GUIDE OF GOOD PRACTICES

Purposeful Recruitment Of Gamers, Rascals And Makers

PROGRAM LABS

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THE MISSION OF MAKERSPACES IS TO PROVIDE ACCESS TO THE TOOLS, THE KNOWLEDGE AND THE FINANCIAL MEANS TO EDUCATE, INNOVATE AND INVENT USING TECHNOLOGY AND DIGITAL FABRICATION, ALLOWING ANYONE TO MAKE (ALMOST) ANYTHING.

THE GUIDE AIMS TO PROVIDE EXAMPLES AND EXPERIENCES OF HOW MAKERSPACES CAN PROMOTE (ENTREPRENEURIAL) SKILLS AMONG EUROPEAN YOUNG PEOPLE

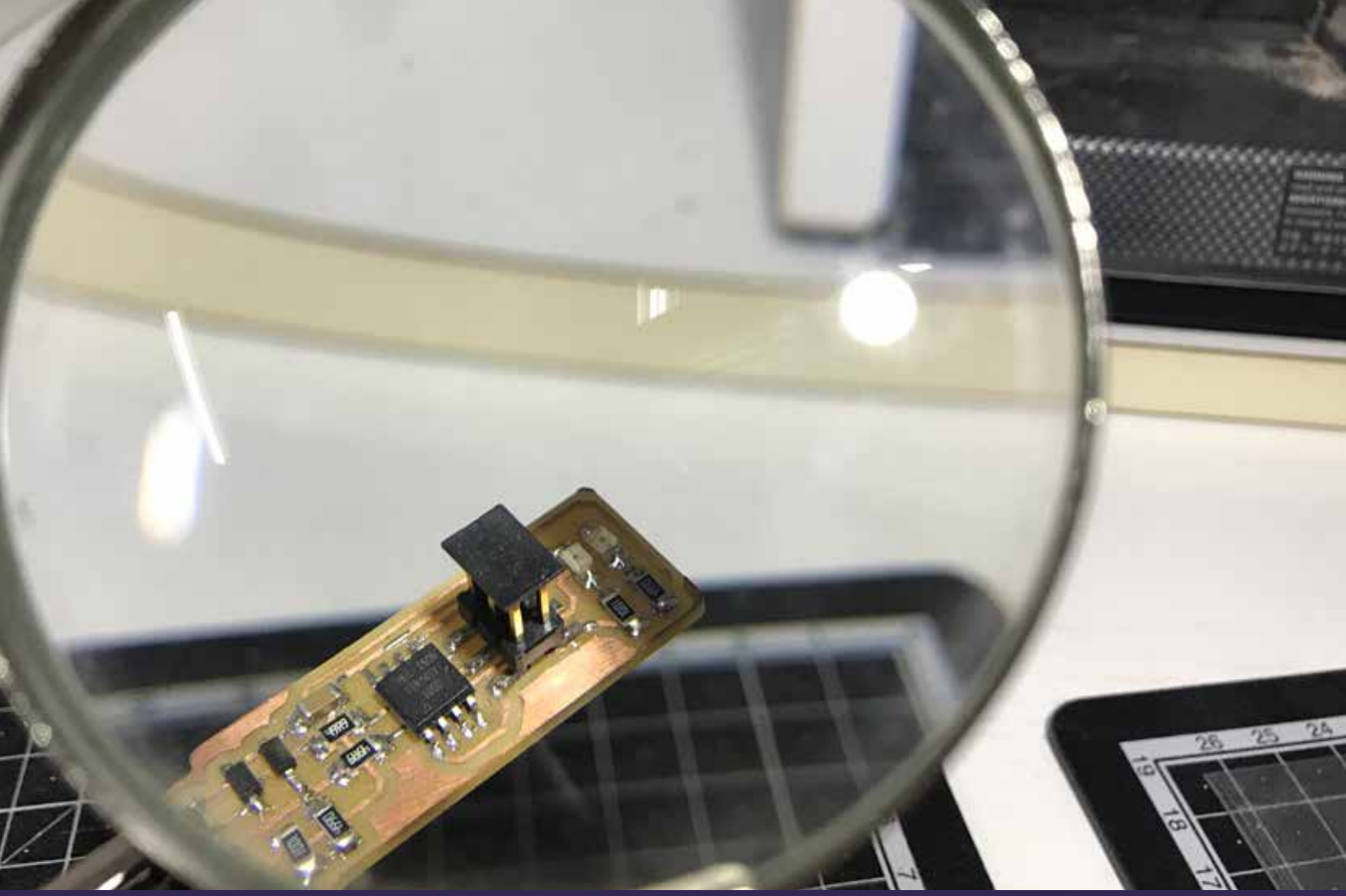
// OBJECTIVES OF THIS GUIDE

- To summarize current literature of Makerspaces
- To give an overview on good practices in Makerspaces regarding the promotion of entrepreneurial skills among European young people
- To share examples on how Makerspaces manage to improve entrepreneurial skills amongst young NEET (Not in Employment Education or Training) youth
- To provide guidelines on how to engage NEET youth in the Maker Movement

This **Guide Of Good Practice** has been developed to inspire the **European Erasmus+ project PROGRAM**. The guide aims to provide examples and experiences of how Makerspaces can promote (entrepreneurial) skills among European youngsters. PROGRAM focusses on young people who are at risk of becoming NEET (Not in Employment Education or Training). The guide pays particular attention to **vulnerable young people**.

The guide is based on **two inquiries**: First, literature was scanned to find good examples in Makerspaces who work with (vulnerable) youth around the world. Second, interviews were performed with different stakeholders from Makerspaces in Belgium, Spain, the Netherlands and Lithuania.

In the last part of the guide we provide **general guidelines** useful to all people who want to engage vulnerable youth in the Maker-movement. Those guidelines are based on a synthesis and integration of the three inquiries described before.



// INTRODUCTION

Makerspaces enjoy increasing popularity worldwide. Currently there are 1750 official Fab Labs (Fabrication Laboratories) located in more than 100 countries. The mission for Makerspaces is to provide access to the tools, the knowledge and the financial means to educate, innovate and invent using technology and digital fabrication, **allowing anyone to make (almost) anything** (Gershenfeld, 2005). Makerspaces globally form a network for research and invention, which they use to share knowledge and to work together.

In this guide, we use the term Makerspaces, because this term is inclusive of Fab Labs and Hackerspaces, representing all collaborative community spaces that explore the maker mind-set and tinkering-practices (Rosa et al., 2018). **Hackerspaces** were founded in the late Eighties with the goal to have a non-repressive space where people interested in programming and tinkering with technology could meet, work and learn from each other. To be named **Fab Lab** you have to comply with the Fab Charter. Furthermore, most Fab Labs have more or less the same hardware and software capabilities. **Makerspaces** do not have to comply with a predefined structure and do not need to have specific fabrication tools, the focus is having a publicly-accessible creative space with the maker mind-set.

1 // DESK RESEARCH

A literature review was done to explore for good practices related to working with (vulnerable) youth in Makerspaces around the world and to explore how Makerspaces can promote (entrepreneurial) skills among young people.

1.1 LEARNING IN MAKERSPACES

There are two typical ways that youth and Makerspaces get connected. On the one hand, several schools have started organizing their own Makerspace within the school itself. On the other hand, Makerspaces develop workshops and programs specifically targeting students and their teachers. The underlying idea is often that through Makerspaces the youth can become more enthusiastic about STEAM education (Science, Technology, Engineering, Arts and mathematics).

The Maker Movement itself also is conscious about their potential impact on education.

> *"Our biggest challenge – and the biggest opportunity for the Maker Movement – is an ambitious one: to transform education." (Dougherty et al., 2013)*

Several pathways are described explaining how the Maker movement can be brought to education. A few examples are (Dougherty et al., 2013):

- By creating a context that develops the Maker mindset
- By building a new body of practice in teaching making – and a corps of practitioners to follow it
- By developing education contexts that link the practice of making to formal concepts and theory (e.g. developing guided for teachers and mentors)

"OUR BIGGEST CHALLENGE – AND THE BIGGEST OPPORTUNITY FOR THE MAKER MOVEMENT – IS AN AMBITIOUS ONE: TO TRANSFORM EDUCATION"

(Dougherty et al., 2013)

DIFFERENCES BETWEEN LEARNING IN MAKERSPACES AND FORMAL EDUCATION

Although there are many ways schools and Makerspaces working collaboratively today, the **difference** between learning in formal education and learning in Makerspaces is often emphasized.

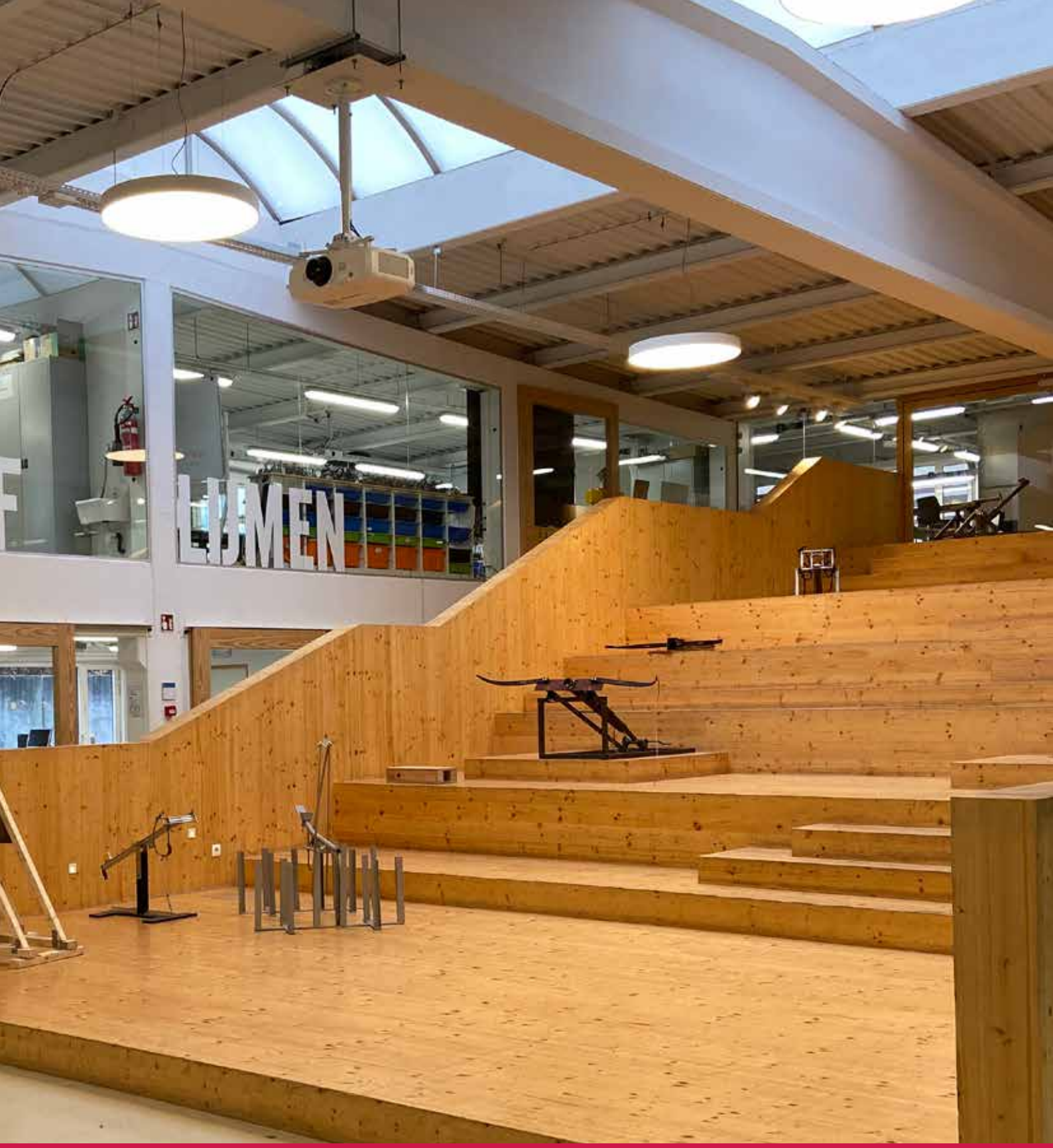
Most formal education settings have some characteristics in common. Typically there are teachers who organize and lead what happens in the classroom. The teachers base the content of their lessons on the curricula with specific measurable learning outcomes. The pupils are obliged to follow the lessons and to carry out certain activities and tasks. Lessons are mostly theoretical, with the exception of lessons in more technical or vocational education. Formal education is mostly a closed system where only teachers and students interact with each other. At the end of a semester exams are organized where students are expected to illustrate what they have learnt by giving the "right" answer. The focus is predominantly on the results and not on the process. This classical model of learning can be described as lecturing or didacticism, where the teacher stands in front of the classroom and acts as an expert in her/his topic.

