Interactive Classroom
Working Group

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Makerspaces in schools

Practical guidelines for school leaders and teachers

Case Study

Karaköprü STEM Makerspace, Turkey

European Schoolnet

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Picture credits:

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Introduction

Makerspaces, which are designed for hands-on, collaborative, creative work, are a fairly recent addition to some schools in Europe and worldwide. Students in school makerspaces can work with materials such as paper, cardboard, wood, metal, plastics, clay, fabrics, electronic components, microcontrollers, construction kits or programmable robots to create many different objects, and complete many different projects, using a variety of tools and machinery.

This case study is one of 15 developed from interviews with school leaders, teachers and other staff who have set up makerspaces in their schools. The schools are located in nine countries i.e. Austria, Belgium, The Czech Republic, Ireland, Italy, Luxembourg, Portugal, Switzerland, and Turkey.

The interviews were part of research carried out by European Schoolnet's Interactive Classroom Working Group and the schools' experiences, the lessons they have learned and the good practice they have developed, have informed the development of a publication "Guidelines on Makerspaces in Schools".

Find the full report and other case studies here: *fcl.eun.org/guidelines*

National context

Almost every city in Turkey's 81 provinces has a STEM class, and maker classes are a national policy priority. The Government's Education Vision 2023 document sets specific goals to create learning labs; specifically "design and skill labs" in all schools in five years. To help to achieve this policy goal specific pedagogical guidelines are expected to be published for teachers.

There are two groups of makerspaces in Turkey. Some are located in school buildings and led by the teachers themselves. The others are located in separate buildings and coordinated by an independent manager outside of school hours.

At national level, the General Directorate for Secondary Education provides funding opportunities for pilot schools at secondary level. At local level, schools themselves are creating and building makerspaces by applying for funding from sponsors, local development agencies, or the Scientific and Technological Research Council of Turkey (TÜBİTAK).

The Karaköprü STEM makerspace

The Karaköprü STEM Makerspace Centre is located between two schools, a vocational school for girls and a secondary school in the centre of the district of Karaköprü in Şanlıurfa province in South East Turkey. There are entrances to the Centre from both schools and a separate entrance on the main road. With its large workshop and informatics room, the Centre serves all primary, secondary schools and high schools in the district and its central location in the district makes access very easy.

The number of students using the Centre varies according to a monthly schedule; students from district schools attend courses at the Centre linked to specific programmes. Weekend courses are usually for 25 students while week day courses

usually have fewer students. Since it opened, the Centre has implemented engineering and STEM programmes for girls, delivered STEM education to more than 500 students and attended exhibitions and competitions with the Gençsem Association thanks to funding received from the Ministry of Youth and Sports and Department of Associations.

Students of all socioeconomic backgrounds use the Centre and, as the service is free of charge including the course books, differences in parental income are not a barrier to the educational opportunities. Participation by socially disadvantaged students is supported by projects in the Centre.

Karaköprü Centre prioritises the participation of disadvantaged students and takes the necessary measures to enable their participation. For example, students from more distant schools are transferred to the Centre in municipality, or other public bodies', vehicles. Also, as weekend courses can take all day, students are served free food by the Municipality.

Motivation, timescale and aims

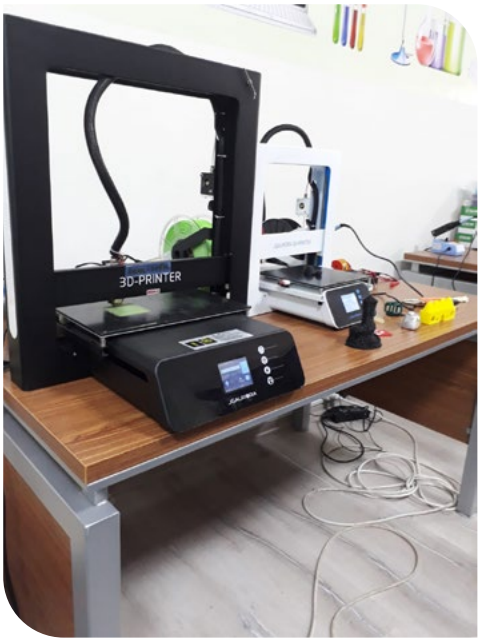
In 2014 a group of Turkish school teachers were involved in an EU funded STEM education project[1] that included creating two STEM workshops, one in Karaköprü Secondary School and one in Yenişehir Public Education Centre. These teachers formed an association called Genç Stem Derneği[2] (Young STEM Association: gencstem.com) and in 2016 they opened the Sanliurfa STEM and Science Centre (http://urfastem.com). In 2017, inspired by their experiences of these activities and by visiting other makerspaces, the group decided to set up the Karaköprü STEM Makerspace Centre.

The main aims of the makerspace are:

- To invest in new technologies, learn how they work and how to use them and transfer this knowledge to the students.
- To make students aware that they could create technologies similar to the ones they use.
- To raise a future generation that are able to develop their own technologies.

