem based project work or "the Aalborg Model for Problem Based Learning". Each semester, students work closely together with a group of other students on a large written assignment[4] (15 ECTS[5]). In addition, students have to follow three courses of 5 ECTS each. The type of problems (e.g. more or less open) and thematic frames (e.g. more disciplinary or interdisciplinary oriented) under which students formulate and solve problems vary according to the engineering programme, however the PBL approach and curriculum organisation remain the same (Guerra et al., 2016).

In the following, we will run through the core AAU principles of PBL clustered in three themes:

a) The problem as point of departure
b) Projects organised as collaborative learning in groups and with external partners
c) Exemplarity and student directed learning.

[4] In the fall, the semester runs from September until December (exams in January). In spring, the semester runs from February until May (exams in June).

[5] One semester is 30 ECTS, 1 ECTS equals approximately 28 hours of study for one student.

These three themes will be discussed in an Innolab perspective.

a) The problem as a point of departure
The problem is the starting point directing students' learning process. The understanding of a problem includes the common sense understanding, where someone is faced with an unsatisfactory situation, which calls for new solutions or, in other words, innovation. In this case a problem analysis will serve as a mean to elaborate on the problem in context and alternative solutions. But the understanding of a problem moves beyond the common sense understanding as a problem also can be understood as an unreleased potential, i.e. an idea for a new product, a new market, a new way of applying what we already know. In other words, it is a creative process opening up for divergent thinking. By connecting these ideas to a need in society in a problem analysis, an unrealised potential is stated and design and prototyping initiated. In each case the problem is the starting point for a process of technological *innovation*.

The knowledge production feeding into this innovation process is based on a constructivist and experiential learning perspective (see for example Kolb, 1984). In this perspective it is recognised that knowledge construction is a distributed process as different actors have different experiences and carry different socio-cultural institutions. Therefore stakeholder-analysis and what Hård & Jamison (2005) have termed "the appropriation of technology to the context of use" is emphasised. This is in alignment with the *user-centric innovation milieu built on every-day practice and research* as stressed in the Living Lab definition. Furthermore, it is explicitly stated in the AAU PBL principles that the problem is authentic and thereby relevant outside the academic community. This relates to the *real-life contexts* of Innolabs.

b) Projects organised collaborative learning in groups and with external partners
Taking the point of departure in real-life problems often implies wicked problems. A wicked problem is a problem where it is unclear where the problem centre lies, and likewise it is less apparent how to intervene (Rittel & Webber, 1973). At AAU, the project organisation has been chosen as the way to educate students to collaborate with each other in groups to solve such problems. In the Faculty of Engineering and science the students have a psychical space, a group room, which is the centre of group collaboration – in this sense, the group room is a Living Lab in order for students to obtain collaborative skills. Projects are supported by courses that ensure that the students become familiar with a wide range of theories and methods, which they can apply in their projects work.
The PBL principles explicitly stress the importance of students to engage in close collaboration with scientific staff and external partners as businesses and other project groups, which is aligned with the *open and distributed innovation processes* that is stressed in the definition of a Living Lab.

As noted by Kolmos & de Graaff (2014) two types of projects can be distinguished; *disciplinary projects* that have the purpose of socialising students into a given discipline and *innovative projects*, which have the purpose of training students to innovate – from idea to product. In innovative projects, Innolabs are needed. In some cases, Innolabs are formally offered as workshops or cross-disciplinary activities to provide students a possibility to move through the innovation process in a pre-designed and teacher directed way. These activities are however seldom obligatory, whereas specific subjects as for example creativity and entrepreneurship are often part of the curricula. However, many Innolabs at AAU are so-called local initiated labs, i.e. initiated by students who formulate a specific problem in their groups, which call for *user-centric innovation* activity.

