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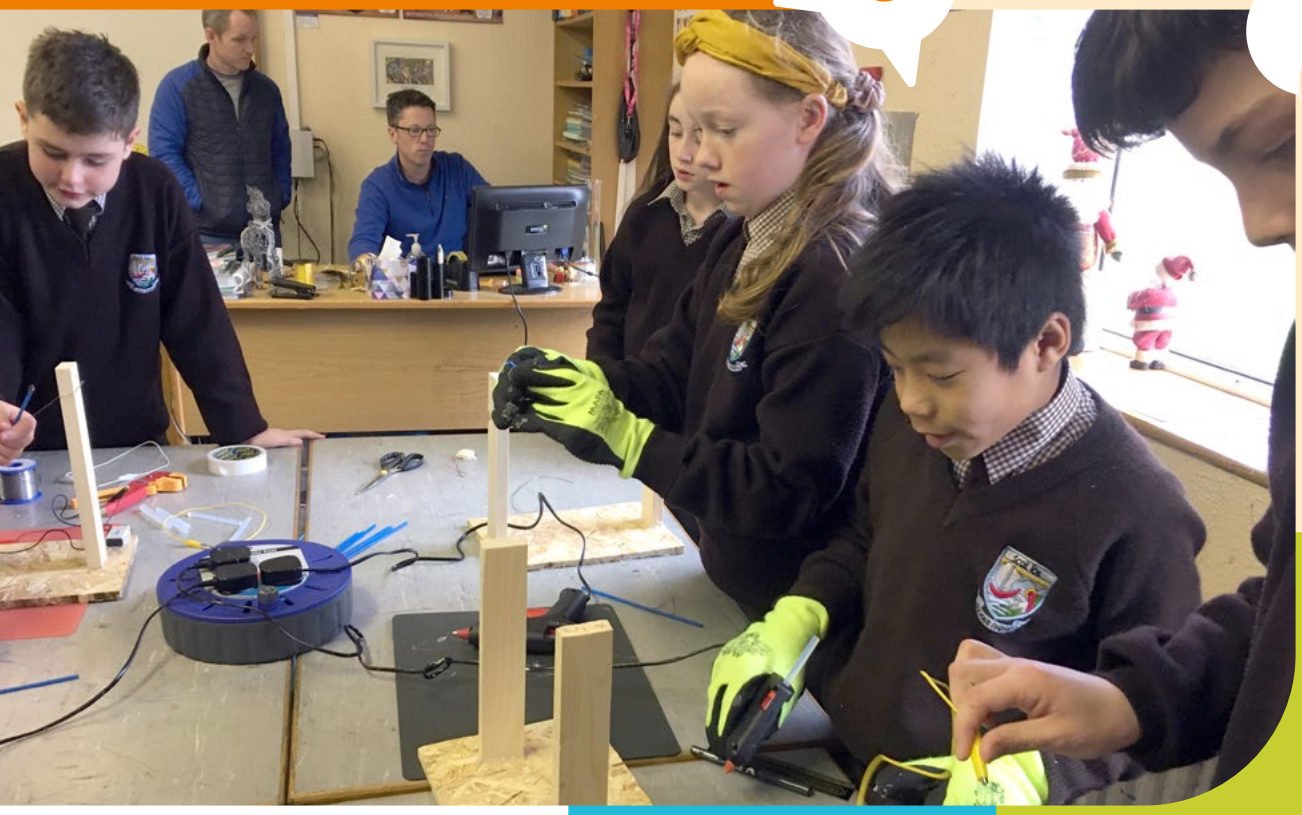
Makerspaces in schools

Practical guidelines for school leaders and teachers

Case Study

Scoil Íde, Ireland



European Schoolnet

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Practical guidelines for school leaders and teachers

Case Study:

Scoil Íde, Ireland

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Scoil Íde, Ireland (cover, pp. 4, 5, 8)

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*

The school

Scoil Íde is a suburban primary school located in Limerick in mid-western Ireland. The school has 788 pupils, 44 staff (including 2 administrative staff). Pupils attending come from a mixed socio-economic background. The school has a strong STEM vision and ethos. It has won awards for digital technologies, and is a 'Digital School of Distinction'. There has been a strong STEM focus on teaching and learning which originated with the previous principal of the school. It is now carried on by the current principal.