Building and equipping the maker space

The Karaköprü STEM Makerspace Centre was created by adapting two existing empty and unused rooms in a workshop area of a public open education centre belonging to the Municipality. The layout of one large room (80 square metres) was changed to be suitable for a makerspace and the smaller room (30 square metres) next door was turned into an informatics classroom.



The five teachers who work in the Centre have worked in other centres and, therefore, had the experience required to understand what equipment was needed for the new Centre. Further ideas and information came from:

- Workshops in other cities;
- Presentations of products by companies;
- Other companies in the neighbourhood e.g. 3D producers;
- International training events.

1 Project details can be found at www.scientix.eu/web/guest/projects/project-detail?articleId=555559

2 gencstem.com

Parents were not consulted about the original choice of equipment, but their feedback has been taken into account when updating equipment in the Centre.

Equipment and technology

Furniture in the Centre is flexible and can be cleared away to enable group work requiring space e.g. balloon pressure experiments. The current equipment in the Centre consists of:

Vex robotics sets	Augmented reality tools
3D printers	Arduino programmable microprocessors
Lego sets	Micro:bit programmable microcomputer
Fischertechnic sets	Mblock coding editor software
Robot parts	Wood and metal
Experiment sets	Filament for 3D printers
Electronic circuits	Ropes and cords

Other basic tools and materials collected from the nature.
3D design software, Web 2.0 tools and open source resources about STEM.

Health and Safety

The makerspace has safety rules concerning wearing eye protection, safe use of dangerous tools, etc. Students are informed about safety rules before every course and they are not allowed to carry out any activities without supervising teachers.

The Municipality enables security of the Centre by providing security guards and CCTV.

Cost and funding

The Karaköprü STEM Makerspace Centre was initially funded by Australia's Direct Aid Program (DAP) which, in Turkey, is administered by the Australian Embassy in Ankara.

DAP supports projects that are "*aimed primarily at achieving practical and tangible outcomes*" in areas such as "*poverty alleviation, community health, schools/education, small-scale infrastructure, rural development, youth, gender equality and the environment including climate change and ad hoc humanitarian relief*".

The Centre was then created in partnership with Karaköprü District Governorship, Karaköprü Municipality and District Directorate of National Education.

The project team identified empty rooms in which to establish the Centre and made use of project funding to cover the costs of refurbishment and equipment. The initial cost of creating the Centre was approximately 100,000 to 125,000 Turkish Liras (approximately 15,000 to 20,000 euros).

The makerspace Director has observed that "*Makerspaces have a high establishment cost and then require regular funding for materials such as filament for 3D printers*". In the case of the Karaköprü Centre, the Municipality pays for these as well as the cost of electricity, water, etc. and the cost is around 1,500 Turkish Liras per month (approximately 240 euros).

A grant from the Adult Training Directorate pays teachers for the time they spend in the Centre during the holiday period. During school time five teachers from the adjacent schools run courses in the Centre on a voluntary basis. Sometimes volunteers are paid from project funds for specific periods.

Sustainability

The installation of the Centre has been completed and it is not expected to need additional funding as long as the regular monthly financial support is provided by the Municipality. The Makerspace Director commented "*in fact, we fully believe that all public bodies and families would support us if needed. The reason is that we serve such a broad group of people*". He added that as new funds do become available the makerspace will be developed further.

Organisation and management

The Centre is open and courses are delivered between 9.00 am and 5.00 pm every day. Use of the makerspace is open to anyone and approximately 20-25 people can comfortably work together in the space. When students attend courses they are organised into groups by age.

A monthly programme of events is sent to schools and announced on websites. Also students from other schools visit the Centre with their supervising teachers. These visits are pre-booked and fitted in around scheduled events. Five teachers regularly volunteer in the Centre when they have time available in their normal school schedules and after school hours. The volunteer responsible on any particular day has the keys to open and close the building and all the workshops.

Some of the teachers are engineers and they act as technicians supporting students and other teachers. There is a Makerspace Director who is responsible for the daily operation of the Centre including timetabling and informing teaching colleagues of availability as well as supporting teachers. The Director, after attending national and international STEM training, has worked as an educator in STEM projects within the Ministry of National Education (MoNE) institutions.

If a volunteer teacher is unable to supervise the Centre as planned, the Director requests a volunteer teacher from the Young STEM Association for the day. The association was established by the Makerspace Director and four other teachers. It now consists of volunteers with different backgrounds and focus, including some university students as well as teachers and engineers. Membership is also open to parents. The association participates as an NGO in national activities and networks and its members see Karaköprü STEM Makerspace Centre as their home space.

