Project Publication

Entrepreneurial skills for young social innovators in an open digital world

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# TOWARDS A MODEL OF EARLY ENTRE-PRENEURIAL EDUCATION: APPRECIATION, FACILITATION AND EVALUATION

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**"DOIT – Entrepreneurial skills for young social innovators in an open digital world"**
**A HORIZON 2020 INNOVATION ACTION**

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# Summary

This paper introduces the Maker movement as a bottom-up movement, placing digital fabrication technologies on people's desks to produce "almost anything". It explores further the pedagogical value of making in education in general and in early entrepreneurial education in particular. Making as a pedagogical approach is analysed referencing established pedagogical concepts as well as a qualitative study including makers and managers of maker spaces. Although maker education has so far only rarely been introduced in formal education, there are many initiatives that bring making and formal education together. According to maker experts, formal education would benefit from making because it is well suited to develop practical skills such as prototyping, supporting creativity and promoting critical reflection. In conclusion we describe a model of introducing making in early entrepreneurial education and conclude with a proposed assessment framework for measuring its impact, which will be tested in an on-going project funded by the European Commission.

Keywords: Making, early entrepreneurial education, maker pedagogy

# Content

# 1. Introduction

Thanks to the availability of digital technologies such as 3D printers, laser cutters and CNC (Computer Numerical Control) machines, digital fabrication and prototyping have become widely accessible for anyone and are no longer limited exclusively to industries. The number of maker spaces and Fab Labs (fabrication laboratories) that make their facilities and digital fabrication tools available to their members are constantly growing in the recent years. Currently there are around 1,200 Fab Labs globally. In these workshops makers design and fabricate their own prototypes, some meant for personal use, others for commercialisation. The inter-changeability of bits and atoms, from design to physical artefacts, is being called the Maker movement [[1]]. It could be said that the Maker movement represents a return of interest to the physical side of innovation following the almost complete shift to the digital side with the dot-com bubble, the rise of the participatory Web 2.0 and the diffusion of Open Source Software. Neil Gershenfeld [[2]] called the Maker movement the next digital revolution as it placed the means of fabrication on people's desks.

It started as a community-based, socially driven bottom-up movement, but today its potential to impact on society is manifold, in terms of environmental, economic and social impact.

Most maker spaces and Fab Labs offer educational activities for children and adults, from kindergartens up to university students [3], recognising the pedagogical value of making. However, there are few examples where making has been introduced to school settings [4], for instance as a school subject, and where the impact and value of making have been scientifically analysed. This paper seeks to close this gap in regard to early entrepreneurial education (EEE) proposing an assessment framework to diagnose the impact of maker activities on attitudes, knowledge and skills that favour an entrepreneurial “spirit”. We depart with exploring the pedagogical value of making in general in reference to established pedagogical concepts as well as a qualitative study with makers and maker managers [5]. We will further describe the DOIT (Entrepreneurial skills for young social innovators in an open digital world) approach, a model of entrepreneurial education that is put into practice in the framework of a EU (European Union) funded project. Finally we will deliver an assessment framework for analysing the impact of maker activities in EEE.

# 2. The Pedagogy of Making

The pedagogy of making builds on several pedagogical pioneers, from reform pedagogues to constructivists, from Montessori [6] to Piaget and Papert [7], who all support self-regulated learning [8], where learners decide on their learning goals and on the when and the how. In this learning setting teachers acquire the role of tutors assisting the learner in their learning paths replacing the traditional teacher-learner relation.

[1] http://www.fabfoundation.org/index.php/fab-labs/index.html
[2] https://www.doit-europe.net/

Making is hands-on learning, where makers learn from others, from trial and error, often in interdisciplinary and collaborative teams [9–11]. In this, making is similar to problem solving and project based learning approaches. Making includes a desire to produce things more collaboratively by improving design suggestions of others or by simply copying, mashing or personalising existing design elements. Making is thus theoretically and historically founded on "learning by doing" principles [12, 13]. As a pedagogical approach, it is learner-centred and project oriented, while allowing learners to follow their individual goals [14]. According to the Horizon report, which anticipates technological trends having an impact on educational settings, maker education will have an increasing impact on education in the following years [15].

