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INTENSIVE MULTIDISCIPLINARY LEARNING CONCEPT IN HIGHER EDUCATION: CASE CERN BOOTCAMP

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ABSTRACT

This paper describes the development, organisation and implementation of a multidisciplinary learning camp concept for master's students. The learning camp concept is called CERN Bootcamp. The motivation for developing the concept was twofold: to enhance master's students' opportunities for internationalization with an intensive summer school course taking place within a limited time span abroad; and to apply a pedagogic approach, which makes the learning experience effective, inspiring and useful considering the needs of the working life. In the concept, the master's students participating in the learning camp solve demanding real-life societal problems in multidisciplinary teams in an open innovation environment at CERN Ideasquare Geneva Switzerland. This happens in terms of design thinking philosophy and co-creative service design methods in the guidance of supervisors from the arranging universities and with the support from the CERN community. The findings of this paper cover the practical contribution from the bootcamp concept and their significance.

KEYWORDS Higher education, co-creative learning, intensive learning camp, service design

INTRODUCTION

The importance of internationalization of students during their studies has increased in the university policies (Fabricius et al. 2017; Marginson 2006). According to The International Association of Universities (IAU) survey, Internationalization of Higher Education: Global Trends, Regional Perspectives (Egron-Polak et al. 2010), the vast majority of higher education institutes have included internationalization in their strategic plan, and indicated that the importance of internationalization increases. Improving the quality of education and preparing students for a globalized job market are essential reasons for internationalization of higher education (Gacel-Avila, 2005). Moreover, international programs not only provide benefits to individuals and their development, they also contribute to the success of higher education institutions as organizations in various ways, such as the circulation of knowledge; increased capacity; increased interaction and cooperation between higher education institutions; sharing positive examples; sharing materials, equipment' and physical conditions, and an opportunity for higher education institutions to compare evaluations of their own work with the work of other higher education institutions (Ugurlu, 2016; Messer and Wolter, 2007). However, higher education students have several hindrances on the individual level, that either hinder from going abroad or from having a "good mobility" (Kmiotek-Meier et al., 2019, p. 32). They include financial resources, (Banov et al., 2017), the socio-economical background (Grabher et al., 2014; Hauschildt et al., 2015; Lörz et al., 2016), linguistic skills (Molodikova, 2013), social relationships (Brandenburg, 2014; Cairns, 2012; Grabher et al., 2014; Hauschildt et al., 2015; Souto-Otero et al., 2013), and institutional barriers (Brandenburg, 2014; Grabher et al., 2014; Hauschildt et al., 2015; Lörz et al., 2016; Bilecen and Van Mol, 2017; Wiers-Jenssen and Try, 2005; Brandenburg, 2014; Souto-Otero et al., 2013; Elliot et al., 2016; Gu et al., 2010; Teichler and Steube, 1991). Indeed, the earlier

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research supports our own observations on students in master's degree programmes, they have very limited opportunities for international mobility during their studies.

International mobility of students studying in master's programs was a clear observed challenge at universities arranging the CERN Bootcamp. Often, students in master programmes are studying alongside their full time jobs and many of them have family and children. While many students would be interested in international mobility, their chances are very limited, particularly for longer mobility periods. Still, the requirements of the working life in the globalizing world set increasing expectations for internationalization in life-long learning. Secondly, instead of traditional classroom teaching, we wanted to develop different pedagogic concept to make the learning experience effective, inspiring and useful considering the needs of the working life. An effective pedagogic approach for a short-term and intensive course was needed. Thus, co-creative service design methods were selected as thinking and development tools in our pedagogic approach. This was supported by the fact that, in almost all areas of the working life such skills are increasingly required which involve co-creation orchestration capabilities. Indeed, there was an evident pragmatic need for our effort, and this paper describes the pedagogic concept developed for responding to it. The learning camp described in this paper resembles hackathons and jams. However, it is more extensive, since it also includes studying theoretical knowledge base and working outside of the actual learning camp.

