Project Deliverable

Entrepreneurial skills
for young social innovators
in an open digital world

DELIVERABLE 6.5

DOIT Impact Estimations

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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 deliverable presents short- and long-term impacts as well as a matrix of four forward thinking pathways for replicating and further improving DOIT activities. Methodologically the deliverable is based on four group discussions of approximately 90 minutes each.

Each discussion was prepared based on the up-to-date reporting of the participating organizations during several evaluation rounds of pilots and roll-out activities. The discussions were semi-structed and allowed enough room to follow up on emerging topics, so that each discussion developed its own focus.

Areas of long-term impact are discussed in more detail and include aligning the DOIT Learning Program with the curriculum; allocating time to workshops; structuring places and materials, building-up support capacity for the DOIT Programme and creating an entrepreneurial mindset.

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1. Introduction

Interest in impact estimation is increasing as more research and innovation is funded in order to boost resilient societies and renewed economies. Research is expected to initiate lasting change, which is best achieved if the activities of the project are sustainable, replicable and scalable. The purpose of this deliverable is to estimate the impact the DOIT project will have over the coming years. As part of the impact estimation we will also discuss barriers and enablers, influencing the unfolding of impacts, and present pathways for DOIT-like activities in the future.

Making as an activity is often described as a way to ‘democratize invention’ (Blikstein, 2013a), this characterizes well the importance of making for learning, tapping into students’ creativity and problem-driven tinkering. Students are encouraged to learn by trial and error as well as looking for the bigger picture in terms of societal practices that need changing in order to get on top of a particular challenge. Today’s challenges related to the environment, health or society are complex, often to a degree that stops youths from engaging with these issues (Calmbach et al., 2016). Making puts a product or service idea in the center around which students can experiment and test their ideas. This way, addressing complex issues becomes more feasible and students can experience first-hand that designing and prototyping is an option for everybody. However, although the potential of making-based learning is known for many years already (Blikstein, 2013b), schools and education providers offering such opportunities are still lacking. Hence, the collaboration between maker spaces and schools in the context of DOIT helps to push for systemic impacts, making provisions that allow for easy integration of making into schools’ curricula.

Beside the positive effects of making-based learning, DOIT also aimed to capture the benefits of social innovation and social entrepreneurship. Still being a quasi-concept, social innovation can be defined as a new combination of social practices, able to respond to a social need more effectively and efficiently than existing solutions (Hochgerner, 2012). Maker spaces are often seen as places where consumerism is challenged and youths is encouraged to look beyond the surface of a product, think about the environmental impact products can have and whether it can be repaired or if valuable materials can be reused in one way or another. As such, maker spaces are locations well suited to learn about sustainability and develop socially innovative solutions which are not limited to technical novelties but include awareness raising around societal challenges, actively supporting communities of concerns and generally promoting a responsible way of living (Unterfrauner & Voigt, 2017).

Starting points for this deliverable are the evaluations of pilots (D6.2 and D6.9) as well as the evaluations of the roll-out activities (D6.3). Methodologically we conducted four small group discussions of approximately 90 minutes each with a maximum of four pilot organizations. Each discussion was prepared based on the up-to-date reporting of the participating organizations. The discussions were semi-structed and offered enough room to follow up on emerging topics, so that each discussion developed its own focus (e.g. how to meaningfully embed ‘entrepreneurial thinking’; how to sustain interaction in communities resulting from the DOIT pilots; etc.).

Consolidating the findings of this deliverable, forward thinking pathways are formulated to show a variety of options for educating Europe's entrepreneurial youths. The deliverable is structured as follows:

- Chapter 2 introduces the impact estimation framework, including impact areas and involved communities such as learners, teachers and businesses; this chapter also describes the data collection method via group interviews.
- Chapter 3 has three main parts, presenting the findings of the interviews. First, we distinguish between short- and log-term impact estimations and then we present a matrix, elaborating four different options for how to replicate and improve DOIT activities in the future.
- Finally, chapter 4 draws conclusions, outlining the conditions under which DOIT activities can not only be replicated but potentially offered at a much larger scale.

2. Impact estimation framework

The impact assessment framework is based on the objectives and evaluation strategies outlined in the first deliverable of the evaluation work package 6. In D6.1, we asked pilot partners to broadly describe their pilots' relationships with the four **expected impact areas** (*social, educational, economic and environmental impacts*). During these short interviews we realized pilots' need to first 'frame' specific pilot activities in relation to these impact areas in order to elicit their social innovation potential and their applicability to entrepreneurial thinking.

The baseline for impact estimation is often the classic model of inputs → activities → outputs → impacts as displayed in Figure 1 (Luoma et al., 2011). The figure describes clearly the differences of the different levels:

- Inputs are all resources required to implement an intervention or a program. Talking about the DOIT Programme this includes facilitators, facilities and equipment as well as the time participants can invest in the DOIT Programme, for example, we set a minimum of 15 hours contact time in total. Soft factors can also be a required input, for example a network of SMEs giving feedback to DOIT outputs.
- Activities are the actual processes transforming inputs into results at different levels. Table 2 provides a high level overview of activities in terms of numbers reached, topics and number of facilitators.
- Results at the level of the DOIT Programme, competitions or trainings are outputs.
- Results at the level of the target group (e.g. increased creativity or self-sufficiency) are outcomes.
- Results at the societal level are impacts (e.g. contributions to the emergence of novel business ideas or consumer trends).

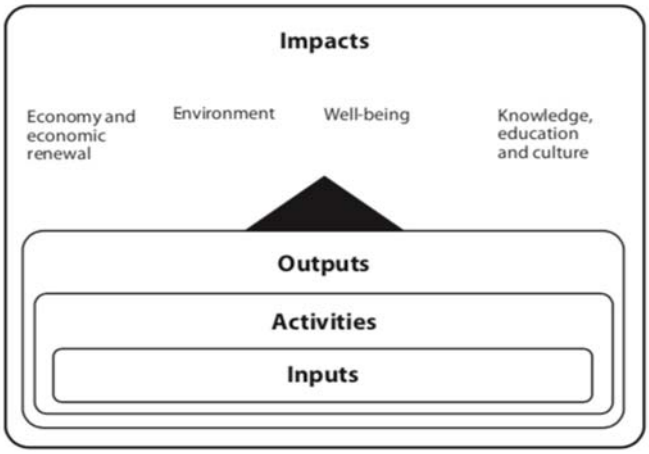

Figure 1:Inputs, activities, outputs and impacts (Luoma et al., 2011)

Following a more comprehensive impact definitions based on the 'social impact navigator' a guide developed by the social impact partnership, the World Bank and Bertelsmann Foundation (Kurz & Kubek, 2016).

Impacts are positive or negative changes produced by an intervention – directly or indirectly, intended or unintended – in the context of its environment, as it interacts with the multiple factors affecting development change. Impact occurs at multiple levels and timeframes – there can be short-term, intermediate and long-term changes resulting from an intervention.

The definition above highlights that impacts can also include unintended consequences as well as consequences materializing relatively quickly. This matches our understanding of DOIT activities as **open processes,** with many factors not being under the control of the project having positive or negative influences on the success of these activities.

