# Star(t) to Shine: Unlocking Hidden Talents Through Sharing and Making

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**Abstract.** The current article embraces the transformational role digital fabrication has to empower people doing things previously unthinkable while making it accessible to a larger audience. Using a research-through-design approach, we have co-designed a six-step workshop series to activate young adults' hidden talents through sharing and making. The division in steps was meant to empower the students gradually and from within their own interests and qualities. The resulting workshop platform serves as a best practice in learning 21st century skills, lowering the threshold of access to digital fabrication in education. The students were active co-creators and obviously learnt new skills. Some students even had a mind-shifting experience, and demonstrated that it is indeed possible to transform dropouts into engaged and successful individuals, who are role models for their peers: "*stars shining bright in their local community*".

**Keywords:** 21st century skills · Empowerment · FabLabs · Maker Movement · Transforming society

## 1 Introduction

The Maker Movement is providing all kinds of people around the world with the tools and infrastructures to unleash their intrinsic ability to create, make, and innovate. This spreading trend of learning-by-doing has the potential to empower people in doing things previously unthinkable, through the potential of 3D printing, laser cutting, Internet of Things, electronics, and so on. The unleashing of creative processes can be coined as 21st century skills, which refer to amongst others digital literacy, creativity, critical thinking, problem solving, as well as collaboration and communication skills. It is commonly accepted that these higher-order skills are essential for successful participation in society. As the OECD concluded in its report 'Towards an OECD Skills Strategy': "Numerous efforts have been made to identify 'key competencies' and 'employability skills' over the past decades. However, apart from the universally acknowledged importance of basic literacy and numerical skills, there is little hard


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evidence of what other skills are required for workers to obtain better labour outcomes and cope with a more fluid labour market" [6].

In keeping with recent trends in STEM (Science, Technology, Engineering, Mathematics) and STEAM (including Arts and Design) education, we elaborate upon the capabilities that FabLabs bring to a broader audience, which have until recently been reserved only to a few professionals and embrace the value of making and prototyping as a way to provide deeper, richer learning experiences [4]. Without doubt, the Maker Movement has impacted the design profession in terms of skills required as well as design methodologies and practices, by making tools and infrastructures easily accessible to a wider spectrum of people. Actually, the FabLab itself provides an excellent framework to facilitate the ignition of practice-based education, as demonstrated by the Fab@School project [3]. We, therefore, have explored what role FabLabs can play in design education by experimenting with these 21st century skills. In this way, we aimed to prepare upcoming design professionals for the changes in design practice [5]. More specifically, we have implemented the power of the FabLab approach to attract people, to get their hands "dirty" with digital manufacturing in Stadslab Rotterdam. Initiated from the educational need to prepare students in the field of Communication and Media Design, Media Technology, and Computer Science in the digital revolution in making and prototyping, the lab bridges the gap between production design and the integration of microelectronics and programming. Stadslab Rotterdam can be best classified as a FabLab+, which emphasizes electronic as well as sensor devices, Internet of Things, and Open Data. In the current work, we elaborate on the educational role of FabLabs, and address how digital fabrication technologies can be made more accessible to uninitiated and underprivileged communities, so as to provide them with a broader skillset than just the ability to use a tool or machine to re-create predefined templates, thus enhancing their participation in society.

## 2 Context

Afrikaanderwijk is a highly multicultural neighborhood in Rotterdam South, the Netherlands, where the generally low level of education of the inhabitants and their ethnic background relegate them to a lower level of society. In our earlier work young adults from Afrikaanderwijk were interviewed to gain insights on their lifestyle, needs, and passions [8] The interviewed young adults were for the most part of non-European descent and second-generation immigrants. All displayed a few common traits: they attended low level schools, struggled to find a job and are frequently stigmatized as problematic. When asked about their dreams, the answers tended to be vague: some young adults wanted to become star soccer players like Lionel Messi, but the common answer was that they did not have anything specific they liked to do or wanted to improve their ability in. From their answers and behaviors, it seemed as though they did not feel allowed to have dreams, ambitions and to cultivate their talents or interests. Interestingly, they all showed that they were tech savvy, digitally social, and full of passions, yet with no engagement in their neighborhood and little means to achieve their dreams for the future. As we identified a strong unexpressed, inherent potential in

the young adults, who actually belong to the first generation of digital natives [7], we decided to trigger the natural fluency in their relationship with new technologies to unlock their hidden talents while co-creating with them a workshop on 3D printing.