Unlike formal education, the model of learning in Makerspaces is rooted in a constructivist, student-centred approach to education (Blikstein & Worsley, 2016).

> *"The makerspace encourages teachers to say to their students, we are all learners now, let's learn together" (Fleming, 2015, p.4)*

The line between teacher and learner becomes blurred. Students might switch between teaching and learning flexibly during a session. Informal learning is often perceived as secondary to formal learning but should be recognized by the school as equally important (Fleming, 2015). It is crucial that teachers and the school value the kind of learning that happens in the Makerspace to have a successful Makerspace. Fleming (2015) describes how a Makerspace at school can become a catalyst for broader changes in the rest of the school. For example, Fleming observed that classroom teachers started to adjust their curricula and teaching practice in order to reflect many of the principles related to making.

An example of the power of **curiosity** and self-directed learning can be found in the Hole-in-the-wall project. Computers in the wall without any guidance were provided for example in slums and showed how an intrinsic motivation to learn is present and powerful if an opportunity (e.g. material) is provided (Hole-in-the –wall, 2013).



“THE MAKERSPACE ENCOURAGES TEACHERS TO SAY TO THEIR STUDENTS, WE ARE ALL LEARNERS NOW, LET’S LEARN TOGETHER”

(Fleming, 2015, p.4)

Makerspaces also bring back **play** back into the picture. The origin of the Maker movement is found in experimental play. Makers play with technology, they take things apart and try to do things that have not been done before. Play is not only highly satisfying, but also offers opportunities to learn skills such as creativity, problem-solving and innovation. Playing builds socio-emotional competences in many domains (Jackson, 2014). Research about the importance of play has been elaborated in the book, 'Play: How it shapes the brain, opens the imagination and invigorates the soul', by Dr. Stuart Brown. He illustrates how the company JPL discovered that engineers who had played a lot were more capable of complex problem-solving. JPL started to include questions about youthful projects and play as a standard part of their job interviews. Formal education has become such a serious business that there's no time and no context for play (Dougherty et al., 2013). One of the challenges is to bring the youthful magic of play back into schools.

A good summary of **the model of learning** in Makerspaces is provided by Blikstein and Worsley:

> *"The Maker Movement is the newest and most prominent instance of a model in which students work on personally or community-meaningful interdisciplinary projects, often freed from a scripted curriculum, empowered to make choices about their own learning, and using technologies to externalize their ideas in sophisticated ways."*

Blikstein and Worsley (2016) made an overview of elements they find important to instill a **learning culture** in a Makerspace.

1. Design activities and projects that can include all students in a meaningful way, without exposing them to excessive levels of frustration
2. Find an optimal amount of frustration and trial-and-error. It is too simple to assume that students will learn from their own mistakes, although it can be a powerful learning experience.
3. Make sure that students do not self-assign to activities within their comfort zone, since this can increase disparity between students
4. Be aware that some groups come to the lab with (negative) views about their own ability with technology. Those can be changed through authentic experiences of success.

"IN A MAKERSPACE, WITH STUDENTS FOLLOWING THEIR OWN PASSIONS AND DESIGNING DOZENS OF DIFFERENT KINDS OF PROJECTS, THE OLD WAY OF RUNNING A CLASSROOM JUST DOESN'T WORK ANYMORE"

(Dougherty et al., 2013, p.17)

TABLE: DIFFERENCES SUMMARIZED BETWEEN MAKERSPACES AND FORMAL EDUCATION

Makerspaces	Formal education
"facilitators"	"teachers"
Mostly peer-to-peer based	Mostly teacher-to-pupil
Building on the interests or the ideas people bring to the lab	Based on the curricula with learning outcomes
Experimental, experiential, hand-on learning	Often theoretical
Doing what you want to do, enjoyment and fun	Obligation to do certain activities and to follow the lessons
"Open system": open to everyone and try to have a diversity in participants	"Closed system": people outside of schools have often no access to get in
Value the process, drafts and "failure"	Do not value failure and implicitly advocate the idea that there are "right and wrong answers"

TEACHER'S ROLE

The role of a teacher in a Makerspace is different from what they are used to and trained for. The Makerspace Playbook describes different metaphors that can help teachers to be a new kind of teacher (Dougherty et al., 2013):

- The Project Manager, e.g. give feedback on quality of work done by their team
- The Principal Investigator, e.g. checking in with students to give them advice and feedback
- The Coach, e.g. talk and limited praise, feedback without riding the players too much
- The Research Librarian, e.g. listen to need's, desires and interests and connect with resources

Those metaphors can help to work effectively in a room full of divergent projects.

1.2 YOUTH DEVELOPMENT IN MAKERSPACES

What benefits brings the participation in a Makerspace to the youth? Young people who participate in Makerspaces might change their views on how they see themselves, technology and the broader world. Furthermore, they learn a wide range of different skills, including entrepreneurial skills.

// MAKERSPACES CAN EMPOWER YOUTH

Kinnula & Ivari (2019) developed a tool that can be used when the goal is to empower children in and through digital technology design. The tool is based on different frameworks such as the criteria for meaningful participation of children by Chawla and Heft (2002). Educators and researchers should benefit from the tool when planning, analysing and evaluating their projects. Makerspaces offer great opportunities to meet these five criteria and thus to empower youth.

Five criteria for effective and meaningful participation (Chawla & Heft, 2002)

Condition	Good example	Bad example
Conditions of convergences	The project is based on children's own issues and interests, the project is organized in natural places for children to enter into and work in	Projects that have relied on researchers' or teachers' ideas instead of children
Conditions of entry	Participants are fairly selected, places easy to access	Whole classes involved without discussion of children's voluntariness to participate
Conditions of social support	There is mutual respect among participants, peer-to-peer learning and sharing is emphasized	Children have difficulty to collaborate
Conditions for competence	Participants have real responsibility and influence, participants are helped to construct and express their views	Projects where participants just do the tasks planned by the adults, lack of support for own projects
Conditions for reflection	Participants understand the reasons for outcomes, they can critically reflect and evaluate	No reflection and evaluation, no attention for power differences

// PERSONAL DEVELOPMENT

The children in "Making Things", a long term participatory project in Genk (Belgium) (cfr. Good practice example 5), developed more confidence in themselves by participating in situations in which they could demonstrate their competence to others. This increased their self-confidence. **The development of self-esteem** might be particularly important for vulnerable youth who often have lower self-esteem and less opportunities to learn by doing.

> *Through demonstrating their competence in assembling the boxes, but also in co-designing the workshops, the children developed a confidence in themselves, their (design) skills and persistence. (Schepers et al., 2018)*

Furthermore, the children's view on technology and making could shift from being **result-driven to being more process-driven**. By engaging in a **learning-by-doing** approach (with trial-and-error) children could be taught to better deal with experimentation. For example, by emphasizing that failures do not exist but are prototypes which are not yet ready, the children started to enjoy the process of creating more, even if the result did not work out perfectly. They developed a growth mindset (Fleming, 2015).

> *"Although the wheels didn't work, the boys really liked [creating cars with the LittleBits]"*

Through the participation in "Making Things" children could **broaden their horizon** and get acquainted with new technologies, other settings and people.

Laura Fleming (2015), who pioneered a makerspace in her high school library summarizes:

> *"Maker education fosters curiosity, tinkering, and iterative learning, which in turn leads to better thinking through better questioning. I believe firmly that this learning environment fosters enthusiasm for learning, student confidence, and natural collaboration."*

A crucial aspect of making is that it is a social experience, built around relationships (Dougherty et al., 2013). When the maker mindset starts to develop more in youth, this supports the development of the maker "not just physically, but also mentally and emotionally".

MAKER EDUCATION FOSTERS CURIOSITY, TINKERING, AND ITERATIVE LEARNING, WHICH IN TURN LEADS TO BETTER THINKING THROUGH BETTER QUESTIONING.

// SKILLS DEVELOPMENT

Makerspaces offer many opportunities to develop a wide range of skills. The potential of Makerspaces in learning has been put forward by the New Media Consortium (NMC) Horizon Report (Johnson et al., 2015):

> *"Makerspaces are increasingly being looked to as a method for engaging learners in creative, higher-order problem-solving through hands-on design, construction, and iteration"*

They identified Makerspaces as one of six important developments in education technology for secondary education. Makerspaces have the potential to effectively develop the **21st Century skills** such as designing, engineering and creativity. Furthermore, a recent report of the Joint Research Centre (JRC) of the European Commission acknowledged the potential of Makerspaces in providing the necessary skills for the work of the future (Rosa et al., 2018). Not only can Makerspaces stimulate **STEAM related skills**, but also teach people to be more **flexible**. One of "the driving forces" of the Maker Movement identified in the report is skills development. The Maker Movement particularly emphasizes the importance of **collaborative skills** beyond the simple human collaboration, i.e. human-machine interaction. Makerspaces help to develop a collaborative attitude among participants and attach importance to values of care and solidarity.

// SKILLS DEVELOPMENT IN VULNERABLE YOUTH

Vulnerable youth often do not have the same skills and capabilities to make use of digital technology or the same access to digital technology. This gap between people who do or do not have those possibilities is called the **digital divide** (Kinnula & Ivari, 2019). A common goal that Makerspaces share is to make digital fabrication technology **accessible** to everyone. It is especially important for the young generation to decrease the digital divide, as they will not be able to live without digital technology (Kinnula & Ivari, 2019).

// ENTREPRENEURIAL SKILLS

Historically, the Maker movement has not been focused on goals for entrepreneurship, such as making for profit (Hui & Gerber, 2017). This is reflected in the JRC report: the participating Makerspaces did not find entrepreneurship to be a fixed objective (Rosa et al., 2018). Some Makerspaces engage with the development of start-ups and business, while others are convinced that entrepreneurship is a separate issue. Recently some Makerspaces have been founded with an explicit aim to encourage entrepreneurial activity (Hui & Gerber, 2017). According to them business can be promoted while maintaining the community-focused values of Makerspaces.

Although Makerspaces do not always consider entrepreneurship an explicit objective of the Maker Movement (Rosa et al., 2018), entrepreneurial skills and mind-set are developed through making. For example, the maker mindset empowers people not only to seek jobs in STEM or creative fields, but also to start their own business (Kalil, 2010). Several competencies developed through maker education (such as creativity, perseverance, teamwork and self-efficacy) are also important in early entrepreneurship education (Geser, Hollauf, Hornung-Prähauser, Schön & Vloet, 2019).

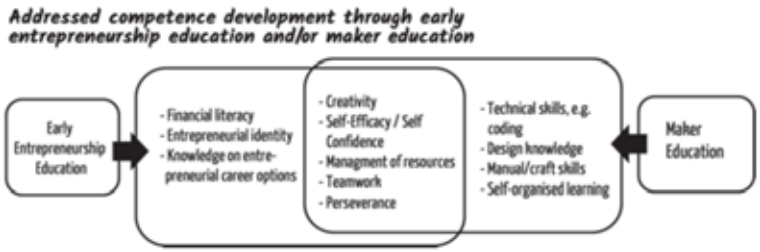


Figure 1. Competence development through early entrepreneurship education and/or maker education. (Geser et al., 2019)

Hui and Gerber (2017) argue that skill acquisition in entrepreneurship is experiential rather than theoretical. Makerspaces contribute to those skills by giving the possibilities to learn through trial-and-error and through social interactions (modelling, being coached by others, etc.) Receiving validation from others helps to build entrepreneurial self-efficacy, which is an important factor in being able to start one's own business.

According to research by Monllor and Soto-Simeone (2019) not only validation by others, but also building technological self-efficacy has a direct effect on entrepreneurial intentions students who followed a business education program. The hands-on experience with digital technology not only increased the confidence in students' technological abilities, but also opened the door for a potential future as entrepreneurs (Monllor & Soto-Simeone., 2019).

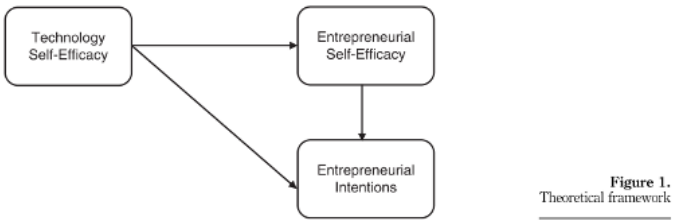


Figure 2. Monllor & Soto-Simeone. 2019

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1.3 CHALLENGES WITH (VULNERABLE) YOUTH

Although many workshops and initiatives have been developed for children and adolescents in Makerspaces, the typical approach of Makerspaces might not be applicable for young people (Posch & Fitzpatrick, 2012). Different from adults, most young people have no prior knowledge about infrastructure, machines or what they could do with them (Posch & Fitzpatrick, 2012). Furthermore, learning is primarily peer-to-peer, but a difficulty might be that there are no peers able to teach available, to teach the others.