c) Exemplarity and student directed learning

With reference to Negt (1968), exemplary refers to the P in PBL and thereby the kind of problems that are addressed. But drawing on inspiration from Klafki (1985) exemplarity also relates to the learning process in which the problem is identified, analysed and solved. Negt (1968) draws on the work of Mills (1959) who introduced sociological imagination to express that imagination in terms of thinking our society different is stimulated by assuming a willingness to view the world from the perspective of others. The problems then has to be exemplary in the sense that someone out in our society perceives the problem to be a problem, which relates to the real-life contexts of engineering. What Klafki (1985) contributed with was the emphasis on the exemplarity revealed when addressing problems. From an Innolab perspective this means that we in interacting with our lab gain competencies that we can transfer to the interaction in other Living Labs. In this sense the Lab in it self is not important – it is the *living* part that is important and the competencies to interact with real life communities.

The orientation towards communities has been characterised by Jamison et al. (2014) as a more integrative approach to learning, embedding Mode 1 and Mode 2 types of learning but adding more contextual, more situated and more student centred types of learning (see figure 2). This relates to the inclusive nature of the Living Lab definition engaging *all relevant partners* in real life-contexts with a focus on *every-day practise*.

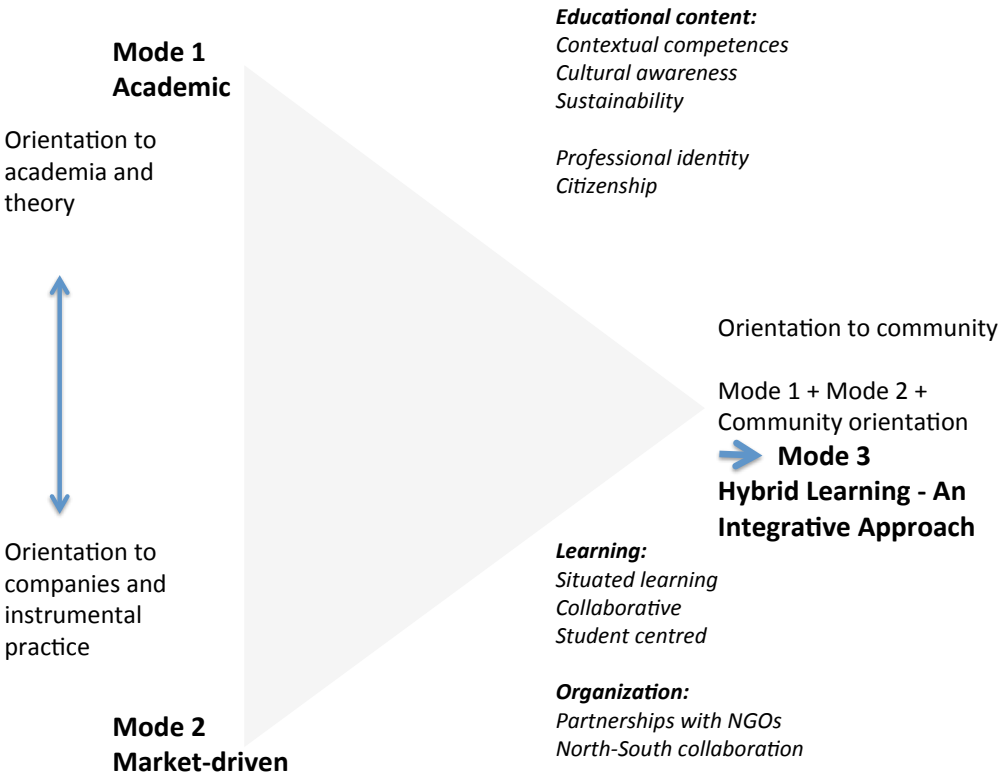

Figure 2 Hybrid learning as a combination of mode 1 and 2 knowledge combined with a community orientation and new perspectives of this Mode 3 on the educational content, learning principles and key partners in the organisation of programmes (Jamison et al, 20014)

The student centred element mentioned in the move to a more integrative approach in figure 2 is also an integrated principle in the way students are working in the PBL environment. This is obtained through relatively open curricula providing the students the opportunity to identify problems themselves that they are engaged in solving, typically initiated by an overall theme description. The theme can initiate company orientation, e.g. by presenting a given sector as a theme, or community orientation, e.g. by presenting a given site like a city centre as theme. But students working on innovative projects have in most cases to target their innovation outside academia – and the direction and outreach, when the theme is oriented towards academia, is in many cases self-directed.