## 2.1 What Makers Say - Empirical Results from Interviews with Makers

In order to understand the value and impact of making, we have conducted 40 interviews with experts in making, i.e. makers and managers of maker initiatives across Europe and asked them, among other questions, how they perceive the educational potential of making [3].

In qualitative analysis of the interviews, it became clear that makers themselves believe that the Maker movement already has an impact on education, as there are numerous examples of collaborations between maker spaces and educational institutions. They either invited school classes to the maker space or installed pop-up maker spaces at schools or rented out some machines to trained teachers, although no integration in the school curriculum is known to date. In respect to the educational potential of making, the interviewees named entrepreneurial education, STEAM (Science technology engineering arts and mathematics) education, and as pedagogical approach collaborative and interdisciplinary learning in particular. For instance, a maker at Fab Lab Barcelona said: *"...this could be a way to introduce them to a new way of production as well as also teaching the young people who are interested in technology...(...) get things moving on a different level when you bring two skilled individuals together by combining these skills"* (maker, Spain). Children are taught to be creative themselves, *"which might lead to further growth of the DIY (Do-it-Yourself) community, which then in turn could have a considerable impact on production processes"* (maker, Denmark). Also, local job creation was named as an argument for developing 21st century skills through making and keeping a well trained work force in the region if making found its ways into formal education.

The makers see maker pedagogy as preparing children better for real life situations: "*I think that they are having this traditional education that is not preparing them for the real world, to be competitive (...). When one day they have to start working and they are being educated like you just sit and listen and here are 10 pages and then (...) they do not know what to do"* (maker, Croatia). Kids' interest in 3D printing and other digital manufacture technologies can be easily triggered and many makers and maker initiative managers claim that the incorporation in formal education would be a necessary step to prepare children for the skills that are needed today to compete on the labour market. Maker initiatives can also provide room for education for disadvantaged kids and young adults by empowering them and thus maker initiatives would have the potential to break barriers and give access to people from different social backgrounds: *"Part of the task, which we set ourselves is of course to try to break barriers, especially for pupils who would never get the idea to study because they grow up in a social environment where they have no contact at all to universities. (...) social origin determines the educational career a lot here (Düsseldorf, Germany). And one of our tasks, which we set out to do, is to provide a bit of support there. (...) When I say we were successful here, even though we have no proper measuring tool for it"* (maker manager, Germany).

After all, making contributes to a paradigm shift in its anti-consumerist perspective that leads from pure consumption to producing and further to prosuming, which is the merge of producing and consuming: *"I don't want to have a kid who thinks 'OK, I want this and where can I buy it', instead of 'I want this and how can I make it'"* (maker, Croatia). Maker education is about opening black boxes, giving first hand experiences how artefacts are produced and

know-how regarding the production cycle: *"One of the things could be that people stop being consumers, but instead become more creators. (...) Today we are in a society of consumerism, so people buy things (...). I really believe that will change the way society works"* (maker, Denmark). Maker objects are believed to create a different awareness of products in general and many interviewed makers showed an anti-consumerism attitude. Makers want to know how products are made, what the product consists of, and open these "black boxes". Some argue that they would like to be in control of the production phase as buying off the shelf means missing out on the different production steps and losing that knowledge.

## 2.2 Maker Education in Social Media

Previous studies analysed the 'making' related discussions in social media [16]. After analysing a total of 50,097 tweets with #makerspaces (12,180 occurrences), #makerEd was one of the more prominent hashtags for indicating the discussion of making in education (4,370 occurrences). However, more informative than the absolute numbers are the co-occurrences of keywords characterising these two data sets. Hence, #makerspaces are most frequently mentioned in conjunction with libraries, schools and STEAM showing how much 'making' is already connected with traditional places for learning, at least as far as the informal debate on Twitter is concerned.