How and when impact occurs differs depending on the type of intervention and the context. Even though impact refers broadly to changes at the societal levels, in most cases a reference to an entire society is not meaningful nor feasible, hence a sub-section such as a neighborhood, city management or a large network of organizations is already a suitable scope. Also, impact estimates are not directly bound to citizens experiencing a DOIT workshop in order to benefit. For example, better air quality, more safety on busy roads and avoiding waste is to benefit all people in a region.

2.1. Impact areas

In order to specify the impact areas, we looked into the specific task descriptions collected under Task 2.4 as well as the evaluation report D6.9. All pilot topics were designed around Sustainable Development Goals (UN SDGs[1]). However impactful activities went across multiple areas. For example, groups of children built prototypes to improve road safety or reduced water use. While these topics were addressing the SDGs of 'Healthy life styles' and 'Responsible consumption', many pilots also addressed the SDGs of 'reduced inequalities' and 'quality education', mainly by the way

[1] https://sdgs.un.org/goals

they implemented their activities. Being aware of inclusive program designs, ensured that participants were not excluded due to a lack of prior knowledge, no access to needed equipment or narrow task designs.

Hence, independently of the specific pilot topics, we asked partners for the way they designed and implemented their DOIT activities, while looking for impacts in the following areas:

→ Social impact includes all consequences for living conditions (health, safety, nutrition, air quality, work live balance).

→ Environmental impact comprises any effects on environment like waste production, the use of energy, water or other limited resources. In many cases there are also overlapping impacts in that riding a bicycle reduces the CO^2-footprint and also strengthens people's health.

→ Economic impact is related to value creation in a wider sense. Monetary aspects do play a role as any activity is easier to sustain if it can cover its own costs. However, since a core theme of DOIT is social innovation, awareness of the common good and shared value creation is an important factor too.

→ Educational impact refers to the accumulation of knowledge on the site of pilot organizations (e.g. manuals, workshop materials) as well as new competencies gained by the participants. Also included are changes of mindsets or organizations changing their internal cultures (e.g. changing assessments or teacher evaluations).

2.2.Impacted communities

Making (i.e. digital fabrication, hands on problem solving etc.) is often displayed as a means to democratize the means of production (Gershenfeld, 2012). However, that is not to happen automatically, and individuals and institutions need to adapt their way of working, innovating the way we learn and consume. The Deloitte Media Centre (Media, 2014) has identified the following trends affecting communities, thereby differencing between consumers, businesses and educators:

i. Flexible ecosystems will enable more collaborative ways of producing and consuming. Practically that means that consumers have a greater share in customizing and personalizing products at lower costs. E-Nable[2], a company making community -sourced prosthetics available is already disrupting the traditional market for prosthetics with prices a hundred times lower than usual offers. Of course, bringing maker products to the market is not only a question of pricing but also of knowledge, i.e. taking measures to adapt a prosthetics and knowing how to run a 3D-printer. The DOIT pilot run by the University of Zagreb (UZAF) was active in that area.

ii. Dedicated platforms will enable businesses to grow by managing infrastructure services (e.g. contracting, supply chains, logistics). Eventually barriers to entry are lowered so that even smaller badges of maker

[2] https://enablingthefuture.org/

products can be produced economically. Makers having an in-depth knowledge of local peculiarities and needs can create viable solutions to niche problems, further enhancing regional commerce. Because of the limited time span of the DOIT Programme, their aims exclude starting small businesses. However, presenting the outputs of their maker activities, makers often included a big picture scenario of how to bring their ideas to the market, including an overview of costs and potential beneficiaries able to finance the further development of maker projects.

iii. Maker spaces become increasingly part of the educational landscape. Either because makers visit schools with pop-up maker equipment or because maker spaces open their doors for schools with dedicated programs. Hence, educators and students get more opportunities to increase the practice part of their learning experience. More importantly, learning challenges can be taken from real world issues, makers are experiencing at the time. Many examples of practice-driven learning with the DOIT Programme were submitted to the DOIT competition[3], which is about finding good solutions to societal problems. Submissions included farmers receiving a warning about rising water levels or temperature control for turtles during hibernation.

There are also several barriers to these trends, as also highlighted in the Deloitte Report (Media, 2014). *Prosumers,* i.e. people consuming, designing and producing at the same time, who want to customize their products might struggle with incompatible tooling and materials, so that manufacturing as described cannot be replicated locally. The same might apply to the DOIT Programme, where using slightly different equipment (e.g. soldering stations, 3d -printing software) can lead to varying learning experiences. Remaining agile in an environment where a great variety of options exists still poses a challenge, as long as the knowledge about compatible set-ups is not widely shared.

Educators might find that making-based learning is difficult to integrate into existing curriculums. That might be linked to the open-ended nature of making activities, going against standards-based assessment procedures. However, as we could see in some pilots in Belgium and the Netherlands, there is an effort at the school level to accommodate open, experiential learning in makerspaces, for example by having practice days at school.

2.3.Planning and asking for impacts

Already during the design phase of the pilots we addressed the issue of impact generation during a project meeting in Billund. During a series of 11 one-to-one interviews with each pilot partner, conducted jointly with WAAG between Jan – Mar 2018, we asked participants to think of their pilots in three ways (frames):

I. What interactions define the practical parts of the pilots? Broadly speaking, this was the maker part of the pilots. This part included the story beyond their workshops and the sort of input they would provide.

[3] https://www.doit-europe.net/challenge

II. Secondly, we asked them to elaborate the 'social innovation part' of their story. Here we asked them to describe the target group in societal terms, e.g. people working on alternative ways of transportation or communities with concerns over their regional air quality (rather than referring to local groups of people using bicycles or measuring air quality).

III. Lastly, we asked for the entrepreneurial part of their pilot story. At this point, it was clear that large scale change (e.g. involving the neighborhood or other classes at children's schools) would not happen automatically. So pilots should find ways to support design activities that help children understand the idea of scaling up and enabling impact outside the project.

We emphasized the need to link up inputs, activities and impacts as described in section two and these early interviews aimed to facilitate some 'forward thinking' (Dorst, 2015) in order to check whether pilot designs are feasible, address the agreed objectives of the DOIT program as well as whether they are using the same core concept. After having this shared understanding in place, i.e. knowing what we mean by entrepreneurial thinking and social impact etc, we organized four group interviews (between the 23rd and 29th of June) to discuss possible impacts with all pilots and work on the impact narratives presented in the next section.

Table 1: Overview of group interviews (June 2020)

Date	Participating Partners	Duration
23-06-2020	MEPF - Mediale Pfade e.V. (GER) SRFG - Salzburg Research Gesellschaft (AT) WAAG - Waag (NL)	97 min
24-06-2020	UCSyd -University College South Denmark (DK) EDUC - EduCentrum (BE) ZSI – Centre for Social Innovation (AT)	92 min
24-06-2020	UZAF - University of Zagreb (HR) RampaLab - Rampa Lab (SI)	86 min
29-06-2020	IAAC - Institute for Advanced Architecture of Catalonia (ES) LUT - Lappeenranta Lahti University of Technology (FI)	78 min

At the time when we conducted the group interviews, a number of reports evaluating and documenting the outputs of DOIT were already available. Hence, reviewing the existing documentation provided a good overview of the pilots (activities implemented, demographics of the target group and particular insights). The following reports were used in preparation of the group interviews.

