

## Educational Practices for Improvement of Entrepreneurial Skills at Secondary School Level

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**Abstract**—Entrepreneurial knowledge and skills can play a crucial role for young people in order to achieve a bright professional perspective. In this context, entrepreneurship education can make a significant contribution to the development of their entrepreneurial attitudes and skills. It can inspire future graduates to develop and internalize entrepreneurial mindsets and prepare them for the challenges of the future. This paper introduces four practices for fostering entrepreneurial skills carried out at Vienna's biggest secondary school Vienna Institute of Technology/Technologisches Gewerbemuseum (TGM). Two of the presented approaches are realized by the TGM alone (the Junior Company and the Learning Office) while the other two are implemented in cooperation with the non-profit association Practical Robotics Institute Austria (PRIA) and the Automation and Control Institute (ACIN) of the Vienna University of Technology (iBridge and Makers@School, the latter also with further partners).

**Keywords**—entrepreneurship, education, self-organized learning, outreach, Junior Company, Learning Office, robotics, makers, co-design workshops

## **1 Introduction**

In the current economic situation, countries are facing a very competitive environment. On the one side they need to adapt to changing market conditions oftentimes combined with a reduction of the public sector and on the other side they require citizens able to create and develop innovative products and processes but also to lead and manage teams. A workforce with entrepreneurial knowledge and skills can play a crucial role to meet these challenges and such abilities enable especially young people a bright professional perspective. In this context, education can make a significant contribution to the development of entrepreneurial attitudes and skills of young people, but also may help them to recognize opportunities, assess the feasibility of ideas, and create high-growth businesses in the future [1].

The development and promotion of entrepreneurship and corresponding education are subjects of current interest throughout Europe [2]. Entrepreneurship education and learners' activating methods have gained attention and have been studied quite extensively [3,4]. Nevertheless, some of these methods and practices only teach about venture creation and business management, rather than educating entrepreneurship. The learners have rarely the opportunity to practice the concrete abilities they would need as entrepreneurs and only seldom is the focus on the development of the students' skills and behaviours [5]. It seems that teachers are provided with relatively few choices to conduct their entrepreneurship education. Jones and Iredale state that at least two changes are required for entrepreneurship education objectives to be met: curricula must be changed and teaching and learning methods developed [6]. On the other side, Byabashaija and Katono observe entrepreneurship education from a broader perspective and claim that it should contribute towards stimulating abilities such as flexibility, creativity and a predisposition to think conceptually [7]. Eurobarometer survey, showed that most higher education students agreed that programmes should include general competences such as communication skills, teamwork, and "learning to learn" [8]. Entrepreneurship education should include different projects carried out by learners, especially when the teacher has been a facilitator rather than a controlling instructor [9].

In order to answer to these requirements and provide future entrepreneurs with essential knowledge and skills, Vienna's biggest secondary school called Vienna Institute of Technology/Technologisches Gewerbemuseum (TGM), which is focused on technological education, offers multiple entry points for young people to engage with entrepreneurship combining different programs and projects. The programs presented in this paper are realized by the TGM alone (the Junior Company and the Learning Office) and the projects are carried out in cooperation with the non-profit association Practical Robotics Institute Austria (PRIA) and the Automation and Control Institute (ACIN) of the Vienna University of Technology (iBridge and Makers@School, the latter also with further partners). The iBridge project represents an intergenerational project, which aims at increasing the interest of young people for research in cross social and cultural scenarios as well as for technology and innovation. The student are encouraged to co-design the ICT solutions with end-users (older persons that are 60+). The Junior Company program is designed to stimulate creativity and entrepre-

neurship and to give students insight into business conditions. The students gain hands-on experience of running a real business involving for instance capital raising, product development, or marketing and sales. The Learning Office represents a learning arrangement to support students in self-responsible and individualized learning. Thus, self-organization and a higher capability to deal with new challenges are fostered, which are regarded as important competences for entrepreneurship. The project Makers@School represents an outreach program with the aim to foster various skills in regard to entrepreneurial activities already at the primary school level. The remainder of the paper presents these programs and projects, concluding with final remarks and future work.

## **2 iBridge: ICT and robotics as a bridge between the generations**

Almost 1.9 million people in Austria are aged over 60, representing 23.5 percent of the population. The proportion of people aged 60+ will rapidly rise in the coming years making up to 30 percent by 2030 and even 33 percent of the population by 2045. This will dramatically increase old-age nursing and health-care [10, 11]. Consequently, new innovative products, services, job profiles are expected targeting the 60+ group in the near future.

