STEM in the classroom

NZASE resource

Making bubbles with a bubble maker, by Soorajc. Pixahive, CC0.

In an ever-changing and increasingly complex world, it is important that students can use knowledge and skills to solve problems, make sense of information, and gather and evaluate evidence to make decisions. These are the kinds of skills that students are developing in STEM. Mike Stone explores STEM learning with the help of two teachers.

What is STEM learning?

STEM is an acronym referring to Science, Technology, Engineering, and Mathematics. The variations on this include STEAM, adding the Arts; STEMM, adding Mātauranga or Medicine; and STREAM, adding Robotics, although some use the R to refer to reading/writing.

Sometimes STEM refers only to the subject groups (as in 'STEM careers'), but it has a specific meaning when applied to learning in the classroom. STEM learning integrates knowledge from different subject areas to solve real-life problems. This means that it:

- Is about inquiry; learning is based around student questions, goals, decisions and solutions. Student projects can be guided by a framework, such as design thinking, or engineering design process. STEM learning aligns well with project-based learning.
- Involves authentic real-world problems, often starting in the immediate environment at school or in the community
- Is focused on the future
- Applies science and maths to solve a problem
- Is collaborative, building tuakana-teina relationships
- Is hands-on and artistic.

Bubble wands by EPS students, This and all later photos by Jamie Christensen.

Learning in this way builds student skills in creativity, critical thinking, communication, initiative and self-direction. They come to see failure as part of learning, and strengthen their persistence. Students learn to make sense of information, and gather and evaluate evidence to make decisions.

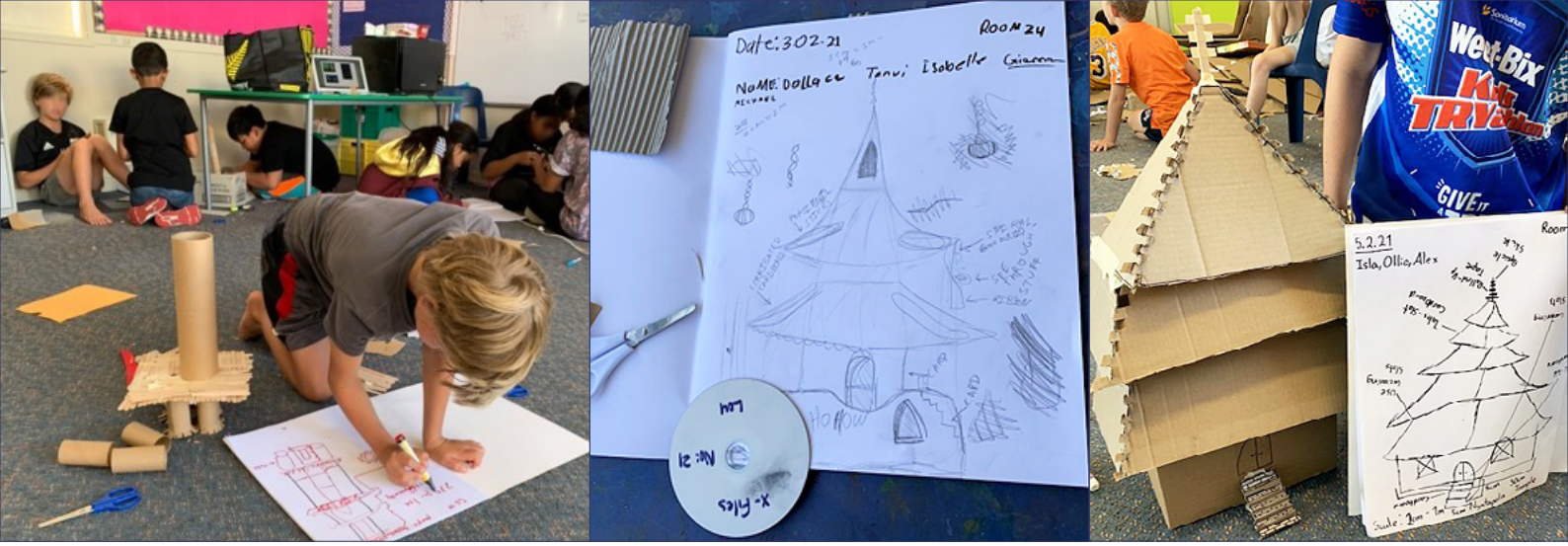
Learning is broader than just the knowledge from those four subjects. For example, "students may learn about an environmental problem in need of solution and the context around this issue, such as social equality, power and privilege, cultural brokering, and environmental justice" (Create and Learn US, 2021).