## 3 Approach

> *"A constellation of stars.*
>
> *Each star shines of its own light, yet together they create a beautiful image. Invisible connections allow the creation of the pattern in the blue sky."*

The above interaction vision has been used to guide a series of co-design activities with the "hidden stars", the often 'neglected' young adults in the age group of 16–24 years. Using a research-through-design approach, the present project aims at strengthening the young adults' awareness of their individual passions and talents, motivating them to share them with their peers in order to develop them together, empowering them both as individuals and as a cohesive community, in order to obtain respect and recognition in a process of mutual benefit towards and from the social ecology of the Afrikaanderwijk.

### 3.1 Searching for the Right Co-creative Partnerships

The first engagement strategy attempted with the youth of Afrikaanderwijk was to involve the founder of an independent youth association in the project, who was involved in the previous study and was the main gatekeeper to the young adults at that stage of the project. As a trigger to spark the young adults' interest in 3D printing, personalized key chains of their local football team were 3D printed and given to them. The outcome of this strategy was not positive: the founder of the association, who had initially displayed interest in collaborating to empower his young adults, dropped out of the project without any explanation. This unpleasant experience showed that a mismatch in agendas between designer and stakeholders undermines the design process. It also showed that designing "for" someone is not the way to go. Although the key chains were designed as a sensitizing prototype and the choice of the design was selected after analyzing the adolescents' answers to the interviews, the design was made "for" them and not "with" them. The element of active involvement and personal empowerment of the adolescents needed more careful consideration.

The second engagement strategy, therefore, stressed partnering with a local school to co-create a project of youth self-empowerment through 3D printing. In our search for local high schools in the neighborhood, we were more sensitive towards engaging with a committed partner with a compatible agenda in achieving the goal of empowering their students. Two schools were regarded as potential partners: one regular high school and a "Wijkschool", which is a local initiative that offers alternative education to students who dropped out of the national educational system. In this way students can get a basic certificate equivalent to the lowest level of education, which enables them to enter the labour market. In the residents' view, the Wijkschool is a "last chance school

to participate in society." The director of the regular high school expressed his doubts about his students' capability to carry out a workshop on 3D printing due to their low educational level, and was unwilling to explore collaboration. Nevertheless, the first meeting with a coach and her students at the Wijkschool opened up chances to collaborate. The coach showed a proactive and open attitude towards the proposal, and displayed no doubt about her students' ability to learn how to 3D print. Interestingly, the two educators displayed quite opposite views of their students: the former seemed to underestimate their potential while the latter educator was actively involved in promoting their talents.

### 3.2 Co-creating a Plan for Empowerment

Obviously, the Wijkschool became our partner in co-designing a workshop series on talent empowerment. A tight collaboration with Sophie, the coach of the Wijkschool, enabled an effective co-design to activate young adults' talents through 3D printing; the resulting workshop proposal consists of 6 iterative steps. The division in steps was meant to empower the students gradually and from within their own interests and qualities. The following steps were carried out once a week during the student's workshop hours:

**Step 1.** *Share your passions:* students were introduced to the FabLab and invited to share their passions and interests;
**Step 2.** *Share your ideas:* the students sketched an initial product idea through brainstorming;
**Step 3.** *Share your designs:* at the FabLab, the students transformed their design into a 3D model with Tinkercad and 3D printed it;
**Step 4.** *Share your knowledge:* students made an Instructable (tutorial) to share their knowledge with global community;
**Step 5.** *Share your opinion:* students were invited to evaluate the workshop, learning how to provide feedback;
**Step 6.** *Share your experience:* the students presented their work to their own local community, becoming an inspiring force to their peers.

In the next section we elaborate on how we carried out the workshop steps through learning-by-doing and evaluated its influence on self-empowerment with the students of the Wijkschool.