Scoil Íde has very strong links with the University of Limerick and local industry. It takes part in robotics and mini scientist competitions. It also is involved in a Numeracy across the curriculum project with the University of Limerick and other partners.

Use of educational technology in the school

The school has two sets of Chromebooks and one full class set of tablets (iPads), which are shared across different classes and class levels. Additional laptops and makerspace equipment are available to students, including STEM kits for young classes, and coding is taught from the very early years upwards in the school. All classrooms are equipped with Interactive White Boards and the school has implemented an e-portfolio system for all classes using Google Drive.

One of the school's teachers is responsible for digital technologies and for the integration of STEM across the curriculum with the pedagogical aspect of this teacher's role being very important. STEM is a major focus of the school in everything it does and the makerspace is a key element of this.

Motivation and aims

The current principal describes her predecessor, Peter Long, as "*a visionary force in the development of STEM teaching and learning and in particular the development of a makerspace for the school*". The makerspace aims to develop skills such as working together in teams, problem solving, computational thinking, communicating across the curriculum and bringing learning to life.

It is not confined to one particular subject although many strands of the Science and Maths curriculum are at the centre of makerspace activities. For example, a popular Hydraulics makerspace lesson on Forces from the Science curriculum also covers Ratios in Maths. Other lessons have incorporated creative elements, including the Music and Visual Arts curriculum.

An aim of the school is to connect learning to practical scenarios and real life, creating more meaningful learning experiences for students. The principal describes the school as having *"a strong history of using Scratch and coding very creatively across all levels in the school for many years"* which was inspired by the work of Mitch Resnick[1] of the Massachusetts Institute of Technology Media Lab. Pat Butler, one of the teachers interviewed, says "*The development of discrete digital technologies skills, such as coding with microbits, and the use of JavaScript and Scratch are a key component and an aim of the school, in line with their digital learning plans".*

Implementation and integrating into the curriculum

It took the school six months to plan and set up the makerspace which, at time of writing, has been operational for approximately 18 months.

The next challenge the principal has identified is mainstreaming use of the makerspace across the whole school. She is keen to develop a plan which will enable the school to provide access to all senior pupils (3rd and 5th class) to the makerspace. This will be part of the development of digital technologies in the school and future planning in relation to School Self Evaluation[2] and in particular the Digital Learning Framework[3].

All makerspace activities in the school are linked to STEM and they address Maths and Science primarily within the school curriculum. Literacy is also important, and procedural writing is an important element of the language curriculum, this is integrated within lessons by requiring pupils to document the steps they took in makerspace activities and a core assessment element.

Pat Butler, noted that skills of problem solving, team work, perseverance, and presentation, as well as both oral language development and writing are important elements of makerspace activities. He observed that *"the fact that the Primary Curriculum[4] facilitates and encourages the integration of these across all subject areas makes the makerspace a particularly effective learning approach".*

There are two primary teachers involved in makerspace activities and all four fifth year classes use the makerspace for at least one day each month. The school has plans to extend use of the space to include third year students. Currently no external people or organisations use the school's makerspace.

1 https://en.wikipedia.org/wiki/Mitchel_Resnick

2 http://schoolself-evaluation.ie/

3 www.dlplanning.ie

4 https://www.ncca.ie/en/primary

Building and equipping the makerspace

Scoil Íde's makerspace is unusual in that it is a temporary adaptation of an existing classroom.

All chairs are removed from the classroom. Tables are set up as stations around the room, for example an ICT station, an electronics station, adhesives and cutting stations. The result is a workshop type lay-out, with the students very central to the set up and organisation of the space. A standard classroom can accommodate 32 pupils.

A mobile trolley, equipped with all the necessary makerspace supplies, is moved from class to class as needed. Pat reported that *"the equipment is carefully stored and labelled and the students are familiar with where to find the materials they need for various activities. At the end of a lesson the students help to clear up, putting materials in the correct locations in the trolley and moving the furniture back into its original configuration. This is very efficiently and seamlessly done"*.

The equipment used has been chosen based on science lessons selected and adapted by the teacher for use in makerspaces and to support the learning objectives of the curriculum. The materials were procured from a number of sources. Kitronic inventors kits were purchased online, along with other electronic components. A lot of recycled cardboard and other materials are also used.