Sang and Simpson (2019) described difficulties working with youth based on 33 qualitative interviews with Makerspaces in USA, Europe and China:

1. Difficulties to encourage or implement collaboration among youth
2. Difficulty to motivate youth to engage in making
3. Difficulty to invite different age groups to work together
4. Difficulty to transform an initial interest into a long-term interest
5. Difficulty to maintain the focus on the projects

Lastly, also the context of the young people can form a barrier to participate in making. The close context, e.g. family, might not appreciate or understand the process of "making". The broader context, e.g. cultural ideology, might put the emphasis on the end-product instead of the process (Sang & Simpson, 2019).

An often cited trap for Makerspaces is called **the "keychain syndrome"**. Some Makerspaces create short "introductory" workshops in which children create keychains and trivial objects but never move on to more complex projects (Blikstein, 2013). Another trap is that newcomers who come to the lab do not experience sufficient facilitation and feel lost and frustrated, which could possibly result in even a lower self-esteem than before coming to the lab. Especially when novices are confronted with other youth who already have previous engineering experience and get their projects done with minimal help (Blikstein, 2013).

1.4 OPPORTUNITIES WITH (VULNERABLE) YOUTH

As written in the Makerspace Playbook (Dougherty et al., 2013), the approach of Makerspaces might reach students who don't fit well into the existing system or who have already dropped out of it (p.4). Makerspaces recognize that making can enrich the educational experience of students who are motivated to a different extent in school (Dougherty et al., 2013, p. 5).

Makerspaces borrow some aspects of the traditions of vocational education, but they diverge since they tear down the walls between the silos of classes in woodshop, computer science, automotive repair etc. in pursuit of a more **interdisciplinary** goal. Technical education has gained some stigma as the educational track to which students who fail academically are sent. Makerspaces however succeed in bringing together all students, capturing the interest of students who are on the verge of dropping out of school just as effectively as those that excel more academically (Dougherty et al., 2013, p.5). Projects that successfully targeted more vulnerable youth can be found in the good practice examples.

1.5 PRACTICES TO ESTABLISH A MAKERSPACE

Laura Fleming wrote a guide with practices to establish a makerspace for schools based on her own experience (Fleming, 2015). The principles outlined by Fleming to establish a makerspace in schools are generally useful information for those willing to establish a makerspace.

Teachers and schools might be hesitant to start a Makerspace if they do not (yet) have experience and knowledge with certain machines, techniques and/or digital fabrication. However, it is not crucial to have any knowledge in order to start. As Fleming illustrates, people from different backgrounds can start with a Makerspace. Fleming does not have a "typical" link with STEM education/programs, but has a background in literacy. The power of the Makerspaces lies in the **collaboration** with other teachers, students and community members. Everyone can learn from each other. Some students might have more skills in programming and can teach those skills to peers and teachers. In addition, facilitators acknowledge the growth-mindset that tolerates risk and failure. Facilitators do not have to be people who have all the answers and just share their knowledge, but rather encourage experimentation and reflection in the Makers. This requires the teacher to take on a more complex and difficult role than normally would be the case (Fleming, 2015).

> *Nobody who uses the space needs to be an expert, not even the teacher. The most important thing is to have a passion for and a curiosity about making in many different forms. (Dougherty et al., 2013, p. 17)*

One important aspect when designing a Makerspace is the level of involvement of the students. The needs, desires and interests of the students and wider school community should be explored and should be taken in consideration during the preparation of the Makerspace:

> *A school makerspace should be able to adapt to a wide variety of uses, not only defined by teachers or the school but also by students' own creative goals and interests. (p.5)*

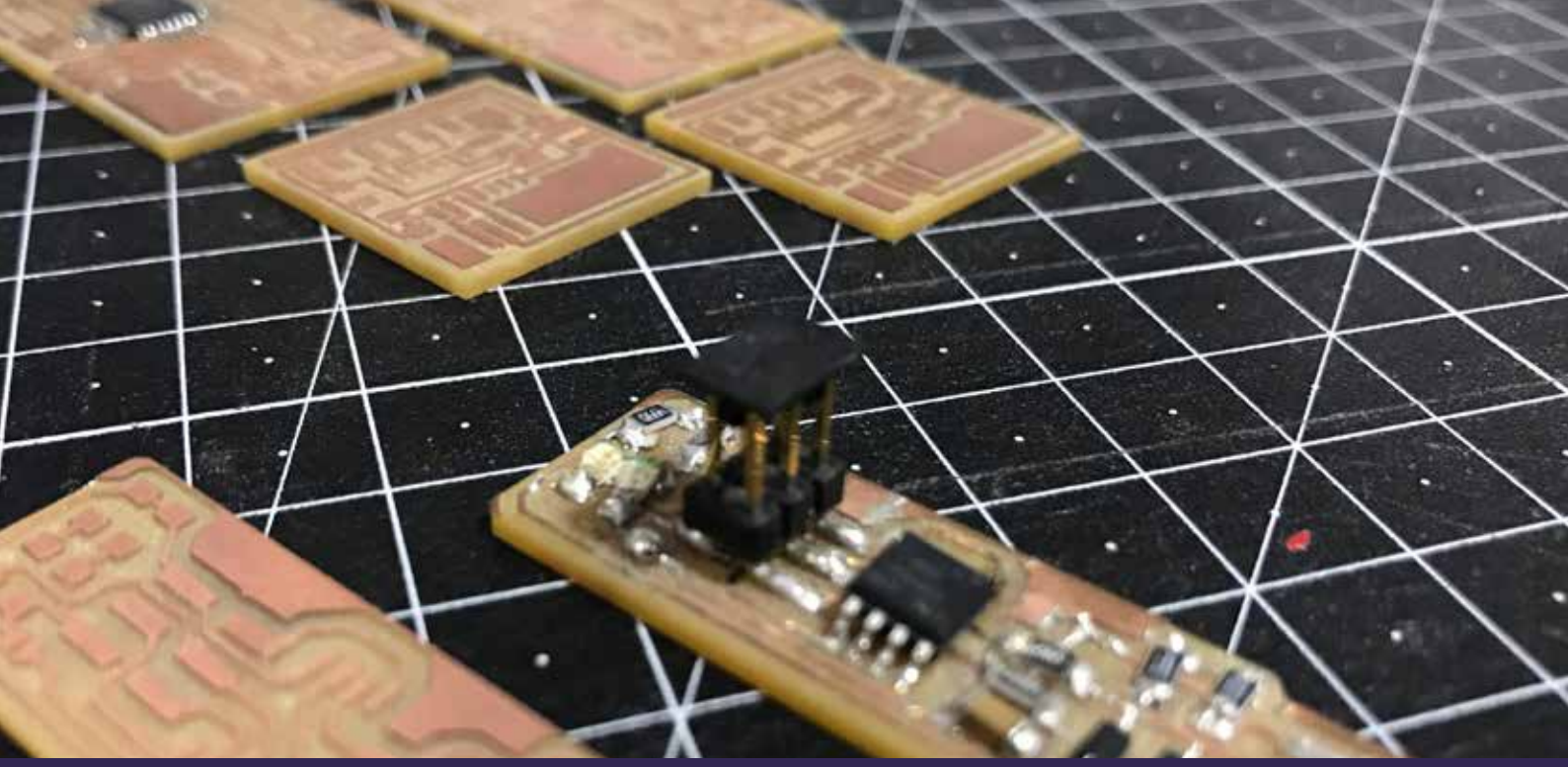
The participation of future makers will make sure that the learning environment will serve the learners and that they will feel ownership over the place (Fleming, 2015). The best promotion of the Makerspace will result from the enthusiasm of the students themselves. As a result of their involvement:

> *"No two makerspaces should be the same."*

Alongside the students and teachers, the support of the school leadership would be essential. Fleming (2015) describes great leadership as establishing an atmosphere of trust, permitted risk taking and professional and social responsibility given to staff to do their very best at all times.

“THE MOST IMPORTANT THING IS TO HAVE A PASSION FOR AND A CURIOSITY ABOUT MAKING IN MANY DIFFERENT FORMS”

(Dougherty et al., 2013, p.17)



MAKERSPACE MIND-SET

Starting a makerspace in a school is not only about the physical space but also about a certain mind-set in teachers, students and even their families.

> *You can find a place, acquire tools and materials, and recruit students, but we will not have succeeded unless we are able to foster a Maker mindset. (Dougherty et al., 2013, p. 21)*

A Maker Culture should be created, a culture that emphasizes informal, networked, peer-led, and shared learning motivated by fun and self-fulfillment (Sharples et al., 2013).

The crucial mindset is the **growth mindset**. The psychologist Carol Dweck has written a book *Mindset* that distinguishes between people with a fixed or growth mindset. A person with a fixed mindset will be more convinced that their capabilities are set as though these are out of their control. A person with a growth mindset believes that their capabilities can be developed, improved and expanded (Dougherty et al., 2013). A person with a growth mindset tolerates risk and failure and is encouraged to experiment. The idea is that failure is a necessary step on the road to success and innovation (Fleming, 2015, p. 9). The growth mindset as described by Dweck is very similar to the maker mindset.

In a Makerspace students of all levels can take full advantage of the resources and activities (Fleming, 2015). Teachers can discover talent in students they were not aware of, as illustrated by this quote:

> *Andy has learned that when educators step back and allow students to tinker, miraculous things happen. Students who have been disconnected from school suddenly find their niche. (p. 29)*

"YOU CAN FIND A PLACE, ACQUIRE TOOLS AND MATERIALS, AND RECRUIT STUDENTS, BUT WE WILL NOT HAVE SUCCEEDED UNLESS WE ARE ABLE TO FOSTER A MAKER MINDSET"

(Dougherty et al., 2013, p.21)

// CONNECTION WITH COMMUNITY EXPERTS

Makerspaces set up within a school might need to be more conscious about building links with the broader community of makers. Fleming (2015) learned that connecting her students with mentors who shared their knowledge on the tools and tinkering was very motivating for the students. It is important to have experts who visit the makerspace to inspire innovation, passion and personal motivation (Fleming, 2015). Different kinds of mentors exist, some mentors have a positive attitude and curiosity that can help young people to carry through difficulties, others might have extensive skills in many kinds of making or deep expertise in one kind of making.

> *Mentors are adults who are interested in working with youth and who may be experienced in one or more forms of making (Dougherty et al., 2013, p. 19).*

Furthermore, these visits from experts demonstrated to the students that makers can earn a living of their making, and that the making skills can form the basis for a trade or a career. To see that the expertise aquired through making can be transformed into a sellable skill, or a powerful life skill, is a critical lesson that students can take away from their experience in the makerspace. Those experts can also be fellow peers or teachers. The aim to introduce the expert makers is to stimulate entrepreneurial thinking, in creating/developing their own jobs and industries depending on their interest.

The makerspace forms the bridge between community and the schools:

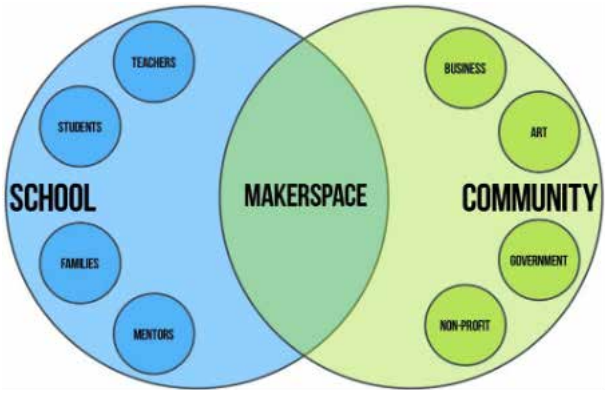


Figure 3 Makerspace @ Lakewood city schools, 2014

// SHOWCASING STUDENT CREATIONS

An important event is the Maker Faires, an event "to celebrate arts, crafts, engineering, science projects and DIY Mindset" (Maker Faire, n.d.). These events can be very inspiring and motivating. In schools it is important to find opportunities for students to showcase, celebrate, and share their creations (Fleming, 2015). For example by tweeting photos of students work, making short videos or photos of students while they are making.

1.6 GOOD PRACTICE EXAMPLES

Many Makerspaces engage with young people through "out-of-school" workshops or within schools. Some inspiring examples of projects with (vulnerable) youth around the world are shortly summarized in the tables below.

// GOOD PRACTICES WITH (VULNERABLE) YOUTH

1.	**Vienna Fablab (Posch & Fitzpatrick, 2012)**
What?	2 days out of school workshops
For who?	10-14 years old
How?	Provide first experiences with 2D and 3D design, printed circuit board, programming In teams of two
Tips?	• 2d printing (e.g. laser cutter) more relevant and satisfying for younger users than 3d printing or programming • map the knowledge of the target group (Do they have any prior knowledge about the machines? Do they know the technologies?)

