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Innovation management in schools: Barriers and enablers to making as educative practice

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Abstract. This paper explores the use of maker technologies as activities embedded in a wider educational ecosystem. Innovations are generally described as the exploitation of new ideas; hence novel technologies and processes need to be adopted by the relevant user groups. The paper starts with a conceptual overview of maker technologies, innovation types and highlights the special situation of educational quasi-markets, where innovation management is different to fully competitive markets, such as the hardware and software industry. At the core of the paper are teachers' perceptions of barriers and enablers to using novel technologies. Assuming a systemic perspective on innovations, the paper also discusses topics such as appropriate funding, national regulations, curricular flexibility, technologies ready to use and adequate training opportunities for teachers. Hence, first findings of a research project on making and innovation management in schools are presented on the basis of 25 interviews from nine European countries.

Keywords: innovation management, making, schools, education, 3d-printing

1 Introduction

Making, as a fundamental human activity, has long been acclaimed to be a critical ingredient to experiential, problem-based learning, following the writings of John Dewey and Seymour Papert [1]. Making in education presents a shift from learning abstract concepts to discovering concepts through active experimentation, inventing and actually playing with technologies in pursuit of a personal goal, i.e. what Dewey refers to as 'authentic inquiry'. Even though the maker movement itself goes back as far as 2001, when the Massachusetts Institute of Technology's 'Bits to Atoms' program started [2], the use of maker technology for teaching purposes in schools and universities has only recently received researchers attention, as shown in a literature review [3] identifying first empirical studies in 2011. Since then, maker technologies have vastly improved, in terms of performance, affordability as well as user friendliness – reaching users beyond the usual suspects of tinkerers and hackers [4].

Additionally, Carstensen argues that 'making' is also a means to address aspects such as a lack of interest in STEM subjects (science, technology, engineering and

maths) in general as well as attracting female students to STEM in particular [5]. Mainly because students can experience the relevance of what they learn in terms of observable changes in the physical world they attempt to control, be it through printing 3D-objects or by controlling the watering of a plant [6]. The result of these experiences is a sense of empowerment, so that young people develop confidence in their abilities to make things themselves and appreciate technologies as means to achieve things they are interested in, so that the ultimate objective of learning might not be programming or electronics but gardening, a game or art. Still, even though making is lauded in German speaking countries, Europe and overseas [7], innovative teaching practices including maker technologies seem to be far from mainstream – given the limited numbers of studies in the previously mentioned literature review [3].

Hence, the objective of this paper is to analyse pedagogical innovations considered as embedded actions in an existing ecosystem with inherent barriers and enablers. More concretely, we wanted to know whether innovation management could be a viable approach to support making as an educative practice in a more systematic fashion. But for that we needed to explore the general innovation culture in schools and their existing approach to manage innovations first. Critical conditions for innovations to be discussed include funding, regulations, curricular flexibility, availability of technologies ready to use and adequate professional development opportunities for teachers. The paper is structured into the following main sections: (1) a brief introduction of maker technologies in education, ways of categorizing innovations and the particularities of innovating within the educational sector; (2) a description of the study design as well as research participants; (3) the presentation of research results concerning teachers' descriptions of innovations, the barriers they experience, and which innovation management practices are currently at their disposal.

2 Related concepts

2.1 Maker Technologies in Education

There is no established canon of technologies that define the maker movement per se, even though 3D printing, single board computers (e.g. raspberrypi.org) and microcontrollers (e.g. Arduino.cc) have received considerable attention in reviews including the educational use of making [4, 8, 9]. What technologies are used is also influenced by costs of equipment and software. Fortunately, in most cases open source and freeware versions are available, such as FreeCAD (freecadweb.org), a parametric 3D modeller, or Arduino's IDE, which also exist as cloud-based web editor (https://create.arduino.cc/editor). Compared with other approaches of technology-enhanced learning such as the 1:1 desktop setting in computer classes, maker tools are relatively inexpensive [10].