The equipment available in Scoil Íde for makerspace activities includes:

ELECTRONICS		
Resistors Batteries LEDs Motors	Multimeter Breadboards Jumper cables Fans	Micro:bit programmable microcomputer Alligator clip connectors Buzzers
ART AND CRAFTS	TECHNOLOGY	SOFTWARE
Cardboard Plastics Glue guns Glue sticks	Chromebooks iPads	BBC platform JavaScript Scratch Junior Scratch

Health and Safety

When a classroom is configured for use as a makerspace, in the evening before it is to be used, care is taken to allow space for pupils to move easily from station to station. Then, before it is used, the classroom is completely cleared of school bags and other items which could cause students to trip over. There are strict health and safety rules regarding the use of all equipment. Adult supervision and monitoring is in place, in particular for activities that involve the hot glue guns and cutting. The students are fully aware of health and safety issues and the procedures for clearing the classrooms.

Cost, funding and sustainability

The makerspace is primarily funded by parental contributions to the school. The school has also received donations of equipment from local businesses. Restocking of the makerspace trolley costs about 500 euros per year. This covers the cost of one lesson per week for approximately four classes throughout a school year. A grant from the Department of Education and Skills, has been used for the upgrade and purchase of devices and some infrastructure. However, it does not cover the cost of equipment for the makerspace.

The school is part of a Digital Clusters project[5] coordinated and funded by the Department of Education and Skills and this has provided them with funding to purchase electronics and Microbits to use to develop coding skills. This ongoing project involves linking up with two other primary schools and one post-primary school to share experiences and good practice.

In the future fundraising will need to take place to cater for further requirements of the makerspace.

Organisation and management

Pat Butler and Mark Gleeson, both full time classroom teachers, work closely as a team to plan the activities in the makerspace, including identifying and adapting suitable lessons that map to the curriculum, purchasing and management of makerspace kit, working with external partners and experts, and reaching out to parents in industry to bring in outside expertise. Pat and Mark upskill themselves on an ongoing basis as well as supporting other teachers.

The makerspace materials are stored in one classroom and are moved on the mobile trolley to other classrooms which are then reconfigured to become a temporary makerspace. All materials are returned to the base classroom when not in use in other rooms.

Pat and Mark say there have been challenges with trying to organise the timetable as four different classes use the makerspace. However, it now works well. Lessons usually take about an hour and they are planned well in advance, which helps everything to run smoothly.

Networking beyond the school

Currently the makerspace tools and materials are only used within Scoil Íde. However, the principal is very conscious that there are smaller schools in the locality which may not have the expertise which is available to Scoil Íde and is keen to share the school's experiences.

Teachers from other schools have been invited to see what Scoil Íde is doing in the area of digital technologies and STEM in particular. The school is very welcoming of outside visitors and they also send their own staff to visit other schools. As a result of this there is an informal community of practice building up, with a lot of knowledge and experience being shared across schools. The school is also very active on Twitter where it shares highlights with the wider school community.

5 https://stemroots.ie/ and https://www.pdsttechnologyineducation.ie/en/Good-Practice/Projects/Clusters/

Recently the school has gained access to 3D printers in a local post-primary school as a result of their involvement in a Digital Cluster[6].

Training and support of teachers

Teacher training is a priority activity for Scoil Íde. Formal, whole staff training takes place three times throughout the year. This focuses on the use of digital technology, including upskilling of teachers as well as how to use certain technologies across the curriculum. The training is delivered by staff members and the Principal is very happy that this approach works better than having outside instructors. Staff sharing of practice and expertise and informal learning are also encouraged and very common within the school. Areas that were focussed on last year included Scratch coding.

The school has strong links with the local Education Centre[7], and has participated in 'Teach Meets' in the Centre. The Education Centre is one of a network of 21 full-time and 9 part-time Education Centres located throughout Ireland funded by the Department of Education and Skills to deliver national and local programmes of teacher professional development on behalf of the Department.

In addition to technical skills, teachers' training needs identified by the school include facilitation skills. Training also needs to address the mindset required which differs from that related to traditional more teacher-centred teaching.

