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Makerspaces for Education and Training

Exploring future implications for Europe

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Foreword

The European Digital Education Action Plan foresees a series of forward-looking papers to contribute to the debate on key trends and future issues affecting the digital transformation of education and training systems and practices in Europe. This report is the second JRC contribution to the debate, in collaboration with the Directorate-General for Education, Youth, Sport and Culture. The report explores the long term potential that makerspaces and making activities can bring to education and training in Europe, trough background research, literature review, scenarios and policy insights.

The first paper under this series was published in November 2018 and focussed on the impact of Artificial Intelligence on learning, teaching and education, providing conceptual foundations for policy-oriented work, research, and forward-looking activities that address the opportunities and challenges created by recent developments in AI.

Both reports are part of the JRC research on 'Learning and Skills for the Digital Era'. Since 2005, more than 25 major studies have been undertaken resulting in more than 120 publications. Recent work has focused on the development of digital competence frameworks for citizens (DigComp), educators (DigCompEdu), educational organisations (DigCompOrg) and consumers (DigCompConsumers). A framework for opening up higher education institutions (OpenEdu) was published in 2016, along with a competence framework for entrepreneurship (EntreComp). Some of these frameworks are accompanied by self-reflection instruments, such as SELFIE, focussed on digital capacity building of schools.

In 2019, a series of 4 reports were published on innovating Continuous Professional Development, in school education and higher education, as well as a methodological guide on conducting evaluations of the provision of open digital textbooks. In addition, practical guidelines on open education for academics were released. Past research has been undertaken on Learning Analytics, MOOCs (MOOCKnowledge, MOOCs4inclusion), Computational thinking (Computhink) and policies for the integration and innovative use of digital technologies in education (DigEduPol), and the potential of blockchain in education.

More information on all our studies can be found on the JRC Science hub:
https://ec.europa.eu/jrc/en/research-topic/learning-and-skills.

Abstract

This report explores the long term potential that makerspaces and making activities can bring to education and training in Europe. Through developing four scenarios with an outlook to 2034, the report supports anticipatory thinking and helps policymakers, makers and educators to better envision and debate the added value that makerspaces and making activities can offer for education and training in Europe.

The report outlines three unique aspects of makerspaces which make them appealing to education and training. Firstly, making activities naturally combine disciplines that are traditionally taught separately; secondly, while exploring real world problems individuals acquire new knowledge and create meaning from the experience; and thirdly, due to informal ways of social interaction in makerspaces, a diversity of flexible learning arrangements are created (e.g. peer learning and mentoring, peer coaching).

The report outlines a number of 'drivers of change' which are used for developing the scenarios for makerspaces in 2034. A 4-quadrant graph derived from two 'drivers of changes' illustrates the possible combinations of developments and their potential impacts. The report offers a number of ***Insights for policy*** in the areas of education, training, validation of non-formal and informal learning, and employability to prompt and foster further discussions about the future role of makerspaces and maker programs in Europe.

Contents

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Executive summary

The aim of this report is to explore the long term potential that makerspaces and making activities can bring to education and training in Europe. Makerspaces are collaborative workspaces for making, learning, exploring and sharing. They are open to a wide range of audience from children and young people to adults. The term refers to a variety of spaces that can be a gathering point for tools, people, projects and expertise. The concept involves participation, collaboration, information sharing and spontaneity. Furthermore, activities in makerspaces are often related to personal development and self-regulation, and foster knowledge production instead of only knowledge consumption.

Makerspaces are becoming increasingly popular as they provide a welcoming space for learning new literacies, and developing new skills by exploring ideas, concepts and technologies. Not surprisingly, makerspaces are proliferating in formal education from primary to vocational education and training (VET) and to tertiary education, as well as in early childhood education and afterschool clubs.

The report outlines three unique aspects of makerspaces which make them appealing to education and training. Firstly, making activities naturally combine disciplines that are traditionally taught separately; secondly, while exploring real world problems individuals acquire new knowledge and create meaning from the experience; and thirdly, due to informal ways of social interaction in makerspaces, a diversity of flexible learning arrangements are created, e.g. peer learning and mentoring, peer coaching.

The report presents four scenarios that take place in 2034. They are the following*: Making as a learning space, Making as a methodology, Making as a community* and *Making as a life skill*. The scenarios were designed using a simple 4-quadrant graph with two axes that were identified as 'drivers of change' (Figure 1).

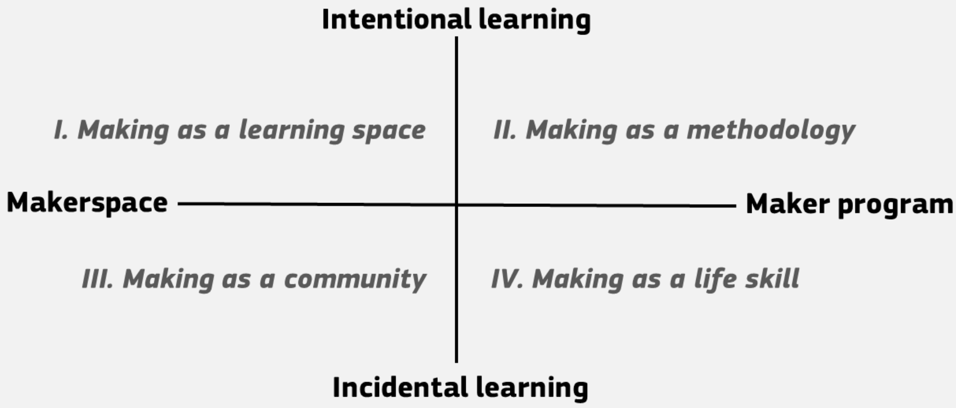


Figure 1. Future scenarios for makerspaces and making in 2034

To support anticipatory thinking, and to prompt and foster further discussions about the role of makerspaces, maker programs and making activities in Europe in the future, the report offers seven *Insights for policy*.

In the area of lifelong learning, the most prominent insight is to consider makerspaces and making as an activity which can keep citizens involved in societal and technological developments so that they can keep abreast with the world around them — but also actively shape it. Makerspaces and making activities can also serve as a stepping stone back to more formal learning activities, and they can provide pathways for employment, for example, through validation of non-formal and informal learning.

As for compulsory education, higher education and other qualification programmes, new opportunities are offered through integrating makerspaces and making activities into curriculum so that they support and foster explicit learning activities and well-defined learning outcomes. This would also secure equity, allowing all learners to participate and benefit from such activities. Overall, makerspaces and making activities are highly suitable for competence-based education and for addressing European Key Competences for Lifelong Learning. However, there is a need for more research and evaluation in this area in order to create transversal knowledge of what works well under which conditions.

1. Introduction

Makerspaces can potentially have a lot to offer for education and training in Europe. Makerspace activities are often linked with creativity, collaborative problem solving, digital competence and entrepreneurship. These are all skills or competences cited in the European Framework of Key Competences for Lifelong Learning, they are deemed important for education and training, but also for the future of work and its changing nature (EU, 2018). Secondly, understanding, tinkering and innovating with technologies around us favours the idea of an active user who makes use of the technologies for his/her own purposes, instead of being a passive consumer of such technologies. Moreover, makerspaces focusing on robotics, on STEM subjects (Science, Technology, Engineering, Math), and on Arts and design can help to foster a link between education, innovation and industry, as well as real-world applications. Last but not least, makerspaces could also be places that create a conducive environment as an incubator for future social innovations and business start-ups.

To help policymakers to start envisaging the role of makerspaces in advancing educational goals in the future, this report aims to uncover a number of implications that the maker-movement could have for society through education and training focused activities. The idea is to be forward-looking in order to inform policymakers, makers and educators in the field of education and training. The outlook is kept open to cover a wide range of education and training from formal education (from Early Childhood Education through to compulsory, VET and tertiary education) to Lifelong Learning and cross-generational learning that can be linked to Continuous Professional Development or to more liberal Adult Education. The aim is to allow informed reflection on the role of makerspaces and their potential implications for policy and practice in the context of education and training in Europe.

A future scenarios exercise is based on the idea of alternative futures that depend on various decisions along the way. In this report, four simple scenarios were developed that take place in 2034. While 15 years might seem a long way ahead, that is when children who started school in 2019 might graduate or be at the early stages of their professional careers. Rather than making predictions, scenarios can help to explore alternatives, uncertainty, complexity and the longer-term implications of decisions taken today. They will provide food for thought for educational policymaking.

The following section provides some background to the terminology used in makerspaces, with a short overview of the maker movement and its implications for education. In section 3, three unique aspects of making activities are introduced to illustrate what makerspaces could offer for education and training in the future. In section 4, a number of trends in education and training are introduced that are considered as important drivers for scenario building. Further on, section 5 presents four scenarios taking place in 2034 in order to help envisioning how makerspaces could be used to advance the goals of education and training in the future. Finally, in section 6, a short discussion is offered as an alternative to conclusions.

2. Emergence of makerspaces and terminology

Makerspace is defined as “a place where people can come together to create or invent things, either using traditional crafts or technology”[1]. The processes of creating and inventing usually also involve

[1] The Cambridge English Dictionary: https://dictionary.cambridge.org/dictionary/english/makerspace

(open ended) problem-solving and immersion in personally meaningful projects (Sheridan et al., 2014). In other words, makerspaces are first and foremost places where people gather to create and make things, and where they cooperate to invent and learn. These spaces are generally open to a wide audience, from young people to adults. Nowadays, a makerspace is usually a collaborative workspace or program inside a school, library or separate public/private facility, offering access to infrastructure and a community. There are FabLabs (Fabrication Laboratories), Proto labs (prototyping laboratories), hackerspaces, mobile makerspaces (e.g. trucks) and various maker-related programmes and initiatives. Such terms are sometimes used as a synonym, although over the course of time, they have evolved differently depending on the identity, habits and community around them (see Table 1).

Table 1. Makerspace terminology

Makerspaces	Since recently, the term has become widespread and is being commonly used by practitioners to refer to any generic space that promotes active participation, knowledge sharing and collaboration among individuals through open exploration and creative use of tools and technology. Originally, at least in the US, it was associated with MAKE Magazine in the context of creating tinkering-spaces for children (Cavalcanti, 2013). Makerspaces do not comply with a pre-defined structure and set of personal fabrication tools (or for that matter, any of them to be considered a makerspace). The focus is on having a publicly-accessible creative space that explores the maker mind-set and tinkering-practices. (quoted and abbreviated from Rosa et al., 2017)
Maker program	In the context of museums and libraries, the term "maker programs" is used to acknowledge that making can take place with or without a dedicated space. A maker program can encompass maker activities that are carried out in a conference room or a library, using a mobile cart, working out of a closet or acting as a 'pop up' in any corner of a museum or library (CMP & IMLS, 2017, p.10).
Making	Making is viewed as an umbrella term that may include programs that refer to themselves as 'tinkering' rather than 'making' or spaces that refer to themselves as FabLabs rather than makerspaces (CMP & IMLS, 2017). While there are differences between those terms, they are grouped together in this report.
FabLabs	FabLabs (shorter for Fabrication Laboratories) are spaces where people meet, exchange ideas and collaborate with the common purpose of designing and digitally manufacturing custom built objects. A distinctive feature of FabLabs is that they must comply with the Fab Charter (FabLab, 2012). All FabLabs have at their core the same hardware and software capabilities, making it possible for people and projects to be easily distributed across them. They are commonly set up in the context of an institution, be that a university, a company or a foundation. FabLabs are supported by a global FabLab association, responsible for dissemination of the FabLab concept, promotion of collaboration among FabLabs. (quoted and abbreviated from Rosa et al., 2017)
Hackerspaces	Hackerspaces are typically setup from within a community for the community, thus being community-funded and community-managed spaces. The idea was to have a non-repressive physical space where people interested in programming and tinkering with technology could meet, work and learn from each other. The spaces quickly grew in popularity, going beyond programming activities to include physical prototyping and electronics. They also provide the learning environment and the necessary support for individuals to develop their projects based on their own interests. An effort is made to distance these spaces from the negative connotations of the term 'hacking' presented in the mainstream media. (quoted and abbreviated from Rosa et al., 2017)

The richness of terms to identify makerspaces illustrates only part of the diversity and heterogeneity of the existing makerspaces in structure, settings, aims and learning approaches. These spaces can work as meeting points or cultural or training centres, for creative making, tinkering and construction. Makerspaces can offer access to high- or low-tech equipment and an engaged community of makers who can provide the 'know-how' (Dougherty, (2016). Access to technology is often central to the makerspace though many have non-tech activities, e.g. arts and crafts or creating prototypes and designs that stay in analogue phase, or move back and forth between analogue and digital.

