Chapter 16
Taking STEM to STEAM and Enhancing Creativity

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16.1 Introduction

In the last decade, STEM education has increasingly become part of Australian educational discourse. The Office of the Chief Scientist (2014) highlighted the importance of STEM, due to the potential of positively contributing to Australia's productivity, economy and job opportunities for its citizens. Arguably, a coordinated and strategic approach to STEM education may contribute to the development of key competencies that have been identified as vital to life in the twenty-first century, such as critical thinking, creativity and communication (Office of the Chief Scientist, 2014; El Sayary et al., 2015). Other identified benefits of embedding STEM in classrooms have included opportunities for real-world problems to be explored in context and a positive impact on student motivation for traditional STEM disciplines (Department for Education and Training, 2017; El Sayary et al., 2015). It is for these reasons that the *National Science and Innovation Agenda* emphasises the importance of STEM being prioritised in the *Australian Curriculum* (Australian Government, 2015) and that a national STEM school education strategy was developed in Australia (Australian Government, 2017).

However, the implementation of STEM approaches that are rationalised on the importance of STEM for the economy have been criticised for their narrow curricular focus (Harris, 2017). The prioritisation on STEM disciplines has led to perceptions that the arts are undervalued by some within the Australian educational

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community (Parliament of the Commonwealth of Australia, 2017). Such criticisms led to a recommendation by the *Inquiry into Innovation and Creativity: Workforce for the New Economy* that the *National Innovation and Science Agenda* to highlight the significance of incorporating the arts with STEM (STEAM) (Parliament of the Commonwealth of Australia, 2017, p. xix).

To begin this chapter, key literature on the movement from STEM to STEAM and the influence on creativity will be discussed. Following this, the findings of an illustrative case study will be presented, where we are investigating the perceptions of two teachers involved in the implementation of a STEAM approach at Hammond Park Catholic Primary School, a school established in 2014 in Perth, Western Australia. Through a semi-structured interview, the authors sought to understand the implementation of this school's STEAM approach and ascertain how teachers perceived the influence of the approach on student creativity. From the case study, we identified and discuss in this chapter, key findings in light of the literature and proposes recommendations for future research.

16.2 STEM to STEAM

Challenges have been identified with the implementation of STEM approaches internationally and in Australia. While the exploration of real-world issues has been identified as a perceived benefit of STEM programmes, it has also been identified that students do not always make connections between STEM disciplines and their everyday lives (Parliament of the Commonwealth of Australia, 2017). Countries such as Singapore and Taiwan, that have been more successful than Australia in implementing STEM approaches, have higher societal regard and renumeration for teachers and teachers themselves have stronger backgrounds in these disciplines (Parliament of the Commonwealth for Australia, 2017). It has been noted that while there is government support and the development of policies in relation to STEM, this has occurred without guidance about how STEM can be meaningfully implemented into the pedagogy and practice of schools (Bybee, 2013; Harris and de Bruin, 2017).

STEAM "merges the arts with STEM subjects to improve student engagement, creativity, innovation, problem solving and learning" (Perignat & Katz-Buonincontro, 2019, p. 31). The arts provide an avenue for fostering imagination and creative expression (Harris, 2017; Perignat & Katz-Buonincontro, 2019) and are essential for innovation (Madden et al., 2013; Parliament of the Commonwealth of Australia, 2017; Simpson Steele et al., 2016). Arguably, taking a STEAM approach can assist in breaking down the traditional barriers between learning areas, with the arts being considered as another discipline to incorporate (Harris and de Bruin, 2017). In the literature, STEAM approaches can be characterised as: ***inter-disciplinary***, focusing on several disciplines under a common theme but as discrete areas; ***cross-disciplinary***, focusing on one discipline as a lens into another discipline; ***transdisciplinary***, where all disciplines are fully integrated focused on a

central inquiry or problem; and ***multidisciplinary***, which explores the relationships between two or more discipline areas, without interacting each discipline (Perignat & Katz-Buonincontro, 2019). In critiquing the economic rationale of the current STEM movement, Pirrie (2020) maintains that putting the A in STEM needs to go beyond simply using the arts as a servant of the other areas. This is supported by Peppler & Wohlwend (2017, p. 88) who state that "the promise of STEAM approaches is that, by coupling STEM and the arts, new understandings and artifacts emerge that transcend either discipline".