However, one of the main benefits of making is the actual fabrication of a physical object (e.g. including sensors, laser-cut shapes, 3D-printed elements or computable e-textiles) in order to obtain a prototype of a solution which can then be evaluated more comprehensively, including usability, tactile experience or aesthetics [8]. A second,

frequently cited, benefit of building and tinkering for learning is the creative process, which enables concepts to be discovered rather than to be acquired passively [11]. The specific outcomes of using maker technologies in education are then reported as [9]: cross-topic integration of knowledge, development of self-confidence and resourcefulness, out-of-the-box thinking, fascination with STEM and problem-solving and the ability to critically distinguish making and consumption.

2.2 Types of Innovation

Innovations are generally described as the exploitation of new ideas; hence innovations imply novelty and use (i.e. the acceptance of the solution by a relevant user group) [12]. A working definition adopted for the research presented is "An innovation can be a new product or service, a new production process technology, a new structure or administrative system, or a new plan or program pertaining to organizational members. … Innovation is a means of changing an organization, whether as a response to changes in its internal or external environment or as a pre-emptive action taken to influence an environment" [13]. An important feature of innovation, considering the possible size of educational systems, is 'degree of innovation', referring to the amount of change required. Tidd suggests the following categorization in order to distinguish between different aspects such as 'What is changing?' and also 'How fast is it changing?' [14]:

- *Disruptive Innovations*: re-writing the rules, reframing the problem;
- *Radical Innovations*: novel, unique service / product;
- *Incremental Innovations:* day-to-day innovations, sustaining existing services.

We found that in the context of formal and informal education, an initial discussion of what teachers saw as innovations was paramount to create a shared, common ground. Some teachers saw themselves as reflective practitioners, rather than innovators. However, most teachers would reference at some stage the rules and norms of their workplaces as limiting or enabling conditions for any type of innovation (technical, organisational, pedagogical etc.). When asking teachers, disruptive innovations were generally seen more critical, due to difficulties around estimating the benefits they would bring to learning (implying that an effect would need to appear on standard evaluation instruments) as well as the effort the innovation would require from the teacher [15]. We are aware, that there is an ongoing discussion about the inflationary use of the term 'disruptive innovations', see [16]. Still, we think that unlike innovations in a business environment, which are readily defined and acknowledged, innovations in educational settings, need some domain-specific adaptations. Not the least because the next section looks at quasi-markets, to which Christensen's notions of low-end or new-market footholds [ibid.] are not easily transferable.

2.3 Innovations in educational quasi-markets

Calling for innovation management in schools is often related to a perceived inability of the educational sector to innovate effectively. Lubienski [17] shows that simply offering students and parents the choice of which schools they want to join, does not yet

create a market where innovation is a differentiator and wherefore innovations become desirable per se. Lubienski makes the argument that educational systems are quasi-markets: "schools are in an ambiguous position for sensing and responding to market-style signals. Particularly when bound by obligations such as open access, equity, etc., schools often do a poor job of acting like private providers" (ibid).

The term quasi-market was introduced by Le Grand in his analysis of public service reforms in the late 1980s [18]. Le Grand described a market where on the one hand providers competed for purchasers, but on the other hand providers were not necessarily profit-maximising firms. Put differently, schools do not show the business-like approach to innovation where profitable innovations are extended and less profitable practices are abandoned; and given their mission to provide a service to a wider society that is desirable. Hence, quasi- markets are different in that [19]: (a) providers may be state-owned or charitable organisations, hence not entirely profit-driven; (b) choice may be exercised on behalf of the user and (c) users 'spending power' is determined by the value of a voucher or earmarked budget, rather than their wealth.

3 Qualitative study design

The research follows a qualitative approach, based on semi-structured interviews. This allows for more flexibility in contrast to fully standardised interview methods [20]. During the selection of teachers to be interviewed, we aimed to include teachers with different experiences concerning maker technologies as well as teachers coming from different school types. With the remaining interviews engaging professions such as strategy advisors, university lecturers or company directors, we wanted to reflect the diversity of stakeholders in the educational sector. Two different interview guidelines were developed: one set of questions for educational organisations and a slightly adapted set for commercial organisations. While all questions were mandatory, the sequence of the questions could be changed. Also, ad-hoc questions were possible in case it seemed reasonable to explore an issue in more details. Interviews were organized and implemented in nine countries (Figure 1). Interviews were done through video conferencing or face to face. All interviews took place in the months between June and August 2017. In some instances, interviewees decided to fill in answers in writing, so that there was an individual reflection phases prior to the interview.

