



The Power of Science Outreach-Conscious Teachers

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Abstract

Science outreach programs at universities have a commitment to increase student participation, in alignment with overarching goals addressing workforce shortages and broadening representation in science. However, as science departments in higher education are negotiating access to classrooms, an obvious partner is being overlooked: teachers. Social marketing's Client Principle regarding impactful behavioural change emphasises the importance of gaining a deep understanding of the specific group you aim to impact. In this respect, teachers are exceptionally well positioned to achieve this understanding, compared to some outreach practices, that parachute science engagement sporadically into the classroom. Teachers possess proximity, permanence, and a strong grasp of pedagogical theory, and as such are a powerful presence to influence change. In our work as teacher educators of science teachers over the years, we have found great value in educating student teachers about pedagogical theories that promote science engagement, such as the multiple dimensions of science capital theory. This article explores two particular dimensions. Firstly, the establishment of professional development pathways through teachers' active engagement with both industry and university settings, to promote career pathways in science-related fields. Secondly, the article delves into the integration of hook pedagogy and cognitive load theory, focusing on how these methods can effectively merge new knowledge with students' existing cognitive frameworks.

Keywords: *Science Outreach, Science Teachers, Science Capital Teaching Approach; Behavioural Change, Hook Theory, Cognitive Load Theory.*

1. Introduction

Science outreach programs at universities commit to increasing student participation, addressing workforce shortages, and increasing representation in science, particularly among underrepresented groups [1]. Science departments in higher education regularly negotiating access to classrooms to provide additional outreach opportunities, the science teacher rarely takes a lead role in outreach work., We believe this is a significant oversight. Teachers are one of the lead influencers of student behaviour [2][3]. Science teachers are instrumental in shaping the next generation of responsible and scientifically literate citizens. Students can benefit greatly from the communication, critical thinking, and problem-solving skills of STEM education delivered by their teacher [3].

2. Marketing science

When influencing behaviour, social marketing's Client Principle [4] states that the first step is to gain a deep understanding of the target audience. This entails delving into the reasons behind behaviours, exploring individual values and motivations, then leveraging this insight to craft appealing information that brings about positive personal and/or societal outcomes. Take, for instance, the case of a post-primary school student who may understand the value of science, yet due to their societal and cultural influences, perceive science as something unrelated to their lives. In this context, teachers can play a pivotal role in situating science in their students' context.



In contrast to some outreach practices that inject instances of science engagement into the classroom, it may be more impactful to collaborate with, or empower teacher stakeholders who are already in a strong position to promote positive change. Teachers possess proximity, permanence, and pedagogical theory, and as such, are a powerful presence to influence change (see Figure 1).

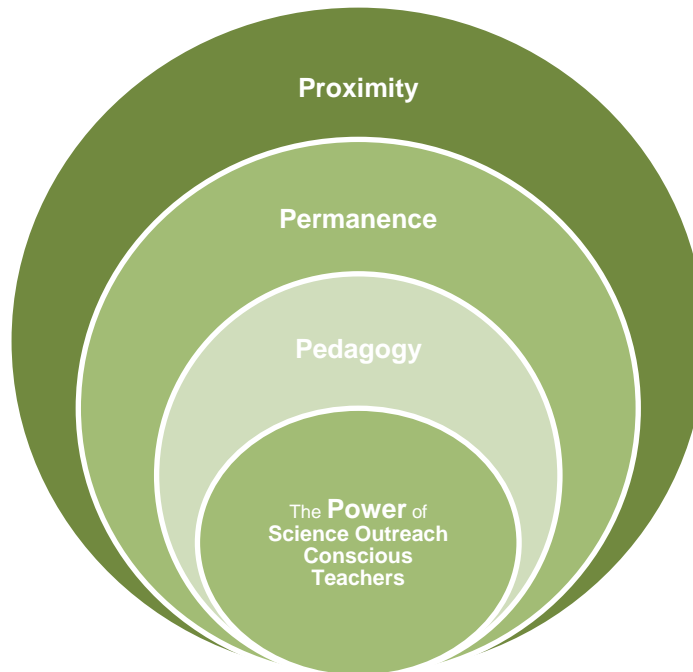


Figure 1. The Power of Science Outreach-Conscious Teachers (Proximity, Permanence and Pedagogy)

In our work as science teacher educators, we have found significant value in educating student teachers about pedagogical theories that positively influence science engagement, and pedagogical approaches such as those discussed below.

3. Broadening the reach of science

Science experiences at school can have a substantial impact on a student's science capital [5]. Although the position one holds in a field may be influenced by their accumulated capital, their disposition or attitude toward that field is shaped by their habitus [6]. Family serves as the foundational context in which habitus is formed, yet habitus is also shaped by larger cultural communities including educational institutions [6]. The Science Teaching Capital Approach (SCTA) aims to broaden the reach of science [7]. These approaches offer teachers explicit evidence-informed strategies to strengthen the science capital of those on the margins of science, for example biology pathways for boys from disadvantaged communities [5].