## 4 Unlocking Young Adults' Talents

Planning a workshop needs to take into account many practical aspects that might seem futile, yet are crucial to make it feasible. For example, various time and location constraints motivated the extensive number of steps: the Wijkschool has two hours per week available for workshops, and the FabLab has its own schedule. Moreover, Sophie remarked that the students tend to lose concentration fast, so each step must be engaging, fun, and straightforward.

The workshop steps were carried out for the most part at the Wijkschool or in other locations in the Afrikaanderwijk, with the exception of the day at the FabLab, for which the students needed to cross the bridge to go to the FabLab to 3D print. The flow of the workshop was planned in progressive steps to empower the students incrementally, allowing them to have the time to accept a new workshop concept, a new technology, and a new view of themselves as inspiring role models for the others. Valuable insights emerged in each step, informing the following one in an iterative process of collaborative learning.

### 4.1 Share Your Passions

**Setup.** The first step, *share your passions*, was carried out at the Wijkschool. This was also the first contact with the students. They were asked to share their passions through an online questionnaire. Then, with an interactive presentation in Dutch, the students were sensitized to the value of sharing their passions, 3D printing, the FabLab, and the following steps of the workshop.

**Outcomes.** The first encounter with the Wijkschool students was marked by initial distrust: they displayed strong group cohesion and a proud homologation to a "street culture" attitude, slightly opposing the first author -the facilitator- as the "outsider."

Engaging with the students with an informal attitude and openly speaking poor Dutch[1] lowered the threshold of distrust in them. Furthermore, sharing her passions and weaknesses facilitated empathy and building trust with the students, in a process of mutual discovery. Initially, the students did not show any particular excitement for 3D printing, and manifested suspicion towards its utility and purpose. Seeing pictures of the FabLab and a video showing the 3D printing process helped greatly to stimulate anticipation towards the experience. Yet, the students' interest really arose when the benefits of 3D printing were highlighted to them: they could use it to make their own business ideas become tangible, and it could also be a good skill to show in their portfolio. This way it became relevant for them, and worthy of their attention.

### 4.2 Share Your Ideas

**Setup.** The goal of the *share your ideas*-step was to engage the students of the Wijk-school in using their passions as an inspiration to sketch an object. The sketch was the first part of a creative process leading to the design of a 3D model, which would be 3D printed at FabLab in the following step. Students were given technical constraints in order for their designs to be feasible on the 3D printers, though they were asked to design something that was meaningful for them: either a personal project or a present for someone important for them.

**Outcomes.** Despite some chaos at the beginning of the workshop, having a structured presentation helped to bring order. The students, later, immersed themselves in a productive workflow, with very interesting results. Some students struggled with the

[1] The first author is originally Italian, studying in the Netherlands.

technical limitations to their designs: one student was very disappointed when invited to simplify his design to be feasible with the current technology, but continued trying.

Other students found the limitations fun and challenging, such as one who took very accurate measurements for his drawing of an iPhone stand, ending up with a fully designed product. Others made the project very personal, such as a student who sketched a medallion with his name and Thai-box champion, or another student, who designed her own logo for her future career as a fashion designer. Overall, the students engaged in the sketching activity in a fluid and spontaneous way, and at the end all those who participated had sketched something meaningful for them (Fig. 1).

**Fig. 1.** Students sketching during step 2 – share your ideas

### 4.3 Share Your Designs

**Setup.** The goal of the third step, *share your designs*, was to stimulate the Wijkschool students to exit the boundaries of their neighborhood and experience a new learning environment at FabLab Rotterdam. A research aim of this step was to gain insights into the effect of changing context on the students' level of engagement. The workshop activities were planned carefully, in order to keep the students' engagement on a high level throughout the entire day. At first, they were introduced to the FabLab facilities and philosophy. Second, they were invited to revise their sketches from the previous workshop, and in case they did not have one, they could make one. After that, the students were introduced to Tinkercad, an open source, 3D modeling software for 3D modeling their sketch. Following this activity, the students would finally 3D print their designs, seeing their idea transformed into a tangible 3D prototype. In this way, problem-solving skills were challenged: iterating by making (as opposed to only drawing) was encouraged and enabled by the 3D printers.