In their different forms, makerspaces have different targets and approaches. Some focus on supporting social innovation, inclusion, lifelong learning, creativity, arts and culture; training unemployed people and empowering certain groups, including women and young people; developing skills, including digital skills, engineering and entrepreneurship as well as boosting innovative education in schools. Learning in makerspaces may occur even if it is not the primary objective. On the other hand, there are makerspaces or maker activities that are directly linked to formal education and learning, too.

A report entitled 'Overview of the Maker Movement in the European Union' offers a good outline of makerspaces and their activities in Europe, emphasising differences across the field (Rosa et al., 2017). For the report, 826 makerspaces across the 28 EU countries were identified. As shown in Figure 2, the thematic interests of activities in makerspaces ranged from digital fabrication, programming, electronics, design, art, education and biohacking to entrepreneurship and environment. The report showed that in 2016, Western European countries seemed to have a higher number of makerspaces, with France, Germany and Italy accounting for more than half of the makerspaces identified. The report also offers a good review of the history and how the movement evolved, thanks to the development and availability of technologies but also due to the influence of a number of social and cultural movements.

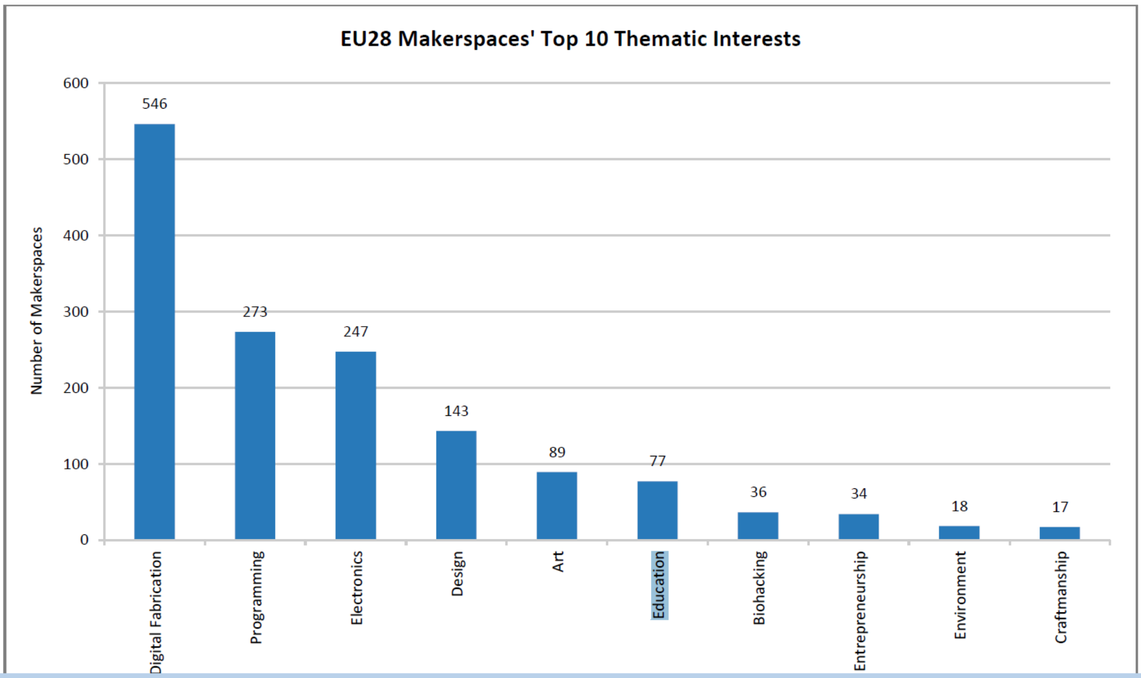


Figure 2. Top 10 focus of activity in makerspaces in EU28 by Rosa et al., 2017.

Makerspace activities have potential to foster creativity, innovation, collaborative problem solving and design thinking - transversal themes deemed important for the future. Although makerspaces were not born as learning spaces for the purpose of education and training, lately their relevance has become to the fore. Therefore, it is rather obvious that such activities have also attracted the attention of educational practitioners, especially in formal and non-formal education.

In the last 5-10 years, many actors and stakeholders in education and training have started looking to understand how making activities could support educational goals. The number of makerspaces located within educational institutions has become an important factor; however, the exact numbers of makerspaces in schools and universities are not monitored systematically. The international Fab Lab Network, for example, lists more than 1700 labs world-wide, many of which are located in universities. FabLearn Labs[2] are a growing international network of educational digital fabrication spaces developed in collaboration with schools and university partners. European affiliates of FabLearn Labs are situated in Denmark (FabLab@SCHOOLdk network of more than 30 schools[3]) and in Finland (Innokas network of more than 600 Finnish schools[4]), others being located in Barcelona, Spain and in Warsaw, Poland. While separate initiatives work together to collaborate, there is also a network across Europe emerging to serve as a European infrastructure[5].

In recent years, makerspaces have proliferated in European museums, libraries, schools and universities. For this reason, it will be important to open discussion about the implications of makerspace activities on, and for, education and training in general. In Section 3, we continue to discuss a number of unique aspects of makerspaces that are important for educational goals of the future. For readers who are not yet familiar with the main aspects of makerspaces and making, we advise proceeding to read the short introductory text in Box 1.

Box 1. Introduction to makerspaces and making activities.

Across the world, several traditions have laid the foundation for the maker movement (see more in Halverson & Sheridan, 2014; Marsh et al., 2017; Rosa et al., 2017). Three common elements of maker movement are tools, people and mindset.

Tools

A typical makerspace includes a variety of equipment and supplies that are made available to participants, however, there is no set list of tools or technologies, as long as it provides instruments for people to design and create their artefacts. Makerspaces often have craft and hardware supplies and tools (e.g. 3D printers, laser cutters, audio and visual devices, software and electronics), whereas some might have soldering irons and sewing machines as well as traditional arts and crafts materials, including ecological material. These spaces do not always include digital technology, since some prototypes and designs can be built out of anything or may include various stages of design that move from analogue to digital (Willingham & De Boer, 2015).

People

Besides infrastructure, the main element of a makerspace is its community for people to meet, socialise and collaborate around a common interest. This community-operated workspace often has a specific work ethic: the community believes in mutual help, and in trial and error. It is often an intellectually stimulating place where people gather to have fun (while creating) (Dougherty, 2016).

Mindset

A strong component of these spaces is the set of values that the community adheres to, also

[2] https://fablearn.org/
[3] https://fablearn.org/
[4] https://www.innokas.fi/en/
[5] https://sites.google.com/view/europa-makes-network/home

known as the mindset. At its core is the idea of creating something and exploring one's own interests. In general, this is also a culture of creation over consumption where partnership, collaboration and creation shape the mindset of the community (Martin, 2015).

Makerspaces are also referred to as hackerspaces or FabLabs. Although there are differences between these typologies of spaces, at the core, they share similar goals. As a general trend on the internet, around 2013-2014, the terms 'makerspace' and 'FabLab' started gaining more popularity among general audience (Voigt et al., 2016), this trend is shown as a relative increase of these search terms in Figure 3 (see red and blue line). In many European countries, the terms 'makerspace' and 'making' is used alongside other national names such as *Kniwwelen* (Luxembourg), *maak plaats* or *werkplaats* (Netherlands), *meikeriai* and *meikerspeisai* (Lithuania), *radošā laboratorija* (Latvia) and *värkkäämö* (Finland).

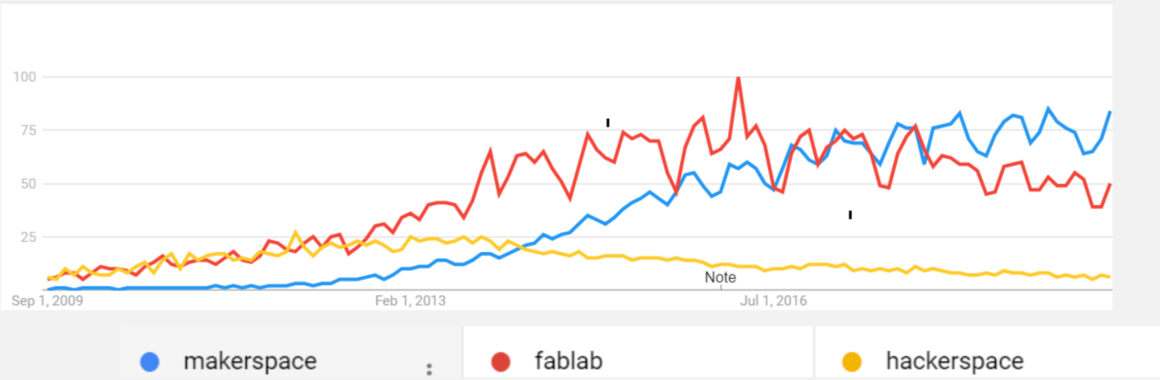


Figure 3. Internet search trends for makerspaces, fablabs and hackerspaces between 2009-2019 (x-axis: relative increase of search terms). Source: Google Trends.

Alongside makerspaces gaining popularity among the general public, an academic research community started emerging around the theme of 'making'. The early studies on makerspaces focused on the phenomena as a 'Do-it-yourself' movement and on its counter culture aspects, uncovering the maker-movement's socio-technical and socioeconomic impact on society6. In the early literature on makerspaces, they were characterised as a community space, a stand-alone membership organisation, or a drop-in space located within a museum (Halverson & Sheridan, 2014).

The sustainability aspects of makerspaces are discussed shortly in the report by Rosa et al. (2017). Within the entities surveyed in EU-28, the most common funding procedure for those makerspaces where information was available was a membership fee, either flat or varied; another frequent one was a payment scheme based on equipment usage time or material consumed. Interestingly, funding schemes were hard to identify for close to half of the makerspaces, however, some of the sources mentioned were private companies, municipalities, regional funds, or institutional or university budgets and grants.

The report did not focus on identifying the provider of the makerspace, but in cases where the main source of funding is through membership fees, it could be expected that this related to third parties such as associations and NGOs, rather than a public entity which often offers services free of charge. As for makerspaces in libraries, sustainability and funding schemes are discussed by de Boer (2015). Three suitable sources are outlined: grant-based funding that guarantees the independent nature of activities; embedding the space in another institution in order to find synergies for staff, training, etc., and charging money for providing various types of educational activities.

[6] For more about the FabLab's research focus, see: https://discuss.fablabs.io/c/research

3. Three unique aspects of makerspaces for educational goals of the future

There are three aspects of makerspaces that make them especially appealing for the field of education and training. Firstly, it is about their **interdisciplinary aspect,** and secondly the fact that, while exploring and focusing on solving authentic real-world problems, individuals acquire **new knowledge** and create meaning from this experience. Thirdly, makerspaces are known for their **flexible learning arrangements** which can span from peer learning, peer mentoring, peer coaching and peer teaching to more structured workshop demonstrations of tools. In the following pages, these three aspects are discussed in detail.

Regarding the interdisciplinary aspect, makerspaces support **'making' in disciplines that are traditionally separate**. This unique feature makes an appealing argument for implementing makerspaces in education and training where disciplines are traditionally taught in silos and practiced in separate places. A case study on makerspaces states the following:

> "This blending of traditional and digital skills, arts and engineering creates a learning environment in which there are multiple entry points to participation and leads to innovative combinations, juxtapositions, and uses of disciplinary knowledge and skill." (Sheridan et al., 2014, p. 526). In the same study, authors frequently observed "people working in one [disciplinary] area, watching someone in another, and drifting over to get involved [in another disciplinary area]" (ibid., p. 516).