Numerous benefits have been identified through the implementation of STEAM approaches and many authors advocate for the importance of STEAM (Conradty & Bogner, 2019; Harris and de Bruin, 2017; Henriksen, 2017; Korean Foundation for the Advancement of Science and Creativity, 2017; Parliament of the Commonwealth of Australia, 2017; Simpson Steele et al., 2016; Walshe et al., 2020). It has been argued that the integration of the arts into STEM allows a richer and deeper exploration of content (Harris and de Bruin, 2017; Henriksen, 2017). Embedding the arts in STEM can enhance student motivation in the other discipline areas and foster thinking and problem solving in the context of real-world issues (Conradty & Bogner, 2019). Research conducted by Walshe et al. (2020) found that STEAM approaches can facilitate positive outcomes in the area of student wellbeing, through the focus on imagination, experiential learning and the facilitation of empathy, autonomy and collaboration. Inquiry and opportunities for active involvement in STEAM activities has been found to be beneficial for girls (Thuneberg et al., 2018). Some studies have also reported gains in student creativity through STEAM approaches (Harris & de Bruin, 2018; Kim & Kim. 2016; Ozkan & Topsakal, 2019).

However, as an emerging area, several challenges have been highlighted in the literature. Firstly, there are varying definitions of what constitutes the arts in STEM, with some studies narrowing down the focus to simply visual art and others focusing on a broad definition that includes the creative arts, liberal arts and humanities (Perignat & Katz-Buonincontro, 2019). In some cases, the arts are actually used as a term to represent inquiry or problem-based learning (Perignat & Katz-Buonincontro, 2019). Critiques have focused on how embedding the arts may not provide enough focus on the STEM disciplines (McAuliffe, 2016; Simpson Steele et al., 2016). Teacher confidence in the arts and STEM areas can be low (Simpson Steele et al., 2016) and some teachers are unsure about their own creativity (Cropley, 2016; Harris & de Bruin, 2018). Other constraints that teachers have identified include an overcrowded curriculum, systems that focus on separate subject areas, increased accountability measures including standardised testing, timetable issues and challenges with collaborating with other teachers (Harris & de Bruin, 2018; McAuliffe, 2016). It can be also be surmised that as STEAM approaches are less developed than STEM approaches in Australia, that similar concerns and confusion around implementation in terms of moving beyond policy exist (Bybee, 2015; Harris and de Bruin, 2017).

16.3 Nurturing Creativity Through STEAM Approaches

A reason that STEAM approaches are advocated for, and even STEM approaches to a lesser extent, are the perceived benefits on student creativity. Creativity is considered a "new paradigmatic currency in education" (Harris, 2017, p. 56). This is partly connected to the identification of creativity as a necessary skill for enhancing the economy and lifelong success (Perignat & Katz-Buonincontro, 2019). Another reason is that students in primary school are at their most curious, providing an opportunity for teachers to harness the development of creativity (Parliament of the Commonwealth of Australia, 2017).

Creativity can be a challenging concept to define and measure (Conradty & Bogner, 2019; Harris & de Bruin, 2018; Lucas, 2016). Creativity is considered a universal trait (Harris, 2017) and words associated with creativity include novelty, originality and impact (Craft, 2015). Craft (2015) differentiates between *little c* and *big C* creativity, with *little c* creativity being the creativity an individual uses in everyday life in coming up with novel and original solutions to problems. In contrast, *big C* is the large-scale creativity that "changes the world or that generates novel ideas which transforms paradigms" (Craft, 2015, p. 154). Lucas (2016) describes five creative habits: ***inquisitiveness***, evident through wondering and questioning, exploring and investigating, and challenging assumptions; ***imagination***, evident through playing with possibilities, making connections and using intuition; ***persistence***, evident through sticking with difficulty, daring to be different and tolerating uncertainty; *collaboration*, evident through sharing the product, giving and receiving feedback and cooperating appropriately; and ***discipline***, evident through developing techniques, reflecting critically and crafting and improving. Some of these habits are supported by the work of Csikszentmihalyi (2014), who maintains that interest plays a key role in the creative process:

> To make a creative contribution, it is not enough that a person have all the necessary information in a given domain, and that he or she knows what to do with it. The creative person must be interested in the information that constitutes the domain—not just the ordinary interest a person must have to gather information necessary to adapt to his or her environment, but an unusually acute curiosity about a particular aspect of it (p. 162).