**Outcomes.** A group of 6 students came to 3D print at FabLab Rotterdam: without previous experience, the students learned how to 3D model on Tinkercad and to use the 3D printers in just a few hours. Through learning by doing, they quickly iterated their designs when they saw they did not print as expected. Their level of engagement was high throughout the whole activity: one student, who had joined only for this step of the workshop, managed to 3D print her keychain immediately and was very proud. "Look I made it by myself! I want to show it to my father" she said.

Some of 3D printers had technical issues, so at a certain point the general level of frustration rose. One student became very emotional after his prototype failed for the third time, and left before his fourth attempt was finished. The girl, who had designed her fashion designer logo in the previous step, could not make her design simple enough to print it as she wanted it. The student, who had designed an iPhone stand, also had to go through many failed prototypes, before he could get his prototype right, yet he relentlessly kept trying until he finally made it.

The peer-to-peer learning environment facilitated bonding between FabLab staff, students, and coach, resulting in a fun and successful experience for everyone (see Fig. 2). Furthermore, their empowerment experienced by making their idea into a tangible artifact had an "addicting" effect on the students, who expressed their desire to come back. The current experience demonstrated that a change in context could positively influence the students' personal commitment. Interestingly, any passerby observing the interaction in the FabLab would not have noticed a difference between university students and the students from the Wijkschool, demonstrating an inclusive community. Everyone was solving problems, designing, prototyping, and sharing tips.

**Fig. 2.** Wijkschool students 3D printing at the FabLab during step 3 – share your designs.

### 4.4 Share Your Knowledge

**Setup.** In step 4, *share your knowledge*, the students were back at the Wijkschool. They collected and structured the main insights gained during their experience with 3D printing by creating a step-by-step tutorial on the website Instructables.

**Outcomes.** Sharing knowledge was the most painful part for the students, and had the highest drop-out rate during the project. Hardly any of the students present at the FabLab participated in this step, which made it rather difficult to create an Instructable on 3D printing. Step 4 showed very clearly how the local context contributes to shaping the students' attitude towards learning, in this case in a negative way. As Sophie remarked, it was a welcome back to the daily reality at the Wijkschool, demonstrating how a disorganized school system creates discontinuity in the participation in the workshop activities.

Almost towards the end of the workshop, the student who 3D printed the iPhone stand at FabLab, showed up to finalize the Instructable, which was a very surprising event. He had displayed a very high level of engagement at the FabLab, demonstrating to be a bright student passionate about learning, yet as the coach had announced, with very discontinuous levels of concentration and commitment. Peer pressure kept him from seriously trying to achieve his goals in life, which was a pity, since he demonstrated that he was quite talented. While making the Instructable he managed to resist his peers' pressure, showing that his motivation could be triggered beyond the need of approval from his group, with the promise of recognition for his skills both at school as well as in the Instructables community. Eventually, the desire to impress an external person who was willing to invest time in his development contributed to his motivation.

### 4.5 Share Your Opinion

**Setup.** In step 5, *share your opinion*, the students were summoned to express their opinion on the workshop, providing feedback for future improvements through a discussion and a mindmap exercise.

**Outcomes.** Seven students participated in this step of the workshop. Clara, Zaha, and Yussef were the three who had followed nearly all the workshop steps, and were therefore, the most informed in the overall process. Moreover, the other students had participated in at least three steps, and could also contribute in a valuable way. The discussion about the workshop steps was insightful, especially in view of using it as material to create the platform in the next stage of the project. When appropriately facilitated, the students managed to give voice to their true opinions, yet they did not display a proactive attitude in proposing new approaches, limiting their input to evaluating what happened during the workshop steps. The mind map activity showed that the students were able to follow the rules of the assignments, yet also showed that they do not go beyond the strict requirements. However, it proved to be a useful tool to sensitize them to the work behind the organization of a workshop, and all the elements required engaging participants effectively.

### 4.6 Share Your Experience

**Setup.** Step 6, *share your experience*, is the last step of the workshop; the students were encouraged to share their experience on 3D printing with the rest of their peers from the Wijkschool during "Be Inspired Day". The goal was twofold: on one hand, allow the students who joined the workshop to become positive role models for their peers. On the other hand, inspire the students to dare to step out of their comfort zone and be open to learning new skills in different environments, in order to have a chance to develop their talents and empower themselves.