Aiming to replicate this interdisciplinary ethos of makerspaces, a plethora of makerspaces has been created to pursue Science, Technology, Engineering, Arts and Math (STEAM) learning outcomes within both formal and non-formal education. At the same time, makerspace activities have potential to combine the development of STEM skills and nurture an entrepreneurial spirit (Fleming, 2015), while obviously supporting the development of digital skills.

The second appealing proposal that makerspaces can bring to the field of education and training is that by making, exploring and by focusing on solving authentic real-world problems, individuals acquire knowledge and create meaning from their experiences. Makerspaces being places where people come together to create and invent things, either using traditional crafts or technology, they are also described as playgrounds for tinkering and construction where learning may occur even if it is not the primary objective (Kurti et al., 2014, p.1). In other words, learning through making activities can be goal directed learning (*intentional* learning[7]) or unplanned, accidental learning (*incidental* learning[8]). There is a growing amount of evidence emerging that shows that

> "the makerspaces help individuals identify problems, build models, learn and apply skills, revise ideas, and share new knowledge with others" (Sheridan et al., 2014, p. 505)[9].

Makerspaces are also conducive environments for competence-based education "focusing on what students learn to do with knowledge rather than on the knowledge itself" (Anderson-Levitt, 2017). As such, makerspaces and making activities could be beneficial for promoting European Key

[7] Intentional learning: https://link.springer.com/referenceworkentry/10.1007/978-1-4419-1428-6_37
[8] Incidental learning: https://link.springer.com/referenceworkentry/10.1007%2F978-1-4419-1428-6_366
[9] See 4.2 for more on the topic.

Competences (e.g. digital competence; competence in science, technology and engineering; entrepreneurship competence; personal, social and learning to learn competence), as well as transversal ones such as analytical skills, critical thinking, problem solving and creativity, and also negotiation skills and teamwork.

The third aspect of makerspaces that appeals to educators is that they allow for a diversity of **learning arrangements** which can span from peer learning, peer mentoring, peer coaching and peer teaching to more structured workshop demonstrations of tools, materials, techniques and processes. Studies have shown that in makerspaces, learning is an ongoing part of social interaction, as in many Communities of Practice. Researchers also talk about 'facilitated making' and 'scaffolded making processes' where conditions are created by peers or experts for the individual's success (Sheridan et al., 2014). Moreover, usually participants

> "can choose which learning arrangements suit their needs, what to work on, when to work on it, and whether and how they want to continue" (Sheridan et al., 2014, p. 527).

This informal atmosphere, open-ended exploration and activities being directed by the interest of individuals is probably one of the more challenging aspects of makerspaces to transpose to the field of education and training.

3.1. Makerspaces in education and training

The three aspects outlined above create an appealing proposition for the field of education and training. Three distinctively differently flavoured practices exist which are described below.

Firstly, there are those that preserve all the above-mentioned features of makerspaces as they simply 'bring' a makerspace to an educational institution. Currently, schools, technical universities and colleges of applied science, but also adult education establishments host makerspaces with various tools and machinery where individuals from different disciplines can come together to work on projects based on their own interest in their own time, regardless of whether they are related to educational outcomes or not. The focus is on creating communities of like-minded people in a spirit of tinkering, open-ended exploration and sharing. The informal community aspect also often results in sharing of practices, co-construction of knowledge and peer learning.

The second approach to makerspaces in education and training is where the making activities are tightly linked with educational outcomes. These learning outcomes might be linked to curriculum subjects, e.g. STEAM subjects or 'Applied Design, Skills and Technologies'[10] or to the requirements of a qualification programme. In some instances they might be linked to the development of different sets of competences (e.g. problem solving, digital competence, working life competence, entrepreneurship, thinking and learning to learn[11]). Or yet in another instances, learning outcomes are a mix of grade-level content from various subjects or disciplines.

In this second type of makerspaces, the learners are nudged, or gently guided, by the context—the space, its activities and tools — to create their own learning for their own reasons (Kurti et al., 2014, p.1). The authors further observe that:

[10] https://curriculum.gov.bc.ca/curriculum/adst
[11] https://www.oph.fi/download/190839_aiming_for_transversal_competences.pdf

“At any random moment, the makerspace may appear to be simply a chaotic melee of students, tools, and strange creations. However, in reality, it is **a well-planned design to allow students discover the concepts the teacher intended them to learn** all along.”

In other words, in this type of makerspace, the learning, even if still driven by learners’ interest and open-ended discovery, is actually intentionally guided by the context, learning outcomes and to a certain extent, by learning arrangements, which might vary from structured ones to more informal peer learning and peer teaching opportunities. Often, as the learning outcomes are linked to the curriculum or to requirements of a qualification programme, there is also some sort of assessment linked with activities.

The third type of makerspace is a mix of the two types described above. The *making* activities take place regardless of whether learning outcomes are set from the start and learning arrangements vary depending on whether they are left to the community itself to mediate. Also, the link with curriculum/qualification programmes may vary, depending on how each study programme sets its learning objectives and plans for their assessment. The focus often remains cross-disciplinary, however.

Picture 1. In Luxembourg, a national programme ‘Digital(4)Education’ promotes digital literacy and entrepreneurship competence through makerspaces in education[12].

Since half a decade, literature is emerging around these types of makerspaces in education and training. Their activities are discussed firstly in the attempt to understand and document the on-going phenomenon (e.g. Meijer, 2015, Blikstein et al, 2016), and secondly in order to document evidence and guide activities in a given direction. In the latter category, a number of handbooks and toolkits exist. Without being exhaustive, a few examples in different contexts are given below. For example, to set up makerspaces and making activities within educational institutions, interesting reading includes work by Crichton & Carter (2017) and by Fasso & Knight (2019). In a European context, Blum-Ross et al. (*forthcoming*) focus on digital literacy and creativity outlining makerspaces in 7 EU countries, whereas European Schoolnet is compiling guidelines for makerspaces in schools

[12] http://www.makerspace.lu/

(Attewell et al., *forthcoming*). As for museums and libraries, there is highly insightful work in this area from the United States Museum and Library Services (e.g. CMP & IMLS, 2017, Willingham, 2018) while de Boer (2015) documents evidence in the Netherlands with guidelines (Burke, 2014). Lastly, within the context of EU-funded Erasmus+ projects, it is wort noting that more than 100 individual projects indicated makerspace type of activities between 2014 and 2019 which clearly demonstrates the relevance of making activities for Europe[13].

4. Future of makerspaces and drivers of change

In order to start building scenarios for the future, a number of issues and drivers of change are identified and briefly discussed below. These are issues that arise from desk research covering various points of literature from journal articles to blogposts in an international arena. The issues were further explored and discussed through unstructured interviews with a number of practitioners and those researching the field (see methodological section on p.23 of this report for more details).

4.1. Nature of activities: explorative vs. directed activities

In makerspaces, activities are typically directed by the interest of the individual. Makerspaces are also described as playgrounds for tinkering and construction (Kurti et al., 2014), where creativity and innovation have room to blossom – usually in a collective context. It is typical to find such freedom of expression and self-directedness in a non-formal setting. However, when makerspace activities are brought to an educational context, the condition of freedom and exploration might become conflicted with other practices. This is especially true in the context of formal education where instruction time is often standardised to small units and activities tend to become more structured.

The tension between direction and freedom is discussed in recent literature on educational makerspaces. Fasso & Knight (2019) talk about positioning activities on a continuum from informal and emergent to more formal and planned. They further explain:

> "Close links between activity and intended learning outcomes require planning and teacher engagement. However, reducing open-endedness can influence the way that makerspace philosophy is reflected, particularly in terms of personal relevance to participants."

Moreover, there is arising criticism about learning activities in makerspaces that have become too prescriptive, something that goes against the philosophy of making. Makerspace activities are compared to school science labs where learners are executing a ready-made script which is

> "designed for rigorous, disciplined, and scripted experiences in which students are guided towards the re-discovery of a unifying principle" (Blikstein& Krannich, 2013).

Other authors also call for innovation and creativity in activities, which they fear might be lost when makerspace activities are fitted into an educational setting:

> "Unless educators intentionally pursue innovation and creativity as learning outcomes, makerspaces will become "imagination ghettos" where issues of access, purpose, and ownership resemble those common in the cloistered environments of early computer labs

[13] Search terms such as 'makerspaces', 'maker movement', 'FabLab' and 'hackerspace' in Erasmus+ Project database in July 2019: https://ec.europa.eu/programmes/erasmus-plus/projects/#

> […] and students are tasked with cookie cutter activities and trivial projects to complete." (Crichton & Carter, 2015, p. 3).

Another issue is how much support is needed for the activities to be carried out, and what is the role, for example, of peer learning vs. instruction by the teacher, or support and scaffolding by a coach? These questions are relevant in identifying the key components so as to create the right conditions for learning. Moreover, if makerspaces in educational settings were to be developed, for well-planned designs that allow students to discover the intended concepts, there is the importance of teacher initial education and continuing professional development.

4.2. Learning through making: incidental and intentional

What is learned in makerspaces and how does the learning take place? What competences are acquired and what kind of knowledge is gained? Does learning that takes place in makerspaces need to be assessed and evaluated? If so, how to assess the acquisition of transversal competences (e.g. higher-order cognitive skills such as problem solving and creativity; or social and soft skills)? What about individuals' initiative taking, personal agency and self-directedness in the process? And should assessment focus on the product or also on the processes? What kind of study credits could students gain from such activities?

These are the many questions asked by educators who engage with educational makerspace activities, whereas for those in more traditional makerspaces, the aspect of learning and its assessment is not necessarily at the forefront. However, for policymakers, in order to build future education and training policies involving makerspaces, these questions are legitimate.

Some practical steps have been taken towards answering the questions above, although evidence is only starting to become available. Early research on 'learning-by-making' was conducted by Seymour Papert who founded the MediaLab in 1963 at the Massachusetts Institute of Technology, a top university in the United States. The MIT MediaLab plays a crucial role in developing and deepening many of the key ideas, e.g. 'learning-by-making' with a goal that learners create their own knowledge by creating and interacting with physical objects. Papert is often cited as the origin and inspiration for makerspaces that focus on digital tinkering, digital technologies and tools (e.g. the Logo programming language). Scratch[14], a popular programming tool for children, was also developed there following Papert's theory of learning. Other research has looked into competence acquisition through making activities (e.g. Taylor, 2016), however, Martin (2015) argues that it is good to keep in mind that there are many connections between previous research on out-of-school science learning and what is now emerging in makerspaces. As for tracking on-going dedicated research on makerspaces, Fab labs.io hosts an international community with a Research arm[15] that offers a good venue to start.

Some educational policymaking bodies and educational institutions have started defining learning outcomes for makerspaces. In the case of British Columbia in Canada, the Ministry of Education has revisited part of the K-12 curriculum called 'Applied Design, Skills, and Technologies' to include more 'applied learning' and 'doing'[16]. Another example is of a community college in Austin, Texas that lists

[14] https://scratch.mit.edu/
[15] https://discuss.fablabs.io/c/research?ascending=true&order=activity
[16] https://curriculum.gov.bc.ca/curriculum/adst

desired student learning outcomes in a makerspace[17] where students, faculty and staff can undertake hands-on, real-world, multidisciplinary projects in an informal, co-curricular setting. In Luxembourg, the Ministry of Education, Children and Youth pilots a FutureHub lable[18] in secondary education, which comes with a specific curriculum (e.g. technology and innovation, programming, big data, information modelling) and requires the schools to have an operating makerspace where students conduct an interdisciplinary project.