Practicalities

Some things to consider at the start:

1. Decide on a vision – what are your goals, how will you integrate the different subjects?
2. Build industry, business and community partnerships, to support the learning but also provide a window into careers.
3. Ensure there is a maths and science component to each STEM project – you may need to talk with others outside your area of expertise.
4. Think about assessment, and your criteria for success. Students could be assessed on their teamwork, content knowledge or application, or design success. Flexibility will be important to allow for different learning paths and project variation.

This type of learning works best with the support of school leaders. The teaching team



EPS student working on pagoda scale models, left; researching pagoda architecture, centre; and making pagoda models to scale for Lunar New Year.

will need strengths in different subjects, time to plan together (mapping the curriculum and designing lessons and assessments) and maybe professional development. There will also be budget considerations.

Support

There are some useful New Zealand resources:

- Women in Engineering sends tertiary students to schools to lead hands-on problem-solving activities.
- OMGTech! provides engaging workshops for both teachers and students on exploring and inventing with digital technologies.
- Modern Teaching Aids sells kits of materials.

There are many STEM resources available online; just ensure that the lessons you choose contextualise the subjects in your acronym, look to solve a real-world problem, are collaborative, allow for multiple solutions, and are hands-on and artistic.

Useful digital tools include Scratch and Gamefroot coding tools; PocketLab sensors; and SketchUp and Tinkercad 3D design tools.

Ngā Kupu

Mātai pūhanga – Engineering (study of)
Hangarau – Technology
Mūhore – To be unsuccessful; failure
Pāngarau – Mathematics
Pātai pakirehua – Inquiry question
Pūrere tā ahutoru – 3-D printer
Tuhiwaehere – Coding
Tūhuratanga āmio – Inquiry cycle
Tukanga hoahoa – Design process
Whakaoti rapanga – Problem-solving.

Te Aka Maori Dictionary and *Paekupu*

Rangitoto College

Tobias Clack found Year 9 students arriving at the school with experience of maker spaces, and wanted to build on this with a course enabling students to drive their learning. He spent six months exploring what local primary and intermediate schools were doing and designed a course to continue that.

In Year 9, students now have two terms in STEAM. They start by learning about Green Energy. Students use solar panels to generate current to drive motors, then build green energy projects; e.g., using solar energy to power microbits or charge batteries, or finding the optimum angle of the lid on a solar oven.

In the following term the class look at origami in space (e.g., the way the James Webb Space Telescope or Mars rovers were folded up to fit inside a rocket for launch). After exploring origami and kinetic sculptures, students are challenged to use origami to open or close something, using coding and developing computational thinking.

The Year 10 STEAM lasts a full year, based around the issues with Auckland's infrastructure – waste water, transport, and housing. In term 1 students look at how the different systems work in Auckland. This includes making biodigesters and solar stills. In term 2, students compare Auckland's system with that in other cities – Singapore, Dubai, London, or Copenhagen. Then in the last two terms students focus on finding a solution for the aspect they want to improve.

"In STEAM students develop resilience, creativity, a willingness to explore and try

EPS student cutting out a plastic stencil with a craft cutter, left; and the resulting bookmarks.

new things," Tobias says. "Students become curious and analytical. For example, three students exploring sustainable energy were looking at alternatives to charcoal, using food waste. They found corn worked well, and banana skins, with similar properties, worked even better. They learnt how to make briquettes from banana skins, finding the best temperatures and ingredients to use."