This paper first reviews the literature of intensive co-creative learning events, such as hackathons, learning camps, and jams. Then, it describes the main activities, outcomes, and the collaborative network in developing and carrying out the CERN Bootcamp concept. Next, it describes the findings. After that, it draws the conclusions.

INTENSIVE CO-CREATIVE LEARNING EVENTS: HACKATHONS, CAMPS, JAMS, SPRINTS

In this section, we briefly review the literature on intensive co-creative teaching and learning events. Such events include hackathons (Leckart, 2012), innovation and learning camps (Taatila and Vyakarnam, 2008), jams (Musil et al., 2010), and sprints (Angelaccio and Fanti, 2011). The principles and ideas of these concepts are very similar.

Characteristics of intensive co-creative learning events

Hackathon. Hackathons originated in the IT community as computing marathons where programmers, project managers, and graphic and interface designers collaborated intensively on software projects to design the next 'killer app' over one or two labor intensive days (Leckart, 2012). Similarly, according to Calco and Veeck (2015), a hackathon is an event where computer programmers, developers, and designers collaborate intensively in teams, at a specified venue, under tight timelines, with the aim of solving complex software-related problems or producing innovative technologies. The key elements of the hackathon are collaborations, networking, mentoring, hands-on engagement in socially-relevant projects, and community involvement (Mtsweni and Abdullah, 2015). The word refers to "hacking" and "marathon". In the context of hackathons, however, a hacker does not refer to computer intruders who commit computer-related criminal activities, such as surreptitiously accessing computer systems for malicious reasons (cf. Warren and Leitch, 2010) but as individuals who has passion for solving problems within a community environment. The participants work with others to solve real problems for real people, and the main motivation behind the hacking culture is about participation, contribution, and learning (Mtsweni and Abdullah, 2015). Hackathons are organized by academic institutions (Calco and Veeck, 2015), the public sector organizations (Gamble et al., 2013), and companies (Mtsweni and Abdullah,

2015). Large companies, such as Facebook, Yahoo, Google, and Microsoft, are motivated to organize hackathons to build new solutions, to empower a community of developers, to entice developers to embrace latest technologies, and to recruit bright software developers into these organizations (Calco and Veeck, 2015, Mtsweni and Abdullah, 2015). Hackathons have also expanded in other areas than just IT, such as health care (McGowan, 2019) and business management (Calco and Veeck, 2015).

During hackathons, enthusiastic individuals come together, form working teams around challenges and, in collaboration, find innovative solutions from the scratch (Kienzler and Fontanesi, 2017). At the end of the hackathon, the solutions are presented and evaluated based on whether they work, are good ideas with a suitable problem/solution fit, show a well-designed experience and execution, and have the 'wow factor' (Brenner, 2011). Hackathons have become popular way of enhancing problem based and innovative learning and teaching both in industry and academia (Kienzler and Fontanesi, 2017).

Innovation and learning camps, sprints, jams. Similar to hackathons, innovation and learning camps, sometimes called as "bootcamps", are used for learning and developing skills by solving real life problems in intensive and interactive events. Bootcamps are used for, for example teaching, developing competencies and solving problems in the area of entrepreneurship (Taatila and Vyakarnam, 2008, Bager, 2011, Kwong et al., 2012) and societal challenges (Ojasalo and Kaartti, 2019). The term is very similar to above terms hackathon and learning camp. Like hackathons, games have grown in popularity evolving their own culture that is similar, but slightly different than the hackathon model (Decker et al., 2015). Jams have been noted to focus on experimentation and innovation, rather than polished products (Goddard et al., 2014). Jams have become particularly popular in the game industry (eg. Global Game Jam, 2015). The term learning sprint also has the similar meaning to hackathon and learning camp, and it has been used, for example in the instruction and development of technology (Angelaccio and Fanti, 2011) and well being (Trang, 2018).