Also of importance to the creative process is perseverance, a dissatisfaction with how things are and a desire to search for alternatives, as well as dependence on the social context (Csikszentmihalyi, 2014). In research conducted by Harris and de Bruin (2018), teachers in the study maintained that creativity is something that can be taught and is transferrable to other situations. In this same study, many teachers felt that they could be successful in fostering creativity in their own classrooms (Harris & de Bruin, 2018).Some researchers have identified factors that support the teaching and learning of creativity. Teachers need to be given opportunities to collaborate across disciplines, be provided with meaningful professional development, have access to quality resources and be explicitly supported by school leadership (Harris, 2017; Harris & de Bruin, 2018). Pedagogies that allow for student leadership, collaboration, autonomy and inquiry are also deemed to be important (Conradty

& Bogner, 2019; Harris, 2017). Therefore, approaches that foster creativity will have an explicit focus on the teaching of real world skills (Harris, 2017) and be capabilities focused (Parliament of the Commonwealth of Australia, 2017).

STEAM approaches may be one way to support the teaching and learning of creativity in line with the factors identified above. This is because the arts are considered a key way that creativity can be nurtured (Perignat & Katz-Buonincontro, 2019). Harris (2017) believes that the arts foster experiential and relational learning experiences and that opportunities for creativity are inherent in artistic endeavours. This is supported by Kamienski and Radziwill (2018), who believe that incorporating arts within STEM disciplines nurture student creativity due to the emphasis on personal creative exploration, inquiry, engagement, personal agency and opportunities for creation. However, it is important to note that creativity is naturally inherent in all areas and can therefore be a focus of all disciplines (Perignat & Katz-Buonincontro, 2019). Studies that investigate different STEAM approaches on student creativity is an emerging area of research (Ozkan & Topsakal, 2019).

16.4 Case Study: Hammond Park Catholic Primary School

To investigate the perceptions of how teachers believed a STEAM approach could influence creativity, the authors selected Hammond Park Catholic Primary School (HPCPS) as an illustrative case study. This case study will include contextual information about the school and present qualitative results from the investigation.

HPCPS has implemented and developed a formal STEAM approach from 2017 and student representatives presented their learning at a Catholic Education Western Australia (CEWA) STEM Showcase in 2019. The CEWA STEM Showcase provided an opportunity for Catholic schools across Western Australia to demonstrate their STEM learning to a wider audience.

Hammond Park is a suburb of the Perth metropolitan area, located approximately 25 kilometres south of the Western Australia capital city of Perth. Established in 2003, this suburb has in the last decade experienced a period of rapid growth, with many young families settling in the area. In the 2016 census, the median age of people in Hammond Park was 31 years old, with children between the ages of zero to 14 comprising almost 25% of the total population of this suburb (Australian Bureau of Statistics, 2017).

HPCPS is a Pre-Kindergarten to Year Six school following the traditions of the Catholic Church. Students enrolled at the school are aged from three to 12 years. The school opened in 2013, recognising the demand for an alternate educational choice to meet the needs of the growing number of families establishing in Hammond Park. The increase in student enrolments at HPCPS reflected the growth of the suburb, with student numbers rising from 17 in the foundation year to 375 in 2020.

The vision and mission of HPCPS is directed towards an engaging style of education that encourages the students' natural curiosity and creativity, challenging them to become lifelong and lifewide learners into the future. The individual

learning style of each student is accommodated through a contemporary, flexible learning approach. The teaching staff scaffold learning opportunities that challenge the students to think more deeply about their learning. Acknowledging the increasing complexity of skills required for employment into the future, they provide opportunities for the students to develop capabilities in how to learn, more than just what content to learn.

Two teachers were invited to participate in this study in consultation with the school principal. A semi-structured interview was utilised in line with qualitative research design, as it was important to understand their perceptions and interpretations (Martella et al., 2013). Qualitative research recognises the importance of context for how individuals make meaning of their lived experiences, beliefs and opinions (Cowling, 2015; Cowling & Lawson, 2015; Roulston, 2013). The teachers were interviewed together and the interview was recorded, transcribed and analysed through a process of data reduction, coding and categorisation (Roulston, 2013). The questions for the interview were developed in an attempt to understand the school's approach to STEAM and how the teachers perceived the influence of STEAM on student creativity. The semi-structured interview questions are included in Table 16.1.

The participants in this study were Teacher A, who was a specialist teacher in the school and Teacher B, who was a classroom teacher. Both teachers had been involved in the approach since its emerging stages and were instrumental in its ongoing development.