In the examples from British Columbia and Texas, the descriptions are written as expected competences, or desired targets, that students should acquire or achieve by the end of the learning activity. They emphasise the relationship between the activity, learning and assessment, moving the focus away from the instruction to centre it on the learner (Adam, 2004). Through shared understanding of the intention of activities, making activities in an educational setting can become more goal-directed and learning becomes more intentional[19], the latter referring to cognitive processes that have learning as a goal rather than as an incidental outcome. Evidently, unplanned learning − also known as incidental[20] or accidental learning − takes place through makerspace activities, as is often discussed in conjunction with informal learning. However, the terms 'intentional learning' and 'incidental learning' are more precise as they are not limited to how learning is organised (as is the case with informal learning), or limited by the method of learning (e.g. peer learning can take place through both intentional and incidental).

4.3. Compatibility of makerspace type-activities with educational curricula

To make the society more equitable, one of the most powerful levers is a fair and inclusive education system that makes the advantages of education available to all (OECD, 2008). The design of an education system, how it is resourced, but also practices adopted both in and out of educational institutions play a powerful role. Thinking about a future education system that is equitable, it is fair to also ask a question regarding makerspaces in education – should they be available to all learners and if so, starting at what age? For example, the principles of makerspaces align well with Early Childhood Education philosophy and practices, and research has found them to be appropriate even in kindergartens (Marsh et al., 2019).

The national curriculum is often a place where values related to education equity are written into action. A small-scale curriculum analysis was conducted in three different country contexts in Europe (Spanish, Finnish and Czech curricula) to understand how makerspace type-activities could be introduced to schools and whether the national curricula facilitated them (DIYLab, 2016). The analysis was based on key points that relate to the principles of DIYLab: concepts such as autonomous and self-regulated learning; inquiry-based teaching and learning; transdisciplinary or interdisciplinary knowledge, links and connections; digital competence; and collaborative learning. The results reveal differences in European education systems and their affordance for educational makerspace activities. The authors conclude:

> "The analyses of Spanish, Finnish and Czech curricula reveal three different contexts. The Finnish 2016 curriculum demonstrates more affinity with the aims of DIYLab, with more emphasis on

[17] http://researchguides.austincc.edu/c.php?g=435250&p=2965899
[18] https://portal.education.lu/futurehub/Section-I
[19] Intentional learning: https://link.springer.com/referenceworkentry/10.1007/978-1-4419-1428-6_37
[20] Incidental learning: https://link.springer.com/referenceworkentry/10.1007%2F978-1-4419-1428-6_366

transversal approaches to competences and a comprehensive, two-pronged consideration of digital competence (as mulitliteracy and ICT skills)" … "Where the Czech national curriculum does not share the lexicon and principles of DIY learning, the school itself does and through local initiatives it has implemented measures that can support the project. The Spanish context also reveals a highly motivated school, although the national curricula do support specific DIY principles such as autonomous learning, among others, providing additional support and incentive to the school." …"By introducing DIYLabs in each school, the project does not challenge current policy but rather attempts to develop an effective and sustainable way to support it through the innovative development of transversal, dynamic and collaborative sites of DIY learning." (DIYlab, 2016, p.13-14)

4.4. Assessment of making activities

Another advantage of descriptions of intended, or explicit, learning outcomes discussed above is that they can facilitate the assessment of making activities in general. For making activities in an educational setting, formative assessment can play an important role in encouraging and guiding students towards the end goals. A recent publication gives examples of how making activities could be assessed through formative and reflective dialogue which also fosters students' growth. Examples include prompts for dialogue on skill development (e.g. skill improvement, areas of strength), knowledge (e.g. comments on domain expertise), learner agency (e.g. comments on proactive thinking and efforts in problem solving), but also reflections on students' action (COVE, 2017, p. 16).

Various types of research are emerging on makerspaces and the aspects of assessment. For example Blikstein, who intensively studies learning through making activities, argues that "assessments should focus on the process and not products" (Gomes, 2016). His studies focus on the assessment of unstructured tasks such as computer programming and building robots. A methodological field of 'Multimodal Learning Analytics', which brings data from various sources such as gesture trackers, eye trackers, skin conductivity sensors, video, audio and sketching data, is used to analyse how students learn programming (e.g. Worsley & Blikstein, 2018).

In general, whether the assessment is formative or summative, what is crucial for the learning process is that "the learner has to invest some effort in reflection and in controlling and maintaining learning strategies" (Blumschein, 2012). Reflecting on one's actions, and metacognition of one's own learning, is important so that the strategies and processes learned can eventually be transferred to other contexts and also be put into use in new and different situation. This is called 'deep learning' (i.e. "helping students develop transferable knowledge that can be applied to solve new problems or respond effectively to new situations" Guerriero, p. 228).

It is clear, however, that more systematic research is needed to understand the best ways to assess the learning that takes place though makerspace activities (e.g. challenges to elicit deep learning). Additionally, further work needs to explore how such activities support the cognitive, tacit and interpersonal skills needed to make sense of the world around us. Moreover, the impact of makerspace activities on overall skills and competence acquisition, as well as its usefulness for the purposes of personal growth, employability and social innovation, for example, are areas where a limited amount of initial research has surfaced to date. Better understanding of these aspects better could help in taking advantage of makerspace activities for education and training.

4.5. The gender question and equity of expectation

In a recent report on K-12 makerspaces, researchers analysed cultural aspects of the makerspace, including curriculum and related activities, as well as how instructors interact with students (Youngmoo et al., 2018). Thirty education makerspaces in the United States were visited during a year-long investigation. One of the major findings was a decreasing number of females participating in activities the older they got (Figure 4). In Europe, an interesting study into students' interest in science career plans and gender divides reports a similar trend in young adults (e.g. Blasko et al., 2018). In 2015, on average 20% of 15-years old students in Europe declared an interest in science-related careers in STEM occupations, but expectations were strongly divided by gender. On average in Europe, only 10% of females are interested in STEM careers while the number of boys expecting a similar career is almost triple this. Between-country differences are remarkable: in Finland only four out of 100 female students want to engage in STEM while in Latvia the number of females that see their future in a STEM occupation is four times higher. This is an example of what is called 'equity of expectation', girls are less likely to choose studies or careers in fields such as maths or computer science, at least partly because of their vision of the right career for them (OECD, 2012). It is expected that this also plays a role in how individuals participate in makerspace activities in education and training, and outside of it too.

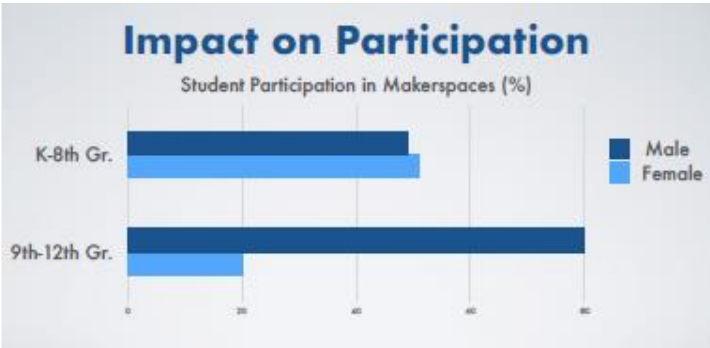


Figure 4. From the report presentation by Youngmoo & Edouard (2018).

In Europe, the gender issue in makerspaces is documented only by a small number of literature. A Nesta report surveyed attitudes among young 'Digital Makers' across the UK and found that there are different motivations for doing digital making: for girls it is because they 'have to at school' and for boys because they 'find technology interesting'. Moreover, the numbers of girls expressing negative perceptions of digital making, such as it being 'nerdy or geeky' was higher. The report emphasises that:

> "The answer to this is not the creation of activities exclusively focused on girls; there is evidence to suggest such a focus can be counterproductive. It is about catering for a broad and diverse range of interests that can be furthered through the means of digital making." The survey also found that girls showed a strong interest in making digital music, for example, although opportunities for this were few (Quinlan, 2015, p. 8).

An example of such activity catering for a broad and diverse range of interests comes from Finland. The activity in question is called 'Dancing with Robots[21]'. Participants work in teams to build and program a robot, plan and execute a dance choreography, choose music and eventually make a whole performance out of it. This new category was recently added to a national robotics tournament in Finland. The tournament is an annual event organised by a national maker-program called Innokas[22] and it includes more conventional categories such as Sumo Robot, where two robots try to push each other out of a circle[23]). 'Dancing with Robots' has brought in new makers, including girls. Since 2018, the finals of the tournament are broadcasted on national television. In a case study of this Finnish maker-program in about 600 schools, the organisers noted that the participation pattern between genders is equal which is probably influenced by the fact that the making activities are organised as part of school activities either during the school day or as after school activities (Vuorikari, 2018, p.104). Additionally, the coaches of the network set a good example for gender balance, half of them are female, offering a great role model for young women in robotics and technologies.

Lastly, around 2012-2013, an EU-funded project called Declic'in reported on female participation in a small number of activities linked with makerspaces in the Netherlands, Belgium, France and Spain (Declicin, 2013). The making activities were organised by different types of organisations; some by youth organisations, others by agencies that get participants through local or regional social and medical services. The project report concludes that in most cases, participation by individuals in making activities was not in the hands of the makerspaces, but they came through external bodies. Their recommendations include tips such as paying special attention when communicating about workshop activities and tools used in courses. For example, to avoid technical terms such as '3D printer', which might attract only certain types of participants, and use more playful ways to communicate (e.g. 'It's a machine that creates stuff'). Moreover, they suggested to focus on more collaborative actions with primary or secondary schools where there is 'de facto' gender parity; and to organise events only for girls. Regarding the leadership role in makerspaces, the project recommends more special attention be paid to gender issues when recruiting and show-casing good examples, for instance where workshops are led by women.

4.6. Resourcing tools and material, the role of industry and public-private partnerships

One of the drivers of makerspaces is the declining cost of technology, electronics, robotics and other resources which enable many of the activities. Makerspaces are proliferating both in public and private spaces where they are being hosted in community spaces, in museums and libraries, in educational institution but also as member-ship organisations by third parties (e.g. private sector and NGOs).

However, having a dedicated place just for the making activities can pose structural challenges, including issues regarding access to resources, staffing and the scale of activities. Moreover, maintenance and updates for hardware can be costly. This has given impetus to 'pop-up' makerspaces that set up activities in ad hoc locations. Examples include a mobile cart that could be

[21] https://areena.yle.fi/1-4242332
[22] https://www.innokas.fi/en/
[23] https://en.wikibooks.org/wiki/Robotics/Types_of_Robots/Contest_Robot

wheeled into a museum or school classroom; a portable kit with equipment, resources and lesson plans with a curriculum link that can be rented out[24]; a mobile FabLab[25] or a truck[26] enabling making activities to be conducted.

Industry partnerships or sponsorships have always been present in education and with makerspaces, new types of public-private and business-education partnerships emerge. One example is FYXXILAB, a Belgian non-profit organisation, that has a large partnership network of more than 70 industry partners. Approximately three quarters of the tools and hardware available in the makerspace is provided through collaborative partnerships. This means that in return, the industry partners receive feedback on the use of their tools in educational settings, and get classroom scenarios and additional educational resources for the use of their tools ¬ something that is well valued (Vuorikari, 2019, p. 49).

The example above is just one model of new types of business-education partnership that are and will be forming, in order to better marshal equipment and resources for the use of education and training. In addition, social innovation plays a major role in makerspaces, where community partnerships and shared spaces can have a big impact. With future decision-making in mind, policymakers in education and training need to also focus on this area, as it may easily create discrepancies in terms of access to educational opportunities.

Picture 2. Tools shelved in a makerspace according to the level of the expertise (green, yellow, red).

[24] https://www.fyxxi.be/tools/toolbox-huren
[25] https://fablabs.io/labs/mlab
[26] http://www.bemaker.eu/program

5. Scenarios of makerspaces for education and training in 2034

Foresight methods involve a process to create collective intelligence about the medium- to long-term future. Foresight methods can be used to inform present-day decisions by helping to understand the possible future consequences of current trends, to detect new signals of change and to determine their potential developments and implications. Various methods of foresight exist ranging from alternative scenarios to vision building and serious games as a way to make foresight more applicable and more concrete. In policy-making, the aim is to see the future as something to shape when taking action. Thanks to breaking away from conventional and short-term thinking, foresight can be a tool to equip decision-makers to better navigate the future and to shape it too (Sucha et al., *forthcoming*).