Table 2: Overview of deliverables informing the impact estimation process

Deliverables reviewed	Relevant contribution to identifying possible impacts
D4.3 - Report on pilots D6.2 - Evaluation report pilots 1 D6.9 - Evaluation report pilots 2	1,002 children overall were reached in the two pilot phases. The evaluation dimensions included: *creativity, self-efficacy, teamwork and collaboration skills, dealing with uncertainty, perseverance, empathy and knowing others' needs, motivation and sense of initiative and planning and management skills*. Also, pilot conditions were evaluated such as the age and the gender of the pilot facilitators, as well as the ratio of participants per facilitator, ranging between 3 participants per facilitator up to 14.6 children on average per facilitator.
D5.5 - Report about DOIT facilitator trainings (YPA)	940 participants were trained from 10 different European regions (Austria, Belgium, Croatia, Denmark, Germany, Finland, the Netherlands, Serbia, Slovenia and Spain). Most of the facilitators were teachers, with 260 primary school teachers and 171 secondary school teachers. The facilitator training activities can have different duration: ranging from workshop session (e.g. 120 minutes) to full days of workshops. The aim of the training was to familiarize makerspace employees and other external participants with the DOIT program and the implementation of social innovation projects, as well as to discuss ways with which these projects can be integrated into the participants' day-to-day business.
D5.4 – Describing roll-out activities / D6.3 - Evaluation results roll-out phase	During the roll-out phase 4,030 children were reached with hands-on activities and a further 13,746 children were introduced to the DOIT program in general. The evaluation concerned learners, workshop facilitators as well as topic selections and findings were reported for ▪ Descriptions of roll-out activities with children ▪ Success criteria for roll-out activities with children ▪ Formats for facilitator trainings ▪ Success criteria for facilitator trainings ▪ What worked well? / What did not work well? The deliverable also included valuable lessons from working:

	- in geographical regions (different countries, urban versus countryside, disadvantaged versus developed neighborhood) - in diverse settings (different topics, in school, outside school) - with diverse target groups (children with disabilities, children with disadvantages groups, minorities, working with girls, etc.)

Given the richness of upfront information, the group interviews started right at the level of estimating outcomes and contributions to societal changes (impacts), which were then backed up by going back to the description of inputs and outputs.

A typical flow of questions is depicted in Fig. 2 below, 'outputs' are related to actual activities, the number of participants and their satisfaction, and 'outcomes' are related to the changes in knowledge, attitudes and behaviors. Finally, 'impacts' are the anticipated contributions to issues on a societal level.

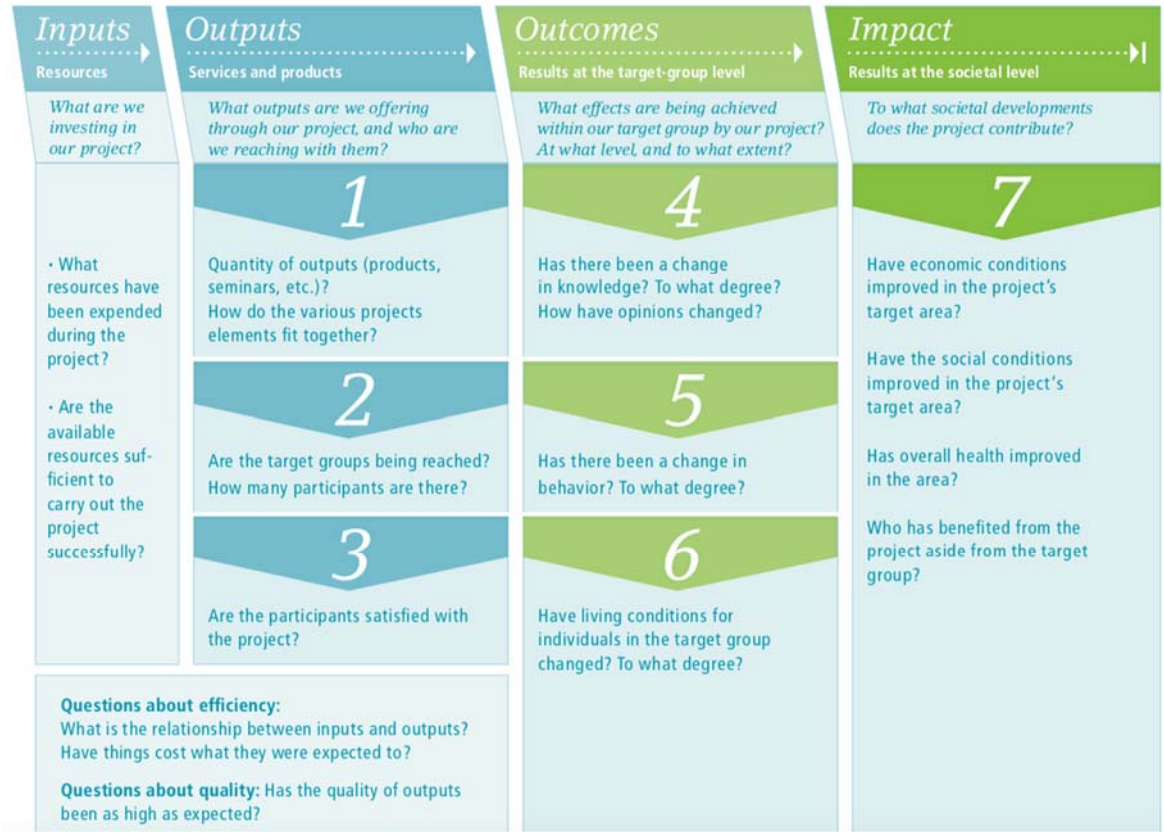

Figure 2: Typical questions for an impact analysis (Kurz & Kubek, 2016)

Our group interview questions centered around changes of knowledge, attitudes, behaviors as well as any changes of relevant conditions within the pilot regions. Overall the group interview had two parts:

→ Short-term impacts (section 3.1): any changes achieved during the past months and weeks and

→ Long-term impacts (section 3.2): any changes the pilot partners could envision due to developments they had seen during the pilot workshops.

In accordance with the project's major objectives we started with a set of concrete questions, out of which we developed bigger stories using a number of follow-up questions:

- How did facilitators perceive the role of locations and settings?
- How did facilitators fit their activities with curricular conditions (if applicable)?
- How did you build up support capacity for maker-education in the future? How scalable is this process in your opinion?
- How did you integrate entrepreneurial activities (e.g. final presentations; inviting outside people with an entrepreneurial background)?
- How well could entrepreneurship, social innovation and transferable skills be fitted into single activities? Or did you find a collection of modules more appropriate?
- How and when did you switch between guided and self-directed or autonomous activities?
- How did you integrate diverse learner characteristics? What difference did diversity of learners make, if any?
- What impact could come from 'meta learning' (e.g. planning skills; being able to coordinate intra-group activities)?
- Thinking about the learning ecosystem (i.e. the combination of learning in schools and at home etc), do you see recommendable ways how workshops could be followed up?

Not all group interviews covered all questions equally and participants could choose to answer some aspects with more details than others, in accordance to the strengths of their pilots. For example, the Danish pilot, working with the college for teacher education, was well placed to talk about DOIT's impact on curricular alignment, whereas the pilots in Serbia, Spain or Germany had more experience in organizing non-formal workshops, where children and youth directly taggled issues they saw in their neighborhood (e.g. designing a playground or avoiding waste in the streets).