Particularly, an exciting market arises in the field of assistive technologies. In this context, service robots are seen as promising means to help older people in their daily activities. Nevertheless, very few newly developed technologies and programs are age-appropriate and accordingly designed for user-friendly or barrier-free operation. Numerous projects already deal with the still young topic of “Assistive Social Robotics”, but there are still a lot of open questions in this research area:

1. What functionality does a robot have to provide?
2. How should a robot look like, behave and interact in order to be well accepted?
3. What are the usage and application barriers?

The Sparkling Science Project iBridge [12] aims to sensitize the elderly people for assistive technologies and, in particular, assistive robotics, by using a “sensitive cuddly toy” prototype and by including the older generation in the assistive robots’ development process. The project is based on intergenerational co-design workshops between young and old, applying a new innovative method of co-operative design aiming to involve all stakeholders (high school students as developers and seniors as end users) in the design process to ensure that the results meet their needs and are usable. The project team, consisting of researchers from PRIA and the ACIN, uses following approach:

- For increasing the interest of children and young people in research and technology, the project will integrate following activities: the development of an innovative “sensitive cuddly toy” (see Figure 1), programming of service robots (e.g. auto-

mous vacuum cleaner), as well as analysis of existing robots for supporting elderly people (e.g. the assistive robot “Hobbit”, developed at the ACIN).

- On the other side of the age spectrum, technical high school students support elderly people in using modern technologies within the frame of PC and internet courses. Especially the young generation – the digital natives – profit from these courses by gaining knowledge about the problems of elderly people and about topics such as safe and barrier-free technologies, which are quite important for service and assistive robotics solutions of the future.
- After increasing the interest of the young people and supporting the older generation towards modern technologies, intergenerational co-design workshops are planned for creating the concept of an assistive robot. The development of the distinct parts of the concept on the basis of the “sensitive cuddly toy” as well as “Hobbit” are carried out by groups of technical high school students, which are supervised by the PRIA and ACIN researchers.
- Based on this concept, a prototype is developed and tested by seniors to identify potential improvements on the hardware and software. The gained insights from the evaluation are going to be incorporated into further technical improvements as well as in the creation of a user manual.

Through many different topics and entry-points (workshops with seniors, research and development in the fields of ICT and mechanics), the participating students are given the opportunity to enter the scientific world and even finish for example their high school education with a corresponding diploma thesis within the frame of the project. By knowing that they contribute to an actual research project and solution of a relevant problem, the students are assured that their work is meaningful. Particularly dedicated students will get the opportunity to deepen their knowledge in the project subject at PRIA or ACIN within the frame of an internship during the summer holidays.



**Fig. 1.** Sensitive cuddly toy

### 3 Junior Company

The Junior Company provides an entrepreneurial learning experience for young people and gives students the opportunity to establish and operate a real business under the guidance of two teachers. The students form a team to add practical experience in the Junior Company to their theoretical skills obtained in the other school settings. Thus, the participants gain hands-on experience of running a real business involving team formation, capital raising, business plan development, product development, marketing and sales as well as liquidating the company. Consequently, this educational program provides an entrepreneurial learning experience for young people and the students' gains are:

- Development of leadership, communication, problem solving, team work and social skills;
- Acquiring of business, design, marketing and financial management skills; and
- Having fun in a life changing experience.