In this report, scenarios with an outlook to 2034 were chosen as a method to create four scenarios around possible futures. Rather than being a forecast, they enable the understanding of a specific issue and help to reflect on how current situations and approaches may evolve and on how decision that are taken today might affect the future. They therefore facilitate strategic reflection and can be used as a tool to support anticipatory thinking. The following implementation steps were taken:

- **Definition of the scope**. The objective and the scope of the foresight exercise was defined through desk research and literature review which included academic literature but also other types of reports (e.g. EU-projects), practitioner guidelines and books/online writings on the topic of makerspaces in education and training. A number of European and international experts were interviewed for the purpose too. This helped define the scope and clarify the boundaries of the issue to address.

  The scope was presented to the members of the ET2020 working group (DELTA) in an online seminar on May 8 2019. The session was attended by policymakers working in the field of education and training, and with the focus on the use of technologies in education. A set of short interactive exercises was run with the group. For example, they participated in an informative vote on drivers of change to be used to frame the future scenarios (e.g. Figure 5). The group was also able to voice their concerns regarding the issues that the scenarios should address. These were later used to feed into issues that were addressed in each of the scenario (Annex 9).

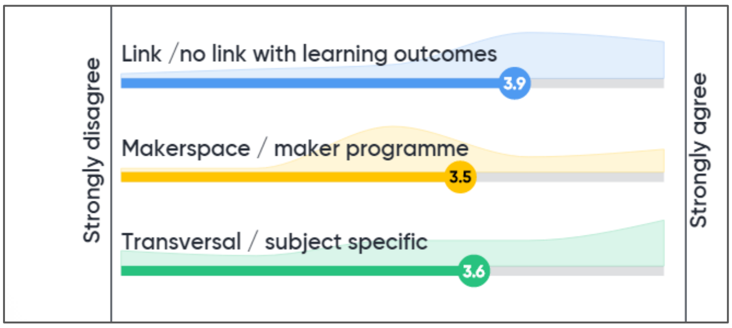


Figure 5. An interactive online exercise to select the 'drivers of change' for scenarios was conducted with a group of education policymakers.

- **Detection of trends, signals of change and identification of drivers.** To explore makerspaces and their implications as future hubs for innovation in education, a workshop entitled 'Makerspaces as hubs for innovation in education' was organised in Brussels in May 23-24 2019 by the European Commission (DG Education, Youth, Sport and Culture). The workshop was part of a series of initiatives that the Commission was undertaking as part of the Digital Education Action Plan[27], which aims to support EU Member States to meet the challenges and opportunities of education in the digital age. The meeting brought together 35 makerspace experts and practitioners from 16 European countries (see p. 6 for 'Acknowledgements'). It helped to gauge and understand the possible evolution of the trends and drivers of change in the area of makerspaces and maker programs in Europe.

- **The generation of scenarios and insight for policy reflection.** For the purpose of this report, a short scenario building exercise was conducted in the above-mentioned workshop. Participants worked in four groups to shape the outlines of the scenarios and contributed ideas for the key narratives. Based on the initial ideas produced in the workshop, the scenarios were further developed by the JRC and DG EAC together with insights for further policy reflection.

5.1. Two axes for the future scenarios

To develop future scenarios for makerspaces in education and training in 2034, a simple structural framework was created based on the input outlined above. Two drivers of change were used to create a 4-quadrant graph where the interplay between the respective drivers illustrates the possible combinations of developments and their potential impacts.

The first driver of change, which represents the vertical axis, is the link between the making activities and intended learning outcomes**. It refers to the type of learning: are the activities driven by intended learning outcomes (i.e. intentional learning) or not (i.e. incidental learning)?** Learning outcomes, also known as learning objectives, are statements focusing on what a learner is expected to know, be able to do and understand on completion of a learning process or at the end of a programme or course (Cedefop, 2017). The intentionality of activities can be described by using learning outcomes that are defined, for example, as part of a curriculum or a qualification programme, whether that is within compulsory education, tertiary education or with any further education which could be linked with career promoting courses (e.g. Continuous Professional Development).

[27] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en

The two extremes on the vertical axis in Figure 6 are:

- **Top**: activities are driven by intentional learning as defined through learning outcomes.
- **Bottom**: no intended learning outcomes, however, incidental learning may happen through making activities, although it is not a primary goal of the activities.

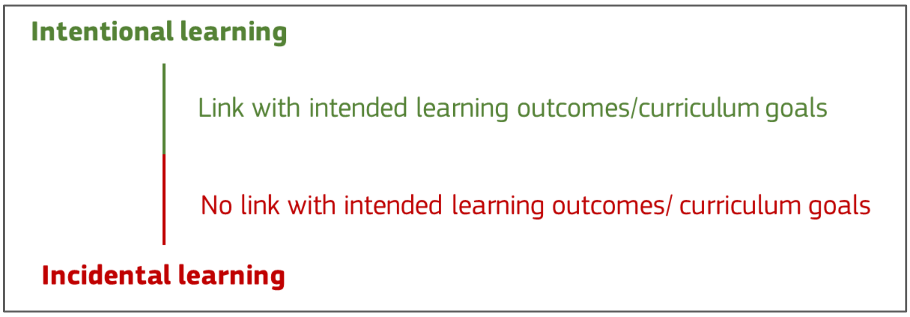


Figure 6. Vertical axis illustrates the link with intended learning outcomes or lack of it.

The second driver of change, which represents the horizontal axis, **refers to the space where the making activities take place**. Traditionally, makerspaces are places where people come together to create and invent things using a range of fabrication tools (e.g. digital and analogue ones). Typically, the space is available for a community to use and often peer-learning, advising and coaching take place allowing for informal and un-structured learning arrangements to take place. Makerspaces are therefore physical spaces where Communities of Practices can form and participants might share more than the tools, such as the mind-set or identity as a "maker" (Halverson & Sheridan, 2014). However, having a dedicated place poses a range of structural challenges, including issues regarding access to resources, staffing and the scale of activities. Therefore, especially in the context of museums and libraries, the term 'maker programs' is used to acknowledge that making can also take place without a dedicated space.

The two extremes on the horizontal axis in Figure 7 are:

- **Left**: makerspace as a physical space with a range of fabrication tools devoted for making.
- **Right**: maker program composed of making activities that are carried out in an ad-hoc environment using a mobile cart or a 'pop up' kit, for example. Activities might also only apply the mind-set, or the attitude of tinkering and making, even without having a set of tools.

Figure 7. Horizontal axis illustrating if the making activities take place in a dedicated space (left) or in an ad-hoc space (right).

5.2. Four contexts for makerspaces activities in education and training

The two axes introduced above draw a simple 4-quadrant graph which is used to develop the scenarios. The four different contexts where the scenarios take place are introduced in Figure 8 with short narratives to better illustrate them.

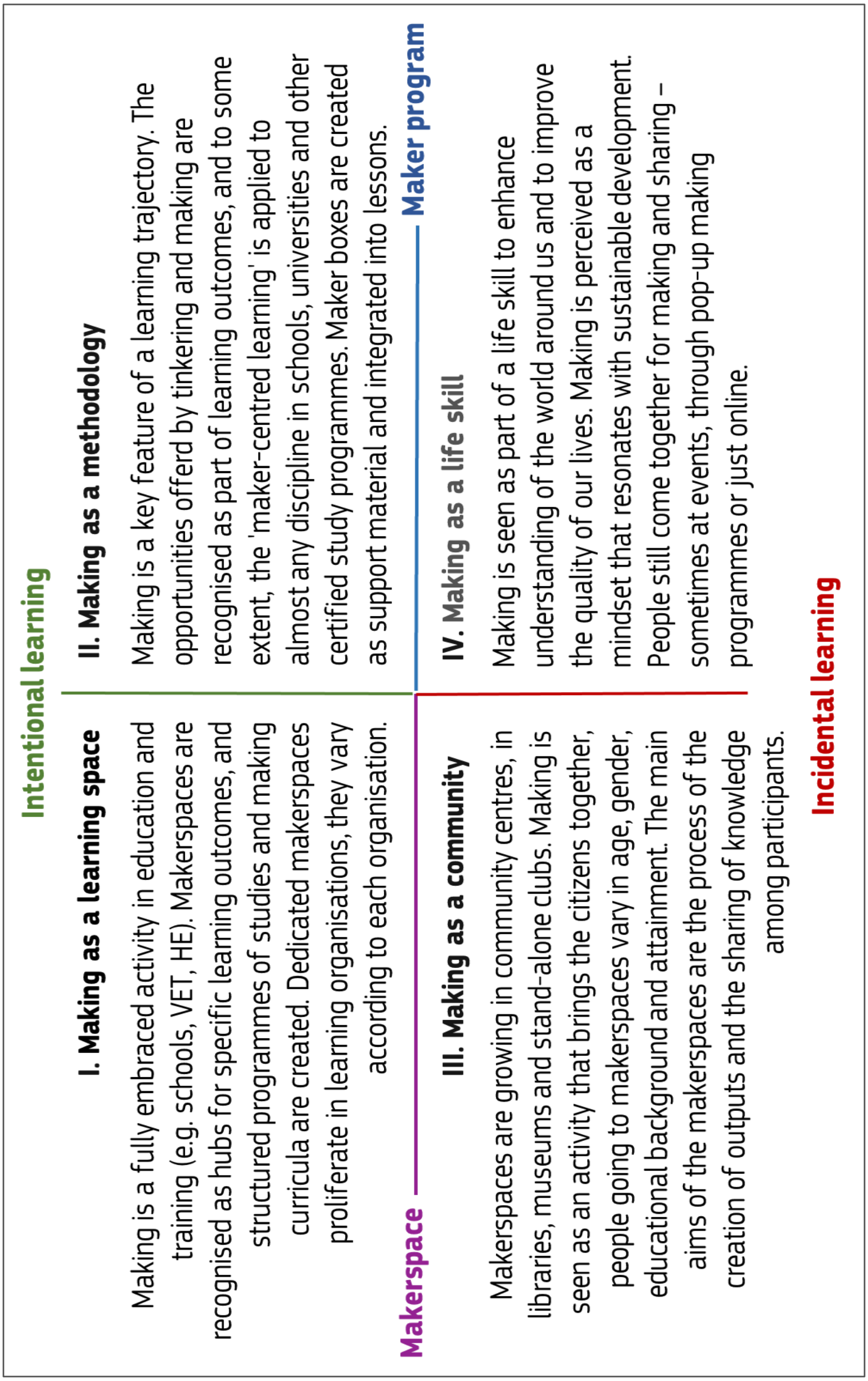


Figure 8. 4 quadrants illustrate different contexts for the scenarios.

5.3. Scenarios

In this section, the scenarios are introduced showing how the chosen drivers of change can affect the context where the making activities take place. The scenarios are sketched out from different perspectives, for example, that of a learner, teacher and a makerspace host, to show various actors and viewpoints. They also illustrate a number of possible educational settings (e.g. school, higher education, lifelong learning). Each scenario touches upon various issues which are drawn from various inputs at earlier stages of the process. These issues are outlined in a table at Annex 9.

Picture 3. Maker-led, project-based learning to help students explore the fun of working and learning together[28].

