A New Teaching and Learning Framework to Boost STEM Education in Australian Schools

1. Summary of Impact

STEM stands for Science, Technology, Engineering and Mathematics and refers to discipline content where an interdisciplinary or integrated approach is the goal.

Although they are vital subjects in an increasingly technology-driven world, many teachers are often unable to teach STEM effectively due to curriculum constraints, a lack of resources and insufficient time for professional learning.

UTS School of Education Senior Lecturer, Dr Jane Hunter has used her High Possibility Classrooms framework to assist primary school teachers in STEM teaching and learning, with a strong focus on more creative, hands-on interdisciplinary processes.

2. The Problem

STEM subjects are integral to the jobs of the future and it is important for students to gain and apply knowledge, deepen their understanding and develop problem-solving and critical thinking skills within an authentic context.

However, according to Dr Hunter, STEM education in primary schools is not reaching its full potential, setting students up for less enthusiastic attitudes towards these subjects in the later stages of their education.

First and foremost, Dr Hunter's research is demonstrating that this is often attributable to literacy and numeracy being the dominant focus in school curriculum in recent years, which has taken attention away from other key learning areas. As a result, many of the teachers in her research expressed feeling 'de-skilled' in the STEM subjects, and consequently lacked the capacity and confidence to teach topics within these disciplines well.

In addition to requiring more professional learning in STEM, there are issues around the kinds of resources needed to teach the four disciplines effectively – practical 'hands on' STEM materials cost money, items such as wires, circuits and digital thermometers. Dr Hunter's research signals that there is an emerging STEM equity gap as many schools struggle to afford the suitable innovative technologies and scientific equipment needed.

As a result of these shortcomings, poorer primary schools are less well placed to expose their students to STEM in the early years. Dr Hunter says this is concerning because young children are naturally curious, and if teachers are unable to tap into this drive to experiment and create early on, it can become difficult to make up this lost learning focus as students move into high school.

3. Beneficiaries

The High Possibility Classrooms framework and ongoing research initiatives in Australia are focused on developing middle level leaders to support teaching and learning in STEM across and between schools. However, Dr Hunter continues to be invited to take her theoretical framework overseas to reach more schools across the globe.

Ultimately, more flexible structures, female role models, extra teacher professional learning and better resources will enhance STEM in primary schools. This is particularly important for supporting teachers to foster STEM literacy in young girls who are underrepresented in the high school years then in STEM industries post-secondary school and at university. Dr Hunter's research indicates that primary-school aged

children are feeling more eager and excited about STEM as a result of different classroom approaches.

4. Approach to impact

Dr Hunter developed the High Possibility Classrooms (HPC) framework from doctoral research (2013) on exemplary teachers' knowledge of technology integration in Australian schools.

The study took place in the classrooms of students aged 6-16 years old. The HPC framework has five conceptions - theory, creativity, life preparation, contextual accommodations and public learning - and 22 underpinning themes of teaching strategies and student learning processes.

Dr Hunter's model does not just look at the technology that is used in schools, but how teaching practice, or pedagogy and rich subject matter, can be enhanced and re-imagined through varied uses of technology or sometimes no technology to engage students in their learning.

As such, the framework emphasises the need to combine these aspects to improve the learning outcomes of students, rather than focusing on teacher centred approaches to STEM or teaching the subjects in isolation.

While this framework serves as an overarching pedagogical strategy for teaching and learning in school classrooms, Dr Hunter has recently narrowed the research priority to concentrating on STEM education in Australian primary schools (2016-17) given the issues outlined previously. Her most recent studies involve 37 teachers from eight primary schools in Sydney's west and south west included the participation of 1000 students.

At the beginning of each research study, Dr Hunter conducts a full-day workshop where teachers learn about the framework and how this can support classroom teaching and learning in the STEM disciplines. Teachers then work in small teams to create units of work involving design processes, inquiry and project-based approaches.

In the planning stage, Dr Hunter provides support and feedback at in-school meetings and online to ensure integration is occurring and that HPC conceptions are present.

Finally, the teachers deliver these multi-disciplinary units in the classroom. Strategies and learning processes include building prototypes, conducting experiments, finding problems, and using authentic equipment. Often the teachers work together to co-teach large groups of students.

Throughout the research period, Dr Hunter provides further resources and shares examples of practice with the participating schools via an online community. In some instances, classroom activities are documented through video and audio recordings, and the teachers come together to share, celebrate and showcase their learning at a final TeachMeet.

During each study, Dr Hunter collects data from surveys, teaching plans, student work samples, and observations in classrooms, interviews with teachers and principals as well as focus groups with students.