2.4. Limitations of impact estimations

As stated in the beginning of chapter 2, impacts are less about what project partners do while implementing the activities promised in the description of work and more about lasting change in the context of project activities. In general, there are known challenges (Luoma et al., 2011) of impact estimations, which also apply to the DOIT project, such as (a) *causality*, relationships between inputs, activities and impacts are often unclear and non-linear; (b) *attribution*, impacts might be due to other factors (e.g. novel technologies, competitions or bootcamps), not being elements of the DOIT program; (c) *incidental learning*, not all learning is intentional and planed, so naturally learning

happens outside DOIT activities too, including tacit experiences, not associated with learning (e.g. visiting a museum, cooking or doing sports) (Marsick & Watkins, 2001).

Additionally, the DOIT project also faced complications in reaching out to ministries and organizations of teacher education during the final stage of the project in 2020, hampered by the Covid-19 pandemic crisis. Especially when lobbying for change, personal contacts and live presentations play a crucial role, since this way a novel concept is easier to comprehend and questioned. As shown in the following Figure 3, our impact estimation framework started with clear impact areas (social, environmental, economic and educational) and specific target groups (learners, educators / policy makers, businesses and consumers). In general, our impact areas also resemble the goals of the work program as described in the final report on ‚Indicators on Entrepreneurial Learning and Competence' (Chatzichristou & Henry, 2014).

Table 3: Mapping of impact areas and program objectives

Impact area	Programm objektives
Education, Society	Improving social innovation and social entrepreneurship attitudes, skills and behaviour, equally for girls and boys
Education	Boosting the innovation and entrepreneurship education capacity in facilitators and institutions
Economy	Contribution to higher youth employment, to new market creation and new jobs (long term)
Education	Influencing national entrepreneurship education policies and strategies in Europe as to benefit the largest number of young innovators
Economy, Society	Impact / link to open innovation paradigm
Society	Impact/ link to gender issues
Research	Impact / link to science & humanities research

As shown in table 3, most items are mapped to 'educational impacts', which consequently take the center stage when describing long term impacts in chapter 3.2. This can be seen as a limitation since 'economic impacts' have been estimated less frequently and businesses played only a marginal role in the pilots. However, on the upside, the educational impact was much more diverse than anticipated including learnings for how to set up educational maker-spaces or how to guide through creativity promoting workshops. We also found that keeping the difference between outcomes (learners produced x prototypes) and impacts (schools integrate prototyping into future course offerings) was not easily maintained, hence we started with discussing short term impacts which we could then use as anchor points to point back at the difference between target group specific outcomes and societal implications.

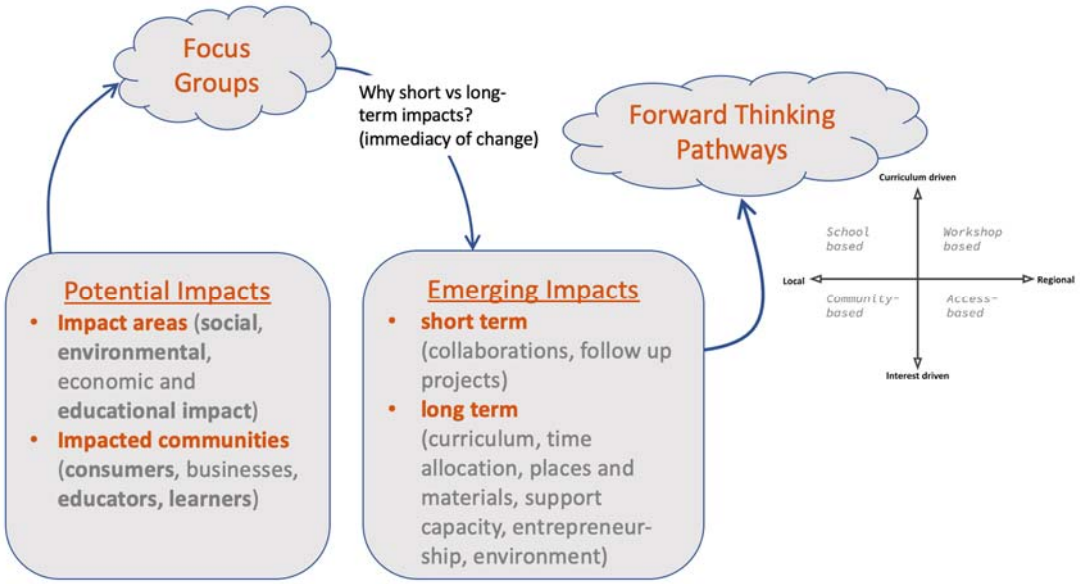

Figure 3: From potential to emerging impacts

Still business aspects around social innovations and skills relevant to future jobs were still promoted throughout the DOIT Programme. Some business-related skills were part of the workshop designs, including things like managing a project or presenting an idea / prototype to others. However, as we will elaborate in more detail in section 3.2.5, these aspects were not primarily seen as business skills and helping others was not directly linked with job creations, even though – depending on the age group - some workshop facilitators hinted at the fact that sustaining such an effort would require a business structure that generated some income.

The group interviews during which we asked pilots about their impact estimates did not include questions about research wherefor they are not explicitly listed in the long-term impact section. Still, with 35 conference presentations, 11 Press releases and 15 Maker fair visits, we can reference a solid contribution to social science research around entrepreneurial learning and maker education. Future indicators of how these contributions impact would be a citation analysis of DOIT publications. However, beyond impacting the academic community, educational innovations need to be promoted in a wide range of communities. For a full overview see DOIT's "D7.4 Final Communication, Disseminations and Exploitation Report".

3. Estimating impacts

The process of estimating impacts is based on the expert knowledge of those who designed and implemented the DOIT pilot and later on coordinated the roll-out of the DOIT Programme. Given the challenge that many impacts get realized only considerable time after the project has ended (e.g. carrier choices or the emergence of job creating enterprises), it would need a longitudinal study to assess the exact impact of an intervention. To overcome this challenge, we use group interviews to capture experts' estimates of impact in conjunction with their descriptions of impact chains. During the interviews it became also clear that impacts do not follow automatically, but that many conditions need to be in

place so that DOIT experiences can unfold. The context for each pilot was different, starting with the organizations organizing the pilots we had different areas of expertise, with some partners being more experienced with entrepreneurial education and others being specialists in maker education. Similarly, age, school types, the overarching educational system and the contact persons on site (if pilots collaborated with schools) played a huge role in how the DOIT program was implemented. Hence, the 'impact chains' presented in this chapter do cannot follow a simple cause-and-effect logic but will also contextualize the estimated impact in terms of enabling and hindering factors.

As highlighted in the impact estimation framework (chapter 2), impacts include short-term as well as long-term changes the DOIT project was contributing to. The next two sub-sections (3.1 and 3.2) will discuss these impacts, followed by a brief outlook on 'Forward thinking pathways' (section 3.3).

3.1. Short-term impacts

We initiated the interviews with specific questions around possible short-term impacts.

- new collaborations,
- emerging follow-up projects,
- sourcing materials and equipment for maker education,
- arranging maker-education support from external facilitators or training internal personnel.