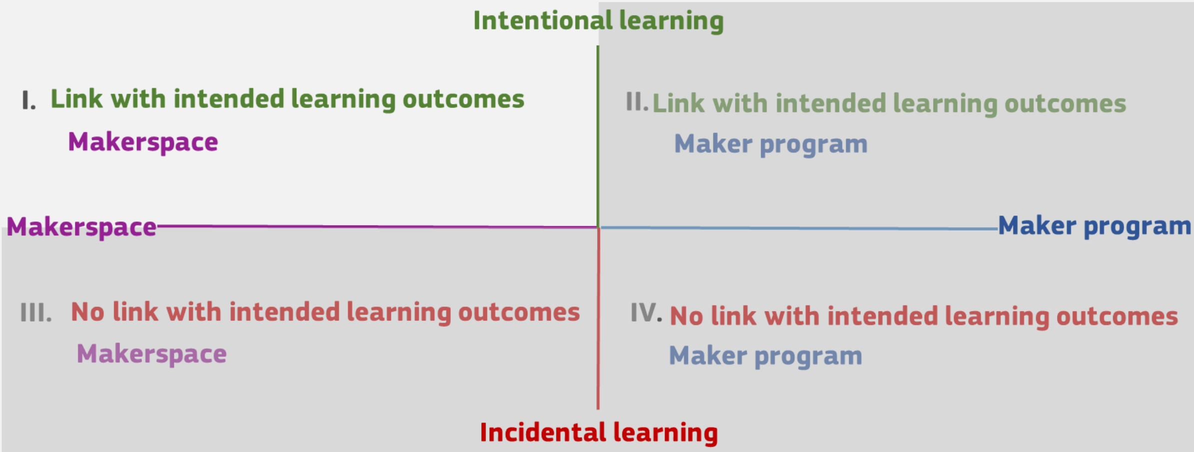
[28] http://makermeet.ie/

Scenario 1: Making as a learning space

Intentional learning & Makerspace

- Perspective: Learner in primary school

- **Issues**: curriculum integration, trans-disciplinarity, competence-based learning, assessment of acquired competences, equity



In May 2034, Petra is in the makerspace of her school testing a prototype of a prosthetic leg. The class is called *Sports, Physics and Arts*, it combines various learning outcomes described in the primary curriculum. Since 2020s, the importance of a school as a versatile learning environment gained importance; instead of classrooms, there are different learning spaces like a gym, a makerspace, a bio lab, a theatre, a film studio, etc. Such new learning arrangements enable pupils to discover new competences and roles while learning.

One of the learning outcomes of the course is related to learning about physical laws of gravity and how such laws have implications on humans. The class starts at a gym. After lots of jumping around, falling off the balance beam, ball throwing and laughter, pupils passed on to study more about how on Earth, gravity gives weight to physical objects — including humans. The following lesson took place in a makerspace where pupils use Virtual Reality tools to further experiment on digital data captured at the gym using sensors with accelerometers. This allows another look to determine what role gravity plays in their range of movements.

Once all pupils reached a minimum competence at universal gravity, pupils decided to create a dance performance to explore gravity from the points of view of dance, engineering and physics. Each pupil, or group of pupils, could choose an area or project to work on, the focus is still on problem solving.

As for Petra's group, they wanted to enhance human's capacity to perform greater movements. Could they really prototype a kind of a prosthetic leg to be used in the dance performance to accomplish that? To find out, Petra's group first spent time researching prosthetic limbs online to then design and 3D print one using the tools in the makerspace. "It still needs further testing and possible re-designs" a virtual assistant tells Petra. The assistant is designed to promote 'engineering habits of mind'.

Teachers help groups in structuring their projects. Each student has a set of tailored learning outcomes, some of which are described in the curriculum, but additionally, the groups will set their own goals depending on the focus of their project. To help with the process of formative evaluation, a virtual assistant designed to promote 'deep learning' keeps prompting pupils with questions along the way: the aim is to help them focus on reflecting on one's actions and learning.

Petra's older sister never participated in the making activities, as at that time, it was still an elective subject that mostly boys would choose. Petra thinks it is a pity as experimenting in the makerspace brings learning more alive. The downside is that as making became compulsory in her school, there was less time for other curriculum areas and therefore choices needed to be made.

Explaining Setting I: Intentional learning in a makerspace

The context, tools and the narrative around the makerspace activities are linked with externally defined learning outcomes such as those in a curricula or accreditation requirements either in formal or non-formal educational settings, including adult education**. Learner-driven open-ended exploration is directed by the interest of the individual**, so the question of how to plan and design the context so that it allows individuals to discover the concepts the teacher/study programme intended them to learn is crucial**.** The scenario includes a type of assessment of the process and the achieved learning outcomes.

Due to the link with intended learning outcomes, **activities are mandatory to all participants** of the programme creating a more level and equalitarian playground. All those participating have the same access to all the equipment and instruction. However, one should be cognisant about what is called **'equity of expectation'** which can play a role in how individuals participate in makerspace activities. In general, 'equity of expectation' indicates that girls are less likely to choose studies or careers in fields such as maths or computer science, at least partly because of their vision of the 'right career' for them (OECD, 2012).

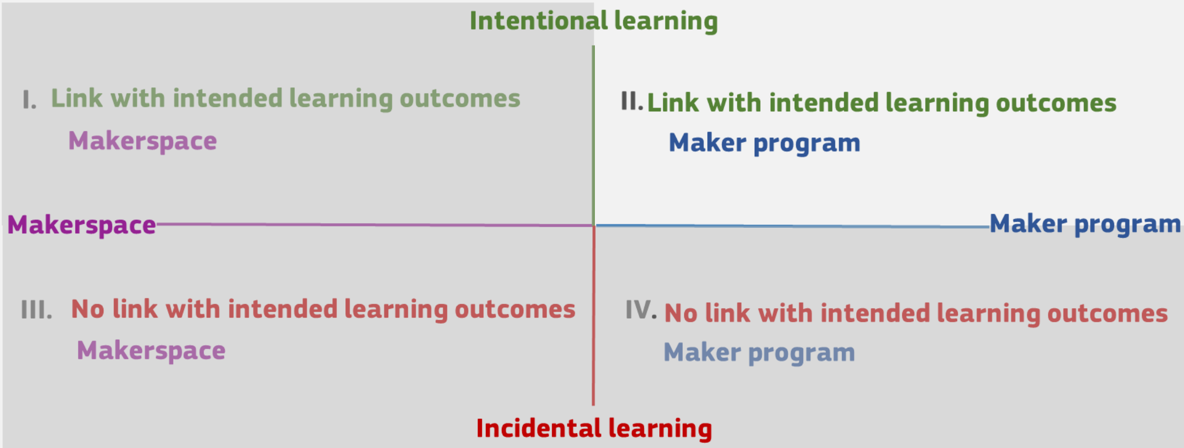
Activities take place in **a physical makerspace with tools and resources**. The makerspace could be located in an educational institution, for example. They could also be hosted in a public space such as library or science museum, or yet in another location that is managed by a community, a civic society player, private entity or an industry group. These spaces could also be part the adult education tradition, even if classified as "non-formal and non-vocational courses". In the case where the makerspace is located in an external building, integrating activities into a day of instruction needs to be planned carefully. Logistics, for instance, have to be taken into account as some planning is needed for commuting between the school and the makerspace, for example.

Regarding the communal aspects, it is likely that **a makerspace becomes a hub for like-minded individuals** who use of the space. Depending on the restrictions on use, individuals could also use it outside of learning activities thus bridging learning into a more informal setting. There is also a potential to link with local stakeholders such as businesses. This type of Community of Practice allows for a diversity of learning arrangements which range from more informal and un-structured arrangements (e.g. peer learning, peer mentoring, peer coaching and peer teaching) to more structured workshop demonstrations of tools, materials, techniques and processes, which might bring added value to individual's learning experience.

Scenario 2: Making as a methodology

Intentional learning & Maker program

- **Perspective**: Teacher in Higher Education
- **Issues**: curriculum integration, instructional and pedagogical practices, link with the world outside the HE, stakeholder involvement, public-private partnership



Sam works in a local university of a farming region where he has been teaching for the last 10 years. With his current course work of semester 2034-2035, Sam is exploring the issues of global warming and its impact on life on earth. Yes, the same challenge still remains, global warming, although our understanding has greatly improved since 2020s.

Sam sets the task for the students to bring a representation/solution to contribute to stop global warming, the focus is in the reduction of gas emission - methane in particular. As is requested from all the lecturers at the faculty, Sam has started using open challenges in his teaching tasks, this approach is also called 'maker-centered learning'. It clearly means more work for him compared to the old-fashioned lab-exercises, but he thinks he sees the impact on students' engagement. Besides, it really breeds the innovation and creativity in students.

For doing the task, the university has organised so that students have access to local industries (e.g. entrepreneurs on the topic of a green society) and to farmers who in this region have lots of cows. The students are given a portable tech-box which includes material and an app entitled 'Virtual Reality Maker' to simulate a set of tools used in makerspaces. Students work in teams, and often involve friends and family members in discussions about their work.

There are usually many reiterations, rounds of trial-and-error and loud debates before the groups are happy to present their solutions/models to others. Some come up with physical objects, others virtual prototypes, and so on. Even the farmers are invited to attend these final presentations which are part of the assessment process. The end goal for the exercise is that students get proficiency in understanding the complexity of the problem, and how it has been intensified by humans and their activities. Importantly, through the making activities, Sam wants students to understand what steps can be taken to solve such problems towards reaching a balance between human/societal development and technology production.

Due to budget challenges from education authorities to universities in rural areas, the funding of the tech-box including the Virtual Reality Maker software actually originates from the local businesses working on or supporting a green society. They use students to test their equipment and to collect initial data for further modelling purposes.

Seeing the positive side of things, this generates a link between students' formal education with the world outside the academia. Sometimes, though, Sam thinks the university is too much driven by local business and their needs, however, he understands that fixing the challenge of global warming needs all hands on the deck.

Explaining Setting II: Intentional learning through a maker program

The context, tools and the narrative around the makerspace activities are linked with externally defined learning outcomes such as those in a curricula or accreditation requirements either in formal or non-formal educational settings, including adult education**. Learner-driven open-ended exploration is directed by the interest of the individual**, so the question of how to plan and design the context so that it allows individuals to discover the concepts the teacher/study programme intended them to learn is crucial**.** The scenario includes a type of assessment of the process and the achieved learning outcomes.

Due to the link with intended learning outcomes, **activities are mandatory to all participants** of the programme creating a level and equalitarian playground. All those participating have the same access to all the equipment and instruction.

Differently from Scenario I, **the activities do not have a dedicated space or lab** as such, but they are arranged through a maker-program and rely on the availability 'pop-up' tools and resources. Various organisations from educational institutions to public entities (e.g. museums and libraries) to NGOs and private businesses can make such 'pop-up' tools and resources available either in their own spaces or bring them to other location.

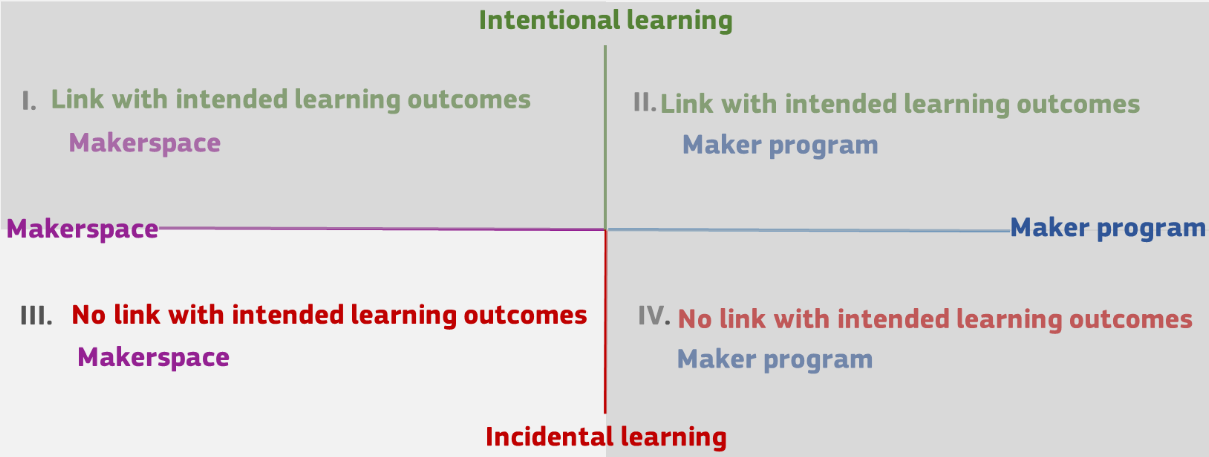
Even if the activities are available to all who participate in the maker-program, there might be a lot of **variety how activities are implemented locally**, thus most likely individuals will not have the same access to all the tools, resources and instruction. Additionally, as there is no physical space where to gather, the formation of local communities of practice might be hindered.