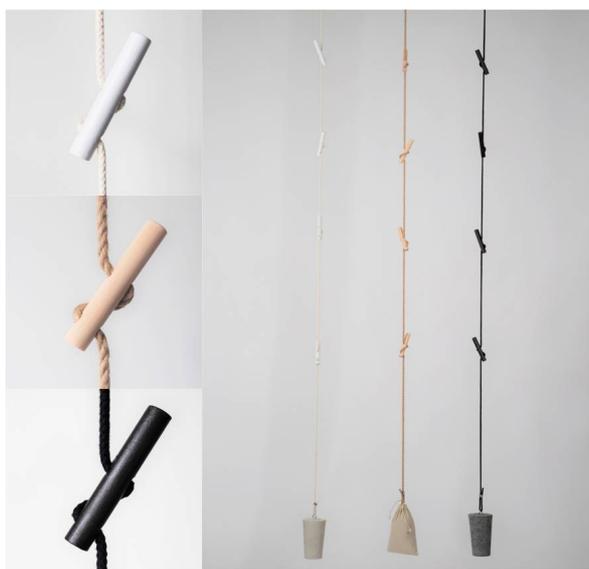
The Junior Company of 2016/2017 combined technical and ecological aspects but also made allowances for creativity and beauty. The chosen product was a fruit jar filled with various objects and illuminated by LED lamps that are charged using photovoltaic cells in the jar's top cover (see Figure 2). The Junior Company itself was denoted as "SunJar". This type of product considers high tech sustainability combined with nostalgic feeling for a target group of people with a focus on renewable energy, life style and decoration. The lamps are water resistant and weatherproof and can be used for outdoor activities. The lamps are offered in different sizes as SunJar Light (500ml) and SunJar Deluxe (1000ml). Additionally the decoration can be varied according to season. Examples are the Christmas Edition or the Mother's Day Edition as SunJar Light Plus or SunJar Deluxe Plus. Generally, there are no limits to individual and creative design variations.

The financial year of Sunjar Junior Company was extremely successful. With a turnover of approximately € 3000, a return on investment of 126% was achieved and the learning effect for the participating students was considered excellent.



Fig. 2. Two examples of SunJar products

In the current academic year 2017/2018 a new junior company named “Rope’n Hooks” was founded. Clothes ropes are produced and sold in three different versions (Black Edition, White Edition, Natural Edition). Four wooden hooks are pushed over an cotton rope. Once they are loaded, they become wedged and thus they keep their position. The rope is hung in a ceiling hook and held in place by a solid concrete weight. The slim wardrobe ropes are handmade - stylish and simple they look like a design accessory. In this hanging wardrobe, the clothes seem to float in the air. A funny idea for people who have a sense for the extraordinary. The robust wardrobe impresses not only by the elegant and slim design, but above all by its high functionality (see Figure 3).



**Fig. 3.** Rope’n Hooks

Parallel to the operation and the teaching in the Junior Companies, a study concerning the entrepreneurial attitudes and skills of the participating students was conducted. The purpose of this research is to explore the entrepreneurship profile of students who are member in a Junior Company (at the department of industrial engineering at the TGM) and to evaluate their entrepreneurship orientation in comparison with other students. A questionnaire with 10 questions regarding personal attitudes towards entrepreneurship was designed to measure the relevance of the personality of young entrepreneurs. These questions were as follows:

1. If I am enthusiastic about a topic, I am willing to work hard.
2. I like to make decisions.
3. Setting my own goals is easy for me.
4. My enthusiasm for a topic is constant and persistent.
5. When meeting barriers I stay calm and try to find solutions.

6. Even under pressure I can concentrate on work.
7. Even on weekends and in the evenings I am ready to work when something needs to be done.
8. If there are problems, I try to find solutions actively.
9. When joining new groups, I find it easy to get in contact with my coworkers.
10. It is easy for me to adapt to different personalities.

Two groups filled out the questionnaire: the experimental group (students who had been interested in membership in a Junior Company) and the control group (classmates who are not interested in this specialized form of education). The aim of the survey is to investigate on different opinions with regard to resilience, adaptability and proactivity. Concerning perseverance, willingness to work, and the ability to set own goals, the Junior Company group performed better than the control group (see Table 1).

At 96%, the level of agreement of members of the Junior Company for question 4 ("My enthusiasm for a topic is constant and persistent") and for question 6 ("Even under pressure I can concentrate on work") was significantly higher than at the control group with only 71% approval (see Figure 4)

Surprisingly the members of the Junior Company answered question 1 ("If I am enthusiastic about a topic, I am willing to work hard") and question 8 ("If there are problems, I actively try to find solutions") less positively than the comparison group (see Figure 5).