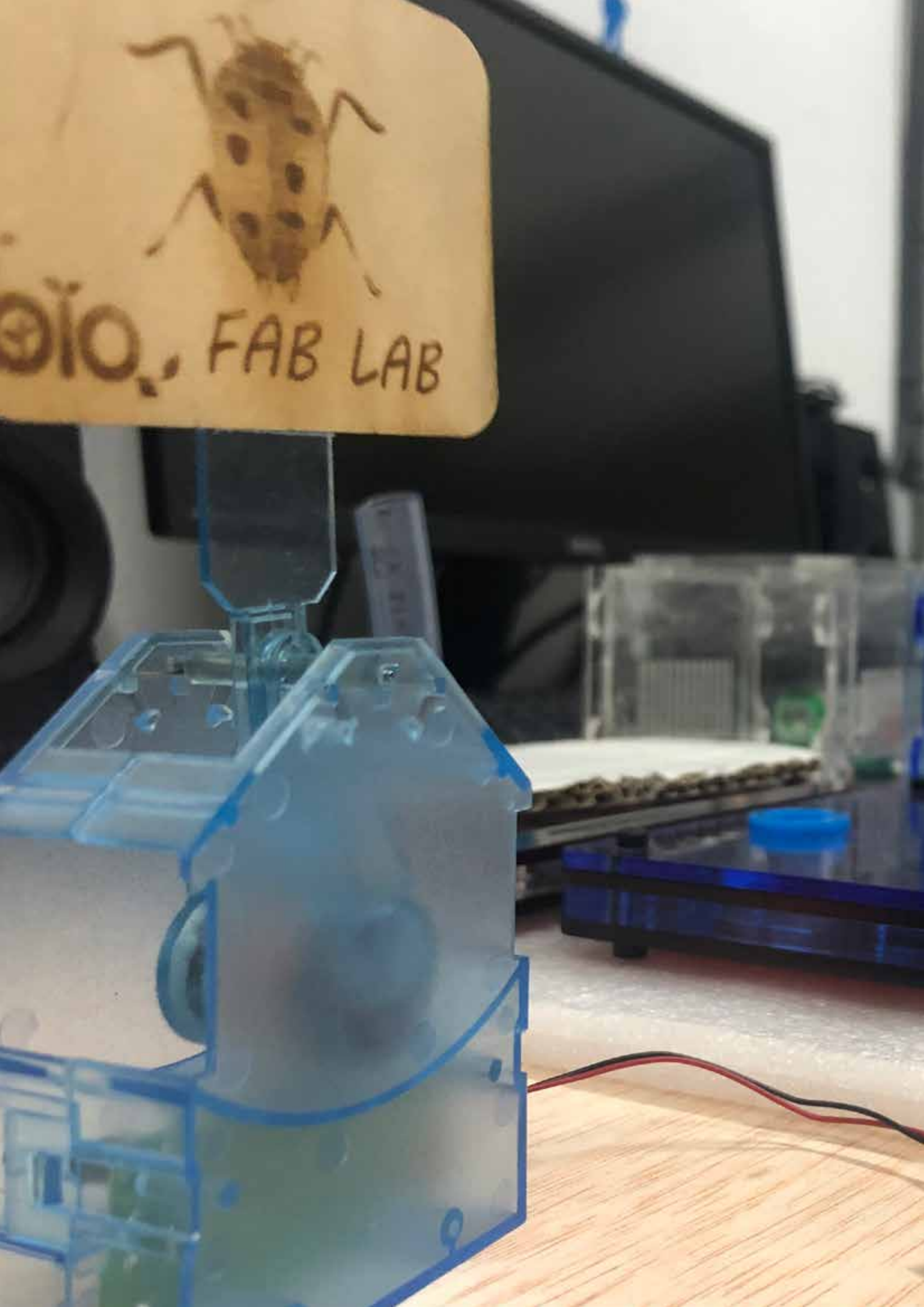
2.	**Maketec, in Tel-Aviv, Israël (Bar-el, 2016)**
What?	Makerspace in a public library runned by teens from high-school
For who?	Children
Aim?	Promoting making and socializing opportunities
How?	Makerspace for children run by teens who were trained in the basic technology and mentoring. 3 principles 1. "Low Floor/Wide Walls": construction kits that are easy to start with and do not require prior technical knowledge (low floor), but which enable a variety of creations (wide walls) 2. "unstructured learning" : free to choose their own projects, choose whether they want help 3. "a third place": community center, teenagers from local high schools as mentors
Tips?	• Let the lab be run by people closely related to the target group (e.g. teens for a lab for children) • Providing autonomy in projects and guidance

3.	**The Afterschool Tinkering program San Francisco (Vossoughi, Escudé, Kong, & Hooper, 2013)**
What?	• Workshop in which they made pinball machines • Workshop in which they designed musical instruments
For who?	African American, Latino/a and Asian American youth from communities with restricted access to educational and economic opportunities
Aim?	To develop teaching and learning practices that cultivate "tinkering dispositions" and shared experiences of intellectual possibility
Tips?	• Equity is not only a matter of broadening access to learning experiences, but rather equity lies in the how of teaching and learning: 1. Specific ways of designing making environments 2. Using pedagogical language (Reframe "mistakes" as drafts) : emphasizing shared activity, process and iteration 3. integrating students' cultural and intellectual histories 4. expanding the meaning and purposes of STEM learning: treating learning as a purposeful and social endeavor • The children deepened their engagement when tinkering was connected to a social purpose; e.g. making an instrument that culminated in a collective performance • Cultivating play, imagination and creativity. • Activities should be designed in a way that there are multiple pathways and a range of solutions. E.g. by presenting a range of pinball models in the introduction and offering a blank canvas to start to imagine their own play field

4.	**Techbridge afterschool program (US) (Ryoo, Bulalacao, Kekelis,McLeod, & Henriquez, 2015)**
For Who?	For young women, with a focus on youth from communities underrepresented in STEAM
Aim?	To inspire girls to discover a passion for STEM through hands-on learning and real-world exposure to STEM projects and fields. Techbridge also offers support for girls' families, role models visiting afterschool programs, school districts, and program partners to provide guidance to young women.
What?	Once-a-week program for the full school year
Tips?	• Focus on the iterative design process as a means of celebrating process over products rather than focusing on failure • Support autonomy and creative authorship helps to work past challenges: having a sense of ownership of the ideas ownership of the challenges and frustrations How to support learning through iteration? • Educators by their side who do not tell the answers • Educators should acknowledge they don't know everything and be humble • Developing a space where asking questions does not define your ability or intelligence - Support a program culture that values process over product!

5.	**FabLab in Genk (Dreessen & Schepers, 2018)**
What?	'Making things': a long term participatory project, set up by two design researchers together with local youth work organisation E.g. workshops designing jewellery with girls (drawing, laser cutting).
For Who?	Children between 6 – 16 years old from socially vulnerable districts in the city of Genk, mainly of Turkish and Moroccan descent.
Aim?	To get the children acquainted with STEM
How?	Embedded STEM workshops in long(er) term trajectories (2 years). Project together with a local youth work group during the leisure time of the children. The children were encouraged to design the workshops themselves before participating in them. An iterative methodological process was used to engage the children, first doing participatory observations and sensitising packages, then a first iteration of the workshops, evaluations, and a second iteration followed by evaluative interviews.
Tips?	• STEM education should be shifted to leisure time (e.g. youth work) instead of in a school-related context to enthuse children. Schools leave no room for play and fun, put more pressure and prioritize abstract thinking. • The involvement of (authoritative) teachers is related with less fun • Long term trajectory is important to go beyond the simple, introductory activities and to start experimenting • People who are new to the makerspace need a considerable amount of introduction and facilitation to the makerspace and the infrastructure. If not, youth might feel frustrated, lost and have even a lower self-esteem. • The content of workshops has to originate from the personal interests of the participants (and not the school curricula) • Backstage activities (informal) are important to build relationships with the youth • It is crucial to take time, energy and effort to build a relationship of trust before the workshops take place

6.	**GAR: Summer youth program (Lee & Worsley, 2019)** **A non-profit refugee resettlement organization in a large, Midwestern city in the United States**
What?	5 workshops of 2 hours
For Who?	16 refugees (5-17 years old)
Aim?	To support equitable and inclusive making
How?	Organisation of workshops aim to "make a game". Participation was voluntary. The facilitators themselves were also novices in making. Each session was contingent on the progress and the response of the children.
Tips?	• Follow the interest of the children • Organize debrief sessions with facilitators to adjust and reframe the making • Freedom to experiment: some children started creating other things than making a game


FAB LAB

7.	After school making program in East Oakland (Ryoo et al., 2016)
What?	Afterschool making program of 12 weeks, educators from the Tinkering studio
For Who?	Working class and low-income youth of color
Aim?	To improve the educational experience of all learners (equity approach) The development of learning dispositions, creative problem solving and deeper understanding of STEM concepts and practices
How?	• Development of a program according to local knowledge and interests • Curriculum designed to foster a supportive culture for creative risk-taking - Multiple starting points and pathways - Learner directed levelling up (e.g. building on previous activities) - Activities to build relationships (e.g. an opening conversation) • Equity-oriented pedagogical moves - asking questions - supporting self-directed learning = teaching in ways that support learners to identify, develop, and pursue their ideas and interests. • Supporting peer-to-peer learning (modelled valuable forms of assistance that taught youth how they could help each other included offering to be "extra hands" at key moments)

8.	Blikstein (2008) Projects in public schools in Sao Paulo
What?	The heliópolis workshop. These subsequent workshops were typically conducted as after-school activities, yet a number of them have ended up as part of regular school work.
For Who?	Students living in the poor neighbourhood Heliópolis
Aim?	• The Heliópolis workshop was conducted so as to demonstrate what might be accomplished by students with technology in a Freirean-inspired environment. • The vision was for students to build projects of their choice, using a wide range of media and technologies: computers, robotics, still pictures, video, and arts materials.
Tips?	• The importance of finding truly authentic generative themes to work around such that could not have originated in any textbook; themes that are time- and people-specific • The mindset of teachers has to switch and challenged (for example the idea that "playing around" and learning are literally incommensurate)

GOOD PRACTICES FOCUSED ON ENTREPRENEURIAL SKILLS

9.	The DOIT project, DOIT pilots in 10 European countries (Austria, Belgium, Germany, Denmark, Spain, Finland, Croatia, Netherlands, Slovenia and Serbia) (Geser et al., 2019)
What?	The DOIT project develops, trials and evaluates a new approach to acquire skills and an entrepreneurial mind-set for turning creative ideas into potential social innovations.
For Who?	Children and young people (6-16 years) Focus to involve groups in rural regions, with disabilities, specifically girls who are typically underrepresented in makerspaces
Aim?	To develop (digital) making, social innovation and entrepreneurial competencies and skills of children and young people
How?	Projects are being organized in different sorts of makerspaces and the maker activities can vary in duration and frequency. The learning program consists of seven steps, starting from creating awareness of a social problem and motivation to do something about it, building a team, prototyping an idea, creating the idea, reflecting and searching feedback, developing a business plan and inspiring others. For each step DOIT materials are available online. E.g. project in primary school in Salzburg : the development of the school's own granola bar (recipe, cookie cutter (3d-print), logo, marketing video, packaging etc.)
Tips?	• The use of "pop-up" makerspaces can help when there are no established makerspaces, but limits the availability of some more advanced tools and the place is not a permanent social space • The opportunity of children with disabilities to develop solutions for special needs themselves should be highlighted

2 // INTERVIEW STUDY

In total **29** makers in Lithuania, Belgium, Spain and the Netherlands were interviewed about their experiences and ideas while working with NEET in Makerspaces. The interviews took place in the Makerspaces or workplaces (e.g. schools) of the participants. Participants were explained the purpose of PROGRAM and the interview study. All participants signed the informed consent prior to participation. Two interview guides were developed: one directed to adults working with youth and one directed to young makers. Topics included in the 'adult' interview guide were: description of the Makerspace, target audience (e.g. experiences working with young NEETs), motivation and involvement, goals, skill development (e.g. entrepreneurial skills), approach towards and tips working with young NEETs. Topics included in the young makers interview guide were: description of Makerplace, motivation, learning in Makerspaces, entrepreneurial skills, difference with school, goals and changes experienced. The interviews were semi-structured to ensure there was room to question and get a deeper understanding in the experiences of the participants.

Most of those interviewed worked as a manager or coordinator in a Makerspace or as educator/teacher. Some interviewees worked as technicians, entrepreneurs in education or as researchers. Furthermore two young female makers engaged in Makerspaces were interviewed. The age of respondents varied between 26 and 64. Although we strived for a gender balance, more male (17) than female participants (12) were interviewed.