The school's STEAM enrichment initiative is centred on the arts and creativity, underpinned by a belief that student learning is enhanced by incorporating creativity into all learning areas. Through the arts, the STEAM approach integrates the other disciplines, breaking down the divisions that can form between them. At the time of developing the approach at HPCPS, several staff members, both specialist and classroom teachers, had a background in visual or the performing arts.

Table 16.1 Semi-structured interview questions

Guiding questions
1. Can you tell us about your school's approach to the teaching of STEM?
2. How are the arts incorporated in your approach?
3. What students does the approach involve?
4. How did the approach begin at your school?
5. How long has your school implemented this approach for?
6. What have been the strengths or positives of your approach?
7. What have been the challenges?
8. What aspects are critical to the success of the approach?
9. What aspects hinder the success of the approach?
10. Do you have any plans for the future development of your approach?
11. Do you see any benefits of integrating the arts into the teaching of STEM?
12. Do you see any challenges of integrating the arts into the teaching of STEM?
13. How do you see student creativity being enhanced through the approach?
14. What do you believe contributes to the enhancement of student creativity in the approach?

STEAM at HPCPS commenced in 2016, as a single event to celebrate National Science Week, which is an annual initiative from the Australian government to promote science in schools. The theme of *Robots, Drones and Droids* stimulated conversations between the science and visual art specialist teachers about ways to draw the learning areas together, after both observed points of commonality and intersection. There were also wider staff discussions occurring around about how to support students to enhance their problem solving, thinking skills and creativity. The high level of engagement by both the students and teachers observed at this event indicated a possible avenue to develop a wider and more systematic approach, as discussed by Teacher A in the following comment:

> The engagement was just crazy. They absolutely loved it. They were just so engaged with it the whole time. We knew that that was already a winner. We had a look at how we could connect things so it wasn't just STEM, because the arts were so embedded in what we do, it's not just STEM. We didn't want it to be engineering and maths, we didn't want it to be science, technology. We looked at how that worked with the kids and then went "Right, okay, so what can we do with this?" (Teacher A, 6 October, 2020).

In 2017, accommodating timetable constraints, the STEAM initiative was expanded to one afternoon per week for students from Year Two to Five, which was the year level to which the school had grown. There was a recognition that while the single event had produced positive results, it was important that teachers still had sufficient time with their own classes to meet curriculum requirements. It was also necessary to ensure specialist teacher availability, hence only one afternoon was planned for. This was a timetabled area, with teachers working in teams comprised of one classroom teacher and one specialist teacher, delivering a term programme around a central theme, focusing on one STEM discipline and one arts area, such as music, visual arts, drama, dance or media arts. There was a focus by the teaching staff to embed opportunities to develop the six key future skills articulated by Fullan and Langworthy (2014): character education, citizenship, communication, critical thinking and problem solving, collaboration and creativity and imagination. Students worked in multi-age groups with the aim that peer mentoring could occur. After each term, the teaching partnership, theme and student groups changed with the aim of maintaining the level of enthusiasm and novelty. According to the teachers, there was an attempt to allocate students into groups based on their interests, but the overall perception of both the approach and student grouping was that it was predominantly teacher-directed. During ongoing reflection during the year, there was a sense by teachers that it was "hard to let go" (Teacher B, 6 October 2020), but as the year progressed, teachers increasingly began to relinquish control of the learning process, enabling the students to take greater ownership and responsibility. According to the teachers, there was a desire to increasingly connect the learning to real-world contexts. There was also a sense that the multi-age grouping was also not working effectively, due to the different skill set and gaps in understanding of the students in the different year levels.

With further iterations of the STEAM initiative over subsequent years, the current model involves students in same year level groupings from Pre-Primary to Year Six, which is most suited to the current school environment. For Pre-Primary and

Year One students, teachers determine a time that suits the students' needs, but from Years Two to Six, there is a consistently scheduled time that STEAM occurs for the entire cohort. In the current model, classroom teachers work in partnership with their partner teacher to develop STEAM inquiry-based projects that involve students exploring contemporary global and local issues, aiming to increase student awareness about care and service in the community. Students worked collaboratively to brainstorm ideas and explore solutions to challenges posed by the projects, responding to provocations presented by their teachers. Classroom teachers, guided by these discussions, planned the projects across all STEAM discipline areas and delivered them as a team, modelling the collaborative approach underpinning the initiative. Sometimes these programmes continued for a school term and even longer, depending on how interested the students remained in the topic. They ensured that the projects promoted development of key skills, such as problem solving, digital fluency, creativity and innovation in the students.