At the first year of study, all students in the Faculty of Engineering and science have learning objectives calling for contextual knowledge and thereby they need to address engineering and science in a socio-cultural context, and students are co-supervised by a staff from the science, technology and society research society. In this way, students are trained to "*facilitate user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values"* as noted in the living lab definition. Thereby it is recognised that students should not only have freedom and possibility to enter a living lab, they also need the abilities to redraw experiences from this lab and use it for research and solution of real life problems.

3. Strategic platform at the Faculty of Engineering and Science (AAU)

The authors of this article are attached to the Faculty of Engineering and Science. The vision of the Faculty is based on society's "Grand Challenges" that are the current and future global challenges in energy, the environment, the aging society etc., according to the Lund Declaration (Faculty of Engineering and Science, 2015). The strategy of the Faculty is divided into three core areas:

- Research
- Education
- Cooperation with society

These three core areas are independent issues, but they constantly influence each other. Researchers and students produce knowledge in close interaction with the surrounding society that sets new standards for research in global sustainable welfare and technological development (Faculty of Engineering and Science, 2015). Greater impacts on the Grand Challenges have to be achieved through the involvement of the public sector and industry in knowledge creation, with a stronger focus on open innovation and the role of end-users (Lund Declaration, 2015).

Many groups work with external actors (e.g. a company, a municipality or a NGO). These actors might have a relevant problem for the students to work with. It gives students a good insight into the "real world" they will be working on later in life.

The Faculty of Engineering and Science's strategy is very much on achieving impact on the Grand Challenges: innovation, including non-technical innovation and new business models are high on the research and teaching agenda. This relies on the strong participation of end-users and industry. Researchers and students in the Faculty have good possibilities to collaborate with the society at large (e.g. other research institutes, industry, end-users and the public) to achieve impact.

4. Innolabs at Aalborg University

In this section, we will present examples of Innolabs as implemented at AAU. In order to identify Innolabs 3 relevant dimensions have to be taken into account:

1. Formal/intentional versus informal/unexpected
2. Disciplinary versus Interdisciplinary
3. Short term versus long term

Formal and intentional Innolabs are Innolabs that are pre-designed and teachers play a central role. It can be classes and meetings between teacher and students. Informal and unexpected Innolabs are locally initiated labs, in which students have the freedom to define the problem to be investigated. Focus is on self-studying and exploring the problem by students themselves. Innolabs can be Disciplinary or Interdisciplinary, i.e. involving one ore more academic disciplines into a project. Finally, some projects are short term (few days to a week) or long term (one semester, half a year).

Based on these dimensions, we have selected the following Innolabs, within the theme "the city is our lab":

Wofie Solution Hub	Formal/intentional Interdisciplinary Short term
Sport science & geography Media technology	Informal/unexpected Disciplinary Long term

Wofie

Wofie is an annual course in innovation and entrepreneurship. The workshop, that runs over four days, is an offer to all 8th and 10th semester students as well as Ph.D.-students at AAU and partner educational institutions in Denmark. Students work in groups with 5-6 other students who come from different fields of study and faculty. In the morning preliminary exercises take place, in the afternoon the groups work on idea generation and move on to build business proposals within the annual theme. In 2016, the theme was "Smart Cities". Experts within business creation and relating areas are available during the workshop and there is the opportunity for sparring about the case. The last day, all groups compete with each other by presenting their business concept to a preliminary jury. The final jury, with a majority of business people, evaluates the individual presentations based on innovation, verification, and business and convince (AAU2, no date).