The underlying reasoning for this topic-selection is that educational initiatives, in order to unfold their impact, need a variety of resources (networks, finances, knowledge etc.). These resources, seen as an investment, can originate from various sources such as *collaborations*, where different partners can share their resources and expertise or from training arrangements, where organizations decide to build up more internal resources.

Short-term impacts are those changes, pilot partners could immediately identify in their own environment and associate with their work in DOIT. Most notably, this included a wider range of collaborations or more intensified collaborations (3.1.1) as well as new projects (3.1.2), allowing pilot partners to continue research in the field of making-based education.

3.1.1. Increased Collaboration

Better and more collaboration impacts the wider network in the national educational ecosystems. All stakeholders can be potentially impacted by better collaborations in the sense that they discover new ways of implementing, coordinating or supporting opportunities for children to develop 21st century skills (Trilling & Fadel, 2012). A case in point is the University College of South Denmark, the partner could significantly intensify collaborations with schools. On top of sending their students to internships, they now collaborate more frequently on small projects. Additionally, this influenced also the thinking of the municipalities who were coordinating the placements of the internships. More concretely, discussions started with the municipalities on a management level in order to figure out how a DOIT like

mindset could alter the way internships are organized today. During these discussions, there was a recognition that new formats would need new regulations around opening up learning for making-inspired practices. This rethinking of regulations touched upon the way external people can contribute to the educational process as well as the way children get access to maker equipment and materials.

EDUCenter already has a tradition and a network for collaborating with schools, collaboration overall intensified as schools told other schools about the DOIT project. Another boost in collaboration came through the changes implied by the COVID-19 pandemic. Alternative ways of learning were looked for and the experience driven approach provided by DOIT was one of these accepted alternatives. At the same time, teachers were also looking for parents who had maker-relevant skills and interest to support such activities. Overall, teachers started to take more advantage of the possibility to follow the curriculum by organizing a project around it.

Compared to other pilots, the Austrian pilot experience (ZSI) with schools did not extend to other schools or municipalities. However, towards the end of the DOIT pilot activities stakeholders realized that they had shared topics and concerns, which could enable more frequent collaborations. For example, the municipality started providing two internships for students from the school and the local printing press supported a project running a school newspaper.

WAAG had already started with making-based educational projects by collaborating with 22 local libraries in Amsterdam. The DOIT project intensified this collaboration, also fine-tuning the way they bring workshops to parts of the city that are less well off. WAAG realized that workshop implementation had to be adapted in some neighborhoods, if children had less self-esteem or confidence to make decisions. So, these workshops required to focus more on personal development and less on technical skills or cognitive knowledge.

Zagreb University (UZAF) intensified their collaboration with 2 primary schools in rural areas as well as a school with kids with learning disabilities. During the roll-out phase the Zagreb pilot also collaborated with three teacher education faculties and the 'Society of teachers and technical culture', comprising more than 100 teachers. Their focus is on getting the message out that educational innovation can go a long way applying new methods and processes and that access to equipment is not always the biggest challenge.

Increased collaboration did also include parents who got involved in projects, such as the 'Playing with Light' installation in Barcelona. However, clearly separated roles for intergenerational projects are essential, otherwise there is a risk that parents – with good intentions – intervene in the learning process and prevent children from making their own experiences.

Intensified or new collaborations with schools were most frequently mentioned, since they were a fitting coordination point for formal as well as non-formal pilot arrangements. This shows the importance to tap into existing infrastructures in order to maximize impact.

However, impact went beyond schools and students when presenting the concept of DOIT during scientific conferences, at maker places (SRFG), Maker Fairs and art festivals[4]. This, in the case of LUT, led to an idea to present and distribute DOIT materials to a national teacher collaboration network. Similar developments were also seen with IAAC and other pilots, reporting that individual schools decided to incorporate DOIT materials in their educational programs. These developments highlight the localized character of educational innovations in the case of the DOIT project.

3.1.2. Follow-up projects and related activities

At least two partners (ZSI & LUT) reported successful applications for an Erasmus-Plus project around maker-education and integrating art in STEM education, increasing the attractiveness of technical education. Other related activities included the support of projects where making and entrepreneurial competence fitted well. For example, Mint:Labs[5] focused on typical STEM activities, but with the help of the DOIT project some follow-up activities were to enrich activities with an entrepreneurial and innovation dimension (SRFG). The underlying idea was also to provide learning opportunities in a variety of neighborhoods.

At WAAG it was agreed that a DOIT workshop developed by Mediale Pfade in Berlin (the Future Monster Lab) will also be implemented in Amsterdam. So, this kind of follow-up is a perfect way to demonstrate the re-use and adaptation of workshop materials in a different context, using the library makerspaces supported by WAAG. The demand for educational maker workshops is also influenced by a long-lasting shortage of teachers (unrelated to Covid-19), so that for one day per week, students can visit organizations outside school, including maker spaces.

Mediale Pfade started a follow up project[6] in collaboration with 'Save the Children Germany', implementing maker-activities within a primary school in an area with children from low socio-economic backgrounds. Especially the in-depth experience with the DOIT Programme helped kickstarting the implementation of school adequate maker spaces.

Furthermore, Kersnikova contributed to a national project, financed by the European Cohesion fund, which was about curriculum changes and teacher education. Here experiences gained during the DOIT Programme as well as DOIT materials were extremely helpful.

Making-based education emphasizes the need to switch from a focus on educational technology (e.g. 'using a 3d printer because there is one') to project-based learning, giving priority to a more holistic learning objective (e.g. creating friendly neighborhoods) (MEPF). This problem-focused way of learning also makes clear that technology is not only serving economic growth but also empowering people (WAAG).

[4] IAAC for example presented the DOIT Programme during the festival of light https://iaac.net/iaac-llum-bcn-2020/

[5] https://www.wissensstadt-salzburg.at/mintlabs/

[6] https://medialepfade.org/projekt/makerspace/

3.2.Long-term impacts on the educational ecosystem

Long-term impacts are presented with plausible lines of arguments. Unlike short-term impacts, where the changes can be observed, long-term impacts need time to unfold, hence they cannot yet be concretely measured or pinpointed to a specific societal change. Nonetheless, any improvement in creativity or self-efficacy arguably makes a difference in the future development of children and youths.

Long-term impacts presented in this section are emerging topics from the group interviews (see Table 1). For that, relevant audio snippets within the interviews were annotated and clustered according to the following six topics:

1. Aligning the DOIT Programme with the curriculum;
2. Allocating time to the DOIT Programme;
3. Structuring places;
4. Building-up support capacity for the DOIT Programme and
5. Creating an entrepreneurial mindset.
6. Promoting environmental awareness

These 5 topics were also seen as the main impacts of DOIT pilots and roll-out activities on the educational ecosystem, including formal and informal learning. The focus of these topics lies mainly in the educational realm and less in the areas of economic or environmental impacts. However, given the age group and the fact that most pilots operated within or with schools, this focus was to be expected. Moreover, we see education as a transversal impact enabler, meaning that well implemented the DOIT Programme increase students' self-perception and problem-solving skills, which at a later stage can generate an impact in a different context (e.g. when working with a care provider or an environment protection organization).