Student learning was communicated to parents via the educational app Seesaw throughout the inquiry process. Teachers were constantly examining student work to identify key learning and to guide the student inquiries, which was documented on a shared *Microsoft OneNote*. Teachers also used backwards planning to document the curriculum areas that they explored with the students. There was a deliberate choice that STEAM would not be formally reported, to encourage teachers to risk-take and build confidence with the inquiry-based approach. The teachers described the approach as "messy, exciting, daunting and evolving". This is illustrated in the following comment:

> I think that's always been our approach, that we've never had this thought that we're going to get to a place of "This is what our STEAM looks like here, it's finished, we're done," it's always we're looking at where the teachers are at, where the students are at, how the students are responding to that and making those adjustments as we go. I don't think we've ever had that "This is what it looks like," it's always changing. We're always looking for that feedback and talking about how the students are responding (Teacher B, 6 October, 2020).

An example of this STEAM approach is presented here in the form of an almost year-long Year Three STEAM project. This project began in Term 2, 2020, following the COVID lockdown in March and April. The Year Three teachers decided that sustainability would be the key concept to be explored in their STEAM time, as this is a cross-curricular priority in Australia. To begin this focus, their first STEAM session was an exploration of provocations connected to this concept, and aimed to find out what the students already knew about sustainability. This included watching clips from the *War on Waste* documentary series. Through these conversations with the students, an emphasis was placed on pollution, specifically the problems it creates and how their school works to help or hinder pollution. With the assistance of their teachers, the students investigated the rubbish in the school and identified that rubbish from the canteen was a significant issue. The students decided that they needed to educate the school community about the issue of pollution and created posters to put up around the school. For this task, they learnt design elements and made use of digital technology tools. They also brainstormed ideas for solving the

school canteen rubbish issue, including making canteen bags out of scrap paper and requesting that everyone have reusable canteen bags. Many of the questions the students had throughout this exploration were focused on plastic and its impact on the environment, particularly after observing the types of rubbish found in the school. The level of student interest in this topic was sustained, even after coming back to school following the Term Two school holidays. The Year Three classroom teachers, in consultation with the Science and Visual Art Specialist teachers, decided to extend their learning in Term Three, by connecting to the Australian National Science Week theme for 2020, which was *Deep blue: innovation for the future of our oceans*. As part of their STEAM learning, the students learnt about endangered animals in the ocean, with a particular focus on improving the student's research skills. This was then used in STEAM, Science and Visual Art classes, to enhance their understanding about the impact of pollution on ocean animals, which then linked back into their classroom work.

In Term Four, the questions the students focused on in STEAM were how they could do something with the information that they had learnt about the impact of pollution on ocean animals. The teachers felt the learning at this point had become much more student-directed, as the students were guiding the direction of their learning. The students decided that they wanted to create an invention to solve the problem of pollution in oceans and chose to work either individually or collaboratively to design a prototype to clean the oceans. This challenged the students to consider a range of key questions, such as how would the design tell the difference between rubbish and animals and where would the rubbish go when it was collected? The students then presented their prototype to a *Shark Tank* inspired panel of teachers. This required them to create a marketing pitch for their product, describe key features and outline the pricing. For this presentation, the students made use of digital technology to assist them to create a logo and presentation for their product. The panel provided the students with feedback and ideas to extend their thinking.

According to the teachers interviewed, there had been numerous benefits associated with the STEAM initiative at HPCPS. The teachers commented that student 'voice' was vital to the success of this pedagogical approach and had become increasingly encouraged by the teachers, much stronger than when the STEAM initiative was first introduced in 2016. The approach was increasingly student-led and there were observable improvements in the students' resilience, as they were prepared to have a go at new and unfamiliar challenges and they demonstrated ownership of their learning. For one of the teachers, this was most evident when students in Year Three presented their learning at the CEWA STEM Showcase, as evident in this comment:

> I was amazed at how those kids were just explaining to people who were coming up, explaining what they were doing, explaining what they were talking about and taking that complete ownership of what they had done. It's a really great thing to see, and they're doing that with the other learning areas in the classroom as well, with taking ownership of what they've learned and sharing that more with how they're doing that (Teacher A, 6 October, 2020.

