

TECH TEACHING

Makerspaces work best with some structure

How do you make sure that there is some learning and teaching happening in a Makerspace? **ET Staff**

It's probably a good idea to have a Makerspace but the problem is that research into what works best and how to get there is thin on the ground ... that is, there's next to none.

Makers Empire, which runs a 3D printing program in primary schools, understood that schools want evidence of learning so they teamed up with the Department of Educational Studies at Macquarie University and three NSW public schools for a 12-month research study into primary school makerspaces.

And the results indicate that what they're doing seems to work. In a nutshell, while some randomness in a Makerspace is a good thing, the best results can be achieved when a bit of structure for the teachers and the students is provided. The findings appear in the report *Makerspaces in Primary School Settings*.

Makers Empire offers a structured approach to teaching 3D printing, providing gamified software, lesson plans, teacher

training and ongoing mentoring if needed and has won over schools in the US, the Middle East and here. In a new development, NSW teachers who've been through Makers Empire's Learning by Design program and implemented it in classrooms will be involved in supporting other teachers this year's NSW Maker Pedagogy Network Project, which is a pretty fine endorsement.

Macquarie's research investigated the program for students and the professional learning program for the teachers. They found the professional learning element provided a grounding in the 3D printing technology and teachers said it gave them confidence in teaching it.

Teachers are given two face-to-face training days separated by five weeks. Support between the training days was provided by an Edmodo group page with online discussions and weekly webinars via Zoom where teachers can ask facilitators questions.

Teachers felt that the professional learning was important

because it helped to improve their understanding of what makerspaces were, how to teach in them, the sorts of technical skills they would need and advanced their 21st Century and design thinking capabilities.

Teachers appreciated the hands-on and experiential nature of the professional learning program, the technical skills that were covered, and the time that it gave them to collaboratively plan with peers.

Suggestions for improvement included providing more time to master the technologies and centring the online professional support around teachers' needs. Teachers were concerned about accessing collegial support, potential technological problems, access to required hardware, how to best support students, and having enough time for planning and implementation.

A pedagogical structure that balances instruction with open ended inquiry looked to provide the most benefit, part of that is teachers providing an authentic problem for the class to solve which lends focus and direction to the Makerspace activity. The best learning took place when online designs were reified to offline designs and back again.

Some stats: researchers observed 31 lessons taught by 24 teachers and saw high levels of creativity (71% of lessons), design thinking (64%) and critical thinking (58%). High levels of student engagement were observed in 100% of lessons.

Analysis of screen recordings from 24 separate episodes of pairs of students



working together on iPads revealed high levels of design thinking; across the approximately 16 hours of video analysed, there were 52 instances of 'Discovery', 142 instances of 'Interpretation', 219 instances of 'Ideation' (the formation of ideas, we didn't know either), 101 instances of 'Experimentation' and 15 instances of 'Evolution'. These were realised through a range of operations in the Makers Empire 3D app, including object creation, positioning, resizing, rotating, joining and rendering.

Often there were high levels of student-to-student dialogue displayed, the teacher circulated and acted as a facilitator as required. Very high levels of engagement were also evident which included off-task behaviour relating to the avatar and gamification aspects of the platform.

In their focus groups, students were enthusiastic about what they had designed using the Makers Empire 3D app and were able to identify the influence of the makerspaces activities on their learning. Among the 34 students interviewed, most either



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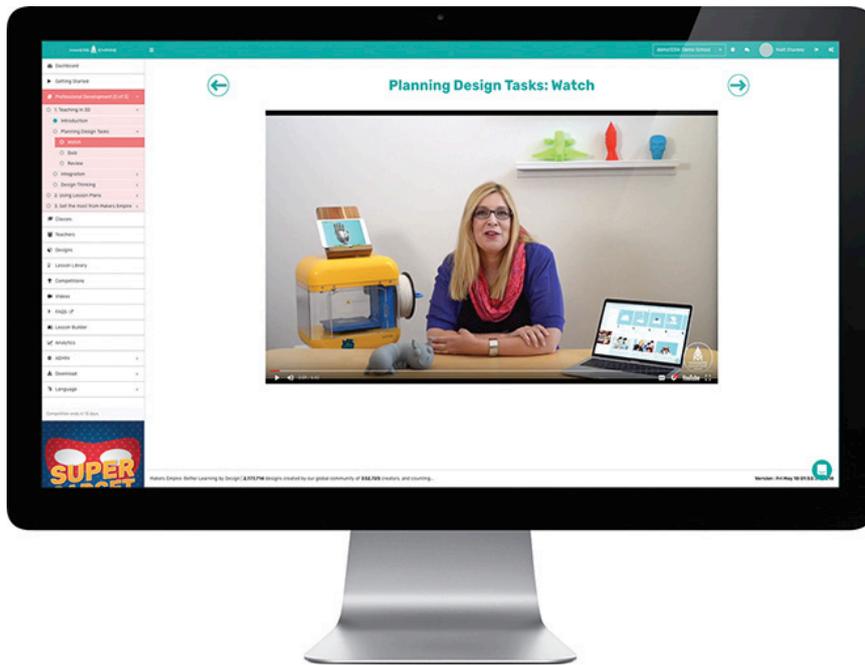
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explicitly or implicitly articulated how the makerspaces lessons involved creativity and imagination (“you can make anything”), critical thinking and problem solving (“I did the same to reflect it to the other side too ... then I add this little thing so we can hold it”), and development of content knowledge through tasks that they saw as relevant to the real world.