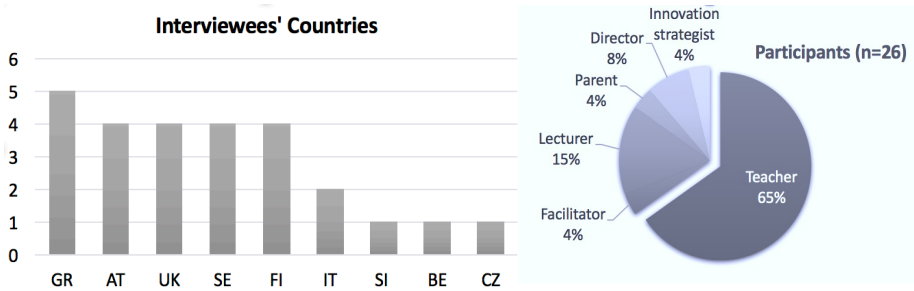

Figure 1. Interviewees' countries of residence and their professional backgrounds

44% of interviewees were between 31 and 40 years. Concerning interviewees gender, we achieved a fair balance between male and female respondents (Figure 2).

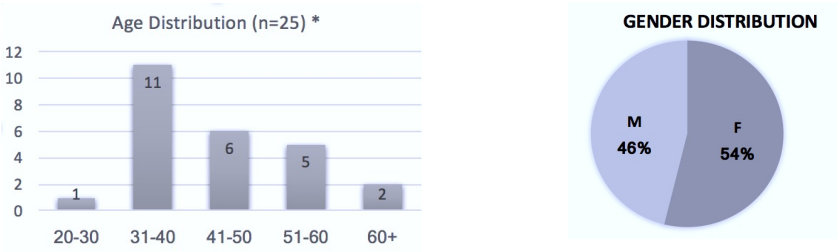

Figure 2. Interviewees' age and gender distribution

4 Research results

The interviews addressed 5 areas: (1) defining innovations; (2) elaboration of innovation barriers; (3) elaboration of innovation enablers; (4) capturing existing innovation management practices and (5) measuring innovation – an aspect not included in this paper. Throughout the paper, the source of interview responses is indicated in brackets with a country acronym and a number, e.g. SI4 stands for interview number 4 with a Slovenian teacher.

4.1 Different perceptions of innovation

A first question when researching the innovation capacity of the educational sector is 'how do we define innovation?'. Lubienski [19] suggests that practices are innovative if they are new within their local context. This interpretation goes counter to the idea that innovation has to be 'new' in general. This is an important distinction, since, as previously discussed, a defining characteristic of innovation is acceptance and uptake of 'new practices' by relevant groups [21]. In our interviews, we asked teachers how they define innovations as well as what they would expect as outcomes. In general, we found responses varying in their degree of specification, ranging from a focus on educational methods and tools to broader notions of innovations being expressions of mindsets or value systems. More specific definitions included the following statements:

- Innovations can be project-driven classes, using new media, based on related professional development There is a need to be on top of current developments. This is also an expectation society and ministry have towards schools. However, the latter also presents a dilemma in that we need to experiment with innovative products and simultaneously demonstrate evidence for improved learning, which leaves little room for experimentation (AT1).

- Innovation is mainly teacher driven, though there is little time for innovation since many topics need to be covered. For teachers, outcomes of innovation shouldn't imply major disruptions but there should be a way to connect with existing practices (AT2).
- Usually, innovations have a strong technology focus (e.g. Smartboards, document cameras). Innovations are an important factor to be different than other schools, especially since there are schools competing for the same students in the area. Once you have too few students there is a risk to be combined with another school in which case you lose sovereignty about the way you structure your teaching. All in all, innovation should make things easier (AT3)
- Innovations include good information technology as well as courses that teach programming and robotics, not yet connected with other science subjects. However, schools should concentrate on applying 'innovative methods'. Schools are not the place to invent innovations (AT5).
- Innovations involve a mandate to focus activities, new technologies and new didactic methods. Since we are a technical school, innovation is inherent to teachers' individual preparation. For example, recently we started teaching about Industry 4.0 (IT15)