Picture 4. Buinho, one of the very first rural FabLabs in Portugal (https://buinho.pt/).

Scenario 3: Making as a community

Incidental learning & Makerspace

- **Perspective**: Lifelong learner early in his career
- **Issues**: Access to all, Community of Practice, methods for teaching and learning though apprenticeship, stepping stone to employment



It's an early evening in 2034. It's now 18 months since Carlo is out of job. He is going to meet his friends at the local makerspace. Since a while, there is a group meeting to explore the intersection of 'Genomic Commons' and personal privacy. This group is connected with a worldwide network of people working on the same topic, the international community has grown greatly since genomics were accelerated by AI in the late 2020s.

The group is creating their own tools using open hardware and open source software to produce open data about this topic. Carlo likes how through sharing the same interest on raising awareness about genomics related to privacy, they can debate, work and tinker together to come up with local solutions. They also frequently run workshops in places like libraries and museums to engage with more diverse crowds. Since a while, Carlo has been taking a leading role for workshops, after all, his first work-stint was as a substitute teaching assistant, even if he didn't have a proper training for it.

The makerspace is located in an adjoining building to a Vocational school. The building is open 24/7 for the students, but in the evenings, it is open to anyone who wishes to use the facility. There is a mix of people: they come and use the tools, some to deliver temporary gigs found on digital platforms, but a majority use them to work on personal projects that interest them. The students, who are soon about to graduate, guide anyone who needs help, they even gain study credits for it.

Since the declining youth cohorts, the municipality decided to start using the makerspace of the Vocational Education and Training school to empower all-age learning. The makerspace lies at the heart of this re-skilling strategy: all types of machinery, tools and resources are already there, and thanks to the versatility of the learning arrangements (e.g. peer-learning and teaching, mingling with experts and learning skills directly from them), there is no longer need for structured courses.

This new apprenticeship model was recently certified and it is starting to show results in getting people to employment, at least for short-term jobs. Carlo was just told that if he is interested, his workshop experience could be extended through the apprenticeship programme to make him a certified trainer for Genomic privacy design. Now - such certificate might be useful for getting him a new job!

Explaining Setting III: Incidental learning in a makerspace

Learner-driven open-ended exploration is directed solely by the interest of the individual and there is **no relationship with externally defined learning outcomes** such as those in a curricula or other accreditation requirements. The scenario might include some type of assessment of the learning process or an end-product of the activities, but that can be optional.

The motivation to participate is intrinsic and **depends on the individual's interests,** which means that there is self-selection in participation. Whether makerspaces are accessible and available for everyone might depend on a pay membership, for example, or where they are located, e.g. some areas are not accessible to all (e.g. business premises, educational institution) or might not be easily reachable due to their geographical location. In the case of children, the participation might also be driven by the interest/choice of parents, thus possibly limiting the variety of socio-economical background of participants. Activities are typically those related to individual's hobby.

Similarly to Scenario I, **activities take place in a physical makerspace** with tools and resources. The makerspace could be located in an educational institution, for example, or be hosted in a public space such as library or science museum, or yet in another location that is managed by a community, a civic society player, private entity or an industry group. Typically, these spaces could also serve extra-curricular after-school clubs or be part the adult education tradition, even if classified as 'non-formal and non-vocational courses'.

The physical space can facilitate the formation of **learning communities** by bring like-minded individuals together who take advantage of common interests and resources as well as engage in peer-learning, peer-mentoring and coaching. Apart from such activities contributing to building a 'maker identity', learning in such environment can act as a 'stepping stone' to access new professional opportunities or a more formal education.

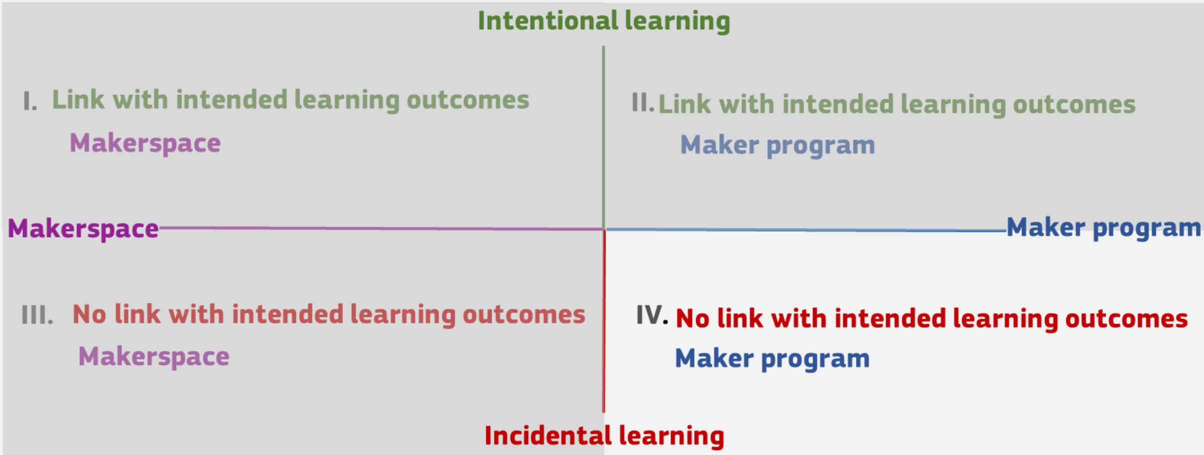
Picture 5. A metal workshop for the women of the village in rural Portugal[29].

[29] https://buinho.pt/

Scenario 4: Making as a life skill

Incidental learning & Maker program

- **Perspective**: Makerspace host (librarian)
- **Issues**: Access to all, exploration, validation of skills



Anna is driving through the outskirts of the city looking for a place to park her truck, the Maker-Mobile. Fifteen years ago it seemed very implausible that a librarian would become a makerspace host, but starting 2034, even the Master's degree in Library Science includes studies on hosting and animating a makerspace.

When still in early 2010s Anna's 'library' truck was full of books, soon after that it became a hub for digital skills carrying computers and giving ad-hoc training to audiences who otherwise would not have access to places for digital skills training. Nowadays, the Maker-Mobile hosts an upgraded repertoire of FabLab equipment in addition to several mini-maker-boxes that people can borrow for a period of time. The box, for example, includes a 3D printer that uses non-plastic material.

In areas like this, where libraries are hard to come by, people from mixed ages and backgrounds are among the regulars to visit the Maker-Mobile. Anna enjoys seeing them exploring various tools and solutions to their problems while tinkering, making and collaborating. Occasionally, she is called in to help, but it does not happen often, as almost always there's another maker ready to help. Anne also organises family-focused sessions where parents and children plunge into making activities together, it's about parents supporting children's development (and vice versa), but also about relationship bonding. As the truck stays put for a few weeks at the time, there is plenty of time to undertake short projects. It seems like a small community of makers forms around the truck, she sometimes wonders what do they do when the Maker-Mobile is not there.

The Maker-Mobile also runs accreditation schemes for validating the skills acquired outside the formal and non-formal education. There are Open Library Badges so that the participants can prove what they have learned through activities, but the industry certification scheme actually creates an additional revenue stream to sustain the type of outreach work that libraries nowadays manage and engage in. This is no trouble for Anna, as the validation of skills is built directly into the equipment. With many sensors and cameras embedded in tools, an Artificial Intelligence-based motion recognition system can validate the skills and issue a certificate recognised by the industry on the go.

Explaining Setting IV: Incidental learning through a maker program

Learner-driven open-ended exploration is directed solely by the interest of the individual and there is **no relationship with externally defined learning outcomes** such as those in school curricula or other accreditation requirements. The scenario might include some type of assessment of the learning process or an end-product of the activities, but that can be optional.

The motivation to participate is intrinsic and **depends on the individual's interests,** which means that there is self-selection in participation. **Whether makerspaces are accessible and available for everyone might depend on** a pay membership, for example, or where they are located, e.g. some areas are not accessible to all (e.g. business premises, educational institution) or might not be easily reachable due to their geographical location. In the case of children, the participation might also be driven by the interest/choice of parents, thus possibly limiting the variety of socio-economical background of participants. Activities are typically those related to individual's hobby.

Similarly to Scenario II, the activities do not **have a dedicated space or lab as such**, but they implement maker-program activities and rely on the availability of 'pop-up' tools and resources. Various organisations from educational institutions to public entities (e.g. museums and libraries) to NGOs and private businesses can make such 'pop-up' equipment available either in their own spaces or outside.

There might be a lot of variety in how activities are implemented locally thus most **likely individuals will not have the same access to all the resources, equipment and instruction**. Additionally, as there is no physical space where to gather, the formation of local communities of practice might be hindered. However, these types of maker-programs initially stem from the world of museums and libraries whose mandate is to make resources available to those who may not be able to afford their own. The advantage therefore is the outreach; these programs can potentially reach out to audiences who initially would not be attracted by makerspaces or have access to them.

Picture 6. Makerspace workshop participants building a 'vibrobot', a simple robot that is controlled by a vibrating motor.

6. Insights for further policy reflections

The scenarios and their descriptions of settings aim to provide a background against which well-informed future-oriented discussion can take place. After a short recap below, a number of insights are picked up for policy-relevant reflections, in order to discuss the possibilities that makerspaces and making activities could bring for education and training in the future.

This report started by introducing three aspects of makerspaces and making activities that make them appealing for the field of education and training. Firstly, this relates to their **interdisciplinary aspect**, and secondly we discussed how, by exploring and focusing on solving authentic real-world problems, individuals acquire knowledge and create meaning from their experiences. In other words, either intentional or incidental **learning takes place**. Thirdly, the flexibility of **learning arrangements in makerspaces offer novel opportunities** as they span from peer learning, mentoring, coaching and teaching to more structured workshops and other activities.

These aspects were reflected throughout the scenarios, while at the same time various educational and training contexts were introduced. In order to introduce varied points of view, all scenarios were presented by different stakeholders (e.g. learner, teacher, makerspace host). The settings, on the other hand, also reflected the possible tensions that might arise when pre-defined learning outcomes are used to implement making activities. Lastly, the settings also touch upon the issue of equal participation in makerspaces and making activities for all.

Commonalities running across all scenarios

- The scenarios envision makerspaces and making activities where individuals can engage in open-ended exploration through activities that are directed by their interests. In all the scenarios, making activities helped individuals acquire **skills from very basic ones to more specialised and advanced ones** to help them to keep up and **master the changing world** around them.
- In all scenarios individuals engage in activities such as exploration and elaboration. Additionally, in the ones taking place in a more educational context, the focus is also on explanation and evaluation (‘maker-centered learning’). This makes making activities highly suitable for **competence-based education** “focusing on what students learn to do with knowledge rather than on the knowledge itself” (Anderson-Levitt, 2017).
- Another common theme is that making activities are seen as a conducive environment for promoting European **Key Competences for Lifelong Learning** (EC, 2018), e.g. digital competence; competence in mathematics, science, technology and engineering; entrepreneurship competence; personal, social and learning to learn competence; civic competences, as well as transversal ones such as analytical skills, critical thinking, problem solving and creativity, and also negotiation skills and teamwork.
- In scenarios where communities are built around makerspaces they are also portrayed as a place to experiment with future **social innovations** and as potential incubators for start-ups.

Below, a number of insights are shared to animate further discussions and reflections that could be of interest to policymakers and other relevant actors in education and training.