He found experts to talk with students, although COVID restricted that somewhat.

Tobias assessed students' teamwork and communication. In each group, students worked with two documents; one where they recorded their own actions and thoughts, and a collaborative document detailing the group's learning and project development.

In 2024 the school plans to create a Year 11 STEAM course using Science, Digital Technology, English and Maths.

Tobias suggests that "to teach STEAM well you need to be prepared to say 'I don't know, let's go and work it out.' And when something fails, 'Can you help us find out what we did wrong?' It is important that students learn to fail with grace, and use that failure to decide their next steps."

Above: EPS students using Keynote Animation to make movies about plastic pollution; left: Making a movie against a green screen.

Tobias found it refreshing and exciting to teach STEAM, with less structure and more experimentation. He enjoyed the variety of projects and the way it made Maths fun. His challenges were a lack of in-depth knowledge in some areas, especially chemistry.

Edendale Primary School (EPS)

Jamie Christensen has run the STEAM programme at this Auckland school since 2021. She takes all the classes for STEAM to give their teacher classroom release time. For the rest of her time Jamie does other things, like taking classes to release leaders.

Her principal and board of trustees are very supportive – they have funded a 3D scanner, 3D printer and a craft cutter. Students also use Tinkercad, which is free.

For one term she taught students how to use Minecraft Education Edition, with a basic introduction, showing them how to use the tools and how to learn with the game. From characters, videos and information imbedded within the game, students learnt about habitats and adaptations. Then they designed a habitat for a specific animal and made a picture book about it.

In another term students learnt about making bubbles – they designed a bubble wand and drew it with 3D drawing pens, which work a bit like a glue gun but extrude plastic. They designed a fair test, and with the wand compared different bubble solutions using observation and inference. Those classes that had enough time used food colouring in the solution to make bubble art.

Jamie plans to have students make Claymation videos. They will make clay models, which they scan with the 3D scanner and print on the 3D printer. Then they make stop-motion movies with them.

The engineering design process they use involves students asking a question, finding out what solutions others have come up with, thinking about how to improve those designs, making their own, then testing and

improving them.

Jamie gets her ideas from several sources. Websites for the tools, like Tinkercad and the 3D pens, include helpful teacher resources. Jamie also goes to events like STEMfest in Tauranga and Auckland to get ideas, and also to make contacts. She has visited the maker spaces in Hamilton and Christchurch libraries and found the staff there really helpful, face to face and also by email. Her local library is running a course on how to 3D print from a drawing, and she is planning to attend, as that will be useful for younger students for whom Tinkercad and 3D drawing pens are too advanced.

STEAM is not assessed at this stage. As with music and visual art, teachers report on student progress in STEAM with general comments on their achievement against lesson objectives, with no levelling. Comments may be made on their understanding of fair tests, observation and inference – which often has more of a Nature of Science focus.

This year there has not been not enough time to get stuck into real-world problems, so for 2023 the programme is changing. Jamie will only teach STEAM and will build in time to 3D print junior student designs between their lessons. She also plans for senior classes to have back-to-back days on STEAM to allow them to tackle those real-world issues in some depth. Also, instead of being release time, the teacher will go along with their class so they learn more about STEAM and using the software.

Jamie finds those students who are not academically inclined can often be very engaged in STEAM. Parents/caregivers talk about how engaged their children are with STEAM as evident in the excitement when they talk about their day.

References

STEM/STEAM, TKI

2021, STEM Meaning and Definition: What is STEM? Create & Learn, USA.

2022, Science, technology, engineering, and mathematics, Wikipedia.

STEM events and groups

Sunday, Tihema/Dec 11, Auckland's STEAM festival, Alexandra Park Function Centre.

Tauranga STEM festival is an annual event (held in October this year), organised by the STEM Wana Trust.

STEM Alliance Aotearoa.

STEM Club Auckland Facebook page.

Top: A 3D-printed bookmark designed by an EPS student with Tinkercad.
Left: A skate park design by EPS students.