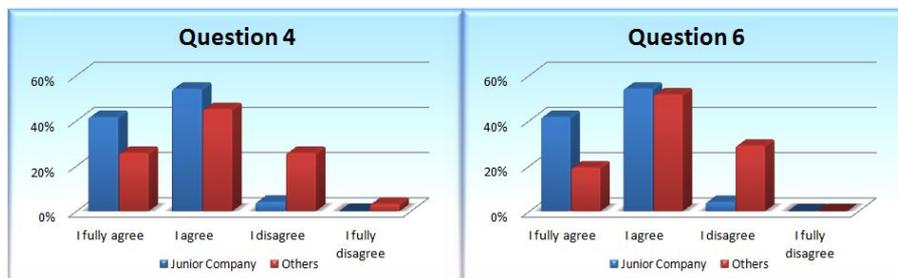


Fig. 4. Comparison between the answers of the two groups to question 4 and question 6

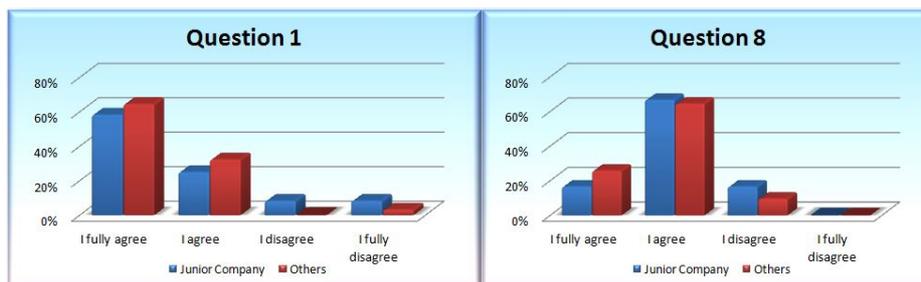


Fig. 5. Comparison between the answers of the two groups to question 1 and question 8

**Table 1.** Preliminary results of the survey

Question No.		I fully agree	I agree	I disagree	I fully disagree
1	Junior Company	38,5%	46,1%	0,0%	15,4%
	Others	40,0%	40,0%	0,0%	20,0%
2	Junior Company	30,8%	61,5%	0,0%	7,7%
	Others	0,0%	60,0%	40,0%	0,0%
3	Junior Company	53,8%	46,2%	0,0%	0,0%
	Others	40,0%	40,0%	20,0%	0,0%
4	Junior Company	38,5%	53,8%	7,7%	0,0%
	Others	20,0%	40,0%	40,0%	0,0%
5	Junior Company	23,1%	76,9%	0,0%	0,0%
	Others	0,0%	80,0%	20,0%	0,0%
6	Junior Company	46,2%	53,8%	0,0%	0,0%
	Others	20,0%	20,0%	60,0%	0,0%
7	Junior Company	46,1%	46,2%	7,7%	0,0%
	Others	100,0%	0,0%	0,0%	0,0%
8	Junior Company	15,4%	84,6%	0,0%	0,0%
	Others	0,0%	60,0%	40,0%	0,0%
9	Junior Company	30,8%	61,5%	7,7%	0,0%
	Others	0,0%	40,0%	40,0%	20,0%
10	Junior Company	23,1%	61,5%	15,4%	0,0%
	Others	20,0%	60,0%	20,0%	0,0%

The Junior Company is only part of the educational focus named TIME (Technical Innovation Management and Entrepreneurship) at the department of industrial engineering at the TGM with lectures in market research, business intelligence and a Young Entrepreneur Workshop. Academic research has shown the positive relationship between entrepreneurship education and entrepreneurial intention and that entrepreneurship education increases entrepreneurial intention [13,14]. So the long-term goal of this study is to discover correlation between entrepreneurial education and students' attitude to entrepreneurship.

The positive experiences of the previous year are already showing signs of success at this year's Junior Company. The interest of the students is higher, the ability to work independently is more pronounced and the desire to exceed the economic success of the previous year is an important motivator. However, these are only preliminary results as the analysis of the actual data has not yet been completed. But what can already be said is, that the study will be continued during the next years.

#### 4 Learning Office

According to Margret Rasfeld, a pioneer in Learning Office work, a Learning Office or learning atelier is defined as a learning arrangement to support pupils in self-responsible and individualized learning. Therefore, these ateliers are characterized by the following attributes [15]:

- Learning materials are available in the form of self-explanatory materials, the so-called learning modules. With these, students are able to work independently on specific knowledge.
- The learning materials can be developed by each student at his own pace and at different levels.
- Each student is requested to plan, carry out and finalize his or her own learning project. Accordingly, students decide for themselves when and to what extent they work in which subject.
- In addition to the professional support, the teachers accompany the students in the planning, structuring and revision of their learning as tutors.
- Regular tutorials, the logbook and the so-called learning paths are used as structuring aids for the work in the learning office.
- The work in the learning office can be alone, in certain situations like oral presentations in front of others, but also in groups.
- The learning office is characterized by a concentrated working atmosphere as every student is aware of what he or she has to do. This leaves the teachers time to support the students individually.
- After completing a module, the students register for a test. Upon successful completion, a certificate is received with a detailed feedback on the performance as well as recommendations for further work.