Solution hubs

Solution hub is a learning platform for cooperation between students and a company. In a solution hub, students from different disciplines and external partners meet to discuss complex projects. A hub includes one company and 10-15 project groups (50-75 students) that collectively work on the project to come up with a real solution to the company's challenges (AAU, no date). The solution hub is part of AAUs educational strategy and aims at the further development of the PBL-model, where students very often work on projects with a mutual binding interaction with external partners. The solution hub approach has also been taken up locally and turned into Design studios that provide intense one week programmes for students to study the sustainable development of

suburban districts in Aalborg (Denmark) and include some time (2-3 weeks) for afterthoughts and further development of ideas and designs.

Companies	**Students**	**Supervisors**
• Innovative input without expenditures • Use of students as "innovation resource"	• Extra dimension to project work • Contributing to solving problems of a company • Improve innovative competences • Get an understanding of how professional competences can be used in practice	• Same project set up compared to traditional projects • Supervision of students

Besides the formal Innolabs as described above, there exist a long list of informal Innolab activities embedded in student directed project work. In this section, we will take some examples using the city as our lab. We have deliberately left out some of the more obvious examples related to for example urban planning and design as well as architecture and design. In stead, we provide an example from Media technology.

Project work

Sports science & geography
A student sport science and geography worked on a project "sports in public spaces". In recent decades, there has been more and more focus on people's health. This is also the case in Denmark, where municipalities increasingly have begun to consider public health in urban development and the development of green areas in the city. Thus, in the project the student focused on health related to urban design. However, by means of literature study, the students found out that there is a difference in the way men and women use public spaces in the city, especially with regard to the use of outdoor fitness. By means of observation, questionnaires and qualitative interviews, the student investigated the use of outdoor fitness in public spaces in Aalborg (Denmark) by women. The analysis showed that several factors in the surrounding environment influenced the use of outdoor fitness by women. The factors that affected woman's use were well maintained lighting, delineation of space, fitness areas/structure, other people in the area, and nature to mention some of the factors. This knowledge can be used to make public space more attractive for women. The city was used as a living lab.

Media technology
Media-technology students were addressed with "Visualise activity" and they were restricted to activities carried out in the public sphere in the city centre of Aalborg. What could the students do – besides go out looking for a *living* problem? One group experienced that people who were studying, used the public library for studying or reading – but they saw a potential in using this public space for creating social relations. After interviews and observations, they designed a visualisation of activities in terms of readings, interest etc. of people being in the library at a given time together with their willingness to enter into a dialogue at the moment. Another group experience that in the evening parks in the city centre were empty, and they say a potential for getting more people out in

the park to exercise and use this free public space to get exercise. After a user-needs-in-context study they designed an evening park using lights to lower anxiety combined with games to get people to enter into running exercised acknowledging the fact that getting people to stay in the part and feel safe, and not just running through the park, would get more people in the park and thereby also reduce the anxiety of being exposed in a dark and lone space. In both cases – the city was used as a living lab.

Conclusion

In this article we have taken point of departure in innovation and living laboratories as implemented throughout the years at Aalborg University (AAU) (Denmark). Problem Based Learning (PBL) is the central learning platform for Innolabs at AAU. Innolabs have in this article been defined as

"A Living Lab is a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values"

This definition is in alignment with the core principles of PBL at AAU: 1) the problem as point of departure ("*user-centric innovation milieu built on every-day practice and research*" and since the problem students work with is authentic and relevant outside the academic community, which relates to the "*real-life context*" of Innolabs); 2) projects organised as collaborative learning in groups and with external partners (at AAU it is important that students work together in close collaboration with scientific staff and external partners such as businesses, which is aligned with the "*open and distributed innovation processes*") and 3) exemplarity and student directed learning (based on the interaction with real life communities).

Based on three dimensions (formal/intentional versus informal/intentional InnoLabs; disciplinary versus interdisciplinary InnoLabs and short term versus long term InnoLabs) we have described the following examples of Innolabs: Wofie and Solution Hubs (formal/intentional; interdisciplinary and short term) and project work from sport science & geography and media technology (informal/unexpected, disciplinary and long term). These examples show a wide range of different Innolabs.

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