Many could articulate how they had met functional requirements of the design problem they had been given. Students often enjoyed the opportunity to direct their own learning in the makerspaces lessons and saw the lessons in part as an exercise in collaboration. However, some students identified that collaboration problems could occur, for instance if their “group wasn’t working as a team”. Some students found it challenging to operate the interface at times, such as when interpreting the app interface, or placing and resizing objects, and some students desired more shapes to work with.

A lot of the students interviewed were highly positive in their reviews of the Makers Empire 3D app, with verbal ratings offered such as “100%” or “11 out of ten”. Eight students (23.5%) chose to voluntarily use the app at home for fun, often with members of their family. All students indicated a desire to keep using 3D design and printing in future lessons. There were 32 students (94.1%) who wanted to use 3D

design and printing once they left school, for instance as a career (“... build houses so like ... maybe people living in the street can have houses for them to get and live in”) or for fun (“... like a toy, because I [already] made a toy ball for my dog”). An informal survey of students at one of the participating schools revealed that 292 of 297 students (97%) would like to complete another unit of work involving 3D design using the Makers Empire 3D app.

That was backed up with teachers feeling a significant improvement in their confidence teaching in makerspaces after the Makers Empire professional development program: questionnaires revealed increases in their confidence to teach in makerspaces from a mean of 3.04/6 (approximately ‘neutral’) to 4.4/6 (between ‘mildly agree’ and ‘agree’). This rose to 5.00/6 (close to ‘agree’) after actual implementation of the 3D technology in schools, which makes sense – we become more confident in our abilities after we have actually put theories into practise.

“We do see a pattern of teachers being quite overwhelmed by the new technology and lacking in confidence in their own abilities to both use the technology themselves and to use it in their teaching. There are, of course, many teachers who are already confident and competent at embedding technology into their teaching,” says Mandi Dimitriadis, Director of Learning.

“When we first started, we trialled our program in schools. This was a few years ago and before ‘STEM’ was an understood acronym. We saw great engagement from students and teachers and wanted to know more. We tested it in a bunch of schools and began talking to people in the South Australian Department for Education who really helped us understand the pedagogy and put together a pilot in around 20 primary schools,” CEO Jon Soong says.

“We are in schools every week – both the learning and technical teams – to understand and see how students and teachers use our program.”

“Makers Empire co-founder, Roland Peddie, was a BAFTA award-winning games designer who noticed the creativity and problem solving skills players showed when customising their avatars. He created an early version of Makers Empire and showed his 4-year-old daughter, who loved it. After he showed it to me, we organised a trial of primary school students and their response – and their teacher’s response – encouraged us to develop Makers Empire as a tool for classroom teachers,” Soong says.

And facilities alone do not a Makerspace create, Dimitriadis says.

“One thing we have definitely learned is that the quality of a makerspace is determined by the learning that happens in it, rather than how big and expensive it looks,” she says.

“A great makerspace is one where students are engaged in intentional making projects. They are using design thinking processes and developing skills to use a range of materials and techniques to design authentic solutions to problems and contexts that really matter to them.”

Dimitriadis has some good advice for any school looking to set up a makerspace.

“I would suggest that all of the teachers who will be using the space sit down together and talk about what they want the space to achieve before they start spending money. For example: will it be a room that classes visit once a week with a specialist teacher, or will be a flexible space that can be accessed on a needs basis? If new furniture is to be purchased, I would look at options that allow for flexible arrangement so that students can work in groups of different sizes and use equipment safely and effectively,” she says.