Statements defining innovations in schools as mindsets, motivational strategies or openness towards increasingly heterogeneous groups of students included:

- Innovations should inspire students to be creative and to create new things. Innovation, as one of the outcomes, should raise students' interests in STEM and make them more open minded about the potential uses of computers and smartphones (GR6).
- Innovations are expressions of open-minded teachers and students. Innovations imply change, which in turn can lead to stress. So, whatever the innovation, it's important to include teachers and students early on (GR7).
- Innovations should help to get the best out of students and teachers. Innovations are a necessity to spark students interest in the subject. Innovations should lead to questions and the urge to experiment, make mistakes and therefore learn (UK11)
- Innovative teaching helps to attract more students. Innovation should be defined by its objectives and not by tools. So, the Internet would be only a tool, but the overall objective must be to learn how to use a variety of information sources (CZ18).
- Innovations are to reform the idea of teaching and learning. We need innovations as motivators for students. The expected outcome is still 'learning'. What did the student achieve (FI23)
- Innovation is about openness and diversity. Innovation is already triggered by the new curriculum we are implementing. Innovation should establish a certain state-of-mind: seeing how things are connected (FI24).

However, there were also voices of concern: "The term innovation is scary for many teachers because it is the term that is constantly being talked about and teachers in the Czech Republic are often pushed into it, whatever it means. It is often understood neg-

atively. For many teachers, innovations mean only watching movies or visiting exhibitions, using computers and a projector. … I would not define 'innovation' in teaching as a necessity to change the way of teaching or the necessity to use new aids or play games, but as an opportunity to include cooperation with specialized workplaces or using the Internet as a search tool." (SI4)

4.2 Barriers to innovative teaching practices

There is rarely an organisation that would say innovation is not important to them, still, many organisations do not consider themselves effective innovators [22]. The barriers brought forward frequently include 'perceived riskiness' or 'short term objectives such as saving costs'; which stop organisations following through with their innovations strategies. One of the key enablers of effective innovations according to Loewe and Dominiquini [22] is visionary leadership behaviour, which in turn requires a common definition or a shared understanding of what innovation is or why it matters to the organisation. One of the reasons we included this point in the interview guide and discussed it in the previous section.

Besides having a shared vision on innovation, the interviews included three possible areas where barriers could be present:

- *Knowledge / Skills:* Knowing about latest innovations in the field, having the skills to preselect potentially applicable technologies [23];
- *Markets*: Knowing which products / markets are relevant, dependencies on market conditions (offerings, educational focus) [24];
- *Funding*: An organisation's ability to make the necessary investments, including financial and man power resources.

Knowledge gaps. In this section of the interview, we asked teachers about their ways to keep up with the growing amount of information related to innovative technologies relevant to their respective subjects. We also asked them what they found particularly important to boost innovations in their schools.

Teachers attempt to be on top of their subjects as well as related educational technologies by: accessing the Internet (SI4, GR6); reading relevant journal and magazines (AT1,GR7); attending open days, fairs and exhibitions (AT2, GR6, CZ18); having local interest groups for exchanging experiences (AT2, GR6, Fi23), using information channels provided by the education ministries, e.g. 'IT at school in Austria'(AT3); exploiting personal contact to the computer department of the local university (SI4, UK11); following e-learning classes (GR7); organizing professional development sessions at the school (UK11); joining Facebook groups (FI23, FI25).

Markets. The 'markets section' of the interview aimed to explore the relationship between teachers and schools' processes regarding the planning and approving of innovations, given that there is a 'market of opportunities'. Firstly, we wanted to know,

whether teachers felt like they were up to date with what the market had to offer. However, with hindsight we can say that these questions seemed too removed from teachers' daily experience. Concerning their knowledge about what the market was offering, teachers stated:

- We don't have a lot of contact in that area. Some of the technologies really need to be presented, so that we can get a better impression of what the innovation is all about (AT1). Similarly, another teacher commented, that yes, the information is there, but once a product is purchased, it's quite cumbersome to get it running. The latter involves a lot of Google searches (AT2).