Pat and Mark say it is important that teachers recognise they do not need to be technical experts but they do need to understand how to approach STEM and makerspace lessons and to help pupils to think like engineers. Enquiry is an important factor in these activities and teachers are encouraged to ask pupils to explore such questions as 'How do touch screens work?' and to find the scientific explanations that back up their answers. Another key element to teacher training is to focus on how science is part of everyday life. Pat and Mark support their colleagues in developing the skills to facilitate use of the makerspace tools and materials in order to develop experimental approaches to learning within their classrooms.

Teaching and learning in the makerspace

When teachers create a lesson they develop instructions, visuals and photographs. Every lesson begins with an introduction to the science behind the activities and demonstrations of how to get started. The teacher may use an example from Instructables[8] to talk through the lesson. Activities found online are adapted for use with the Irish curriculum and Pat and Mark sometimes develop a lesson themselves using tools like Lego Mindstorms[9].

In 2017 a small group of students from the school won the Intel Mini Scientist competition[10] with a Makerspace project called 'RoboBall[11]'. That experience fostered an even greater enthusiasm for makerspace activities among pupils and teachers. The school's 2018 winning project was 'The Micro:bit Moisture Monitor[12]', the project involved four year six students and their report explained:

"The inspiration for this project idea stems from the sizzling hot summer of 2018. It made us realise just how dependent we are on water and got us thinking about how we can play our part in the

6 https://stemroots.ie/

7 Limerick Education Centre https://www.lec.ie/

8 https://www.instructables.com/teachers/

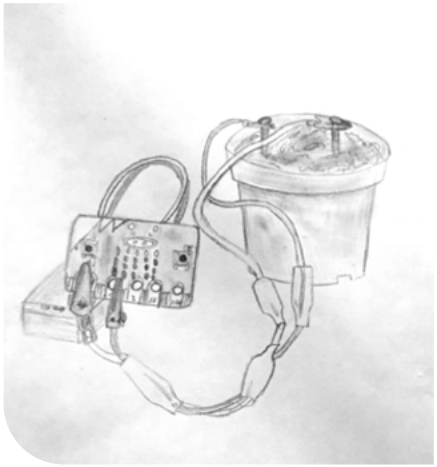
9 https://www.lego.com/en-gb/themes/mindstorms/about

10 https://www.intel.ie/content/www/ie/en/education/mini-scientist.html

11 https://www.siliconrepublic.com/machines/intel-mini-scientist-winner-2018

12 https://twitter.com/Intel_IRL/status/1102614748737224704

conservation of water use. We decided to focus on our school environment. Using our computer coding experience we decided to develop an automatic watering system that would only water plants when necessary. This will hopefully help to conserve the levels of water use in our school when it comes to watering plants. We programmed the BBC micro:bit which is a credit card sized computer using a programming language known as JavaScript. Our device can detect soil moisture levels and make a decision as to whether a plant needs watering or not. A reading above 500 indicates that the soil is wet and doesn't need to be watered. Any reading below 500 means that the soil is dry and will activate the water pump. The maximum reading is 1024 (Saturation). When we connected our device to the wetlands around the pond in our outdoor classroom, we detected this maximum reading of 1024. Our long term goal would be to develop a system that takes care of the plants, fruits and vegetables in our school polytunnel".



In other examples of makerspace activities students have:

- programmed BBC micro:bits to work as thermometers in the classrooms. They then monitor and record temperatures. At Christmas the students programmed the micro:bits to operate the lights on a Christmas tree.
- used Lego Mindstorms to build robots e.g. a baseball batter robot that is programmed to strike a ball as soon as the sensor on the robot detects the ball. In recent years some students have entered the VEX robotics primary schools competition.
- built marble runs and motorised cars using cardboard, plastics and motors.

Teachers at Scoil Íde have needed to address the challenge of finding effective ways to conduct assessment within a makerspace lesson. The idea of recording what students are doing, and pupils creating their own digital stories outlining their process within a makerspace activity is something the school would like to further develop. This would complement the school's e-portfolio development.

Added value and benefits

Teacher Pat reports that *"pupils are hugely motivated and engaged by the makerspace activities"*. They are *"far more engaged in scientific processes and more likely to experiment with hands on experience"* and *"handling the diodes, resistors, breadboards, microbits, and other components is helping pupils to develop a very real understanding of science, technology and engineering"*. He has also observed pupils having a greater curiosity about the world around them and how it works, with boys and girls being equally interested.

