Makers@SEK

Any person not directly involved in the maker movement may ask themselves: Why is maker culture necessary? Our technological ecosystem is constantly transforming, the digital economy is maturing and acquiring a new meaning. The most highly-paid jobs in the coming decade will require skills that are based on teamwork, tackling new challenges, learning rapidly, using computer thinking and a creative mindset capable of connecting different areas of knowledge.

Makers, through makerspaces, *'can be defined as a fan of 21st century technology. With a passion for technology, design, art, sustainability and alternative business models. They share interests with online communities, dream about inventing products for themselves...'*

Makers are also creative entrepreneurs and members of a community of maker entrepreneurs, capable of taking on different roles: sponsor of projects from other makers, business persons creating their own projects, social activists in the service of the community and advocating for the less advantaged. Tim O'Reilly, businessman, publisher, maker and entrepreneur believes the true driver behind this movement is the capacity of each maker for analysing problems, understanding them in context, putting forward a creative, effective, achievable and sustainable solution and rolling it out themselves.

Barry Katz, Stanford lecturer in strategic design, believes that the maker movement is a natural evolution of the traditional industrial production model: society's technological advances enable organising production systems differently. This new organisation supported by maker communities and producers enables production of objects in small batches, on demand, tailored to the tastes of each buyer, at affordable prices and with a minimum environmental impact.

The maker movement and its role in education

The maker movement was born from a revolution in education that started in the 70s and was led by the tireless mathematician and educator Seymour Papert, he proposed using technological resources to support learning, a precursor to today's makers. Availing himself of constructivism, Papert advocated for the creation of technological learning resources (computers and simple programming languages) helping children to improve learning and boosting creativity. In his book *Mindstorms: Children, Computers and Powerful Ideas* (1980), (named subsequently used by the robotics game by MIT and LEGO) Papert explained how as a child playing with gears lying around his father's workshop helped him understand mathematics and drove him to "*…Try and turn machines into instruments that were flexible enough so that many*

children could create their own, something like the gears were for me..."

The integration of the Maker Mindset was always based on Papert's ideas. This was possible thanks to an initiative headed by Dale Dougherty, a tireless maker, coiner of the term and main promoter of this experimental play learning culture. His contributions include: Setting up the magazine Make para to promote maker culture, founding the Maker Shed collaborative environment and maker community, in addition to a showcase for maker products, and setting up Maker Faire held around the world to connect the maker community.

Education methods in Maker environments

Digital media and simplified programming are driving an unheard of revolution in education, with particular traits that set it apart, including experimentation and play. Dougherty says the maker movement fosters informal and collaborative learning based on digital repositories to share and disseminate experimental product projects and online gaming, something impossible in other eras. Dougherty adds "*...Learning experiences in a maker space helps students develop a maker mindset that can be applied to any professional activity or discipline...*"

Paulo Blikstein, researcher in maker education and its impact on learning says *"… the majority of learning that occurs in makerspaces takes places during the learning and creative processes…" and adds "…Our main finding was that children around the world are familiar with technology, the majority use it to consume products from the digital world, not to create physical products…"*

This raises the question, what methodology should be used to teach this methodology? The majority of authors agree that makerspaces are open to any teaching-learning method focussed on students and can help to foster: social skills, emotional intelligence, cross-curricula knowledge and invisible skills, applied to the following methodologies: project-based learning, design thinking, inquiry, participative action, computational thinking, entrepreneurship, etc.