Lifelong learning and pathways for employment

Insights for Policy 1: Makerspaces and making as an activity to enhance understanding of the world around us and to improve quality of our lives

- Makerspaces and making activities are **an example of low-cost, low-threshold** learning activities that can keep people involved in societal and technological development that take place around us. Making activities can help citizens to keep abreast with the real-world relevance of those developments.
- Makerspaces and making activities can **empower individuals** and inspire them to innovate their own desired technologies, instead of being a consumer of these technologies. Current challenges in this area include human and ethical implications regarding Artificial Intelligence and automation processes (e.g. algorithms, robotics). Digitalisation also means high flows of data with consequences for privacy, security, safety and ethical standards.
- Makerspaces and making activities could be called '**hobby learning'**, something that is non-formal and not aimed at professional purposes. However, such activities can also serve as a stepping stone back to more formal learning activities, especially for those who have previously had negative experiences in education.
- A study looking at benefits of non-formal and non-vocational training in general shows that such activities can help the acquisition of Key Competences but they also generate many other "individual and societal benefits, such as **wellbeing and social cohesion**, and therefore are considered as a system worth financing (Manninen, 2017)."

Insights for Policy 2: Makerspaces and making as an activity for Lifelong learning to provide better work opportunities

- Makerspaces and making activities could be seen as complementing vocational adult education systems in the future: they could be used for professional re-orientation as well as for **learning new skills that are needed for a job** (e.g. for workers whose skills have become obsolete as a result of automation).
- **Gaining more evidence** of the role of makerspaces and making activities in skills acquisition and for the purposes of professional re-orientation would be an important goal for the future. There should be experimentation with methods to encourage participation in such activities (e.g. learning vouchers).
- Further reflections should be made **on how to recognise the skills and competences gained** from making activities. Moreover, what kind of certification or other form of recognition could be envisaged so that individuals could get back to education and training or find new ways into employment?

Insights for Policy 3: Makerspaces and making activities outside formal and non-formal education and training

- Makerspaces started as places where people came together to create and invent things using traditional crafts or technologies, allowing individuals with different abilities and interest to fulfil their talent. They were associated with like-minded people coming together driven by personal interest for purposes such as common good and fun. This is typically

informal and peer-led environment induced learning, mostly incidental (also known as accidental learning), along with opportunities to gain individual and social capital.

- It is clear that in the future, regardless of how makerspaces and making activities might be used for education and training purposes, makerspaces as they were initially known will always have their place, without fear of becoming 'institutionalised' or part of established rigid structures for education and training.
- While this report focused mostly on makerspaces provided by public entities (e.g. educational institutes, libraries, museums**), the field is rich in associations, NGOs and private sector actors** who work with diverse groups, especially youth groups in after-school activities and marginalised groups. Their role has not been discussed thoroughly in the scenarios and has only been touched upon briefly elsewhere in the report, although their input is important in infusing social innovation and making resources available to those who may not be able to afford their own.
- Ideas about how traditional makerspaces and making activities, and those with intentional learning goals, can cross-pollinate each other and co-exist in a win-win way will be important for the future. Already the current trend shows that many traditional makerspaces offer not only out-of-school activities but also **more structured trainings**. It will be crucial to guarantee their inclusiveness in the future.

Compulsory education, higher education and other qualification programmes

Insights for Policy 4: Makerspaces and making as part of basic education

- To **secure equity in education**, basic education remains a priority because it includes the entire cohort. If makerspaces and making activities were made part of basic education, this arrangement would facilitate access for an entire cohort of students to such activities, thus potentially counterbalancing other factors that might play a role in participation (e.g. socio-economical background, gender, personal interests and motivations, family priorities, capabilities).
- Offering maker education in all European educational institutions ('Maker education for all') could result in a resource-intensive proposal, not only because makerspace facilities with a high-quality selection of tools could be expensive, but also because it would require major efforts in upskilling teachers and coaches, logistics, etc. Only a few education providers (e.g. government, municipality) could afford it. Therefore, maker programmes and makerspaces provided by third-party players (e.g. NGOs, associations, businesses and other private entities) and by public entities (e.g. museums and libraries) play an important role in guaranteeing a more equitable education system that contributes to equity.

Insights for Policy 5: Makerspaces and making activities in the curriculum

- **Curriculum planning** and the design of education programmes and qualification requirements is a way to integrate makerspaces and making activities into learning activities within compulsory education, Vocational Education and Training and in Higher Education. In this context, a number of EU Member States have added topics such as coding, programming and computational thinking into school curricula (JRC, 2016[30], Eurydice, 2019).

[30] https://ec.europa.eu/jrc/en/computational-thinking

Some promote interdisciplinary learning activities, e.g. phenomenon-based learning, project-based learning (FNAE, 2016), activities that can be fostered through makerspaces.

- Such policy-level targets described in national curricula, preferably in a non-prescriptive way, can readily be turned into intended learning outcomes to be achieved through learning arrangements in makerspaces and through making activities. However, such decisions are often left to individual educational institutions, and can fall low on a priority list. Therefore, **incentivising good practices in integrating makerspaces and making activities into education at all levels would ensure that most learners could have access to them**.

Insights for Policy 6: Makerspaces and making activities as explicit learning activities

- The scenarios explored the possible tension that could arise when making activities have intentional learning outcomes, as opposed to learners engaging in such activities without any learning outcomes in mind.
- In the last five years, a number of research groups in education and educational practitioners have called for intentionality in making activities. The aim is to use them to achieve set objectives, in terms of learning outcomes which are defined in the curriculum, for example, related to grade-level content from various areas (cross-disciplinarity) and to develop transversal competences such as analytical skills, critical thinking, problem-solving and creativity.
- Intentional learning can also facilitate transferability of the strategies and processes learned to other contexts, so they could be put into use in new and different situations (e.g. 'deep learning'). However, 'the learner has to invest some effort in reflection and in controlling and maintaining learning strategies' (Blumschein, 2012). Therefore, **reflecting on one's actions**, and metacognition of one's own learning, have an important place in intentional learning activities so that the strategies and processes learned could become more visible for the learner him/herself. This is also noted by one of the Key Competences for Lifelong Learning, namely that of the Personal, Social & Learning to Learn competence (Caena, 2019).

Insights for Policy 7: The need for evidence based planning and design makerspaces and making activities

- Sound scientific evidence is needed to inform policy making in the area of makerspaces in education and training. In order to gather the right evidence, further investment is needed in research and evaluation in this area to create transversal knowledge of what works well under which conditions. Currently, only limited research exists on a limited range of issues. If we are to ensure European citizens with future-proofed competences and capacities, investment in research in this area will be key.

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8. Key terms used in the report

FabLabs (shorter for Fabrication Laboratories) A distinctive feature of FabLabs is that they must comply with the Fab Charter (Fablab, 2012). All FabLabs have at their core the same hardware and software capabilities, making it possible for people and projects to be easily distributed across them. They are commonly set up in the context of an institution, be that a university, a company or a foundation. FabLabs are supported by a global FabLab association, responsible for the dissemination of the FabLab concept, the promotion of collaboration among FabLabs, the share of expertise, the brainstorm of ideas, and the spread of research. (quoted and shortened from Rosa et al., 2017)

Formal education and training according to the International Standard Classification of Education 2011 (ISCED 2011) is defined as “education that is institutionalised, intentional and planned through public organisations and recognised private bodies. Formal education consists mostly of initial education. Vocational education, special needs education and some parts of adult education are often recognised as being part of the formal education system.

Hackerspaces are typically setup from within a community for the community, thus being community-funded and community-managed spaces. The idea was to have a non-repressive physical space where people interested in programming and tinkering with technology could meet, work, and learn from each other.

As the spaces grew in popularity, going beyond programming activities to include physical prototyping and electronics took place. They also provide the learning environment and the necessary support for individuals to develop their projects based on their own interests. An effort has been made to distance these spaces from the negative connotations of the term ‘hacking’ presented in the mainstream media. (quoted and shortened from Rosa et al., 2017)

Non-formal education and training is defined as any organised and sustained learning activities outside the formal education system. Non-formal education is an addition, alternative and/or complement to formal education. Non-formal education may therefore take **place both within and outside educational institutions** and cater to people of all ages. Depending on national contexts, it may cover educational programmes to impart adult literacy, life-skills, work-skills, and general culture[31].

- **Adult Education Survey** defines four types of non-formal learning activities can be singled out: Courses; Workshops or seminars; Guided on-the-job training (planned periods of education, instruction or training directly at the workplace, organised by the employer with the aid of an instructor) and Lessons.
- **The Survey of Adult Skills** (OECD[32]) uses a list of possible non-formal education activities, including open or distance learning courses, private lessons, organised sessions for on-the-job training, and workshops or seminars

[31] https://ec.europa.eu/eurostat/cache/metadata/en/trng_aes_12m0_esms.htm
[32] https://www.oecd-ilibrary.org/docserver/5jxsvvmr9z8n-en.pdf?expires=1563360365&id=id&accname=id24042&checksum=AF2E693D9C051E77357083DD3932CFBA

Informal learning is defined as intentional learning which is less organised and less structured. It may include for example learning events (activities) that occur in the family, in the work place, and in the daily life of every person, on a self-directed, family-directed or socially-directed basis[33].

Learning activities are any activities of an individual organised with the intention to improve his/her knowledge, skills, and competences. Intentional learning (as opposed to random learning) is defined as a deliberate search for knowledge, skills or competences. Organised learning is defined as learning planned in a pattern or sequence with explicit or implicit aims.

Learning outcomes: statements of what a learner knows, understands and is able to do on completion of a learning process The definitions and descriptions of learning outcomes as used in qualifications frameworks, qualification standards and curricula are statements and expressions of **intentions or goals**. They are not outcomes of learning, but desired targets. **Achieved learning outcomes** can only be identified following the learning process, through assessments and demonstration of achieved learning in real life, for example at work. (Cedefop, 2016, p.30-31).

Makerspaces is widespread concept commonly used by practitioners to refer to any generic space that promotes active participation, knowledge sharing, and collaboration among individuals through open exploration and creative use of tools and technology (for more, see Table 1, p. 7).

Maker programs, especially in the context of museums and libraries, the term is used to acknowledge that making can take place with or without a dedicated space (for more, see Table 1, p. 7).

Making is viewed as an umbrella term that refer terms similar to 'tinkering', although some might argue that there are meaningful differences between those terms (for more, see Table 1, p. 7).

Recognition (of competences): All learning activity undertaken through life, which results in improving knowledge, know-how, skills, competences and/or qualifications for personal, social and/or professional reasons. Source: Cedefop, 2008[34]

[33] https://ec.europa.eu/eurostat/cache/metadata/en/trng_aes_12m0_esms.htm
[34] https://www.cedefop.europa.eu/en/events-and-projects/projects/validation-non-formal-and-informal-learning/european-inventory/european-inventory-glossary#R

Annex: Issues explored in Scenarios

		1	2	3	4
Equity					
	making activities available for all through curriculum	x	x		
	making activities available only for those interested			x	x
	rural areas		x		
	gender issue	x			
	involvement of (local) government/ policy makers			x	
	access to all taxpayers			x	x
What is learned and assessment					
	Nature of activities: exploration vs. directed actives	x	x		
	What competences are acquired	x		x	x
	grade/course-level content to develop mind-sets	x			
	What is assessed: product and processes	x			
	Organisation of guidance, mentoring and peer-opportunities			x	x
	Using 'making' to assess competences that are often not assessed	x			
Formalising learning					
	Link formal and non-formal education			x	
	Recognition and credentials			x	x
Resources					
	resources provided by the education provider	x		x	
	resources provided by the public sector				x
	resources provided by public-private partnership		x		
Different stakeholders					
	teachers	x	X		
	learners	x	x	x	x
	facilitators			x	
	librarians				x
	community of practitioners			x	
	local business		x		
	family		x		
For whom			x		
	compulsory education	x			
	training in VET school			x	
	HE		x		
	Lifelong learning (for unemployed)			x	
	fun-learning but also a stepping stone			x	x

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