There were more comments on how schools decided about the adoption of innovations:

- On one side, we have some quite rigid structures and on the other side there are no 'extra' financial resources. So, schools need to collect money from parents, donors or do things like 'Sponsor Runs' – basically running for money (AT2).
- If innovative technologies are used in the classroom, it is important to have a sufficient quantity of those. After all, most groups are heterogeneous and if all students need to participate in the activity I need enough devices to allow for groups that advance at different speeds (AT3). We only have one lab for 1,300 students where we can use 3D printer, Lego robotics or Arduinos (AT5).
- Our decision making is constrained by the Ministry of Education. If they are not interested in a particular innovation, it cannot become part of the formal curriculum. Also on one occasion we got a national product, even if this was far removed from the current state of art (SI4). The kind of innovations that a teacher is allowed to introduce is limited to what the government proposes, since that's the reason why the funds were assigned to the school in the first place. If a teacher has a good idea, he's not allowed to put it into practice because he does not have enough funds. (IT15)

Funding. Funding explored how teachers perceived the level of investment the schools put into learning, professional development and technological infrastructures. There were two main arguments driving the discussion about funding:

(a) *Type of school:* private or public, or in Finland we had a research-oriented school, or in Austria we had the 'new middle schools' which had a somewhat better funding than other school types.
(b) *Source of funding:* there will be national differences, but some parts of the school's cost are covered by a national budget, other costs are covered by the local community (municipality) and then there is some extra money coming in from parents or donors. Although the latter depends on the network the school has as well as the general socio-economic situation of the region where the school is located.

But even if different sources can be combined, it seems like the teacher needs to develop quite some fund-raising qualities if he or she wants to get a project of the ground: "*Funding is absolutely a big problem, the school budged sounds quite big, but there are lots of big costs. The primary cost is the teachers, the building and then very*

little is left. About 30.000 is like nothing for a school of around 1300 studying. The whole budget has been frozen for 3 years now and no inflation adjustments were made. You always have to pay the teachers and the building first, and it always get less and less left. It's is really hard to get even 100 € for something, you have to ask for 10-20 € things, and don't get any money. In our school, parents have a strong organisation and they continuously contribute, but not all teachers want to go to ask parents. You need to have a budget from the school." (AT5)

Then there is the economic situation of a country, which determines how much budget is made available for education: "*Funding is very low. Our Ministry of Education is not funding neither schools nor researchers in the academia. And this is the major obstacle. Almost all we do is through external contributions.*" (SI4) Or similarly Greece: "*Finally, innovation is traditionally related with paying extra for acquiring the necessary new equipment and that is a real barrier in a country under financial crisis like Greece. But, judging by my experience, innovation is not an expensive thing and people in charge should know about it.*"(GR6) Interesting about the last comment is the statement that innovation doesn't have to cost much. Of course, there is a difference in wanting to use Arduinos and stepper motors of about 50 € or a Lego Mindstorm Robot that can cost anything between 200 € and 500 €. In contrast to these statements, we also have schools which are facing no difficulties in getting the necessary resources – at least as far as the technology is concerned: "*We have a pretty good situation with the technology. Our high school is a pilot school in technology area and in our secondary school we get quite good support for investing in new technology (for example Drones and the equipment for programming*)." (FI23)

4.3 Existing innovation management practices in schools

Lessig [25] highlighted the importance of managing innovation by quoting Machiavelli, an Italian philosopher, known for his acute analysis of politics: "Old versus new. That battle is nothing new. … Innovation makes enemies of all those who prospered under the old regime, and only lukewarm support is forthcoming from those who would prosper under the new. Their support is indifferent partly from fear and partly because they are generally incredulous, never really trusting new things unless they have tested them by experience" [25]. Hence, innovation management needs to reduce the risks for those innovating, present firm support from management and provide the required resources in terms of finance and expertise.

Typical innovation management methods include establishing a personal responsibility for knowledge, knowledge management as business strategy, assessing external knowledge, knowledge management trainings, reward systems for knowledge sharing and establishing best practices [23]. Most important is a process or network perspective on innovation management. Current innovation management applications [14] emphasizes the importance of networks for (a) sharing information, (b) sharing infrastructures and (c) co-specialization. Additionally, the networking aspect of innovation management has led to the increased use of social media such as Facebook Groups or WhatsApp Groups. The figure below lists tools and organisational arrangement interviewees mentioned in the context of their schools.