As first technically focused secondary school in Austria, the TGM recently introduced a class format denoted as “Lernbüro” (German for Learning Office) [16] in the Information Technology department, which fulfils the above mentioned characteristics. In contrast to the original approach by Margret Rasfeld with offices only available for German, English, maths or other general knowledge disciplines, the TGM offers according to their field of expertise also technical Learning Offices for systems engineering (electronics and informatics), software development, media technology or network technology.

For instance within the software development Learning Office, the students have to do small projects with programming background. Likewise to an entrepreneurial environment, the students are confronted with a problem and have to think about new solutions using their individual knowledge. Consequently, they develop a concept and subsequently an implementation.

Regarding exams, the Learning Office approach in the TGM differs from Rasfeld's approach. Our approach encompasses main tests for major subjects, which have mandatory tests in regular curriculum organization. These main tests are meant to help the students to prepare for their final exams, which are centralized all over Austria. Moreover, these main tests are also used to compare the learning office approach with the regular curriculum organization. This comparison was done in the following way: Two tests per semester were set in parallel for two groups. The experimental group of students learned the topics in the learning office setting. On the contrary the control group of students was instructed in a common curriculum organization with teachers giving lectures and mandatory homework. The following differences were observed:

- At the first test in the first semester the results were equal. The only difference was that the students in the learning office did not spend much time at home for learning maths.
- By the end of the semester the students in the Learning Office did have more stress in order to accomplish all of the given tasks. This was an important moment for the students as they realized that they should also carry out work at home in order to fulfil all given tasks in time.
- At the third test after two-thirds of the school year, the students in the Learning Office obtained far better results compared to the control group. During that time, the Learning Office students regularly carried out work for school at home.

Self-organization and self-reflection are probably the most important personal competences that we need in the fast-moving society. This is characterized by lifelong learning, which itself must be learned. To ensure that the changeover from a regular curriculum organization to the Learning Office is not too difficult and these key competences can be obtained, a learning coach (i.e. a teacher from the Learning Office, usually the class board teacher) takes care of each pupil individually in four-eye conversations. A coach is responsible for about 16 students and these talks take place in two-week intervals. The learner's success of the previous two weeks is discussed: what has worked particularly well, and what has maybe not worked out that well. Based on this, a plan for the next two weeks is then jointly determined.

Based on the test-results as well as based on observations during this first instalment of the Learning Office at the TGM, it can be concluded that it offers an individual way for students in order to learn and prepare for exams. Moreover, the students are able to achieve better results with less required work at home (but still needing some). Students use the time in school more efficiently when learning for themselves in contrast to sitting in a classroom and listening to the teacher. Another observation made was that Learning Office students are happier in school and show a different attitude towards learning: they really learn for themselves and not only to be able to achieve a positive exam. Therefore, they have more fun in school, they are much more motivated and their ability to organize themselves is significantly higher in comparison with the control group. Consequently, the students in the Learning Office are better self-organized and have a higher capability to deal with new challenges. It can be concluded that the Learning Office environment fosters competences needed for entrepreneurship.

## **5 Makers@School**

For increasing the number of students in the STEM domains at university but also school level as well as enhancing their chances on the job market, outreach activities need to be carried out for fostering the interest for those domains. The idea of the maker-movement is to create and develop new items and products by using tools such as 3D-printers in open working spaces or laboratories, which are denoted as maker-spaces. In this context, workshops with maker-tools for children can increase interest in technology, development, engineering and design already from an early age. Such a

maker-activity represents a constructionist learning approach that imparts competences such as innovation development and problem solving often in team work. Such activities enables the young people to become active protagonists as creators of ideas, inventors, designers and producers.

The project Makers@School represents an outreach program attached to the TGM that is carried out by the Practical Robotics Institute Austria (PRIA) [17] together with several partners. It is financed by the Austrian Federal Ministry for Transport, Innovation and Technology in the frame of the “Talente regional” program. The project’s aim is to foster various skills in regard to entrepreneurial activities already at the primary school level. Figure 6 presents an overview of the activities that are carried out in the frame of this project, of which the actual implementation activities are scheduled for the upcoming school year.

