CASE STUDY

Moving forward: STEM education in a selection of schools in Victoria

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STEM is a hot button issue in education in Australian schools. What does effective integration of the four disciplines of Science, Technology, Engineering and Mathematics in teaching and learning look like? How do you assess STEM? Where are the Arts/Humanities in STEM? Perhaps all school education P-12 should just be STEAM? Why are 'inquiry' and 'hands on' learning such important processes in effective STEM education?

These teacher questions were common in an Independent Schools Victoria (ISV) undertaking in six P-12 schools in 2017. The project commenced in late 2016 with a Teach-Meet style information workshop for a small team from each school. It focused on understanding how to use a pedagogical framework known as High Possibility Classrooms [HPC] to plan and conduct STEM learning experiences for students in primary and secondary school classrooms.

Nature of the projects

The Project Team from ISV visited the schools on a number of occasions throughout the year to understand how the STEM projects were unfolding. Teachers completed a survey instrument to gauge their concerns about a new innovation like STEM and how such concerns might shift across a whole year. Each school team participated in a mid-year collaborative STEM workshop and for the final round of school visits the academic partner [article author] joined the ISV Project Team.

Communication throughout the project was maintained via a Google+ community set up for contributions from the school teams – the site was also rich with authoritative professional learning information and STEM resources. Towards the end of the project a series of phone interviews were conducted to understand what was learned and what further actions could be useful for the next round of STEM learning in 2018 and beyond.

Adopting different approaches to STEM

Each of the school teams adopted different approaches with some choosing shorter STEM experiences that were 'one-off' while others integrated the Arts and Humanities to make the five disciplines of STEAM. Learning was planned in four week and term long blocks using integrated design processes offering momentum to timetable learning in different ways.

Vignettes of projects conducted in three schools on what teachers choose to do when STEM and STEAM was a priority are presented here; verbatim comments from conversations with some of the teachers from each school team are in italics.

Vignette 1: Strathcona Baptist Girls Grammar School (SBGGS)

The focus of the school team at SBGGS was a Year 6 unit seeking to examine the big question of: What impact can we have on the future health of the planet? After expressing hesitation about what content, skills, and technology would be required for integrated STEM to align with the curriculum the project team were satisfied that many core principles of deep understandings of sustainability were addressed.

Students made time-lapse movies of sustainable house construction, they hypothesized about possible problems that might be encountered and the teaching team invited community experts to participate in classroom learning including one parent, an engineer [female role model] who is employed in an oil company was able to share her expertise in conservation.

Penny, a teacher in the STEM team at SBGGS said: *"The girls loved the project and produced some powerful work. I believe you can have a STEM focus in everything you do in the primary school classroom."* This idea is gaining traction.

David, another teacher from the team who previously taught Mathematics in the senior school noticed: *"STEM can be simple at this level especially when students do experiments – they are very engaged in the lab every time we give them an opportunity to do work in there.* When asked if STEM is particularly important for girls he said: *"It will set them up for senior school – job opportunities open up when girls study these subjects … really important they go into senior school with no gaps in their knowledge."*

When questioned about the success of the project on sustainable house construction David linked his response to creativity: *"It is amazing how much they get out of creating a 3D image on a computer. They had to do that for the house initially. The girls loved it."* Teachers at SGBBS talked about how the project had 'pushed them out of their comfort zone' but this action was a positive experience. Further reflection by both teachers revealed that in 2018 – Science would be a priority at SBGGS through developing a scope and sequence for the whole school starting with P–6 and then refining how teachers report and assess students' digital literacy skills.

Plans are in place for the school to partner their STEM focus with experts from a local university. David also highlighted that as a teacher it is often daunting to know what to access in STEM: *"There are many excellent resources he continued: it's difficult to know what is really good. It takes time to sift through and find the right materials."*

Questions were raised about inquiry and direct instruction and that effective STEM learning needed to involve both – in fact to be unstructured in the classroom or to experience open ended learning often meant setting up highly structured practices where students could either problem find autonomously or work to find solutions in small STEM teams.

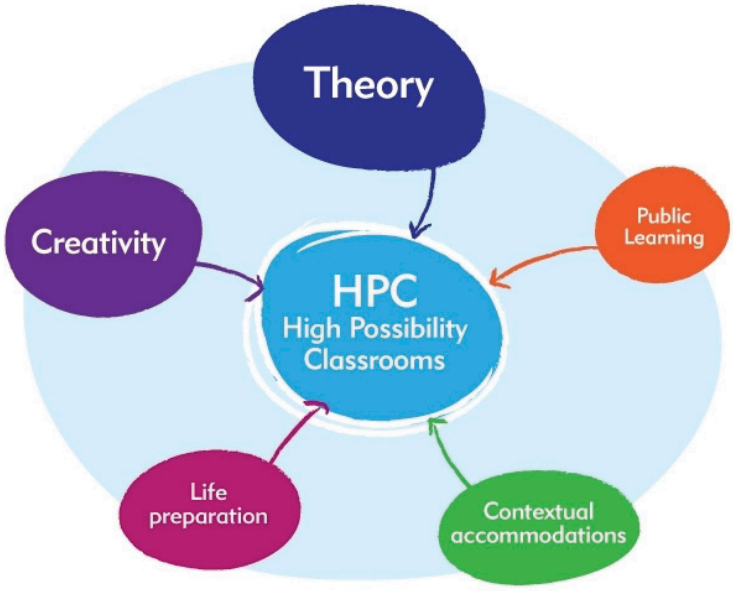
Vignette 2: Kilvington Grammar School (KGS)