Through the STEAM project approach, there was an explicit focus on teaching students how to ask effective questions and to develop their research skills. The teachers noted that in a relatively short space of time, more insightful questions were emerging and the teachers believed that at this point, deep learning was starting to occur. Another area of observed improvement was that collaboration between students had increased. The teachers shared that while some students preferred to work individually in the classroom, they deliberately choose to work collaboratively in the STEAM sessions, recognising the variety of strengths that a group of students brought to a project. When reflecting on benefits of the approach for students, one of the teachers reported:

> I think one of the positives that comes to mind is the kids that have surprised us. There's kids that might not necessarily excel usually, they're the moments where you go "Wow," they're able to really show their understanding, and I think they've been huge moments for us…They just amaze us with what they're able to show us (Teacher B, 6 October, 2020).

Of significant importance was the ongoing enhancement of student engagement, learning and creativity. The teachers reported that they would often field questions such as "Are we doing STEAM today?", "When do we do STEAM?" and "Can we work on STEAM?". Students were seemingly making connections between their learning in STEAM and their learning from the key curriculum learning areas, as illustrated in the following comments:

> The year threes are bringing a lot of stuff in from their STEAM learning that I'm actually doing with them in art, and I know that they're also talking about it in their writing as well… And there's a lot of links that the teachers are making with Humanities and Social Sciences and other areas as well (Teacher A, 6 October, 2020).

> Hearing them make a lot more connections between things that they're learning rather than seeing everything as standalone, they're always connecting the dots and drawing things in (Teacher B, 6 October, 2020).

The main way that the teachers observed student creativity was through the curiosity that the students demonstrated in their learning, evident through their enthusiasm and questioning. The students appeared more confident in using their creative skills to demonstrate their understanding, and by using a range of styles and modes to present their outcomes. It was also noted by the classroom teachers that students chose their own way of showing their learning and they were presenting their work in more creative and imaginative ways outside of the STEAM lessons. One of the teachers stated:

> I find they're willing to have a go at "Can I show it this way?" And they'll try different things before they figure out how they're going to do it (Teacher B, 6 October 2020).

Benefits were also identified for teachers in relation to the implementation of this STEAM initiative. With experience of facilitating student inquiry in STEAM, "the classroom teachers become more familiar and more confident with this learning approach" (Teacher B, 6 October, 2020), which led to it being a part of regular classroom teaching and learning. Teachers also shared that the STEAM approach was supported by the school's leadership, which was evident in many ways,

including being a focus of school improvement planning, timetabled in the weekly schedule, promoted on the school's website, the basis of professional learning community meetings and providing time for staff to be coached by the STEAM coordinator. Several challenges were identified in relation to the implementation of this whole-school STEAM initiative. A primary challenge reported by the teachers was their ability to relinquish management of the student learning and to place trust in the students' ability to effectively explore their own interests. It was noted that STEAM learning projects could sometimes become messy and appear chaotic, with a great deal of noise as students collaborate on projects. This could be challenging and may even hinder the ongoing success of this approach, as some teachers struggled when they were taken out of their comfort zones. This is discussed in the following comment:

> The only thing that I can see potentially doing that is with staff changes and everything else, people not understanding our approach, not understanding where it's come from and how it's evolved. It doesn't really hinder us at the moment because we share that and we make sure that people understand how this works, what we're doing, where we've come from (Teacher B, 6 October, 2020).

An emerging challenge in the current STEAM model was the inclusion of the arts. The arts are pivotal to the STEAM initiative and needed to be honoured, but this could be daunting for those teachers who do not have a strong artistic skill base. This is reflected in the following comment:

> If a teacher is not confident with themselves as what they know or understand about the arts, they're sometimes a little hesitant to go "This term we're going to be talking about media arts," or "We've got a visual arts specialist in the school, do we really want to go in this area?" or "I don't know anything about music, how am I going to do music in STEAM?" That probably makes people a little bit more hesitant in how are we going to put the arts in there (Teacher A, 6 October, 2020).