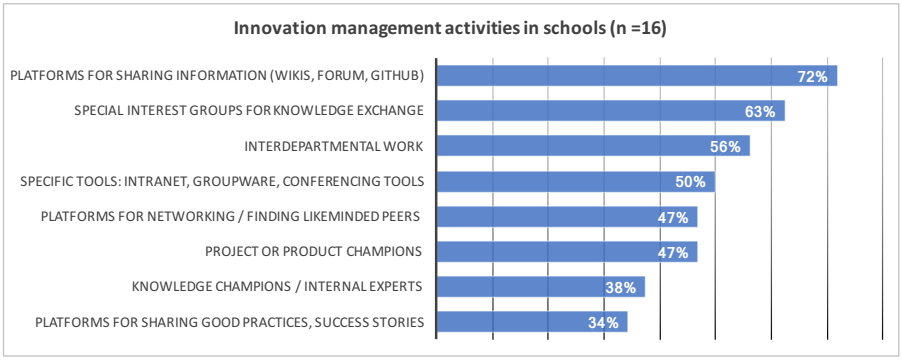

Figure 3. Interviewees perceptions of innovation management tools in their schools

In some instance networking platforms were not confined to the limits of the school and also connected teachers at a regional or national level, like the use of peda.net in Finland or bildung.at in Austria. Peda.net is a social networking platform with personal profiles and discussion forums. There are different ways of using it and teachers, students and parents can sign in and check or comment what has been done at the school or at the day-care. However, it is primarily the schools and teachers, who decide how they are using it. Bildungt.at is a sharing platform for services, content and initiatives, including online materials supplementing school books or specifications of and recommendations for learning management systems (LMS).

Expertise-based innovation management differentiates two types of tools [26]:

a) *technical tools* related to the acquisition and use of new information and
b) *relational tools* related to the exchange of knowledge, internally as well as externally.

Although this differentiation is not always clear cut and depends on how a technology is used, we can see that the top five tools include strong networking capability and the last three tools mainly enable knowledge-push strategies (Figure 3). However, there is no technological determinism in innovation management, which leads Tidd [14] to remark that several decades of research on innovation management have failed to create a comprehensive framework to guide innovation management. The author's main argument is related to researchers' neglect of environmental contingencies: speed of change of technologies, changing demands for services and innovations in general or access to relevant research communities (since not all changes can be covered in-house). In some instance some very fine-grained factors might also play a role, e.g. when the same technology (Moodle in this case) was used with great enthusiasm for a variety of innovation management tasks (SI4) whereas another organisation made less positive experiences, so that the tool was soon replaced (AT5).

5 Discussion and outlook

Enriching the educational landscape by new technologies has a long tradition and discussions about technological features frequently dominate the debate. Even today,

when technology and the use of software is commonplace in many areas of life, the embedded nature of educational technology is still neglected. As the reflected in the diverse interview responses, changes in educational systems are 'changes of running systems', hence the management of innovations is a much-needed ingredient to ensure the efficient usage of the already scarce time resources of teachers and learners alike.

On top, a strategic approach to 'making' in the schools of the interviewees is missing. 'Strategic' in the sense that 'maker technologies' enable different ways of learning which also needs to be taken into account in teacher preparation programs and curricula. As put forward by Resnick and Rosenbaum [27]: "The tinkering approach is characterized by a playful, experimental, iterative style of engagement, in which makers are continually reassessing their goals, exploring new paths, and imagining new possibilities. Tinkering is undervalued (and even discouraged) in many educational settings today, but it is well aligned with the goals and spirit of the progressive-constructionist tradition—and, in our view, it is exactly what is needed to help young people prepare for life in today's society".

The quote shows how existing preferences in the educational system, e.g. emphasizing content delivery and quantitative assessment, run counter to a pluralism of learning paths including the bottom up experiences of creating tangible objects, the notion of adapting solutions to changing conditions and an essentially different way of accessing STEM problems. Hence, making and tinkering requires not only a rethinking of students' interactions with specific topics but also the rethinking of STEM curricula (e.g. project rather than subject-driven organisation of knowledge) and assessment methods (e.g. collaboration and scientific inquiry skills rather than concept recall).