For the further development of PROGRAM, we will discuss two main themes retrieved from the interviews:

- The way Makerspaces are able to engage and motivate young people
- The impact of this engagement on those young people in terms of their skills and ideas

NEET NEEDS MORE ENCOURAGEMENT, PERSONALIZED DIALOGUE AND WORK WITH THEM. MOSTLY SUCH YOUNG PEOPLE HAVE ALREADY HEARD A LOT OF CRITICISM AND BAD COMMENTS.

2.1 MAKERSPACES ENGAGE AND MOTIVATE YOUNG PEOPLE

Most participants had some experience working with (NEET) youth in their Makerspace. One of the biggest challenges for Makerspaces, and at the same time offering a great opportunity, is how they can motivate (NEET) youth to engage long term in the Makerspace.

One of the core sub-themes related with motivation is the comparison between formal education and the one received in a Makerspace, described in the sub-themes "Makerspaces as playground, not as school". In addition, five sub-themes about crucial elements when working with NEET youth, will be illustrated. Each of those elements was also touched upon when comparing Makerspaces with formal education:

- Makerplace as a safe community
- Practices to support competence
- Building and strengthening autonomy
- Providing a link with real life challenges
- A balanced team of facilitators

// MAKERSPACES AS PLAYGROUND, NOT AS SCHOOL

In total 34 references were made by 17 participants about how the education in Makerspaces differ from formal education programs. Many participants accentuated that being in a non-school environment motivated people to be more engaging. Therefore, it was not sufficient to be located outside the school building:

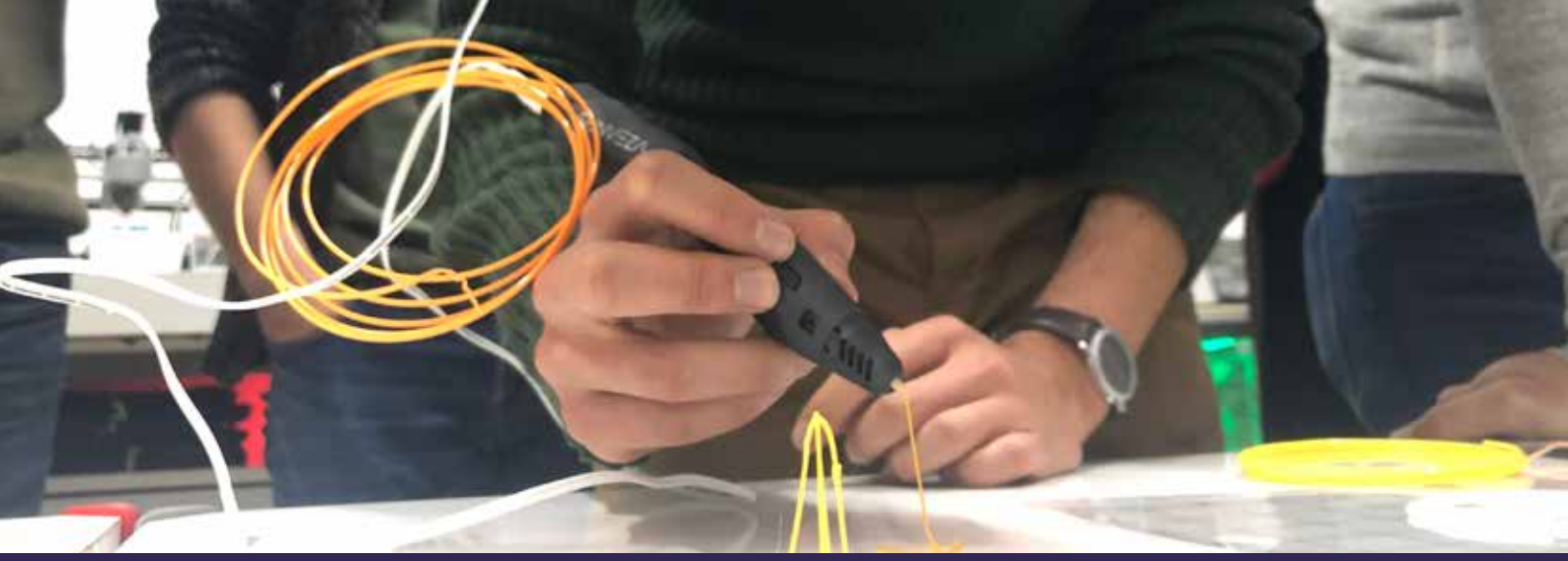
> *"The important thing we learned when you work with vulnerable children is that if you want them to broaden their horizons and get to know new things, that works best outside of the school and not within the school. (….) You could not get the school completely outside of the children by just putting them in the fablab" (Belgian researcher and maker, 39 yrs)*

Participants often explicitly compared the Makerspaces with schools. Some of the Makerspaces' strengths were considered to conflict with the goals and visions of schools. One of the strengths of the Makerspaces is that there is no obligation to participate and there are "not such strict guidelines" as in schools. This was seen as an important source of motivation. For example, "in other cases at school (…) if you are a little tired and it's not really interesting, you quickly get bored and lose attention."(Maker, 26 yrs, Spain)

> *"Important that you let them do what they feel like and not force them for anything. And that's particularly difficult for schools" (Belgian researcher and maker, 33 yrs)*

Participants described the Makerspaces as workshops, not classrooms, with a more informal and relaxed atmosphere. The most crucial for this atmosphere was the helpful and collaborative attitude of the people there.

> *The pleasure and enjoying the making is very important. Even if this pleasure has nothing to do with the laser cutter but they are playing a game in the corridor. It shows that they experience the fablab as a nice place. This is more difficult in a school context. There are a lot of things not allowed. A participant explained this: "This is school fun, but not real fun". (Belgian researcher/Maker, 39 yrs)*



Several participants acknowledged that *"the best workshops are the ones without a manual or handbook. In which the participants are free to experiment"* (Belgian Fablab employee, 35 yrs). Standardized workshops are not considered motivating and often would be known to be boring for the participants as well as for the facilitators due to the recurring content. In short, the Makerspaces should be *"an accessible **playground** for the students"* (Belgian entrepreneur in Maker education, 41 yrs).

How Makerspaces are able to motivate young (and old) people to take the initiative and engage/participate as makers themselves is one of the crucial aspects that seems to stand out when comparing the methods with formal education.

// A MAKERPLACE OR MAKERSPACE IS A SAFE COMMUNITY

The community aspect was mentioned by 19 participants (49 references). Not only are Makerspaces a community of makers, but Makerspaces are also engaged in the broader community. For example, by making things for the community (e.g. table games for an old people centre) and by valuing ecology and sustainability.

The Makerspace as a community implies that there is no competition between makers, but collaboration. Or as summarized by this participant:

> *"We work all together to make your own project." (Belgian teacher, 50 yrs)*

This collaborative environment is seen by the interviewees as one of the reasons people are motivated to come. Makers feel comfortable and get inspired by each other. It is linked with the attitude of the people present in the Makerspaces: being helpful, open to suggestions, sharing knowledge, acting as a companion. (Spanish Fablab coordinator, 42 yrs)

Thirteen interviewees mentioned the importance of the Makerspace being **a safe space**. The participants should feel welcome and comfortable. This is a necessary condition to be able to experiment, learn and be creative.

> *Once they find themselves more comfortable with the tools they start thinking about new ideas and projects, so it is important that they feel welcome and comfortable. (Spanish Fablab Coordinator, 42 yrs)*

> *So it should be a safe space. You should feel that it is allowed to experiment and fail. (Belgian entrepreneur in education, 41 yrs)*

They should feel safe meaning *"that they are not really afraid to make mistakes here, that they are not afraid to experiment, to experience new things."* This was considered even more crucial for the NEET youth.

> *The community feeling and feeling safe is key to involve youth in makerspaces and keep them involved. Especially this target group needs a safe environment. (Dutch Fablab manager)*

// PRACTICES TO SUPPORT COMPETENCE

Working with NEET youth in Makerspaces, differs from working with adult makers who often have a higher level of technological knowledge. Furthermore, NEET youth have not experienced many successes in their life. Many of them experienced failures at school and have low self-confidence.

> *NEET needs more encouragement, personalized dialogue and work with them. Mostly such young people have already heard a lot of criticism and bad comments. (Lithuanian teacher 38 yrs)*

The Makerspaces adapted their approach when working with this target group in several ways. First of all, it is crucial to **adapt the difficulty of activities** to the entry level of the participants. Most young people won't have any experience with digital technology or programming yet. Several Makerspaces deliberately started with simple tasks and small introductory projects with quick results. The focus should clearly lay on the practice and not on the theory. For example, one interviewee explained that making something simple (with their hands) at the beginning can be a good method to shake off the anxiety or tension and prepare them to start with a more difficult task.

> *The basic method to have less theory and more practice. In the beginning, he tries to get students interested with faster results and then move on to more complex and deeper learning and doing. (employee Makerspace, 36 yrs, Lithuania)*

According to some interviewees, youngsters often lack ideas at the start. It is important to show them **the possibilities** of the Makerspaces and examples of already existing projects (mentioned by nine interviewees). It is necessary to see the opportunities and possibilities of technology in order to activate a desire in themselves to create something and to trigger the desire to create and increase interest in Makerspaces. Especially sharing successful and rewarding stories with other young people can be inspiring.

> *Another thing that helps with motivation is to see something already created. Again, there is a noticeable vacuum of ideas and the ideas of young people are technologically narrow. In this case, when they see those opportunities and what can be done with that equipment, they have a desire to do something for themselves, to ask. This creates a need for further exploration. But it all starts with small introductory projects and visual presentations. (teacher, 40 yrs, Lithuania)*

Although it is important to start with something simple, a potential pitfall is that the students do not evolve further and continue with the same simple tasks. For example:

> *A problem is that some students keep doing the same thing because it is familiar (e.g. making 10.000 different key hangers with the laser cutters) and they do not develop further skills. (teacher, 45 yrs, Belgium)*

Facilitators must try to find a balance by providing activities that are challenging, but that also after some efforts, lead to a successful experience:

> *You have to find a way of getting people out of their comfort zone and at the same time still in their comfort zone. (entrepreneur in education, 41 yrs, Belgium)*

The safe place of the Makerspace (cfr. safe community) also apport to the competence of students. They learn that trial-and-error is part of the process and that it is **allowed to make mistakes**. Experimenting is encouraged by the facilitators and the feedback is constructive. This way students cannot fail.

Competence was also supported by **acknowledging** results, skills developed and how much efforts were put in. One way was by letting the youth be **proud** of what they have made. Sharing their projects with others could play an important role in giving room to that pride. A usual practice in Makerspaces is to teach and help each other. Explaining to and teaching someone else can be an especially empowering experience.

> *It is also important that they bring those things to their surroundings and that way more people see it. And they can be proud that they did it themselves. (employee Makerspace, 36 yrs, Lithuania)*

Also the facilitators could play a role in **pointing out improvements** along the sessions and sharing it with the group. For example, one of the Makerspaces let makers write down the steps taken and reflect on their own evolution and the skills they have learned in a booklet. This could be further encouraged by the facilitators.

The development of competences should **not be limited to technological skills** only, other skills should be recognized and valued as well by the facilitators. *It is important to find a role for them that connects with their capacities and interest, and to acknowledge that role equally as the others.* For example:

> *I helped children make a soapbox for a race with school. One of the children was not really interested in making the car and stood aside, but a bit later she started spontaneously drawing logos. Then it is important to catch that opportunity. I acknowledged her role as designer of the logo and the drawings for the soapbox. (employee Makerspace, 35 yrs, Belgium)*

// STRENGTHENING AUTONOMY

One important way of motivating youth is by involving them as much as possible in the Makerspace. The Makerspace should become their place, by *"feeling ownership"* towards their personal projects or even ownership of the place. Although only one participant explicitly mentioned autonomy, the interviewees described several practices that helps develop youths' autonomy. The ideas and choices of participants are recognized and respected instead of being silenced. This is the opposite of behaviour controls.

One of the key strategies used by makerspaces to successfully include the youth-makers is by focusing on their interests (mentioned by 10 interviewees, 20 references). This implies that educators should be open towards the ideas of the youth and be flexible in their guidance. When starting with a new group, it is important to adapt the way of working as much as possible to the interest of a particular group for example:

> *For example: we decided to change the title of activities to catch the interest of girls at risk of exclusion. Instead of calling it digital fabrication we call it creative fabrication. (technical coordinator, 48 yrs, Spain)*

The Makerspaces were also seen as places that could help youth to discover their interests.