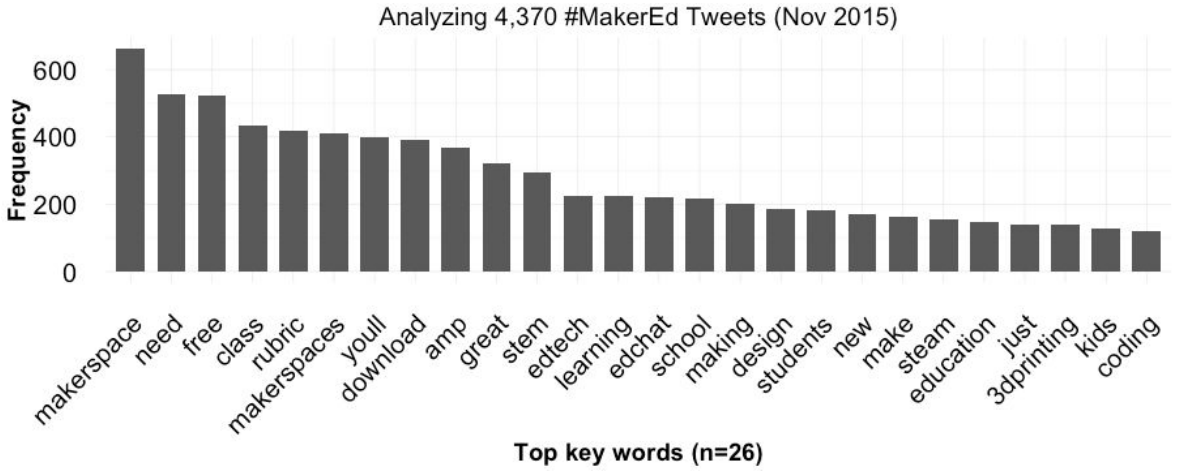


*Figure1: Co-word analysis of 4,370 tweets containing #MakerEd (Nov 2015).*

Based on a qualitative screening of these tweets, these words indicate the contextual constraints of introducing making into formal education, where 'classes' are the standard unit for teacher – learner interactions and where 'rubrics' are critical instruments to assess learning (see Figure 1). 'Free' refers to the availability of freely available materials supporting 'maker education' that are promoted over the Twitter network. This is not necessarily an indication that only free materials are thought after.

# Making in Early Entrepreneurial Education

At first glance, making supports many skills relevant to entrepreneurship: setting goals and devising paths to achieve them, the ability to integrate the skills of others (collaboration) and it is highly interdisciplinary, since making proceeds iteratively and supports primarily problem-based learning. Nevertheless, despite the promising nature of introducing making in education, there are only rare examples where making has been integrated with formal

education, apart from short term arrangements such as project or maker days [e.g. 17] at schools or teachers who incorporated making in their classes without the curricular support other forms of learning have.

## 3.1 Objectives of Early Entrepreneurial Education

As stated in the 2016 Eurydice report, defining goals and learning methods for entrepreneurship education is still an underdeveloped area in most European countries [18]. First and foremost, we do not propose a narrow, commercial definition of entrepreneurship education, but work on the basis of the more comprehensive definition provided by the EC thematic working group: "Entrepreneurship education is about learners developing the skills and mind-set to be able to turn creative ideas into entrepreneurial action. This is a key competence for all learners, supporting personal development, active citizenship, social inclusion and employability" [18].

Putting skills and attitudes at the core of the definition, means that some broader objectives, e.g. creativity, planning or teamwork, are already addressed in other programmes, run by schools. A first overview is provided by Lackéus [19]: *Entrepreneurial attitudes*: self-confidence, self-efficacy, sense of initiative, ambiguity tolerance, perseverance; *Entrepreneurial skills*: creativity, planning, financial literacy, managing resources, managing uncertainty/risk, teamwork; *Entrepreneurial knowledge*: assessment of opportunities, identifying with the role of an entrepreneurs – self-reflection, how-to knowledge (accounting, finance, marketing and communications)

## 3.2 Facilitation and Evaluation of Early Entrepreneurial Education

The EEE approach as developed in the DOIT project builds on the advantages of maker pedagogy since its effect on most of the above mentioned attitudes, skills and knowledge is promising. However, it is not meant to replace existing EEE such as entrepreneurial games or companies [18] but adding to these more traditional settings. Specifically, the focus of DOIT is on social entrepreneurship, assisting children between the age of 6 and 16, in their path from the ideation phase with the identification of a "problem" from their life worlds to calibrating options for businesses based on their inventions. The programme will be tested in 10 different pilots across Europe with 50 children each, thus involving 500 children in total. The following table (Tab. 1) gives an overview of the programme elements.