5. What has changed as a result of this work?

5.1. The Outcomes

Dr Hunter's research findings indicate that adopting the High Possibility Classrooms framework has been effective for teaching STEM in primary schools.

In the first instance, Dr Hunter's research found that primary school teachers' capacity and confidence in teaching STEM increases when they use inquiry, design and project-based processes to create integrated term-long units of work. She found that teachers, regardless of how much science or maths they had previously studied, are motivated to research and teach difficult concepts like computational thinking, laws of motion and light conduction when they are supported to grow their practice.

Teachers used words like 'empowered' and 'invigorated' in interviews to describe how they felt after being exposed to the High Possibility Classrooms framework. They could

see more engagement of their students in STEM and subsequently they too felt more confident in their ability to teach these subjects in new ways.

Some of the schools were so enthusiastic after the research project/s that they have made the High Possibility Classrooms framework a strategic priority in their school plans

Students in focus groups at all schools expressed excitement and zeal for STEM, and wanted to spend more time learning concepts and the big ideas in these subjects.

Dr Hunter has shared her work with the scholarly community through numerous publications and conference presentations. However, she also emphasises the importance of using her research to reach wider public audiences and regularly engages with the media.

In addition, she has worked on a number of government-commissioned projects and her research continues to influence the government agenda and policies in STEM education in schools.

5.2. Impact

Improving an entire aspect of education and giving equitable access to high-quality STEM education to all Australian children is certainly no small feat.

Dr Hunter acknowledges that in spite of the limitations of any research study, sustaining changes to teaching and learning in STEM will only be effective if schools share and grow their knowledge and develop cultures of shared practice past the duration of a research project. To support sustaining the impact of the High Possibility Classrooms framework in each context her 2018-19 research is building teams of coaches who are middle level leaders in schools.

However, while it is clear that most primary school teachers improve their practices when using the framework, it's also evident that students have a much better experience in their STEM learning as a result. As such, her work has made an

important impact in not only the lives of the teachers but also in fostering students' love of STEM.

Dr Hunter hopes that by continuing to work with schools and by being vocal about this issue, the government will respond by continuing to fund and consider increasing the funding for STEM teacher professional learning and the availability of material resources particularly in disadvantaged public schools.

In addition, she is seeking to expand her team to be able to assist, follow-up and offer ongoing support to more primary schools, especially in rural and remote areas. Noting that a number of teacher education programs in Australia universities include examination of the High Possibility Classrooms framework in their preservice programs while in The Netherlands and the US, two universities are using the framework.

6. What has helped you accomplish this work?

6.1. Personal enabling factors

Dr Hunter has worked as a classroom teacher, head teacher, policy advisor and senior officer in large education jurisdictions. She considers her key strength as an educator to be this theory–practice background.

Her inspiration to improve the education system comes from her own understanding of the privileges she has had in life, great mentors along the way and the importance she places on creating the best possible lives for all young people. She speaks fondly of her parents as well as her teachers growing up and at university. The recognition that not everyone has dedicated parents or access to a high-quality education has given her the drive to use her skills to level the playing field for those children who have not had such 'a positive head start'. A committed teacher at heart, Dr Hunter truly believes in the transformative power of education and that it can be the 'ticket out of poverty' for many young people.

As a result of her passion and great work, Dr Hunter has received various awards for education research and teaching in higher education throughout her career, and she is also an active member of a number of professional associations.

6.2. External enabling factors

The school-focused projects are currently operating as Category 2 funded research. Such financial support is particularly important to release her to work with schools. Funding for the research means visiting schools, providing regular access to STEM experts and ongoing professional learning opportunities all designed to build capacity and confidence in the school teams Dr Hunter works with.

In addition, she collaborates with school principals and reports progress in the research to the funding organisation. AT UTS, Dr Hunter is mentored by the FASS Director of Research Training, Professor Sandy Shuck and the Associate Dean Research and Development, Professor Alan McKee.

Ultimately, it is the effort and determination of the teachers, their collaborative processes and willingness to keep learning and growing their professional mindset that makes these initiatives successful.

7. Challenges

While impact-driven work is important, Dr Hunter has to strike the balance between meeting academic research outputs and engaging in wider public debates. However, she believes that her many years of government work have taught her to ensure that research should always try to feed into current issues and policy frameworks in school education.

Another challenge that Dr Hunter is trying to tackle is the scale of what is needed in teacher professional learning in STEM that is evidence informed. In an ideal world, she would like to be able to assist more schools and in the coming year there are plans to expand the team to make a wider impact through further research, short course programs and PD workshops.

8. Associated research

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9. References

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https://theconversation.com/stem-education-in-primary-schools-will-fall-flat-unless-serious-issues-are-addressed-88017

10. Additional indicator information

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