The STEM teaching team at KGS was drawn from the Science, IT and Mathematics departments in the school. The focus of this project was Year 7 where students had to design and build a toy that would teach 10- year-old children about forces. Alice the team leader at KGS explained:

"I find with STEM there is a huge cross over between STEM skills and enterprise skills, project management, budgeting, financial literacy and collaboration skills – the unit was designed to bring them together."

In the project, teachers taught the process of forces [Science topic] to each group. Then, students worked in teams of four [acting as a financial advisor, scientific advisor, design consultation and an IT consultant] to make a toy. The student teams conducted market research about what kind of toy would appeal to a 10-year-old [Maths and Statistics concepts] using data from a nearby toyshop and then presented the data to the class in pie graphs/bar charts.

In the Science component of the project students created their toy using a design process. Finished toys were presented in a showcase to parents, younger students and local business owners, which included a chance for the audience to vote for the 'best toy' in People's Choice and Industry Awards. Summing up the STEM



experience in this project Alice remarked: *"It was engaging hands on learning. Students had the chance to develop something that is different to their normal classes. The level of extension in high ability students was surprising but in lower ability students too. The open-ended nature of the task allowed that – but also students were accountable through having to present their work at a public showcase."*

Alice mentioned one key group instrumental in their STEM thinking: the Foundation of Young Australians. This organization according to its promotional material is one of many new platforms promoting innovation and entrepreneurialism to: "make Australia more technology savvy, competitive and environmentally sustainable".

Vignette 3: Westbourne Grammar School (WGS)

The WGS team was keen to learn from other schools to build their professional capacity and confidence and used ideas from KGS to develop their project. James, the team leader outlined the approach: *"After attending the second TeachMeet in June we wanted to do a more authentic project for 98 year 5 students. We were open to the HPC ideas and adapted what we planned to do. Students needed to create a toy that could be used by prep students on a wet weather day … they conducted surveys in conjunction with a design thinking approach and developed empathy statements."*

Students had a timeline to support them. Teachers used the Penn State design-thinking model based on define - ideate - prototype - test. Each student kept a learning journal and a portfolio that ran parallel to the development of their toy. They did a pitch to the prep students who had to vote for the 'best toy' and there was a final exhibition of 'toy maker' learning for parents and the community featuring a video made by students.

James continued: "*We wanted the students to learn how to collaborate to build their team working skills, to imagine and to work creatively linked to the school's deep thinking goals and across curriculum in Design and Technology, Art, Mathematics and English.* In reflection: *"Students really embraced the authentic purpose of the task – this meant creating something for the prep students to use. And, they had to be accountable for their own part of the project including working successfully in a team."*

A frequent and overarching comment about *the high levels of engagement* of the students was validated through an exit ticket survey – it was clear they liked working in new ways using the *design matrix* and the *fail forward idea was a nice challenge.* Giving students more practice at working in a team and *letting the reins off* in the ways these primary school teachers usually taught was important.

Current arrangements in schools that are organised around small blocks of learning time, limited assessment options, little time for teachers to meet together in teams and current reporting structures within a day that has frequent interruptions are **significant hurdles**

Final thoughts

In a keynote address in October to teachers in independent schools in NSW, Professor John Fischetti from the University of Newcastle challenged delegates to transform their primary schools through *creating a S T E A M mindset* of: Science involving inquiry, Technology being about invention, Engineering meaning innovation, the Arts focused on creativity and Maths involving problem-solving. These ideas were touched on each time school teams came together. STEM curricula in schools foster projections towards the future as well as drawing from the past. To be managed effectively STEM calls into question the ways schools are structured.

Current arrangements in schools that are organised around small blocks of learning time, limited assessment options, little time for teachers to meet together in teams and current reporting structures within a day that has frequent interruptions are significant hurdles. These factors work against the effective integration of STEM learning – there are many challenges ahead. However, what is clear is that STEM and particularly STEAM education is life worthy learning. The three schools featured here are testament to that notion and what is possible.

Dr Jane Hunter is a former primary and high school teacher. She is currently leading a series of postdoctoral research studies in Australia to build teacher capacity in STEM and STEAM in schools. Her work reinforces the importance of teacher professional learning and building teacher capacity through ongoing school-university partnerships. The pedagogical framework featured in her recent book: Technology integration and High Possibility Classrooms: Building from TPACK is leading education change and was developed through deep studies of practice in teachers' classrooms. Jane also teaches pre-service teachers in the Master of Teaching Program (Secondary) in the School of Education at the University of Technology Sydney. Follow her on Twitter @janehunter01

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