Advantages of intensive co-creative learning events

Intensive co-creative learning events have several advantages (Table 1). They improve creative thinking of participants. The different learning environment boosts learning and innovation. They increase self-confidence of participants. Real-life problem solving motivates the learners. Also, learning is faster than in the class room setting.

Table 1. Advantages of intensive co-creative learning events

Advantage	Author
Creative thinking is improved	Bager, 2011, Kwong et al., 2012, Calco and Veeck 2015, Kienzler and Fontanesi, 2017
Different environment boosts learning and innovation	Heap, 1996; Kwong et al., 2012; West, 2004; Pretorius et al., 2005; Bager, 2011
Increases self-confidence	Arya et al., 2013,Taatila and Vyakarnam 2008, Kienzler and Fontanesi, 2017
Collaborative skills improve	Musil et al., 2010, Bager, 2011, Decker et al., 2015, Gamble et al., 2013, Mtsweni and Abdullah, 2015
Real-life problem solving motivates learning	Taatila and Vyakarnam, 2008, Taatila, 2010; Bager, 2011, Mtsweni and Abdullah, 2015
Fast learning	Taatila and Vyakarnam, 2008, Bager, 2011, Thomas and Owen, 2013, Goddard et al., 2014, Silver et al., 2016 .

Secondly, *creative thinking*. Hackathons and learning camps increase creative thinking (Zheng, 2013).) An informal environment away from campus helps creative thinking because of the opportunity to discuss their ideas in a more openly to obtain greater feedback from mentors and peers (Known et al., 2012). Moving people from their normal work place or school environment to a camp site can be an efficient means for team building, creativity training and innovation boosting purposes (Bager, 2011). Hackathons are increasingly being used in creative work environments to solve problems and create new products, and even more important, to inspire originality, creativity, and innovativeness (Calco and Veeck, 2015). Similarly, Kienzler and Fontanesi (2017) found enhancing creativity as one of the advantages of hackathons, and Taatila and Vyakarnam's (2008) findings support this.

Firstly, *different environment.* New environments that physically and symbolically remove people from their daily routine and activities, allow individuals to think in a clearer and less constrained manner, both in the educational and working life organizations (Kwong et al., 2012; Heap, 1996; West, 2004; Pretorius et al., 2005; Doorley and Witthoft, 2012). In camp teaching approach, students are taken away from their normal school environment to another location, mixed with students from other disciplines and/or schools, and with external people and teachers become facilitators of problem and future oriented knowledge creation processes related to real life problems (Bager, 2011).

Thirdly, *self-confidence*. Self-confidence of participants increases in co-creative learning camps (Arya et al., (2013). Taatila and Vyakarnam (2008) found that students gained self-confidence during an entrepreneurship bootcamp. Similarly, Kienzler and Fontanesi (2017) found students' increased self-confidence in a hackathon.

Fourthly, *collaborative skills*. According to Bager (2011), in a learning camp, participants covering multiple fields of knowledge and experience work in an intensive and collaborative atmosphere, and it is normally possible to reach a higher level of abstraction and find surprising and unusual ideas and solutions to posed problems. The research from jams shows that participants can gain skills in collaboration (Musil et al., 2010). Similarly, Decker et al. (2015) found that collaborating with and learning from each other is essential part of a hackathon, and the collaboration is non-competitive and positively perceived, and it enables meeting new people with similar interests and learning from one another. Likewise, the aspect of community and collaborative work is central in hackathons (Mtsweni and Abdullah, 2015). The importance of collaboration is highlighted also in the public sector hackathons since the challenges that face the public sector organizations are more complex and require more collaboration than ever before (Gamble et al., 2013).

Fifthly, *real-life problems.* Hackathons, bootcamps, and jams typically address real-life problems and innovation. For example, students may be the problem solvers while the problem owners are private companies (Bager, 2011). Solving real-life problems "makes most camp participants perceive such learning as relevant and useful" (Ibid, p. 294). Similarly, if students are able to see the value of what they are learning in class within a real-life setting, their passion and participation in the field increases(Mtsweni, 2015). In entrepreneurship education, the real-life cases allows the students to build their own perception of the reality of entrepreneurship in a holistic manner (Taatila, 2010). Real-life cases support changing the learning environment from teacher- or institution centric into student centric (Taatila and Vyakarnam, 2008).