*Table 1: DOIT programme elements of early entrepreneurial education (EEE)*

| **EEE elements** | **Description of possible activities** | **How the activity could be supported** | **Evaluation dimension** |
|---|---|---|---|
| 1. Motivation (Do it because you can) | Students get motivated by early successes or by envisioning the scope of their possibilities | Presenting/telling success stories that motivate, e.g. by peers | Self-confidence<br>Self-efficacy<br>Sense of initiative |
| 2. Co-design (Do what matters) | Students are asked to collect and select potential ideas for innovations, this includes methodologies and approaches to identify the true roots of a problem, e.g. talking with relevant stakeholders | Methods and Materials to detect true roots of a problem, Creativity tools | Self-confidence<br>Sense of initiative<br>Creativity |
| 3. Co-creation (Do it together) | Students will make the project a reality collaboratively – including | Planning methods<br>Interdisciplinary group | Creativity, sense of initiative, planning, |

| | | | |
|---|---|---|---|
| | more knowledgeable others (entrepreneurs, makers). | working | managing resources, managing uncertainty/ risk/ teamwork |
| 4. Iterate (Start it now) | The development of projects is focusing on concrete prototypes and their continuous improvement. | Lean prototyping methods using different materials, understanding the decomposition of design challenges | Teamwork, creativity, managing resources |
| 5. Reflection (Do it better) | Within and after the development of the projects, students are asked to reflect their work and to get and give feedback for better (future) results. | Moderation skills; Reflection and feedback phase; sharing of failure experiences | Assessment of opportunities, managing resources |
| 6. Scaling (Do more of it) | Depending on students' age, project results are brought to a bigger group of users. | Developing plans for scaling. Testing the robustness of a solution if replicated multiple times | Assessment of opportunities, financial literacy, managing resources, managing uncertainty/risk |
| 7. Reaching out (Do inspire others) | Students are asked to share their ideas and projects to a wider public | Public presentation and sharing of the idea and the (success) story | Role of entrepreneurs, entrepreneurial career options |

The evaluation method is based on a mixed method approach, with quantitative and qualitative measures. It follows a pre-post design, comparing the baseline data before and after the programme, where possible. For some of the above listed dimensions standardised psychological assessment tools are available, for instance, for measuring creativity (e.g. TSD-Z) and self-confidence (e.g. CFSEI-3) [20, 21]. For others, a self-rating survey will be developed to cover dimensions such as planning capacity or the perceived role of entrepreneurs. Not for all dimensions and EEE elements a pre-post comparison is feasible, e.g. for the assessment of opportunities or teamwork. For these, qualitative instruments will be used along the path accompanying the different programme elements. Interviews with facilitators and children will be carried out to understand if and how children identify with the role of entrepreneurs, how the deal with uncertainties or think of entrepreneurial career options. Semi-structured interview guidelines based on critical incidence technique (CIT) steering self-reflection and self-evaluation will be developed for interviewing two (randomly selected) children per pilot.

Furthermore, an artefact analysis of the developed prototypes will be carried out.

Facilitators will be asked to fill in a researcher diary at various occasions and will be interviewed after the programme reflecting based on their observations throughout the programme and on their dairy entries. With qualitative content analysis software the qualitative data will be analysed and complemented with the quantitative analysis constitute a rigorous evaluation framework.

# 4. Conclusion and Outlook

The argument that formal education in general and early entrepreneurial education in particular would benefit from making and the maker pedagogy is not without foundation but empirical data for grounding these claims are lacking. Setting goals and devising paths to achieve them, collaborating with others, in project based learning environments are typical characteristics of maker work as well as entrepreneurial activities. However, making as subject has so far not been introduced to formal education settings - with a few exceptions. The project DOIT constitutes an attempt to bring making and social entrepreneurship education together and to analyse in sound and rigorous manner its effects on the development of entrepreneurial skills, attitudes and knowledge. Thus, we will systematically evaluate the DOIT programme based on mixed method approach combining qualitative and quantitative measures and contribute to the science base as empirical insights into the effect of maker pedagogy in reference to opportunities and constraints are currently lacking.

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