3.2.1. Aligning with the Curriculum

Most pilots made the experience that the DOIT Programme could be well integrated in project weeks or project days etc. However, that was also seen as something opposed to learning in subject-based classes, being the more important part of school. Initiatives reducing the tendency to oppose projects and subjects, are developments to enhance subject-based learning with a focus on competencies (Germany) or phenomena-based learning (Finland)[7]. Both trends, emphasize the need to implement curricular developments locally and flexibly, so that teachers can identify observations and local experiences as starting points for learning. Most importantly, project-based learning doesn't rule out subject-based learning, but teachers are encouraged to find the necessary embedding of topics in projects to make learning more purposeful, e.g. in terms of problem solving (Symeonidis & Schwarz, 2016). So MEPF negotiated a weekly time

[7] https://www.teachermagazine.com.au/articles/what-is-finlands-phenomenon-based-learning-approach

slot of 2 hrs under the condition that they would show afterwards how various curricular topics were attached to their the DOIT Programme.

The idea of project-based learning is not new to schools, however, there are different ways of implementation and some teachers are better able to open up the curriculum than others. In some instances, it already helped to bring teachers together in order to discuss the integration of several subjects into one project, so that there is no competition between subjects fighting over students' attention. Additionally, workshops with teachers can demonstrate the potential of these different approaches, but then it's still a sizeable effort to integrate making with specific subject matters. From experience, only the very interested teachers would invest that extra time. So there is certainly still a gap in terms of facilitating the transition to making-based education and supporting teachers in creating their own materials. One way to narrow this gap is the Toolbox[8] developed by the DOIT project, listing a huge array of activities, described in terms of the objectives of the activity, the suggested age group as well as the materials needed. The Zagreb pilot, for example, found the toolbox as the perfect addition to their Fabbox, containing mobile maker technologies. Whereas the Fabbox included the technical knowledge, the DOIT Toolbox included the methodology around using these technologies.

Similarly, pilots reported that a shift to 'real projects' was a good strategy to break up traditional cycles of 'teach and learn', in that sense pilot partners had workshops with teachers exploring ways of how art and making can provide context for subject matters (Rampa Lab).

A concrete example how DOIT impacted teacher education was reported by UCSYD: the experiences and the DOIT Handbook will be integrated into the current teacher education curriculum. However, many pilots still saw a lack of overall acceptance of maker-education as an equivalent learning mode. Pilot partners saw tightly formulated learning objectives at odds with the openness of the actual outcomes of maker activities. So teachers' comments indicated that they saw the DOIT Programme as complementary to traditional forms of schooling. Though, as commented by EDUC, some teachers saw the synergies between subjects, DOIT activities and learning outcomes, for example students' progress diary could serve as input to the language class. Similar links between what had to be learned and what happened during the DOIT Programme were also discovered by math teachers around calculations and measurements needed by a particular project.

3.2.2. Providing time

Bringing teachers on board already highlighted the fact that 'time' is a scarce resource especially if no additional hours can be freed up and existing teaching obligations remain unchanged. Put differently, we see a lack of 'disruptive innovations', i.e. innovations that 'disrupt' current teaching formats and instead pile up on existing practices.

In fact, educational innovation often requires managing changes and transitions (Voigt et al., 2018), so that they can create their best impact. As mentioned in 3.2.1 it is often the teachers, who are required to re-define their professional identities. Thinking about resources in terms of skills, it's critical to adapt a 'guide on the side' identity rather than the

[8] https://toolboxadmin.doit-europe.net/react/#/welcome

'sage on the stage' position. In practice this means that impact is not created by knowledgeable teachers alone, but by learning processes which enable students to discover solutions themselves as well as to provide peer2peer support.

There was a minimum of hours per pilot required (15 hrs), but actual time arrangement varied from compressed 2-3 days to two-hour time slots per week, creating concepts, planning next steps and prototyping their projects. Impacts beyond the actual project work included changing attitudes of teachers towards technologies in the classroom in general. For example, a positive experience with microcontrollers prompted a school to invest and try out other technologies related to developing videos and supporting creativity (ZSI).

Another challenge brought up by the participants in the group interviews was the way time is planned in schools. Time as a resource is often allocated to prescribed activities with pre-defined outcomes, whereas making often includes activities with an open end as well as a diversity of ways to engage with the activity (IAAC and LUT). Makerspaces emphasized that this is not merely a semantic difference but that it also goes to the heart of being inclusive. Open workshop designs make participation possible for students independently of their interests (including gender related preferences) and capabilities. For example, some workshops produced fully functional prototypes and others, produced a mock-up where functionalities were mainly ascribed[9]. From a motivation and entrepreneurial point of view both types of outputs can generate similar impact. The skill needed on the side of the workshop facilitators is to recognize the tool that fits best the knowledge and the goal of the group.

An example how this would work in practice was mentioned by IAAC, working with Arduino, block programming is faster and easier to learn. That's important if students have no or little previous experience with programming. On the other side block programming frameworks can quickly become a limiting factor since typically text-based coding provides more flexibility.

A similar reflection applies to prototyping with the help of digital fabrication tools. Depending on the prior knowledge within the group and the time available, 3d printing could become an activity or not (IAAC). Hence the idea behind openly designed workshops is less to become proficient in either programming or 3d printing, but to spark the interest in these areas and to provide an experience where these skills have a meaningful impact on the project results so that students are inclined to continue learning also after the project timeframe (LUT).

3.2.3. Structuring places

Creating space plays a critical role for the success of the DOIT Programme. Several pilots referred to the prevalence of a 'classroom mentality' if places are not rearranged. A 'classroom mentality' describes students who showed more of a consumerist attitude, since they didn't associate the school environment with the idea of self-driven learning, responsibility and making decisions themselves. On the other side, outside the classroom, it could happen, that students struggled to find adequate norms of behavior and communication potentially disturbing the workshop. One way to address this was to have an initial workshop at the school, explaining how a DOIT workshop is different and then go

[9] For example, LUT prototypes included a swimming turtle, operating on sun accumulators, cleaning lakes and rivers by eating plastics.

outside the classroom (WAAG). This change of environment was also positively noted by the teachers who argued that later in school, students go on to have internships and need to be comfortable in different environments without an authority showing them the boundaries. Alternatively, if there was an option to organize large rooms, a student council could be involved in discussing the set-up of a place (MEPF), defining a workshop area, a teamwork area, a presentation corner etc. This also increased the ownership felt by children, who then knew how and why a space was structured the way it was. At the end, structuring the place in purposeful ways had also an impact on the participating teachers, who saw how space could be less regulated, providing more freedom to children while still ensuring the required safety.

It also became evident during the group interviews that there are many differences across Europe in the way schools have to follow a more or less defined curriculum. In general, we could observe that private schools (e.g. Evangelische Schulstiftung in Germany), had more liberties to experiment than public schools.

Summing up, in terms of creating space two different approaches could be observed, one approach was to use the facilities within the school in order to demonstrate that they didn't necessarily need to invest in new facilities, e.g. creating a fully equipped maker space (UCSYD). An observed side-impact was teachers realizing the multiple ways they could re-purpose existing facilities in ways that would support making-based education. Changes they had to make to the classroom were as simple as distributing corners to different groups and organizing the logistics of accessing tools and materials.

3.2.4. Building-up support capacity

If we define impact as a contribution to a societal change (chapter 2), then the question of scalability, i.e. whether people outside the project context can use the methods and knowledge created by DOIT, is very important. The key actions defining the answer to this question are the facilitator trainings implemented in all pilot regions. For example, WAGG enabled libraries in Amsterdam to offer maker-based education workshops by themselves in combination with schools. This way, these workshops were offered on a more regular basis, becoming part of the educational landscape in Amsterdam[10].