Sixthly, *fast learning*. Students learn faster in hackathons and camps. The rationale behind student camps is that students learn something different and faster than in normal classroom settings while being actively involved and put under pressure (Bager, 2011). Fast learning is enhanced by quickly responding to feedback and adjusting the proposed solution accordingly (Silver et al., 2016), putting the negotiated solutions or plans into action relative

quickly (Taatila and Vyakarnam, 2008), and rapid prototyping (Thomas and Owen, 2013, Goddard et al., 2014).

Challenges of intensive co-creative learning events

Intensive co-creative learning events have their challenges. *Extra funding* is needed to move students out of classroom to a location where they can eat, sleep and work; and it requires extra time and resources on part of the university and partners because the planning of camps must involve academic university staff and assistance by administrative personnel (Bager, 2011). *Allocation of study points for camp participation* may be a challenge in academic institutions. According to Bager (2011), many departments and scholars regard camps as a useful extra-curriculum activity, but not as an academic learning experience qualifying for study points. In addition, in the context of game jams, significant *imbalance between gender participation* has been referred (Fowler et al., 2013).

CASE DESCRIPTION

The CERN Bootcamp is an all-year round project including planning, implementation and assessment. It is a joint effort between the 3 UAS consortium Haaga-Helia, Laurea, Metropolia, and the University of Helsinki HIP Helsinki Institute of Physics, and Ideasquare team in CERN Genava. An extensive multidisciplinary and international group of professionals participate in planning and implementing the Bootcamp, consisting of 5 supervisors from the Finnish consortium, 5 mentors from CERN Ideasquare, 1 coordinator from Finland and 1 from CERN Ideasquare. Altogether, the core team consists of 12 persons. In addition, several administrative and supporting persons help in the process. Next, we explain how the implementation and development of the CERN Bootcamp is organized.

The implementation cycle of the course starts immediately after the previous implantation is over. This takes place in the late summer or early autumn when the feedback from the earlier course implementation has been analysed, the students have been received their credits, and the total results are summarized and reported. Next, the application for the funding of the next year's Bootcamp is prepared. If the funding is granted, the timetable for the next year is agreed with CERN and preliminary reservations are done to Ideasquare premises as well as for the accommodation and flights. Next, the planning of marketing, challenges for student projects, and detailed planning of implementation can begin.

Firstly, the **challenges for the each implementation are identified**. This takes place jointly with the supervisors, CERN Ideasquare mentors, and the stakeholders of CERN. The challenges are aligned with the United Nations' Sustainable Development Goals (United Nations, 2019). The challenges are typically wicked problems, such as climate change, pollution of seas, integration of refugees, and health and well being issues (Rittel and Webber, 1973; Camillus, 2008).

Once the challenges are jointly identified, specified, and agreed, they are communicated to potential applicants through marketing. Students **apply** to the Bootcamp by filling out an application form, in which they tell about their motivation and interest in the *challenges* communicated to them. Based on the application and the success in the earlier studies, selected students are invited to group discussions to further assess them for the final selection. In addition, for example the multidisciplinary nature of student groups is considered in the selection. Altogether maximum 25 students are selected.

Service design approach is applied when solving the societal *challenges*. According to Foglieni et al. (2018), the service design approach is "a fundamental element for introducing change in business, organisations and the public sector". Furthermore, it is a holistic approach, taking the system point of view and integrating several areas of expertise through design-led approaches, methods and tools (Mager and Sung, 2011; Patrício et al.,

2018). The students typically explore their *challenges* in terms of the following phases: 1) define the problem, 2) ideate solutions, 3) prototype, 4) test and 5) present the solution and assess its impact.