> *When students are doing something that really interests them and motivates them, they will learn more than when they have to do obligated tasks. Personal projects will be most efficient to learn. (entrepreneur in education, 41 yrs, Belgium)*

Two interviewees stressed that the focus should be on stimulating the intrinsic motivation of the youth.

> *An intrinsic motivation is the best motivation to learn. Those students will put the targets higher and will have a stronger mental focus. Thus it is crucial to start from the interest of the youth involved. (entrepreneur, 41 yrs, Belgium)*

Involvement could not only be strengthened by exploring the interests of the group but also be asking feedback of the youth after and during workshops.

Freedom to choose what they want to do, how they want to do it and when, was seen as crucial. However, freedom had to be balanced. One interviewee, for example, mentioned that a school cannot provide complete freedom from the start, but that there should be a gradual increase in autonomy. Freedom was also related with *"freedom to be themselves, to move within the space or take a break, as long as the rules determined initially are respected"*. Another form of freedom was the freedom to share your ideas and thoughts.

Some Makerspaces gave responsibility to the students themselves during longer courses to prepare some of the sessions for others. The students felt responsible and prepared sessions with care and gratitude. Other Makerspaces let the group vote and discuss certain (specific or particular) decisions. One project involved children themselves in designing the workshops.

The strongest intrinsic motivation is doing something because you like it. The making should be fun and playful.

> *The pleasure and enjoying the making is very important. Even if this pleasure has nothing to do with the laser cutter but they are playing a game in the corridor. (researcher, 39 yrs, Belgium)*

> *Activities in FabLab are fun for everyone, and when people see publicly uploaded photos, it is very exciting for everyone. (teacher, yrs 35, Lithuania)*

All those elements were utilized by the Makerspaces in order to empower the youth, giving them the opportunity and confidence to make things and solve problems.

Although many interviewees stressed the importance of starting from the interest of the youth, some flexibility is crucial. Some started with predefined projects, since youth might not have any ideas at the beginning. Importantly, from the moment the group has some idea, they will act as mediators and support them in using the machines and the material they need. A balance between guiding youth to avoid "emptiness or boredom" and being flexible to adapt to their curiosity and interest is crucial.

> *In the second part of our methodology, project development, we found that it works better to start with some predefined projects (Initially the students often find it difficult to decide or imagine what to do) so we try to help awaken their creativity and curiosity (too much freedom sometimes is not productive) (Makerspace director, 49 yrs, Spain)*

“AN INTRINSIC MOTIVATION IS THE BEST MOTIVATION TO LEARN. THOSE STUDENTS WILL PUT THE TARGETS HIGHER AND WILL HAVE A STRONGER MENTAL FOCUS”

(Entrepreneur, 41 yrs, Belgium)

// PROVIDING A LINK WITH REAL-LIFE CHALLENGES

Makerspaces are embedded in the community. Makerspaces, also the ones within a school building, should be open to people from outside the school.

> *It is an added value for the students that they can get into contact with people from outside the school (e.g. locals from the fablab). You can get expertise from outside the school within the school. (teacher, 40 yrs, Belgium)*

The projects that makers usually work on are typically linked to their personal interests. The aim for the facilitator is to help the youth gain the ability to find solutions to personal issues. This means that the youth would work on something concrete, useful and meaningful to themselves. One example was a Makerspace in which the students choose to do something that improves the world, linked with the sustainable development goals.

> *Showing examples of successful real life achievements, how something can be solved/made and realizing or discovering for themselves solutions to problems in which they can relate to. (technical coordinator, 48 yrs, Spain)*

Some Makerspaces work with assignments from companies, "from the world of work". Other Makerspaces encourage users to set up their own business and support young entrepreneurs. One suggestion in working with NEET youth was to make a clear link with job opportunities:

> *Another idea when working with vulnerable youth from socially disadvantaged backgrounds is to create a link with job opportunities or the labour market. For them finding a job and earning money might be important. Try to give them a more positive view on the new opportunities that exist because of technology through their experience in the project. Because they might be afraid that technology will lead to job loss. (entrepreneur in education, 41 yrs, Belgium)*

"IT IS A SURPLUS FOR THE STUDENTS THAT THEY CAN GET INTO CONTACT WITH PEOPLE FROM OUTSIDE THE SCHOOL. YOU CAN GET EXPERTISE FROM OUTSIDE THE SCHOOL WITHIN THE SCHOOL"

(Teacher, 40 yrs. Belgium)

The different examples given in the interviews highlighted that the making in Makerspace has a goal that is clear for the makers and that is linked with their real life and values. In contrast, at school many tasks are just tasks that are filed away and serve mainly to demonstrate that you have learned something to the teacher. Especially for NEET youth, the clearer the purpose of the task is, the more motivated the youth will be and the more chance they will have to enjoy and learn without realizing it. Accomplishing a real assignment of a company, could further strengthen their self-confidence and pride.

// A BALANCED TEAM OF FACILITATORS

Although the technological skills of the facilitators and the infrastructure of the Makerspace are important, many interviewees mentioned that social skills within the team are indispensable:

> *Most importantly, I think, is to have a responsive team that knows how to communicate and motivate, that is friendly and knows how to listen… For me it is most important, we can have all the fancy tools and qualifications possible, if the team is not capable to smile a little and say "hi" to the granny that crosses the street, I have a hard time believing that the sessions will be successful. (Makerspace technician, 50 yrs, Spain)*

Four participants mentioned the importance of having people with social expertise (e.g. social workers, youth workers) in the team, especially the Makerspaces working with NEET youth.

> *You need a team with different expertise: e.g. some people with technological skills, other people who have more social skills, or skills to guide children. (researcher/Maker, 33 yrs, Belgium)*

According to some participants having a supervisor with the same background as the young people (e.g. migration background) could be even more powerful. This social worker could help to understand the background and the needs of the youth involved.

Furthermore, to work with young people **patience** was considered crucial.

> *There is a realization that it takes patience and more to work with such young people. That patience button comes on and then he tries to show more, praise, encourage. (engineer teacher, 36 yrs, Lithuania)*

The first challenge for the facilitators is to develop **a relationship of trust** with the participants. This was described as empathizing, listening to the youth and trying to understand who they are.

> *Important to motivate children is that they have trust in you. A relationship of trust is crucial to be able to reach vulnerable groups. (researcher/Maker, 33 yrs, Belgium)*

Secondly, youth might behave in a reluctant, challenging or aggressive way. As a facilitator it can be difficult to confront their behaviour. As summarized by one of the Makerspaces:

> *A challenge or difficulty in working with (vulnerable) youth is that you sometimes forget that this group needs extra care and that you should handle them with more care. (coordinator, 50 yrs, the Netherlands)*

When teachers are involved in the Makerspace, they should be enthusiastic and take another role than they would do normally in class. They should be able to tolerate the freedom given to their students within the Makerspace:

> *Furthermore, if there are workshops with schools, teachers who engage with enthusiasm themselves create a different atmosphere than teachers who put themselves aside with their phone or teachers who walk around to keep the discipline. (researcher/Maker, 33 yrs, Belgium)*

Several participants described the difficulty of finding good teachers/facilitators. Many skills were expected from the teachers involved in a Makerspace:

> *It is a challenge to find adequate teachers since they should be technologically skilled as well as social-emotionally skilled. This combination is rather rare. (entrepreneur in education, 41 yrs, Belgium)*

> *When working with NEET's, there should be someone available who is trained in doing so and who also has technical skills at the same time. (employee Makerspace, 30 yrs, the Netherlands)*

Other interviewees did not expect one person to have both technological and social skills, but to have a balanced team with different profiles and background. Teachers should also be not too rigid and for example be open not to follow the manual or handbook.

> *Teachers should be open minded as well physically open as mentally open. Thus, teachers might not be too rigid in their didactics. (entrepreneur in education, 41 yrs, Belgium)*

On the other hand, enthusiastic open-minded teachers might lack the experience to work with the machines and the equipment in the Makerspace. Therefore, **the training of teachers** is a must and definitely crucial. Some participants made suggestions about how such a training could look:

> *Our philosophy is as follows: we provide only one piece of the puzzle: for example, a piece of code … and you have to find the solution yourself. In summary: we don't provide explanations from a to z. We believe in the training of teachers who are trained in this way of thinking. (projectmanager, 46 yrs, Belgium)*

> *The train-the-trainer should focus on having insight in their own competences profile (key competences framework) and learn how to support self-directed learning. Teachers do not have to learn how they have to give a workshop. (employee in Makerspace, 35 yrs, Belgium)*

> *Training of the teachers will be very important. The teachers should get familiar with the "maker pedagogy". This can happen through a boot camp, where they are not in the role of teacher. The training should try to allow the teachers to raise curious and surprised children within them. It's not so easy, you have to create a context. (entrepreneur in education, 41 yrs, Belgium)*

Teachers should be familiar with the Maker movement. There should be no *"shame to try things", "you should feel that it is allowed to experiment and fail"* (entrepreneur in education, 41 yrs, Belgium).

> *And for this you need a different mind-set of the teacher, not a focus on the product but the process. Students should learn that they learn from their mistakes. It should not even be the purpose of a workshop that they succeed immediately. (researcher, 39 yrs, Belgium)*

STUDENTS SHOULD LEARN THAT THEY LEARN FROM THEIR MISTAKES. IT SHOULD NOT EVEN BE THE PURPOSE OF A WORKSHOP THAT THEY SUCCEED IMMEDIATELY.

ON
MAAKLAB

2.2 WHAT CHANGES THROUGH MAKING?

How does making affect youth? What kind of changes did the interviewees observe in youth participating in their Makerspace?

// DISCOVERING THE POSSIBILITIES OF TECHNOLOGY AND THE OWN POSSIBILITIES

Increased self-confidence and self-esteem
An important effect of making is that it can lead to an increased self-confidence. This was seen as especially important for NEET youth, who were characterized by most interviewees as having low self-confidence. Simultaneously, it is more challenging to increase their self-confidence.

> *"The experience of building things and demonstrating this to friends and family, has a positive influence on self-confidence and feelings of self-worth." (entrepreneur in education, 41 yrs, Belgium)*

Importantly, self-confidence does not grow automatically within a Makerspace. Youth should be supported in doing activities that are out of their comfort zone. In particular the experience of success in something that seemed difficult or impossible at the beginning can boost self-confidence. In addition, sharing their results with others (e.g. family) can also increase self-confidence and self-esteem.

> *"Example of a workshop where they had to put together a box. It was very difficult and a lot of cursing but in the end every child had their box. Afterwards, they were very proud. First it did not go, but in the end they did it. Their self-esteem grew." (researcher, 39 yrs, Belgium)*

An increased self-confidence and self-esteem is an important drive for sustained motivation to participate in the Makerspace. For NEET youth is it also a crucial factor to help them find activities they like or a job.

The youth engaged in Makerspaces received different kinds of **rewards for their participation and engagement**. Feeling rewarded can boost self-esteem. One of the best and most effective reward, is that the participants can keep the work they have designed an produced. That also allows them to share their creation to their surroundings (family/friends) which is even more rewarding. Sharing the things they made with others also positively affects their self-confidence. Some Makerspaces explicitly encourage makers to give weekly presentations of their projects to their fellow makers.

> *We realized that we had to start with sessions or workshops in which the pupils would design and build something to take home at every session. This kind of reward or sign of achievement helps to keep them motivated and coming to every workshop. (technician, 50 yrs, Spain)*

Ideally, the making itself should be rewarding as well. If autonomy is supported and makers make what they decided they want to make, the intrinsic motivation will be strong. It's important to start little by little with small steps to be able to experience rewards. This should be more motivating and will lead eventually to bigger projects. There was one Makerspace that gave the makers an explicit reward (a certificate) for what they learned in the Makerspace.

Technology and design, something for me as well

Young people might be ignorant about the possibilities of digital technology and/or might have a negative attitude towards digital technology (e.g. finding it too complicated, difficult). Facilitators try to demonstrate that digital technology has evolved and gotten easier, so that they everybody can get involved with technology.

> *We demonstrate how technology has evolved and things can be done and understood easily so that they maintain their interest and become more and more curious about the tools and processes, how do things work? (coordinator, 42 yrs, Spain)*

It is important that youth makers develop a positive attitude and curiosity towards digital fabrication, realizing that technology and design is also something they can do. According to one of the participants, it is important that NEET youth discover the new opportunities created by the new technology today as they might be afraid that technology will lead to job loss.