Networking beyond the school

The Makerspace Director reports that "*We are in contact with all makerspaces in the city. Since we are similar in nature, we come together and exchange ideas. Generally, we have a beneficial dialogue and we sometimes organise joint events".*

Training and support of teachers

All the educators operating in the Centre receive STEM Trainer or Maker training within EU projects and from the Karacadağ Development Agency. The volunteer teachers develop course plans together and exchange ideas to achieve more productive courses. Practical activities in courses can include, for example, programming drones, VEX robotics kits and Arduino microprocessors. In addition to technical skills, the courses help teachers to improve their computational thinking, critical thinking and mathematical modelling skills. Some courses help competent teachers to brush up on specific skills.

The Karacadağ Development Agency is the biggest supporter of teacher training. Thanks to the funds they offer, the Centre's educators receive training from expert professors and participate in international training within EU-funded projects.

At every meeting of the Young STEM Association experiences are shared and seminars for sharing good practice are organised in schools. The Association plans to create a project for increasing the maker skills of teachers and intend to double the number of teacher training events in this way.

Teachers from nearby schools, beyond the schools adjacent to the Centre, use the makerspace and sometimes carry out workshop activities in the Centre with their own students. The Association provides training for these teachers.

Teaching and Learning

The curriculum focus and priorities of the Centre are shaped by the courses and programmes offered by the Ministry of National Education (MoNE). In general, the teachers integrate the curriculum requirements into maker activities. Having learned topics in school in a theoretical way, students implement them in a concrete way by making things at the Centre. Many curriculum subjects are supported by activities in the Centre, especially Sciences, Information Technology and Technology and Design.

The Centre's team organises maker activities in the Centre and exhibitions in schools. Activities in the Centre include:

- Creating apps using App Inventor.
- Programming and coding activities e.g: programming Arduino microprocessors, drones, etc.
- Using 3D design tools.
- Creating models, drones and rockets.

The teachers work collaboratively, taking joint decisions and exchanging ideas before, during and after the activities in order to develop more effective courses. As well as knowledge in specific scientific and technical fields, the Centre values and fosters teamwork, collaboration, critical thinking and creativity.

Teaching methods employed in the Centre include project-based learning, problem solving and group activities and the educators include Information Technologies teachers, Computer Engineers, Science teachers, Technology and Design teachers and Mechatronics Engineers.

Some students have participated in national and international competitions, which the Makerspace Director says is "the biggest source of pride for us". These students have been involved in both experiments and production for maker competitions. Also 50 schools in the district were granted funds by TÜBİTAK for a mini science festival. Many of the activities exhibited in this festival were created with the guidance of Karaköprü STEM Centre and support of the Centre's teachers.

Added value and benefits

The Makerspace Director commented that "*the Makerspace is an environment where schools and education goals come alive*".

Benefits and positive impact on students, observed by teachers, include:

- Students make an effort to improve themselves.
- Thanks to applied learning in the makerspace, students retain what they learn permanently.
- Students learn to use technology effectively.
- Students develop a habit of research.
- Each maker activity involves problem solving and, therefore, students problem solving skills have improved.
- Students' communication, team work and peer-to-peer learning skills have improved.
- Producing and exhibiting products has a great influence on students social as well as cognitive development.
- The flexibility of the environment, and the tools and materials it offers, means students are more engaged and less bored; therefore they learn better.
- Students have a more positive attitude to school.
- Some of the activities in the makerspace (e.g. operating drones, creating apps using App inventor or designing household objects) start preparing students for future careers at an early age and can involve learning about applying for patents.

After working in the makerspace students sometimes make positive comments, e.g:

"*Now, I have a different perspective of the tools around me*".

"*Now, I understand the topics better*".

"*Being an engineer is actually fun, I would like to be an engineer in the future*".

Challenges

The main challenge the Centre faces is restrictions on the amount of time teachers are able to dedicate to it. Sometimes there are timetabling clashes between their other teaching duties and courses in the Centre. The Makerspace Director explains that "*In such cases, we try to overcome this issue by inviting other educators or by informing the school and postponing the course to a later date"*.

The Makerspace Director explained that "*our educators are good at makerspace activities but teachers from nearby schools are not very experienced, so we try to inform and train them*". However, he has found that teachers in some schools are reluctant to participate which has prevented mainstreaming of the makerspace and STEM practices in these schools. He says "*involving just a couple of teachers from every school is enough to have a positive impact on our students' future*".

Future plans

Following the signing of a protocol between the Municipality, the Ministry of National Education and Kızılay (Turkish Red Crescent) this year, the current makerspace will become part of a larger science centre as new classrooms will be added.

All the STEM classrooms in the Municipality will be integrated into the Centre and the makerspace will be a duplex science centre. Next year, the STEM makerspace will have eight more large workshops and activity areas. Four full time engineers will be added to the five teachers who currently work in the space. This will increase the capacity of the Centre, allowing 174 schools in the district to make the maximum use of it.

The case study complements the European Schoolnet's publication "Makerspaces in schools / Practical guidelines for school leaders and teachers" (2020).

Find the full report and other case studies here: **fcl.eun.org/guidelines**

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