**Outcomes.** For the occasion, a keynote presentation was designed with the title: "Share your experience. How technologies, design, and open minds bring people together." The slides were meant as a support for the different speakers of the day: the two authors, Sophie the coach, as well as Clara and Yussef, the two students who participated in most of the workshop. The reaction of the audience was a bit chaotic: the students were quite undisciplined during the presentation, until Clara and Yussef, their


**Fig. 3.** Yussef on stage, sharing his experience on 3D printing towards the audience at the Klooster (Theater) during the "Be Inspired Day".

peers who had participated in the workshop came on stage; they showed the audience what they had made and how it was meaningful to them, as it addressed their own passion. The students were sensibly more silent during their presentation, and a general state of curiosity and excitement rose when the medallion made by Yussef was passed around for them to see it (Fig. 3).

The "Be Inspired Day" was obviously "the moment of truth"; the unique experience created with a group of students of the Wijkschool was presented to the wider student community. The audience's response was, understandably, quite defensive, yet it was evident that the presentations had inspired positively more than one student, crucially bridged by Yussef and Clara, who became new role models.

## 5 A Platform for Stars to Shine

The experiences of the workshop series clearly stressed the synthesis of the most valuable interactions for a peer-to-peer workshop platform aimed at activating the students of the Wijkschool to self-empowerment. Differently put, the outcomes informed the design of a workshop platform for empowerment, which employs online social media, FabLabs, and ubiquitous technologies to foster community participation and peer-to-peer learning. The platform aims at allowing a community of students to share and develop their portfolio of skills through a series of hands-on workshops within their school or youth center, where they can become active co-creators according to their level of participation. Figure 4 shows how the "ladder of student participation," inspired by Arnstein's model [1], assigns different roles to the students, according to their engagement in the workshop activities. The hierarchical structure depicted in the model is not static; on the contrary, social mobility is encouraged, allowing the students to move up and down the ladder throughout the different workshop cycles.


**Fig. 4.** Ladder of student participation.

The workshop platform is launched within a school or youth center, facilitated by a local coach. The first step is *Join the Group*, where the coach introduces the new workshop platform to the students and invites them to join the dedicated Facebook group. The second step is *Design your Badge*: here students personalize their membership badge. Each badge has a unique RFID tag connected to a personal FB profile. After the launch, the workshop runs in cycles, which are sustained by the student community. In the third step the coach launches a *Call for Themes* for the next workshop. Students propose their idea and vote for the best one. In the fourth step, the

*Winner* is announced: the idea with the most votes wins. The winner receives a "relay stick" with an active RFID, and is entrusted with authority and central communication functions to become the chief in charge. In the fifth step, *Invite*, the chief in charge has a week to organize a workshop, and invites peers by connecting with the relay stick. The sixth step consists in the *Workshop and Instructable*, at the FabLab, where students make their own real 3D printed or laser cut product. Then they create an Instructable to share their knowledge. After the workshop the students *Rate the workshop*: by tilting the relay stick, the students give their rate, which appears on the Facebook group. A week later, during the Be Inspired Day, the Chief in Charge and the Crew Members inspire their peers by sharing their workshop experience Fig. 5.

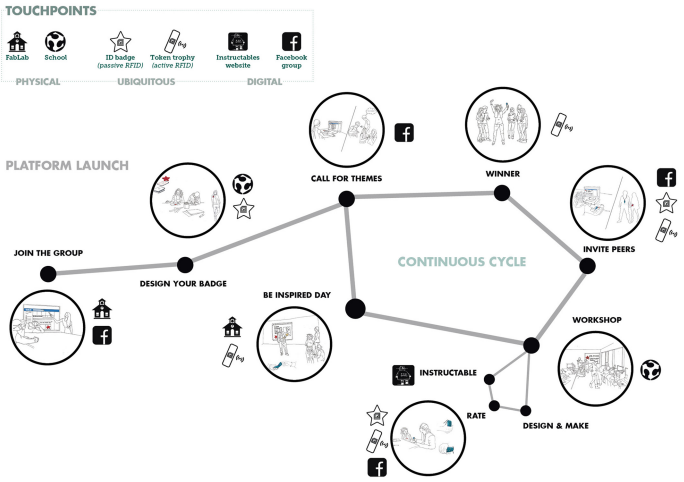


**Fig. 5.** The workshop platform.

The platform has been evaluated with the participation of students from two different Wijkschools during two workshops on laser cutting. The outcomes confirmed the results on students' empowerment and exceeded expectations [see 8, 9].