> *Once they discover the possibilities within a fablab the motivation usually keeps growing independently. (Fablab manager, 36 yrs, Spain)*

> *3D printing process looked a little strange at first but I would be willing to try something with it now. (young maker, 27 yrs, Spain)*

By making technology accessible and learning how to use technology for your own projects, youth can develop a more positive attitude towards technological improvements. They will be able to see technology more as an opportunity than as a threat for their future. (entrepreneur in education, 41 yrs, Belgium)

Mostly, this is a gradual process, in which people slowly increase the complexity of the machines they use and the things they make. As explained by one participant, her interest was triggered to use electronics because she felt more confident:

Yes, there are things like the Arduino and stuff like that, that I would normally not get near but now I have more confidence to look at electronic circuits because sometimes things look harder than they really are and maybe in the future I could try to use electronics in some of my projects. (young maker, 26 yrs, Spain)

One of the facilitator's goal is to ensure that the participants feels that they belong and that they are part of the team. When young makers see the possibilities of the place and have the confidence that they can make use of those possibilities, intrinsic motivation can become very strong.

And as a place, well every time I think of a new personal project now, I think about how I could get some of it done there with the machines, advice and tools. (…) I think it's a great place, I would say it's like a centre of possibilities. (young maker, 26 yrs, Spain)

Yes a lot, before technology for me was in another world, I only knew basic things like print a document, send an email... Suddenly with the Fablab it's like a hand fan, when you open it, you see how things work and all the possibilities that can be achieved with technology, it's incredible. (young maker, 27 yrs, Spain)

An important change is that youth start to understand the underlying principles and process of making. The focus should not be solely on learning to use the machines. It is important that youth have insights in how the machines work, how to develop a concept from an idea, a design from a concept and prototype a product from a design. Having this insight in the process of making would be really motivating to youth.

"The creative process of making is the core, and knowing how a machine works, that can be included but should not become the core of the story" (researcher/maker, 33 yrs, Belgium)

"ONCE THEY DISCOVER THE POSSIBILITIES WITHIN A FABLAB THE MOTIVATION USUALLY KEEPS GROWING INDEPENDENTLY"

(Fablab manager, 36 yrs, Spain)

// DEVELOPMENT OF SKILLS

Interviewees mentioned that practically all skills can be developed in a Makerspace. Apart from to the development of technological skills, soft skills are trained as well.

> *Practically all skills can be developed in FabLab. From drawing and constructing to public speaking. (engineer teacher, 36 yrs, Lithuania)*

The difference with formal education is that the skills developed depend on the project the maker is working on. It is the maker himself who chooses what to make and thus also what to learn (learning objectives). One interviewee mentioned how she made teachers during training reflect on the competences students might develop in a Makerspace:

> *We asked 150 teachers (different groups) with whom we did a workshop in the Fablab, to put 4 Ping-Pong balls in different vases. They had to put them in the vase with the competence they felt they had worked on during the workshop. The interesting result was that the teachers found that all competences were equally trained during the workshop, not only the technological skills. Each vase contained more or less equal amounts of ping pong balls. (Makerspace employee, 35 yrs, Belgium)*

How to develop skills?
Most Makerspaces start with some kind of introduction to digital fabrication tools. Some start with introductory exercises, followed by adjusting a model and finally leading to designing an own model. The goal for young people to develop a personal idea for their own project.

Usually in the makerspace, the learning is done by "trial and error" and learning by doing. Not too much theory, but practice. Young people are encouraged to take their own initiatives and therefore, to take the lead of their own learning.

> *Philosophy is learning by making mistakes. (coordinator, 50 yrs, the Netherlands)*

Importantly, students are not left to their own devices. Six Makerspaces stressed the role of coaching. For example:

> *Taking risks: usually we talk to them individually, similar to a coach session, we prepare them to the risk of failing when working on a project, and how to evaluate results and not give up, take a different approach and try again. (director, 49 yrs, Spain)*

> *He also does coaching talks in between: "How come you did not do that?", "What plans do you have?". To let them grow in the process and to help them. (teacher, 45 yrs, Belgium)*

The coaching plays an important role in motivating young people and in underlining the role of the process versus the result. The coaching method allows facilitators to adapt the content to the needs and to recognize differences of personality within the young persons. Ultimately, an aspect that can play an powerful role in Makerspaces is peer learning, *students teach each other*.

> *Not only teachers, but also peers can act as educators in a fablab when they have some years of experience. Peers that themselves have a background in a socially disadvantaged family, and who improved their own situation through fablabs, can function as important examples that can motivate other young people. (entrepreneur in education, 41 yrs, Belgium)*

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Wide range of skills

> *The pupils will therefore be able to develop manual and digital skills as well as a wide variety of soft skills. (Fablab manager, 36 yrs, Spain)*

Many skills are developed in Makerspaces. The most obvious skills are the so-called hard skills. Makers learn digital skills and technical skills. For example, they can learn to operate machines, learn about materials, learn to create using their hands, programming and designing. Some Makers mentioned that some youth lack very basic skills that can be learned in the Makerspace.

> *FabLab is all about digital skills. Focus on what can be done with a computer and then realized with the help of a machine. Very often when I observe children I see that they sometimes lack basic computer literacy skills. How to save information, how to document. (technology teachers, 40 yrs, Lithuania)*

Alongside hard skills, many soft skills might be developed. The most important soft skills are communication, teamwork and perseverance.

> *Furthermore perseverance is something that can be learned in the fablab setting. But that is not so easy, because we have a generation of young people who are being educated to be impatient. (teacher, 40 yrs, Belgium)*

Both hard and soft skills can help students to find employment. In some Makerspaces the focus is explicitly put on helping them find jobs.

Entrepreneurial skills

All interviewees agreed that entrepreneurial skills could be developed in Makerspaces. Most of the Makerspaces interviewed did not specifically focus on those skills, but rather saw it as something that "naturally develops" through making. Other Makerspaces, more related with higher education institutions, do focus explicitly on entrepreneurial skills. They encourage makers to design products and to start their own company providing a product or service. Other Makerspaces gave the students the possibility to sell their products for example during a Christmas community market. In general, those entrepreneurial activities could further motivate youth to engage in the Makerspace.

> *We tried the Junior Achievement Fair and did it for the first time. For us teachers, this was also a new thing. And as the students tried to sell the product they created, their wings just grew. They are currently creating new items for the next fair, which will be held in the spring. (technology teacher, 35 yrs, Lithuania)*

The entrepreneurial skills most mentioned by the interviewees were creativity, learning to take risks and experiment, along with communication skills. In addition, self-confidence already mentioned above was seen as crucial for entrepreneurship.

> *Well we have to take our chances sometimes, we are not really sure if something is going to work out but we have to try it anyways. If it comes out bad, we have to try again or take a different approach, it's like a challenge. (young maker, 26 yrs, Spain)*

Other examples of entrepreneurial skills that participants referred to were leadership, taking responsibility, problem solving, financial literacy, time management, work ethic, working with customers and working with deadlines. The kind of entrepreneurial skills learned also depend on whether it is more an individual project or a collective project someone is working on.

> *Some students take a lot of responsibility in the Fablab, explain to others how to use machines, but they take no responsibility to study the regular courses. (teacher, 45 yrs, Belgium)*

“PRACTICALLY ALL SKILLS CAN BE DEVELOPED IN FABLAB. FROM DRAWING AND CONSTRUCTING TO PUBLIC SPEAKING”

(engineer teacher, 36 yrs, Lithuania)

r attention

// CONCLUSION OF THE INTERVIEWS

Twenty-nine Makers (young makers, coordinators, managers, teachers, researchers) from Lithuania, Belgium, Spain and the Netherlands were interviewed on their experiences and ideas developed while working with NEET youth in Makerspaces. The first theme describes how (NEET) youth can be motivated and engaged in Makerspaces. This is seen as the most important and crucial step when working with youth. Once they are engaged, learning can take place. The theme 'Makerspaces as playground, not as school' gives an important general explanation for why Makerspace might motivate NEET youth (more than schools do). The other subtopics give more insights in how Makerspaces differ from traditional schools.

Several aspects typical of Makerspaces are highlighted as reasons why NEET youth might be motivated in making. The first is that the Makerspace is a safe community, where mistakes are allowed and a collaborative attitude prevails. Secondly, the feeling of competence is supported, for example by paying attention to improvements, attention to the development of all kinds of talent in young people and by adapting the difficulty of assignments. Thirdly, Makerspaces offer many ways to support and strengthen the autonomy of young people. Makers are encouraged to start from their own interests and curiosity. They choose what they want to do, when they want to make it and how they want to create it. Making is not an obligation but is a fun activity. Fourth, many Makerspaces link activities and assignments with the outside world. A Makerspace is not closed-off from society. Making can be a way to help the community, a way to get to know other makers from the community and real life challenges (e.g. community or companies) can be a starting point for creation. Fifth and crucial when working with NEET youth is the ability to have a team that demonstrates not only technological skills but also social skills. Furthermore, the maker-mindset is an important aspect that should be part of the training of teachers.

Those five elements are an inherent part of the practices of most Makerspaces, but are often less present in formal education. Makerspaces offer unique opportunities to focus on those elements (e.g. supporting autonomy, competence, community feeling) that enhance intrinsic motivation while traditional schools often fail to do so. Furthermore, the embedding in the community and the real world makes the process of learning by doing different from tasks at school. However, as one Belgian participant mentioned:

> *"Fablabs are not a wonder solution for NEET"*

The second theme 'What changes through making' describes the (potential) impact making can have on NEET youth. Making can have a positive impact on the self-confidence and self-esteem of NEET youth. Through making they discover the possibilities of (digital) technology but also their own potential. Many skills can be developed, not only technological skills, but also entrepreneurial skills and soft skills such as communication, presentation, creativity, etc.

There are many challenges when working with NEET within Makerspaces. The Makerspace should be a safe place with room to experiment and to fail. The youth should be surrounded by a balanced team of facilitators capable of building a relationship of trust, motivating the youth, have technological expertise and a lot of patience.

Makerspaces can be described as a place where you play to learn but also learn to play. The fun element is central for makers. Play to learn is related to the main focus on "learning by doing". It is through having fun while making, that youth learn about the process of designing, technology, etc. Learning to play means learning to experiment, to try out without a fear of failing but enjoying the process of making. This is in opposition with the usual focus on results in school and in the broader society.

3

// GUIDELINES AND CONCLUSIONS

The third part of the guide brings together the insights from the desk research and the interview study. To synthesize the findings self-determination theory is used as an exploratory framework.

Based on the desk research and interviews, we conclude that Makerspaces have the potential to develop entrepreneurial skills and to increase entrepreneurial intentions. Although there is a difference between Makerspaces in how much explicit attention is given to entrepreneurship, the act of "making" by itself positively affects many entrepreneurial skills such as learning to take risks, creative thinking and communication. Furthermore, making has a positive impact on self-confidence in general and specifically in their own technological and entrepreneurial abilities. Self-efficacy, the belief in one's own capacities, is crucial in changing peoples' behaviour. For example, an increase in entrepreneurial self-efficacy had an impact on the entrepreneurial intentions of students (Monllor & Soto-Simeone, 2019). In particular for youth at risk of becoming NEET (at risk youth*), building their self-confidence was seen as a necessary condition to prevent them from becoming NEET. Entrepreneurship is also encouraged through the link with the real world and the community members. For example, by coming into contact with (expert) makers from the community, youth can see how making can help them in getting a job or even in starting their own company.

// HOW TO ENGAGE NEET YOUTH WITHIN THE MAKERSPACE

Importantly, the first step is to engage young people in the Makerspace. As long as they are not engaged, learning skills and personal development cannot take place. The biggest challenge when working with NEET youth is to stimulate their intrinsic motivation to make. Based on the desk research, the good practices of Makerspaces and our interviews with Makerspaces we found that **the self-determination theory** is a useful framework to synthesize and explain how youth can get motivated to become "makers" and how they can be engaged in effective learning. Self-determination is an evidence-based theory about motivation that helps to understand the underlying mechanisms of why Makerspaces can motivate and engage makers. The first part of this section explains the Self-Determination framework in general. The second part applies the self-determination framework on the findings of the desk research and interviews. The last part highlights the important role of the facilitators.

MAKERSPACES HAVE THE POTENTIAL TO DEVELOP ENTREPRENEURIAL SKILLS AND TO INCREASE ENTREPRENEURIAL INTENTIONS.

// THE SELF-DETERMINATION FRAMEWORK

The self-determination theory (SDT; Deci & Ryan, 2002) makes the important distinction between **intrinsic** and **extrinsic** motivation. The reasons people engage in certain behaviour can be placed on a continuum varying from a more external motivation (e.g. being afraid of punishment or avoiding the feeling of guilt) to an internal motivation (e.g. because of the belief it is valuable or doing something for fun). The more the person has a sense of personal commitment (internalization of the motivation), the greater the persistence and quality of the engagement.