From the perspective of the selected students, the **CERN Bootcamp journey** starts with an individual pre-assignment. In the pre-assignment, they get familiar with service design and how to work during a short-term, intensive program aiming at solving wicked problems. This method is often called as a sprint (Knapp, Zeratsky and Kowitz , 2016). Thereafter students get together for the kick-off event for two days. This is the first time when all the parties: students and supervisors from Haaga-Helia, Laurea, Metropolia, and the University of Helsinki HIP, and mentors from CERN Ideasquare meet each other. The main content of the kick-off days focuses on getting to know each other's, choosing the c*hallenge* and creating the student groups accordingly, learning how CERN and its stakeholders can support the development task, finding the viewpoint to study the selected *challenge* further, preparing a plan to gather data, and agree on the expert interviews. The data collection starts right after the kickoff and continues till the end of Bootcamp days at CERN Geneva. At CERN and Geneva area students have the opportunity to make interviews with scientists and experts of international organizations, such as United Nations, World Health Organization, Red Cross and many others. The first two days at the Bootcamp is about data gathering, analysing, learning, and creating insights in the *challenge*. Next, the student moves on to ideation phase, which addresses the question, What kind of solutions could solve the identified problem? The best ideas will be prototyped and live tested. Thereafter, the ideas are finalized. At this point, the societal impact is also assessed. The solution and the impact is presented in the last afternoon of the Bootcamp. Afterwards, there is still one task in the students' journey, which is the learning diary. In addition to internationalization competences, such as cultural and communication skills, students learn to apply service design approach and basic tools to develop sustainable solutions; recognize opportunities to solve societal problems with social innovation and understand their impact; act as a developer in open innovation networks and environments; and conceptualize and commercialize services. The feedback is gathered from the students both orally and through a questionnaire. Supervisors and mentors from CERN discuss about their views and experiences of the implementation after the Bootcamp, and again when the student feedback has been analysed. This is the moment when the next implementation cycle starts.

PRACTICAL CONTRIBUTION

The implementation of the CERN Bootcamp is much different from a typical classroom implementation taking place in the university's own premises. It requires significantly more man-hours from the organizing instructors. The implementation and organization takes place in multi-stakeholder network in two countries. The collaboration of three universities of applied sciences and a university brought various advances and benefits (cf. Ojasalo and Kaartti, 2019).

- Excellent student feedback. The average overall grade was 4,48 (with scale 1..5). Also, the student feedback shows that the learning environment, CERN Ideasquare, offers a great learning experience and a pleasant and encouraging working environment. Furthermore, they value a possibility to broaden their networks.
- The CERN Bootcamp concept provides with a suitable way of internationalization to master's students who are taking their studies alongside a full time job. It enables this goal within a short but intensive period.

- An opportunity to broad multidisciplinarity with student groups, more viewpoints in ideation for and development of the bootcamp, stronger funding base for organizing the bootcamp, as well as synergies with the practicalities.
- The CERN bootcamp enables addressing the United Nation's sustainable development goals in education and creative problem solving.
- It enables to demonstrate and communicate experiences of multi-actor and multidisciplinary co-creation activity in an open innovation environment, which is a central element of each partner's strategic intent and pedagogic philosophy.

CONCLUSIONS

The purpose of this paper was to describe the development, organisation and implementation of a multidisciplinary learning camp concept with master's students at CERN Ideasquare Geneva Switzerland. There was a clear and twofold reason for develop such a learning concept. There was need for a concept which enhances master's students' opportunities for internationalization with an intensive summer school course with a limited time span. There was also need for a concept that applies pedagogic approaches, which are different from the traditional classroom teaching and make the learning experience effective, inspiring and useful for the needs of the working life. This paper provided a detailed case description of the phases and activities of the CERN Bootcamp concept. It also explained the value of the developed concept.

The following opportunities for further research emerge from our effort. Firstly, a comparative study on pros and cons could be conducted with different forms of student mobility in higher education. Secondly, the special requirements needed from instructors of international intensive learning camps should be examined. Thirdly, the international collaboration between different educational institutions and their network should be examined in more detail.

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