## 6 Discussion and Conclusions

The platform as well as the intended interactions have been evaluated, and it can be concluded that they lowered not only the threshold of access to digital fabrication in education, but also the students became active co-creators in the workshops while collaboratively learning new skills. Key to the project's success lies in leveraging the students' technological fluency by making digital fabrication accessible and engaging them in an open co-design process. By making and sharing, they quickly acquired the so-called 21st century skills. The current project also showed the potential to build a thriving community of empowered individuals, serving as a "best practice" for future interventions not only in similar socio-cultural conditions [10]. More specifically, the

gained insights contribute to how 21st century skills can be embedded in STEAM educational programs, as well as how they contribute to successful participation in society, see also [2]. By connecting the people to a network where the FabLab is one of the nodes, a learning community can spread beyond the physical environment of a school. On the one hand, the school is alleviated from the cost of implementing an internal FabLab, on the other hand, students are entrusted with the tools to shape their own learning curriculum, inspiring others to do so. FabLabs all over the world can use this process in a very cost-effective way in order to create new co-learning processes that can reach out to underprivileged and uninitiated communities in a more inclusive way, empowering individuals to contribute to open social innovation.

Differently put, one reason why the Wijkschool students have failed in the current education system might be that traditional educational models are not appropriate to teach new generations of digitally savvy youngsters. Traditional silo mentality is the biggest obstacle to change, as it perpetuates a top-down approach where the teacher is the owner of the knowledge while the students are seen as passive receivers. In order to promote 21st century skills, we embrace and advocate for a participatory bottom-up approach to learning by making, where:

1. By identifying the inherent learning potential of digital natives, reluctant students are transformed into empowered individuals;
2. By giving students ownership of their creative process, the learning experience is more effective and lasting;
3. By entrusting the students with the tools to shape their own learning curriculum, they become co-learners and co-creators of knowledge.

It can be concluded that harnessing the most valuable assets in the local community, which are the young adults' passions and digital literacy, and sharing these assets by rules of trust and reciprocity, enables a community to become cohesive and to empower its members. More specifically, the two presenting students at the "Be Inspired Day" demonstrated in a convincing way, that it is indeed possible to transform from dropouts into engaged and successful individuals, who can become role models for their peers: "*stars shining bright in the local community*".

It was striking to see how Yussef, the student who made the medallion, was convinced that participating in the workshop was a mind-shifting activity for him. He clearly understood that he too could have a key role in this transformational change, by becoming an ambassador of the project. Clara, on the other hand, got accepted in a highly selective fashion design school. Her dream of becoming a fashion designer had always seemed far fetched, but through participating in the workshop activities, she was able to design and make her own logo tangible, motivating her to create her own portfolio and apply for admission to the fashion design school. Breaking the autopilot of the status quo in the Wijkschool also proved to be an empowering experience for Sophie, the students' coach. Her passion for participatory educational approaches was not encouraged, and even hindered, by the school's management. Yet, she has been empowered by the collaboration with FabLab, since by facilitating her students' learning process with digital technologies, she could remain a relevant role model for them while learning new skills herself. Today, change goes faster than one can cope with, so it is not easy to remain relevant as an expert in a rapidly changing

environment. Teachers need to learn how to teach in a different way. The current project empowers teachers to rapidly scale up their knowledge, allowing them to develop new skills so they can stay relevant for their students. By flipping the classroom, we can break the traditional divide between teacher/expert and student/recipient to create communities of co-learners, subverting a mistake-averse teaching model into an environment that allows for experimentation and dynamic lifelong learning. In their new role of facilitators, teachers can become meaningful role models for their students, while at the same time training the students to become facilitators themselves. In this way, they can create a ripple effect on a wider societal scale.

If we have the teachers and their colleagues on board, and they feel empowered to be ambassadors, we likely can scale the current practices, repeat them, and have them embedded in the educational system, as well as making the platform self-sustaining.

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