However, roll-out activities need to be adapted to the target group. Roll-out activities with workshop facilitators from outside the school system is different to working with teachers. Non-pedagogues have often substantial experiences from previous workshops (MEPF). Whereas, inside the formal education system, it's less a question of training teachers and more about getting teachers to reflect on their role in making-based education, which is also part of the DOIT philosophy.

Outside the workshop, also the parents recognize how a different learning arrangement can engage students which otherwise might have trouble following a teacher or who have learning impairments (Kersnikova). These groups of learners often benefit from the open learning approach, where facilitators intervene as little as possible except for

[10] In Amsterdam, DOIT was able to tap into existing efforts to establish making-based education. Hence, libraries becoming also maker spaces was not the outcome of a single project but it took multiple projects over an extended period to get there.

pointing to options when students get stuck while working on their projects. If people who started 6 years ago as students go on to do the facilitator training now, then learning through making becomes an approach that can sustain itself from within (Kersnikova , UZAF). Similarly, a group of students started a project and continued working on the topic even though the 'official' project had ended (Kersnikova, ZSI). These observations can be taken to indicate a changed attitude towards learning as an intrinsically motivated action.

Discussing the need to facilitate a robust support of making-based education, it was suggested to appoint student groups with looking after the school's computer and maker equipment, the same way student groups are already looking after the school's garden or cleaning the classrooms.

3.2.5. Creating an entrepreneurial mindset

The notion of entrepreneurship, especially for younger age groups (6-10) was much discussed throughout the project and there was a consensus that an entrepreneurial mindset wasn't about starting a company at a young age. Hence presenting the final product of the maker workshop, possibly to an audience from outside the school, and getting feedback was seen as an important step towards acting in an entrepreneurial way. The objective was that students see how their projects could transform into something else in the future and how their approach was seen as valuable and interesting by professionals (ZSI). Also, it was highlighted that entrepreneurship was not limited to the final step of marketing or selling a product but started already with recognizing challenges and needs within one's own environment and finding ways to address them with the means available. This first step included gaining convivence that one can make a difference and is not always dependent on outside authorities to get things started. Related to the process of identifying a problem, multiple pilots reported interesting thinking processes, e.g. how an awareness for an issue developed through continuous questioning. For example, water, at first glance, doesn't seem to be an issue in countries such as Austria or Croatia. But then students realized, depending on the location, water needs to be transported to rural areas where there are no water pipes. Or it might be the case that there is too much water, so that early warning systems need to be in place so that villages can take precautions.

It was also reported that the use of terminology mattered, depending on the age of learners and participating country. With higher age groups (14+) pilots made positive experiences in using the terms 'clients', 'products', 'pricing' and were able to create simulated customer relationship situations. Terms such as entrepreneurship or social entrepreneur were less favorably perceived in countries such as Slovenia or Croatia, where it was mostly associated with a person getting rich quickly and a positive contribution to societal progress was not really associated with entrepreneurship.

3.2.6. Promoting environmental awareness

Often a place implies also the availability of materials and equipment, e.g. if we think of a maker space or a textile workshop room in a school. Many pilots aimed to reuse as many materials as possible (EDUC), e.g. collecting broken electronics (MEPF) or used materials from parents. On top, the use of places can be combined, as in the case of EDUC where making-based education happened within the school as well as in a FabLab, for which the school acquired two

Fablab memberships so that teachers could go with a small group of students if any special equipment was needed. Although not explicitly put on the agenda, reusing materials for prototyping introduced youths to the concept of a circular economy where they can think of what materials they need and also how a modular design supports the extraction of materials or the replacement of materials in case something needs to be fixed.

The pilot in Zagreb highlighted that often the limitations are not so much around materials or machinery, but about very strict regulations, which inhibit changing the way education is organized. Whether there is room for trying out new things or not, depends then a lot on the headmasters and the teachers. Hence, what the Zagreb pilot was emphasizing during school visits was the message that processes are more important than resources. In fact, if needed, Zagreb could provide 'Fab-boxes', which are mobile sets of maker space facilities.

Some pilots sourced materials from schools and families, pilots involving established maker spaces already had a repertoire of materials and others made it part of the DOIT workshop, i.e. students got a budget for buying the materials they needed (LUT).

3.3.Outlook: Forward thinking pathways

The previous section presented dimensions where the DOIT Programme were likely to have an impact according to the experts implementing pilots and roll-out activities. Discussing experiences in areas such as allocating time to making, integrating making with the curriculum, adapting the available spaces, building up sufficient support and eventually encouraging an entrepreneurial mindset didn't lead to uniform answers. Providing open ended workshops was not per se better than activities aligned with specific curricular objectives; or implementing a workshop outside the school was not inherently preferable to using rooms within the school.

What we found during the interviews was that most pilots were aware of the advantages and disadvantages of their choices and were able to react to or prevent undesirable effects such as non-inclusive workshop activities or disruptive behavior. Or they could situate a workshop in terms of benefits, either promoting the development of children as whole persons or aiming for the development of specific competencies. Whereas personal development versus competence development was never displayed as an either – or choice, but something that goes hand in hand and workshop facilitators knew when to emphasize one side or the other.

In order to come up with some forward-thinking pathways we combined two dimensions that seemed to comprise most of the issues discussed into a four-quadrant matrix (Figure 6). The two dimensions are

- Objectives of making-based education and
- Settings of making-based education.

The objectives dimension ranges from '*curriculum driven*' to '*interest driven*' (see sections 3.2.1 and 3.2.2) and the settings dimension goes from '*local*' to '*regional' (see sections 3.2.3 – 3.2.5).* Similar dimensions were also suggested

by the JRC foresight matrix on (Vuorikari et al., 2019), distinguishing on the horizontal axis between dedicated and ad-hoc learning places and on the vertical axis between intentional and incidental learning.

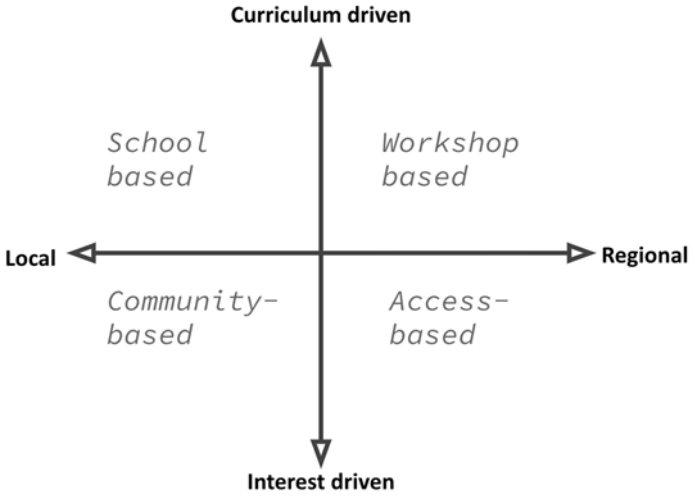

Figure 4: The forward-thinking pathways matrix for DOIT-Activities

Depending on where a DOIT activity is located on the two dimensions 'settings' and 'objectives', we can distinguish four pathways for future development, describing different potentials for DOIT activities to be adapted and scaled.