Teacher Mark says *"very large improvements have been observed in pupils' ability to work collaboratively"*. He also notes that *"the makerspace approach is very inclusive and is of enormous benefit to students who have learning difficulties, all of whom can fully engage and contribute within this environment. As there is such a range of activities there is always a role for everyone, irrespective of academic ability."*

When working in the makerspace environment pupils now work out their own roles within activities. However, while there is a lot of pupil autonomy, the teacher supervises carefully and facilitates as needed. Mark reports that he has *"seen a lot of improvements in pupils' communication skills and their ability to solve problems within a team"*. Pupils are developing skills in coding and computational thinking as well as gaining knowledge of the curricular areas they are studying.

The teachers agreed there are advantages in having a dedicated makerspace instead of trying to carry out making activities in a traditional classroom. In Scoil Íde the makerspace is created when a classroom is adapted the evening before the planned makerspace session. However, the teachers believe it is of a significant benefit to pupils to be in a makerspace created within their own classroom as this facilitates access to other teaching and learning materials.

The pedagogical approach the school's teachers use in the makerspace includes them acting as facilitators of constructivist learning which aims to connect Science and Maths to things pupils see in their everyday lives. This ensures optimal engagement by pupils.

The pupils have a great sense of pride in the outputs from the projects they carry out in the makerspace. They take these home, giving their parents and guardians an opportunity to see what their children are doing and achieving. As well as contributing to the pupils motivation this also extends their learning beyond the classroom as they explain to parents and guardians how they built a particular object and how it works. There has been a lot of very positive feedback from parents, and some parents employed in engineering and STEM have volunteered to speak to the classes.

It has been explained that the school aims to have pupils leaving primary school as confident users of technology with strong STEM and Science skills. The teachers also noted that *"their work in the makerspace helps them to develop strong oral language and presentation skills, which will be very relevant and beneficial to the post primary Junior Cycle programme[13]"*.

Challenges

The main challenge mentioned by teachers at Scoil Íde is that planning must primarily be done outside of school time. The school's teachers are very supportive of Pat and Mark's efforts with the makerspace. Their goal is to encourage and support teachers with the rollout of makerspace in their own classrooms, however only Pat and Mark run the makerspace activities. When the makerspace is run in other teachers' classrooms, informally there is a lot of buy in and interest but the challenge for the future is for all teachers to be able to plan and facilitate activities themselves.

13 https://www.ncca.ie/en/junior-cycle

Pat and Mark say that, although the current system is working very well, a dedicated room for the makerspace would allow for a little more flexibility and ease of access on a more regular basis. Pat also mentioned that access to good, tried and tested, lesson plans for makerspaces which are mapped to the Irish curriculum would be very helpful, as a lot of time is currently spent finding suitable activities and then mapping them to the curriculum.

In order to address these challenges, the teachers also note that more funding would be helpful and they would also welcome more involvement from industrial partners.

Future plans

Development and mainstreaming of the makerspace will be informed by the school's use of the Digital Learning Framework[14] as part of their School Self-Evaluation (SSE)[15] process to identify and plan the next steps in their plans for further developing STEM teaching and learning. The Digital Learning Framework, developed by the Irish Department of Education and Skills, gives schools and teachers a structure which allows them to identify where they are on the journey towards embedding digital technologies in teaching, learning and assessment, and enables them to progress in that journey.

The school plans to look at how they can broaden the makerspace's use to include 3rd class level. This will be a gradual and phased approach and part of the school's digital learning planning process.

Professional development for teachers is a significant factor in the school's future plans including continuing to share expertise and knowledge whilst participating actively in a Digital Cluster project. The purpose of the Digital Learning Clusters[16] project is to demonstrate the innovative use of digital technologies in teaching, learning and assessment, through clusters of schools collaborating on specific projects. Having a makerspace already set up made it easy for the school to become involved in a Digital Cluster and to reap the benefits of this.

14 https://www.education.ie/en/Schools-Colleges/Information/Information-Communications-Technology-ICT-in-Schools/DLF.html

15 https://www.education.ie/en/Schools-Colleges/Services/Quality-Assurance/SSE-Primary-and-Post-Primary/School-Self-Evaluation.html

16 https://www.pdsttechnologyineducation.ie/en/Good-Practice/Projects/Clusters/

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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