Makers in Education: Teaching is a Hacking Stuff

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Abstract Several changes and challenges affect contemporary society: public administration, business, society at large. The lowest common denominator is digitization through IT tools. And what about school systems? Do they play a decisive role in enabling the skills needed to these challenges? We send our children to school to prepare them for a fast-changing world. But have our schools (and teachers) changed in the last 100 years? Modern teachers are being asked to change their teaching and learning practices, and to implement methodologies (including the use of IT tools) and make way for new teaching practices.

Keywords Teaching · Making · IT · Methodology · Skills

1 Problems and Goals

1.1 Troubleshooting

Currently, school systems have more than one problem with which to contend. A video [1] by Next School [2] (almost 9 million views on YouTube) identifies six problems with the world's education systems:

- Industrial age values
- Lack of autonomy
- Inauthentic learning
- No room for passion
- No differences between children's learning styles
- Too much lecturing.

Seth Godin [3] and Ken Robinson [4] agree that the current education system was designed in the Industrial Age to churn out factory workers. Yet, while modern

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society is no longer based on the values of mass production, Taylor's principles of scientific management still run deep in schools.

A few years ago, I asked my students to do some research and represent the values of Industry 4.0. I asked them to work in teams. One of the teams produced an excellent video, in which they highlight the differences between Fordism and modern organizations: working time, organization, tools, skills (operational and educational), process ownership). Everything has changed.

Our education system, however, sends several dangerous messages to our children: they should follow the established order, rather than taking responsibility and making the most of their lives; they should only memorize concepts and a standard set of information against which what they know will be measured (not evaluated); everyone has to learn the same things, at the same time in the same way; if you take a bit longer to learn something, you are a failure; do not use digital resources.

As a result, children are bored and not engaged, and most of what they learn has already faded the day after their exams. All this is proof that our education systems are outdated and ineffective.

1.2 Changing the Paradigm

Education systems seek to meet the challenges of a globalized and extremely dynamic world by offering static teaching/learning models.

The educational model that forms the basis for modern education systems was designed for a society that no longer exists. It was strongly influenced by the deductive reasoning that developed during the Enlightenment and is based on classical thought, rooted predominantly in academic learning. Schooling is organized according to the Aristotelian units of time, space and action. Curiously, its organization resembles a factory production line: bell rings (time); separate facilities (space); children grouped by age (batch processing); one entity intervenes with another entity, so that the first modifies the second (action).

First, there needs to be a shift away from batch schooling to custom education. The education system should not be designed for a standard (and its related standardized tests), but should bring out the divergent thinking and creativity of each student. As a computer science teacher, I tell my students that solutions often exist in multiples and are the result of heuristic, action-research processes. This means taking account of every student's specific skills and awareness, rather than evaluating them against a standard.

A radical change is needed; one that takes us from a vertical approach to teaching/learning to one that is horizontal. In this paradigm the aesthetic—as opposed to the anesthetic—should be taught, stimulating children to share, collaborate and learn together.

Fig. 1 A classroom in 1920 (a), a classroom in 2020 (b), a computer lab (c)

2 A Maker in Education

2.1 A Quantum Leap

A visitor from 100 years ago would struggle to make sense of today's world.

But if he went into a school, he would see something familiar: the layout of classrooms is almost identical, with a teacher's desk, students' desks arranged in a row, a board (at that time it would have been a blackboard, now it is an IWB). Even the computer labs retain this layout, which was typical of the Fordist-Taylorist factory (Fig. 1a–c).

Classroom activities are mainly based on the top-down transmission of content by a teacher sitting in a chair.

What we need, instead, is a physically active teacher engaged in a horizontal relationship with her students (Fig. 2).

We need to switch from a premise of “*Let me explain how to do it*” to one of “*Let's do it together!*”

2.2 What is an Edumaker (Maker in Education)?

A maker in education is a hybrid between a hacker and a maker.

The term *hacking* dates back to the early 1950s, when MIT students in Boston, driven by a thirst for knowledge, coined the term “*unnel hacking*” to define their raids in underground tunnels.

Therefore, hacking arises from a desire for knowledge.

What is a *maker*? Borrowing the definition from Dale Dougherty, editor of MAKE magazine: “*Makers want to hack this world the same way we used to hack computers.*”

Fig. 2 Education activities

This is why I believe makers and hackers are very similar.

A maker in education has a proactive attitude, he does not say “no! *You don’t care about this stuff!*”, but rather, “*let’s try to do it together*” and asks himself “*what can the kids learn?*”

A maker in education upturns the system from learning by transmission to one of working in collaboration; from the *global* (all the same things) to the *glocal* (all the same opportunities).

A maker in education builds a knowledge network that:

- develops a business idea with students and promotes entrepreneurship;
- builds relationships between schools and local authorities;
- exports his teaching model to other schools in the area;
- experiments with an open didactic model and favors “other” methods over traditional methods;
- shares his own teaching experiences which are replicable.

Table 1 draws parallels between a maker and a maker in education.

Table 1 Maker versus maker in education

Maker	Maker in Education
Rethinking production and business models	Rethinking the learning model
Manual skills	Robotics, 3D printing
Cooperation	Cooperative learning
Design	Redesigns learning content (less standardized “production” and more customization), while moving beyond the idea that owning content leads to competence. “Designs and redesigns the curriculum”
Sustainability	Physics: Dematerialization; Virtual: focus on skills
Virtual and physical communities	Virtual and physical learning community using several kinds of channels (I.M., learning platforms...)
Sharing knowledge and technology	Sharing knowledge and technology

A maker in education overturns a paradigm. He is an *edumaker* [5].

3 Experience of a Maker in Education

3.1 Co-m@king_LAB

Co-m@king_LAB (*Coding and making laboratory*) [6] is a knowledge hub for creative design and prototype realization, which uses innovative practices and technologies related to *making* and *IoT*.

Activities combine a “*hands-on minds-on*” approach with research/action-edge content: Third Industrial Revolution; *Europe 2020*; *Digital Agenda*; Open Data (and, more generally, Open Innovation); Internet of Things; Makers, Industry 4.0.

This is pursued using open-source hardware and software platforms (e.g., Arduino, Raspberry). The aim is to achieve the operating competences of the maker’s new digital frontier techniques, as well as educational and cognitive competences (*analytical thinking, creativity, problem-solving, collaborative working*).

Students are involved in designing, creating robot prototypes (including 3D printing components) and developing hard skills (programming, designing, using electronic boards) and soft skills (cooperation, team building and leading, creativity, problem-solving).

Co-m@king_LAB aims to update computer science teaching in Italian *Licei Scientifici* (science-oriented high schools), through the use of unconventional methods and tools (for example, the mobile laboratory). It seeks to go beyond the physical space of the classroom to foster a school based on relationships, skills and Papertian constructionism.

4 Conclusions

In the paradigm still in force in today's school systems, only students learn. Yet this model no longer works: teachers also learn and learning methods are synchronous (in terms of space and time).

We should remember that technology is not neutral: we need to “*think with machines*” [7] and teaching is not exempt from this requirement.

Through technology, children get used to taking part and being proactive. In the same way that the Web has evolved from 1.0 (internet of information) to 2.0 (internet of people) and 3.0 (internet of things), teaching cannot stay the same. In a world where 20 years is a temporal abyss: Twenty years ago, computer operating systems were installed on 12 floppy disks; today we can download them from the internet.

The school system is stuck in a 1.0 model and struggles even to understand that change is necessary.

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