The three SCTA pillars are: a) personalizing & localising the science content, b) eliciting ideas from students, valuing what they know and care about and linking this to science, and c) building upon Science Capital dimensions (Figure 2). SCTA approach has demonstrated: 1) an increase in student intent to study science, 2) a significant increase in the science capital scores of those considerably below the national average, 3) improved students' perception of the relevance of science to their lives, and 4) the delivery of a more inclusive and participatory classroom experience [7]. Therefore, conversations around this method with student teachers, as an outreach technique to engage their students, is a critically important step towards teachers being more proactive in promoting science.

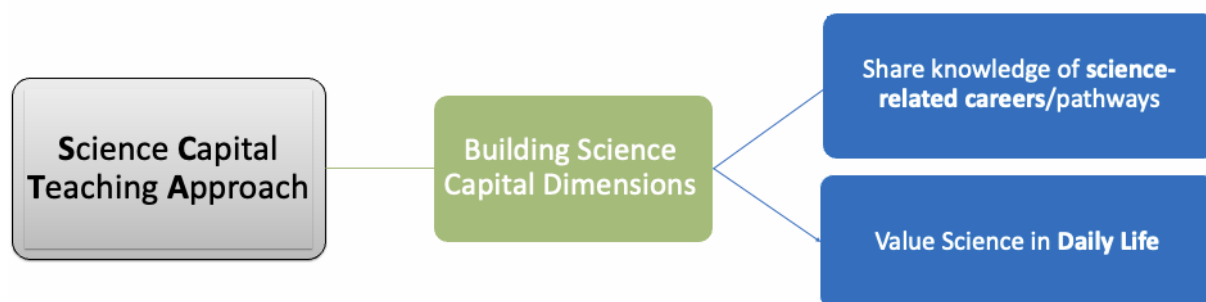


Figure 2. Building Science Capital [adapted from [5]]

Of the eight Science Capital Dimensions influencing student science uptake, we elaborate on two, below, as examples of how teacher educators can build their students science capital and embrace their science outreach role.

3.1 Share knowledge of science-related career pathways

Workforce shortages in STEM fields have been a concern for many years. Although research has found that children enjoy studying science in school, this interest rarely develops into science-related aspirations or career choices [1][8]. Outreach-conscious teachers may help address these shortages by nurturing the next generation of STEM talent through their own direct engagement with industry. One of the most influential moments for teachers is during their initial teacher education is being immersed in processes and practices of active situated learning [9]. However, if we want teachers to design authentic learning experiences which integrate science experiences within real-world contexts, first-hand experiences are essential [9]. As such, at the University of Galway, we offer pre-service, and newly qualified teachers two science career related opportunities:

Teacher internships in industry

In 2022, the University of Galway joined 6 other universities in Ireland as part of a STEM Teacher Internship (STInt) Program¹ that has the capacity to enhance teacher experience and instruction through immersive professional experiences in real-world STEM contexts. Preservice teachers apply for paid industry placement during the summers of their teacher education programme. The idea of a triadic partnership between schools, industry, and higher education to shape STEM learning experiences for students is a powerful one. Such collaborations can lead to valuable professional learning for teachers so that they are in a better position to impart knowledge about science careers to their students [10].

Teachers' residence in university

School-University partnerships [11] have been established for decades providing clear benefits for both parties [12]. This symbiotic relationship is a core element of the Teacher in Residence program that we offer to newly qualified teachers through the CÚRAM medical devices institute at the University of Galway. Teachers learn about science on the cusp of research innovation, and with further guidance on scientific inquiry and engagement pedagogies, work with scientists to create lesson plans for their students. Immersing in future science career pathways, further enhances the classroom experience that teachers can bring to science education.

3.2 Value Science in Daily Life

Science Capital is an evidence-informed pedagogy that encourages teachers to get to know their students, value their contribution to the class, and contextualise science learning around student interests and their everyday lives. Hook pedagogy [13][14] builds on students' prior knowledge and

¹ STEM Teacher Internship (STInt) Program, a Summer Industry Placement experience for pre-service teachers, established in Dublin City University in 2016.



attempts to capture student curiosity to entice them into deeper science engagement (McCauley et al., 2015). Grounding science in daily life enhances its relevance for students [15]. Therefore, hooks, as an instructional approach that aims to generate situational interest by creating learning environments, not only captures and maintains student interest, but also integrates it into their cognitive framework by leveraging existing knowledge and establishing connections with pertinent real-life illustrations. This is a pedagogy that builds on the core dimensions of students' science capital. Cognitive Load theory [16] research notes that germane load is the mental capacity that directs the integration of new information with new knowledge in students' existing cognitive frameworks. This is what educators should aim to encourage. It's the 'a-ha' moments when you learn something new. Hook pedagogy can play a pivotal role in bridging this connection.

By incorporating carefully crafted emotional triggers at the beginning of class, teachers have the capacity to design lessons that resonate with their students' everyday experiences. This approach is intended to trigger science interest again and again, with the intention of transitioning from a situational and temporary interest to a sustained and persistent enthusiasm for science over time.

4. Conclusion

Teacher educators are uniquely positioned to impact STEM outreach by instilling a conscious understanding in teachers that a part of their job is to do outreach work – to highlight the value of science and science skills in future life, and to draw students towards science careers. We propose that the SCTA perspectives on science outreach and education, combined with opportunities for preservice teachers to engage directly with industry emphasises the crucial role of teachers in STEM advancement.

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