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References

1. Martinez, S.L., Stager, G.: Invent to learn: Making, tinkering, and engineering in the classroom. Constructing modern knowledge press (2013).
2. Gershenfeld, N.: How to make almost anything: The digital fabrication revolution. Foreign Aff. 91, 43 (2012).
3. Papavlasopoulou, S., Giannakos, M.N., Jaccheri, L.: Empirical studies on the Maker Movement, a promising approach to learning: A literature review. Entertainment Computing. 18, 57–78 (2017).
4. Voigt, C., Montero, C.S., Menichinelli, M.: An empirically informed taxonomy for the Maker Movement. In: International Conference on Internet Science. pp. 189–204. Springer, Florence. IT (2016).
5. Carstensen, T., Walter-Herrmann, J., Büching, C.: Gendered Fab Labs. Fab Lab: Of machines, makers and inventors. 53–64 (2014).

6. Zuiker, S.J., Wright, K.: Learning in and beyond school gardens with cyber-physical systems. Interactive Learning Environments. 23, 556–577 (2015).
7. Peißl, M.: Making an Schulen: Potentialanalyse eines Workshops über 3D-Druck, VR-Brillen und Podcasting. BoD–Books on Demand (2016).
8. Barrett, T., Pizzico, M., Levy, B.D., Nagel, R.L., Linsey, J.S., Talley, K.G., Forest, C.R., Newstetter, W.C.: A review of university maker spaces. Presented at the (2015).
9. Vossoughi, S., Bevan, B.: Making and tinkering: A review of the literature. National Research Council Committee on Out of School Time STEM. 1–55 (2014).
10. Schön, S., Ebner, M., Kumar, S.: The Maker Movement. Implications of new digital gadgets, fabrication tools and spaces for creative learning and teaching. eLearning Papers. 39, 14–25 (2014).
11. Papert, S.: Revolution des Lernens : Kinder, Computer, Schule in einer digitalen Welt. Heise, Hannover (1994).
12. Chesbrough, H.W.: The Era of Open Innovation. MIT Sloan management rev. 44, 35 (2003).
13. Damanpour, F.: Organizational innovation: A meta-analysis of effects of determinants and moderators. Academy of management journal. 34, 555–590 (1991).
14. Tidd, J.: Innovation management in context: environment, organization and performance. International Journal of Management Reviews. 3, 169–183 (2001).
15. Cohen, J.D., Huprich, J., Jones, W.M., Smith, S.: Educators' Perceptions of a Maker-Based Learning Experience. The International Journal of Information and Learning Technology. (2017).
16. Christensen, C., Raynor, M.E., McDonald, R.: What Is Disruptive Innovation? Boston: Harvard Business Review. (2015).
17. Lubienski, C.: Do quasi-markets foster innovation in education? A comparative perspective. OECD Education Working Papers. 0_1 (2009).
18. Bartlett, W., Le Grand, J.: The theory of quasi-markets. In: Quasi-markets and social policy. pp. 13–34. Springer (1993).
19. Lubienski, C.: Innovation in education markets: Theory and evidence on the impact of competition and choice in charter schools. American educational research journal. 40, 395–443 (2003).
20. Froschauer, U., Lueger, M.: Das qualitative Interview: Zur Praxis interpretativer Analyse sozialer Systeme. UTB (2003).
21. Rogers, E.M.: Diffusion of innovations. Free Press, New York (2003).
22. Loewe, P., Dominiquini, J.: Overcoming the barriers to effective innovation. Strategy & leadership. 34, 24–31 (2006).
23. Chase, R.L.: The knowledge-based organization: an international survey. Journal of Knowledge Management. 1, 38–49 (1997).
24. D'Este, P., Iammarino, S., Savona, M., von Tunzelmann, N.: What hampers innovation? Revealed barriers versus deterring barriers. Research policy. 41, 482–488 (2012).
25. Lessig, L.: The future of ideas. Vintage (2002).
26. Hidalgo, A., Albors, J.: Innovation management techniques and tools: a review from theory and practice. R&D Management. 38, 113–127 (2008).
27. Resnick, M., Rosenbaum, E.: Designing for tinkerability. Design, make, play: Growing the next generation of STEM innovators. 163–181 (2013).