An area identified as vital to the success of the STEAM approach, was teachers' and students' willingness to be flexible. It was evident that the teaching culture associated with the initiative was strongly linked to a safe environment for innovation. The staff were willing to trial new ideas, without fear of judgement as learnings were valued from any failures. The teachers also recognised that critical reflection was essential to supporting the ongoing refinement of the approach. Finally, teacher accountability was deemed significant, through visible planning and sharing of learning to parents.In looking towards the future, these teachers were aiming to create a visual representation of the inquiry model which could support other teachers' as they implemented the STEAM approach. There was also a desire to develop a scope and sequence of key skills that students could work towards achieving, and which would arguably contribute to their overall learning success. However, the teachers' most significant aim was to continue working with the school's leadership team and staff more widely to ensure STEAM remained a priority, even when challenged by other school-wide initiatives. This is illustrated in the following comment: "What we want to make sure is that STEAM is always a priority in the school". (Teacher A, 6 October, 2020).

16.5 Discussion and Implications

There were many positive outcomes evident in the exploration of the STEAM initiative at HPCPS. The teachers were striving to harness the power of the arts in order to foster student creativity, while looking for meaningful opportunities to break down the barriers between learning areas (Parliament of the Commonwealth of Australia, 2017). Over time, the approach at HPCPS evolved to be authentically transdisciplinary (Perignat & Katz-Buonincontro, 2019), as teachers develop learning experiences around a central inquiry that emerged from the students' questions and integrated all STEAM disciplines. This was in contrast to the initial stages of the approach, where there was a narrower interdisciplinary or cross-disciplinary focus on just two STEAM discipline areas (Perignat & Katz-Buonincontro, 2019).

In the example of the Year Three project presented in this chapter, each of the STEAM discipline areas were authentically included: Science, in relation to the focus on living things, the environment and sustainability; Technology, in relation to digital technology utilised for students to demonstrate their learning and design technology in relation to the design of their prototype; Engineering, in relation to the students finding solutions to problems; Arts, in relation to the Media Arts that were explicitly taught and demonstrated through the student presentations; and Mathematics, which included the analysis of data in relation to the school's rubbish, the geometric skills that formed part of invention design and the connection to money in their invention challenge. Similar to reports from Peppler and Wohlwend (2017) and Harris and de Bruin (2017), the teachers at HPCPS continued to honour the role of the arts in supporting student creativity and their deep exploration of a real-world problem and learning of curriculum content.

Previous studies also identified the potential benefits of STEAM for enhancing student motivation, skill development and wellbeing (Conradty & Bogner, 2019; Harris, 2017; Kamienski & Radziwill, 2018; Walshe et al., 2020). These benefits were also evident in the current study and the participating teachers reported a high level of student engagement. Factors that seem to contribute to this engagement at HPCPS included the whole-school inquiry pedagogy underpinning the approach and the focus on student voice and agency in driving the learning. When examining the perceptions of the teachers through the lens of Lucas' (2016) five creative habits, there seems to be indications that student creativity was fostered through the approach, as evidence of inquisitiveness, imagination, persistence, collaboration and discipline were present in students' STEAM learning experiences. The example reported in this chapter, highlighted students demonstrating *little c* creativity, in that they were coming up with novel solutions to the problem that they had identified in relation to ocean pollution and the impact on the environment. However, it should be noted that the generalisability of findings from this study is limited by the number of teachers that were interviewed, as well as not specifically exploring the perspectives of the students themselves.

This investigation also highlighted some key outcomes for the teachers involved in the initiative. There was evidence of teachers enhancing their skills and

understanding of inquiry pedagogy and developing their own collaboration skills as they facilitate students' STEAM learning projects. In many ways, the teachers themselves were developing their own creative habits, as they too demonstrated inquisitiveness, imagination, persistence, collaboration and discipline (Lucas, 2016). The STEAM programme and teachers' innovations were explicitly supported by the leadership of the school through timetabling allowances, professional development, coaching and promotion of the approach; all factors identified as important to an initiative's success (Harris, 2017; Harris & de Bruin, 2018). There was also recognition in this current investigation that in order for the STEAM approach to continue, it needed to be identified as an ongoing school priority with suitable resourcing. This resourcing could include targeted professional learning for teachers as those new to the approach may lack confidence with the arts and the inquiry approach, which has been previously identified as a barrier to successful implementation by Simpson Steele et al. (2016).

In conclusion, this illustrative case study of Hammond Park Catholic Primary School represents an exciting example of the potential that STEAM approaches can have on creativity. Future studies that investigate the features of high-quality STEAM approaches and the perceptions of students themselves in relation to their experiences of STEAM and creativity would enhance this emerging research area and could contribute to positive student outcomes.

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