First, '**school-based**' activities are organized locally, take the school setting as a departing point. This pathway implies referencing learning objectives as described and operationalized in schools and access to materials and equipment or personnel support for learning is organized according to mostly existing regulations. If the workshop fits well with the sometimes restrictive regulatory frameworks, such workshops can quickly reach out to students and parents through established communication channels. Safety and insurance is often included when using schools' infrastructures. Replicating workshops in the future could go through teachers or self-organizing student groups.

Second, '**community-based**' activities are also locally started but rather than bringing the DOIT workshop to the school, students come to the DOIT workshop. Places might be maker spaces, science centers, museums or libraries. Similar to school-based activities, these places have equipment and materials available, and regulations around safety are mostly in place. However, they differ from school-based activities in that students who come to the workshop are self-selected, which can re-enforce structural inequalities (Voigt et al., 2020). Replicating these workshops in the future might depend on the availability of experienced facilitators. As discussed in section 3.2.2, the actual needs and capabilities of a group of students are sometimes recognized only after the workshop has started. Hence, if a group is overchallenged or bored, facilitators need to make decisions on the spot by hinting at alternative approaches or refocusing students' questions in order to minimize frustration levels.

Thirdly, '**workshop-based**' activities are based on highly mobile activities, allowing maker educators to visit places and present the DOIT program to specific target groups (e.g. academics at a conference, teachers during teacher training, interested parents and students during maker fairs). These activities target entire regions which might not have lots of local opportunities (smaller cities or rural areas). Replicating these workshops depends on the possibilities available to

the attendants of the workshop, who might transfer their experiences and learnings to a 'school-based' activity in their own workplace environment.

Lastly, '**access-based**' activities also target regions, however they do so without the context of an objective defining conference, teacher workshop or fair. Rather, they rely on people accessing DOIT materials online according to their specific areas of interest. These activities are the least guided activities since there is often no possibility for providing feedback. Examples include online courses, or descriptions of activities in form of PDFs. In this quadrant, replication could mean to provide the materials on as many platforms as possible or to translate it into multiple languages as it happened with the DOIT-Handbook [11].

Of course, these four pathways are not mutually exclusive and future the DOIT Programme can be implemented in multiple ways, so any combination of the four quadrants is also possible. For example, successful 'school-based' workshops can be recorded and redacted and made available online for 'access-based' workshops. Likewise, experiences with 'community-based' workshops, e.g. mastering a particular challenging problem, can be presented during a 'workshop-based' activity at a fair or conference, or documented on instructables.com for an 'access-based' activity.

4. Conclusion

This deliverable presented short- and long-term impacts based on interviewing 10 pilots. Thereby we used a qualitative, semi-structured process to collect the necessary information. Beside listing the main impact areas, we also discussed factors boosting impact or what systemic conditions have to be overcome for the DOIT Programme to develop their full impact.

We identified six main areas for impact:

- → Aligning the DOIT Programme with the curriculum;
- → Allocating time to the DOIT Programme;
- → Structuring places and materials;
- → Building-up support capacity for the DOIT Programme;
- → Creating an entrepreneurial mindset and
- → Promoting environmental awareness.

Finally, two topics were not thematized as strongly as anticipated: gender and climate change. Although we know that gender adequate workshop designs were in the minds of facilitators and participants of workshops were also balanced in terms of male and female students, it seems that gender equity is so much part of the foundation of maker education that it is hardly mentioned anymore. The impact on people acting against climate change is more subtle and we did not

[11] https://doit-europe.net/doit-handbooks

see it sufficiently linked with the actual DOIT activities, which happened mostly at the level of mockups and prototypes. As a side effect we can argue that by using waste material and broken electronics, students were introduced to the ideas of a circular economy and the need to reduce waste in general. Also, many DOIT activities had environmental topics such as saving electricity or cleaning water, however, only by testing these ideas with external communities with regards to their feasibility, effectiveness and acceptance could we claim to have an impact on climate. This is not to diminish the DOIT Programme, since making climate change part of the educational program is already a valuable and necessary first step.

Whether or not DOIT activities can be sustained and scaled beyond the lifetime of the project will depend on classic conditions as described by (Weber & Demirtas, 2015):

- A replicable service: Inputs and processes need to be described in a way that is clear enough to be repeated by someone who was not involved in the development of the toolkit. For this, DOIT provides workshop descriptions with a focus on essential steps and conditions in order to avoid unnecessary complexity originating from long lists of requirements.
- Sourceable knowledge: Knowing what is needed is only a first step, affordable facilities and people with the required expertise have to be mobilized as well. This is typically embedded in partners existing networks.
- An adaptive model: The success of a model in one pilot context, doesn't mean it is easily transferable to a different context. Most often, it will be necessary to adapt aspect of the program to the age group, the type of school or different priorities and standards. The adaptivity of the DOIT Programme has already be shown in cases where the same program was offered to different groups.
- A viable operational model: Outside a project context, activities need a mix of income streams (workshop fees, sales of services, grants, public sector funding etc.), able to sustain the activity over the short and medium term. Sustaining an activity also includes necessary adaptations or monitoring the quality of the activities.

Eventually we use the discussion of impacts to present a matrix, outlining how to further improve and replicate DOIT activities, based on the educational objectives and the possibility of the setting. Kurz and Kubek (2016) have a related matrix for scaling innovations, which evolves around the questions of 'How much effort and time do we want to invest in scaling?' and 'Are we ready to give up control over how the DOIT activity is re-used?'.

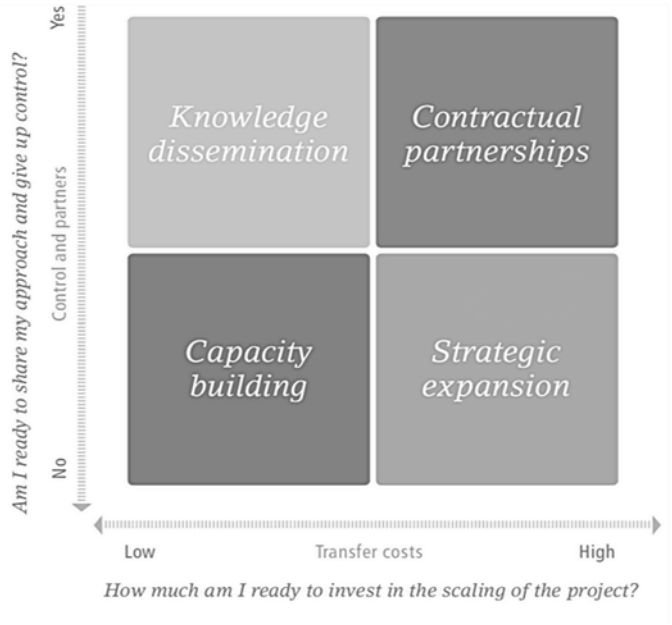

Figure 5: Scaling innovations (Kurz & Kubek, 2016)

The report at hand is a good demonstration of how activities create impacts in multiple areas simultaneously and how important the expertise of the designers and facilitators of DOIT activities is. Moreover, the group interviewing method used to obtain the information was critical, as not every potential impact was clearly recognized as such and became more evident by listening to examples from other pilots or by explaining one's own experience to others.

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