> *"When intrinsically motivated a person is moved to act for the fun or challenge entailed rather than because of external prods, pressures, or rewards." (Ryan & Deci, 2000)*

Although two persons can be both very motivated, the type of motivation will have important consequences for outcomes such as learning and creativity. More internal motivation, especially intrinsic motivation results in high-quality learning (Ryan & Deci, 2000). However, also within extrinsic motivation there are types of motivation which are more internalized (e.g. identification and integration) and types that are more externalized (e.g. external regulation or introjection). The most autonomous form of extrinsic motivation is integrated regulation.

SDT has studied which social and environmental factors can stimulate or undermine intrinsic motivation. Intrinsic motivation can be stimulated when the psychological needs of people are fulfilled. Self-determination theory describes three fundamental psychological needs: the need for autonomy, the need for relatedness and the need for competence. It is not sufficient that people experience competence to enhance or maintain intrinsic motivation, they must also feel autonomous which means that they have determined their own behaviour. Social environments are thus characterized by SDT in the terms of the extent to which they are (Deci & Ryan, 2002):

1. autonomy supportive versus demanding and controlling
2. effectance supportive versus overly challenging, inconsistent or discouraging
3. relationally supportive versus impersonal or rejecting

In the following paragraphs we will illustrate how makerspaces can be(come) social environments that are autonomy, effectance and relationally supportive. The support for autonomy, competence and relatedness not only facilitate more self-determined and high-quality functioning and learning, but also promote the development of more effective self-functioning, higher quality relationships, resilience, and psychological well-being in the long term.

// INTRINSIC MOTIVATION IS STIMULATED BY THREE CRUCIAL INGREDIENTS IN THE MAKER MOVEMENT

The way Makerspaces succeed in engaging NEET and improving skills in NEET or vulnerable youth is essentially the same as the way they improve skills in general. The principles underlying Makerspaces match well with the needs of NEET youth and might even be a better match for them than formal education. However, some aspects need to be given more attention and consideration when working with NEET or at risk* youth.

Makerspaces offer a social environment where the three basic psychological needs can be fulfilled: autonomy, competence and relatedness. As a result of those three crucial ingredients, intrinsic motivation is facilitated. Makers are generally intrinsically motivated to 'make', this is evident from both the good practices and literature that emphasize that making is fun and the entirely voluntary character of engaging in a Makerspace. The elements that contribute to this motivation of 'makers' are the same ingredients that are crucial to engage youth at risk within Makerspaces.

1) The Makerspace should support the autonomy of the young makers
An autonomy supportive environment means that choice and self-regulation are encouraged and supported. As illustrated by our own research and the good practices, the core is that makers decide if they want to make something and what they want to make.

Examples of autonomy supportive practices were:

- Provide a setting that allows children to work with new technologies according to their personal interests (Blikstein, 2008)
- Maketec: the children are free to choose their own projects and whether they want help
- 'Making things': the youth were involved and decided themselves on which project they wanted to work

Even in projects where the activity has not been decided by the young people, autonomy can be provided by offering choices in how they will design the product, how they will start and so on. For example, the after school Tinkering program in San Francisco offered the youth a range of pinball models in the introduction and a blank canvas to start from. The GAR summer youth program aimed to make a game, but offered children freedom to experiment and some children started creating other things than games.

One aspect differs from adult makers: young people often need some introduction and guidance with the possibilities of digital fabrication before they can start imagining and creating their own ideas and projects. Many Makerspaces working with vulnerable youth started with small introductory projects with quick results or share already existing projects.

An autonomy supportive environment helps students to overcome challenges. The experience of ownership of the ideas give them more endurance to overcome frustrations. The relationship between autonomy and persistence has been supported by SDT studies (Deci & Ryan, 2002).

Research into SDT has shown that a more controlled motivation predicts not only more impoverished learning but also greater behavioural problems and risk of disengagement or dropout. Thus, to prevent youth at risk of dropping out of school, providing an autonomy supportive climate such as the one found in Makerspaces might be crucial.

Practical tips:
- The only project that will really trigger youth is one that is based on their own interest
- The first step is to find a theme that is close to the reality of the makers and their interests
- Facilitators should be flexible and open to the interests of the youth
- Youth are free to choose if they want to make and how they want to make it
- Give multiple options from which they are free to choose
- Low-threshold introductory activities can stimulate ideas for 'making' and self-confidence
- Give space and freedom for play, imagination and creativity

2) The Makerspace should support the competence of the young makers
Many interviewees emphasized that NEET youth often have not experienced many successes in their life and experienced failure at school. Many youth at risk of becoming NEET have low self-confidence. Providing a competence supportive climate might thus be especially important working with youth at risk. Building the self-confidence of youth was the core of the successful Flemish youth program (YOTA) with the goal to help vulnerable youth to get and keep a job.

Important in working with at risk youth, who might have no prior experience with the materials and technology in a Makerspace, is that sufficient time and effort should be given to **introduction** and **facilitation** to the infrastructure and the makerspace. The first step is to map the entry level of the participants. The difficulty of both the introduction, facilitation and later projects should be adapted to the participants. Facilitation is important. It takes a considerable amount of onboarding and facilitation before young people can start hacking and learning by themselves. Otherwise, there is a risk that youth might feel they are not competent and feel frustrated and even end up with a lower self-esteem.

An important part of making is the **iterative design process**. The focus is not on the products but on the process. Students are allowed to make "mistakes", because mistakes are an essential part of the process of making. The language used by facilitators to guide and provide **feedback** to makers is very important, for example "mistakes" are translated as "drafts". This focuses on the process and promotes a growth mindset in the youth so that they get the confidence to develop their capabilities.

The competence of the young makers can also be supported by **the attitude and role of the facilitators**. Facilitators must take on a humble role and acknowledge that they don't know everything. They should not take an authoritarian role. Furthermore, they can support competence by noticing improvements between sessions and sharing it with students. According to SDT, positive informational feedback enhances intrinsic motivation. Feedback should be focused on the behaviour and not on the person. Importantly, facilitators must have attention not only for technological skills but also for other skills (e.g. social skills, creativity). All kinds of talent of youth should be recognized and valued.

Peer-to-peer learning, encouraged in Makerspaces, might be an especially powerful route to support the feeling of competence of young makers. For example, in the Afterschool making program in East Oakland (Ryoo et al., 2016), peer-to-peer learning was supported as an equity-oriented move. In Maketec it was teenagers who led (teenagers were leading) the makerspace for children (Bar-el, 2016).

Examples of competence supportive practices were:

- Reframing "mistakes" as "drafts" : emphasizing process and iteration in making
- "low floor/wide walls" : activities that are easy to start with and do not require prior technical knowledge but which enable a variety of creations
- Peer-to-peer learning
- Writing down the evolution of a project in booklets
- Sharing the projects with others (e.g. presentation, showing to family)

Practical tips:

- Map the knowledge of the target group and keep that in mind while preparing the introduction, guiding the projects, coaching etc.
- Invest sufficient time in the introduction of the Makerspace
- Be careful not to end up in the key-chain syndrome: search for a balance between challenging activities but not impossible
- Design activities with multiple pathways and a range of solutions
- Support peer-to-peer learning
- Focus feedback on the process not the products
- Facilitators don't act as experts, but take on a humble role
- Facilitators have attention for a wide range of talents and skills, not only technological

3) The makers feel part of a broader safe community of collaborative makers

Relatedness is one the psychological needs according to the SDT. It is supported by the caring involvement of others. According to SDT it is not competition but rather collaboration that enhances intrinsic motivation. Collaboration is an essential part of Makerspaces. Makers share their knowledge, skills, designs, products, coding with other makers around the world. Collaboration is linked with the attitude of the makers in the Makerspace. They are described as helpful, open minded and acting as a companion.

The aspect of relatedness came to the fore in working with at risk youth*. The importance of providing a safe place was repeatedly emphasized in the interviews. This was seen as a necessary condition for experimentation, learning and creative expression. A safe place means that the youth have no fear of failing or making mistakes. Being a safe place is linked with the support of competence, for example a space should be developed where asking questions does not define your ability or intelligence. It is crucial for facilitators to take the time and energy to build a relationship of **trust** with the youth. Some at risk youth* might have more difficulties establishing a relationship of trust with strangers. One of the projects involved youth workers who already had a longer relationship of trust as a bridge to form a relationship with the facilitators. The bond between the youth workers and facilitators encouraged the youth to trust the facilitators as well.

The community aspect is also inherent in the Maker culture. Makerspaces are open to everyone. The community is involved within the Makerspace and many Makerspaces make things for the broader community. A Makerspace located within a school can form a bridge between the school and the community or outside world. For at risk youth* providing a link with real life and hearing experiences or success stories of other makers can be very valuable. Getting to know community experts can also be a powerful way of introducing and stimulating entrepreneurial thinking.

Good practice examples of supporting relatedness:

- Informal backstage activities to build relationships with the youth (cfr. 'Making things')
- Opening conversations (cfr. After school making, Ryoo et al., 2016)
- Linking the making with a social purpose; e.g. making an instrument that culminated in a collective performance (cfr. Afterschool Tinkering program, Vossoughi et al., 2013)

Practical tips:
- Rely on collaboration not on competition
- Take sufficient time to invest in a relationship of trust
- Build a bridge to the community, connect with other makers
- Invest in a safe climate with values of care and helping each other
- Support peer-to-peer learning
- Leave room for informal activities and conversations not related with making

The facilitator's role

Facilitators or educators play a crucial role in establishing an environment in which autonomy, competence and relatedness are supported. As stated above some aspects of this have been illustrated. Facilitators can use specific pedagogical language that emphasizes the process of iteration and the development of ideas (Vossoughi et al., 2013). They can widen the definition of learning, intelligence and science, creating openings for young people who may not be positioned as "successful" in their formal education (Vossoughi et al., 2013). They can support autonomy by being flexible to follow the interests of the youth. Especially for some teachers, being a facilitator in the Makerspace can be a very different role to behave in. As summarized by this quote:

"If facilitators are teachers, they must let go of their teacher role and re-invent themselves"

As a facilitator they stand "side-by-side" with the students to figure things out and they are not expected to know everything. It is important that they are open minded and not too rigid.

Working with at risk youth* implied more attention being paid to the **social skills** of the facilitators. Some projects searched for facilitators who had both social skills and technological skills, but that combination was especially hard to find. A solution by other projects was to make up a balanced team with some people with more social expertise (e.g. social workers) and some with more technological expertise. Another essential skill working with at risk youth* was patience.

When teachers are expected to become facilitators, **training** is important since they have to learn to take on another role and they might lack the experience to work with the machines and the equipment. Such a training should focus, just as the learning in the Makerspace, on creating a context in which the curious and playful teacher can come to the fore. By being involved in making, teachers can learn about the Maker attitude and culture. Other aspects mentioned as important in training were insight into teachers' own competence profile and explaining how teachers can support self-directed learning.

Good practice examples:
- Teachers support self-directed learning by asking questions (Ryoo et al., 2016)
- Teachers don't tell the answers but support the search for them (Ryoo et al., 2015)
- Teachers emphasize shared activity, process and iteration (Vossoughi et al., 2013)

Practical tips:
- The team of facilitators must be balanced in terms of social and technological skills
- It is more important that facilitators are trained in the Maker pedagogy and a growth mindset, than in their technological capacities
- Facilitators must stand "side-by-side" with the students, not taking the expert role
- Facilitators must have an open and flexible mind-set to be able to follow the interests of the youth

// SUMMARY OF THE GUIDELINES

These guidelines are based on both the good practices, the many interviews with Makerspaces combined with the empirical validated theory of Self-Determination. Three elements are crucial to engage at risk youth* in "making".

1. The makerspace should support **autonomy**
   For example by:
- Following the interest of the makers
- Offering freedom to "make" or to just watch others making
- In predesigned tasks, offering choices and different possibilities

2. The Makerspace should support the **competence** of the young makers
   For example by:
- Starting with easy tasks that can boost the self-confidence
- Finding a balance with more challenging projects but still within reach
- Using "Making" pedagogical language and focusing on the process, iteration and drafts
- Give makers opportunities to share their ideas and products with others

3. The makers feel part of a broader **safe community** of collaborative makers
   For example by:
- Inviting community experts
- Making things that help the community
- Instilling a collaborative culture without competition

It is not the tools and materials which form the essence of a Makerspace, but rather the Maker Mindset that inherently fulfils the psychological needs for autonomy, competence and relatedness. These three ingredients are crucial to enhancing the intrinsic motivation to make. When youth become engaged in 'Making" they learn not only technical skills, but also many social and entrepreneurial skills. Furthermore, their self-confidence increases, which is fundamental for entrepreneurship and routes to employment.

IT IS NOT THE TOOLS AND MATERIALS WHICH FORM THE ESSENCE OF A MAKERSPACE, BUT RATHER THE MAKER MINDSET THAT INHERENTLY FULFILS THE PSYCHOLOGICAL NEEDS FOR AUTONOMY, COMPETENCE AND RELATEDNESS.

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