Makerspaces and ecosystems

Stephen Heppell, expert in learning space design, says that "…*the informal and playful nature of students' experiences helps them identify their interests. These open innovation spaces allow for any application and learning…*". Colleen Graves adds "…*A makerspace is not just a place to build objects, many times its is a place that gives things meaning, often more important than what you actually do…*"

Educational writers such as Gary Stager, Sylvia Libow, Laura Fleming, including Blikstein, highlight the importance of makerspaces in learning in general and not just in sciences, engineering, technology, arts and mathematics (STEAM). Dougherty highlights the informal culture and positive emotional impact fostered by makerspaces, which he considers both intensifies the impact of learning experiences and helps students develop permanent invisible skills such as problem solving, critical thinking, patience and resilience and entrepreneurship among others. TheRSA.org "*…Makerspaces are more than just places to create objects. They are spaces to experiment with different lifestyles, that meet the challenges and opportunities of a world where technology is ubiquitous…* "

So, is it necessary to have a special space for a makerspace? Makerspaces can be special spaces in some institutions if they have special production resources such as: Laser cutters, 3D printers, recording studios, etc... Experts, however, remark that the lack of space or budget should not be an impediment, since maker activities can be ubiquitous, dynamic and flexible. The Horizon 2016 Report on K12 education recommends decentralising makerspaces and distributing them in different areas around schools to generalize activities and help students of both sexes learn by creating and helping them be passionate makers.

Makerspaces are helping to transform and renew schools, they are recovering unused spaces such as workshops, labs and libraries. The simplicity and informal nature of spaces reuse old furniture and resources involving students in the whole transformation spaces or classroom makeovers.

What activities take place in makerspaces?

According to the Horizon Report, among other studies by eduction experts, there is no standard repertoire of activities for makerspaces in schools. All that is needed is to set up areas where these activities can be done and fit them with the basic resources needed for students to work on projects that are connected to the real world. The only requisite for these open areas is for them to meet basic safety standards and be emotionally safe spaces, meeting the needs of individual users. "…the aim is not for each school to have a makerspace, but to place our students in spaces that fuel their imagination and creative spirit in all they do and learn…"
However, if we were to identify strategic areas for learning STEAM skills, these would be:

Programming - Coding	Creating apps and programs
3D printing	Creating objects, devices and tools for play and artistic creation.
Laser cutting and precision cutting	Creating play objects
Soldering	Constructing devices and circuits
Electronics and Arduino	Building devices

Arduino	
Robot building / Robotics	Constructing and programming robots and drones
Electricity paper circuits	Toys and handcrafts
Wearables – fashion - Sewing	Clothes and interactive accessories that adapt to users and environments
Wood working	Play objects and arts and crafts
Take-a-part & recovery	Recycling, sustainable design, sustainability
Internet of Things	Devices and tools based on physical sensors.
Video game creation	Video games and simulators
Audiovisuals	Shooting videos and content creation
Editing and creating electronic music	Creating content and electronic music
Drones (air, land and sea)	Guiding devices and using them on missions
Virtual and augmented reality	Using, adapting and creating content
Gastronomy	Traditional cooking and the science of cooking

Maker mindset activities have an open timetable, they can take place in traditional lesson times, they can also be open to students over the whole day to be used at break times and after-school as extracurricular activities. This makes them attractive for children, helping them make friends with others that share their interests. They are excellent spaces for forging ties, socialising, networking and creating inclusive learning communities. One of the hallmarks of makerspaces is that they are open to all.

Keys for a successful makerspace

Stephen Heppell recommends all those interested in creating maker learning spaces to follow the guidelines below::

1- Each school should set up their own makerspace using available resources, without getting wrapped up in having the latest technology.
2- Use commercial kits sparingly. Distrust expensive technology touted by the media, lacking user communities and with short lifespans.
3- Avoid using formal set ups for makerspaces and specialisations promoted by the media, some of them such as robotics and 3D printing are neither the easiest nor the only activities available to makers.
4- Students' activities should be: free, open, informal and playful, open to all students.
5- Fostering the user communities needed to develop an informal learning culture, allowing makers to openly share knowledge and experiences.
6- Fostering a relationship of trust between educators and students in the use of spaces and available learning resources.

In summary "*...A makerspace is a metaphor for a unique learning space, that fosters DIY, play and inquiry with an open-to-all layout...*" Laura Fleming librarian and makerspace manager.