The project involves a series of workshops for primary and middle school classes that offers a glimpse of the topics of entrepreneurship, innovation and science to these young pupils. Important topics such as product design and 3D-printing are tackled by the workshops. In a later project-stage, the young pupils form teams and work on their own small maker-projects. To address the topic of science in this context, the pupils reflect on their projects and describe them in a paper that they can present at a small school conference.

In this context, the project Makers@School aims at giving a better understanding of the maker-movement to the young people for fostering their interest in science, technology and innovation. At the beginning of the project, a series of workshops shall impart the basics of the maker-movement, such as product development, 3D-printing or programming.

Later on, the students carry out their own maker-projects. While these are supervised more intensely in the case of primary or middle school students, the groups at the colleges for a higher vocational education act more independently in the frame of graduation projects. For providing more insights into scientific working and thinking, specific workshops with researchers are carried out that enables the students to compose an age-corresponding scientific paper about their maker-project or another topic of interest. A small scientific conference at their own school shall then provide the opportunity to present the project results as well as the paper.

A final highlight for each involved class is the opportunity to visit the Industry 4.0 Pilot Factory of the Vienna University of Technology.

Within the frame of this project, a web platform for makers is developed for supporting its sustainability. Using this platform, the stakeholders (i.e. companies, students, and educational institutions) can network with each other and present ideas and solutions to the public. Thus, the students have the chance to achieve visibility to the companies for enhancing their own job perspectives.

## **6 Conclusion**

Changes in the economy and workforce call for an entrepreneurial mindset. Through an appropriate education already at school levels, the students can acquire

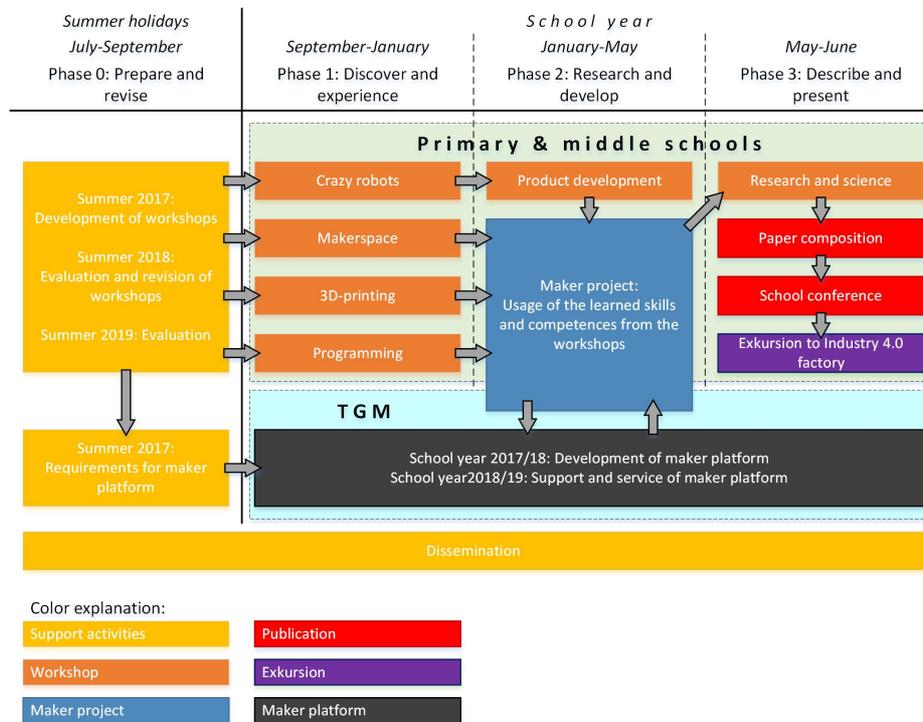


Fig. 6. Overview of the activities of the project Makers@School.

relevant skills and mindset required for entrepreneurship. This paper presented current practices applied at the technologically focused secondary school TGM in Vienna, Austria. The preliminary results of the conducted evaluations for the Junior Company and the Learning Office generally show improvement of the corresponding skills and mindset.

Future work will be concerned with more detailed investigation of the evaluation as well as the gathering of additional data within the implementation of the Junior Company and the Learning Office as well as of the projects iBridge and Makers@School in subsequent school years.

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