KINROSS WOLAROI
SCHOOL

COLLABORATIVE APPROACHES IN PRIMARY SCHOOL SCIENCE:

Opportunities and Impacts

SCHOOL | Kinross Wolaroi School, Orange

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Contents

Executive Summary

The purpose of this document is to describe and report the findings of a school based research project titled Collaborative Approaches in Primary School Science: Opportunities and Impacts. This project was conducted at Kinross Wolaroi School in Orange and was funded by the Association of Independent Schools New South Wales (AISNSW) through a School Based Research Project (SBRP) grant worth $141,000 over two years (2017-2018).

The project involved linking our primary teachers with specialist secondary science teachers for the programming and teaching of primary science. The research aimed to investigate the impact of the school based project on primary teachers' confidence and competence in teaching science; students' knowledge outcomes and experiences in school science; and, the pedagogical approaches adopted by secondary school science teachers.

Ethics clearance to conduct the research was obtained from the Human Research Ethics Committee at Charles Sturt University (CSU). There were 10 primary school teachers and three secondary school science teachers who agreed to participate in the research and 234 primary school student participants.

There were three overarching research questions that guided this project:

1. What impact does the collaborative team teaching and programming have on primary teachers' confidence and competence in teaching science?
2. What impact does this approach have on students' knowledge outcomes and experiences in primary school science?
3. What impact does the project have on the pedagogical approaches adopted by science teachers in their secondary school science lessons?

A Type-II Case Study was employed to investigate the impact of the project on teachers and their students. Teachers also used an action research cycle to reflect on the science programs of work and their teaching and made changes to future implementation cycles throughout the project. We also used a phased implementation approach in introducing the project to different year levels and classes in different terms. This allowed us to compare results within and across year levels.

Data were collected from student and teacher participants throughout the project. Interviews were conducted with both students and teachers. Teachers also completed an online reflection and feedback form on two occasions while students completed questionnaires about their perceptions of science lessons at school. Students also completed pre and post-occasion questions related to the science content covered over the course of each school term. These responses were coded based on the complexity of the explanation using the Structure of the Observed Learning Outcome (SOLO) Taxonomy.

Findings revealed that the collaborative programming and team teaching approach appeared to positively impact primary teachers' confidence in teaching science and seemed to have an effect on some of the secondary teachers' approaches to teaching science. Students reported an increase in practical work during their involvement with the project. There appeared to be more active learning in science. It was also interesting to note that students felt teachers were explaining scientific concepts better during the project and felt that this helped them understand science. Students' complexity of responses increased and they seemed to be using more scientific language within lessons.

The collaborative programming element of the project seemed to be critical in the success of the project. All teachers acknowledged how valuable it was to have time to program collaboratively with the secondary science teacher and their year level colleague. This project has forged ongoing relationships between the primary and secondary school departments at Kinross Wolaroi School where we have built a teacher community of practice centred on the programming and the teaching of primary science. We are committed to sustaining these relationships and collaborative approaches to programming and teaching primary science beyond the life of the funded project.

Introduction

Kinross Wolaroi School is an independent, co-educational day and boarding school located in the regional city of Orange, NSW, Australia. The school has two main campuses. The main campus known as 'Wolaroi' is 20 hectares in size and accommodates the main teaching facilities as well as facilities for boys boarding. A second campus, called "PLC", is located five kilometres away and houses the girls' boarding facilities and a recreation and examination centre. All classroom activities for all students enrolled in the Early Childhood Centre and in classes from Kindergarten to Year 12 occur on the Wolaroi Campus.

Kinross Wolaroi is a non-selective school with over 1100 students (including 350 boarders in Years 7 – 12) and 305 staff. The school is owned by the Uniting Church of Australia and has a proud tradition of educating young people in an innovative learning environment that blends quality teaching, modern facilities and heritage buildings with creative outdoor learning spaces. The 110 teaching staff are recognised for their specialist qualifications, leadership capabilities and engagement in educational research. The school is committed to a whole school approach to student wellbeing that includes teaching and learning, co-curricular and the emotional and social needs of every student. Even though we are a K-12 school and are predominately located on one campus, the primary and secondary departments tend to work and operate in isolation from each other. That is to say, there have been very little, if any, opportunities for collaboration around programming and teaching.

In 2015, some of our primary teachers connected with our secondary science teachers to explore the possibly of using the secondary science laboratories for some of their science lessons. This was an attempt to try to make the primary science lessons more inquiry based. This resulted in a few primary classes attending the science laboratories for a handful of 'whiz bang' lessons but there was no real depth to what was being taught and little connection to other lessons that were covered within the Primary Connections Units. Furthermore, there was limited collaboration in the programming of science.

Given these initial attempts to try to make primary science more inquiry-based, we submitted an Association of Independent Schools New South Wales (AISNSW) School Based Research Project (SBRP) grant application in 2015 to try to explore this work further but were unsuccessful. After attending the AISNSW Research Symposium, receiving feedback on our initial grant application and through developing professional dialogue with successful schools we decided to undertake a school based pilot project.

During Term 2 of 2016, we were successful in obtaining a Charles Sturt University Community-based Grant worth $2500. We were also successful in obtaining $5000 through our school's Strategic Initiatives Funding Scheme. This allowed us to explore some of the research literature related to primary science education where we found that many primary teachers often lack the content knowledge needed in order to teach the content of the science curriculum. This often results in them having a lack of confidence in teaching science or a low science teaching efficacy. Secondary science teachers tend to possess strong content knowledge in their specialist area but often fail to implement effective teaching strategies.

Based on this literature search, we collected some information on our primary teachers' confidence in teaching science where we found many of our teachers indicated they lacked confidence or wanted professional development opportunities to help them teach primary school science. The initial results from the pilot project became the stimulus for why we wanted to undertake the collaborative programming and teaching within primary science. This community—based pilot project also allowed us to trial a collaborative approach toward the programming and teaching of science in two primary classes (a Year 1 and a Year 3 class) over a period of nine weeks in Term 2, 2016.

We sought to investigate the impact of the collaborative approach on teachers and students within these classes. We collected questionnaire data, conducted interviews and examined student work samples collected from the two participating classes. We compared these with data from the two non-participating classes from the same Year levels. It was evident that in the classes where the team teaching occurred, students were using more scientific meta-language to explain concepts and this was also evident in their work samples. Teacher interviews revealed that they felt the team teaching approach helped build their confidence and knowledge of the content.

At the political level, there is rhetoric around the generalist versus the specialist teaching of science in the primary school. There are good arguments supporting both approaches. Within our primary school, we have specialist teachers for Music, Religious Education and Personal Development, Health and Physical Education. During our pilot project, initial interviews with teachers revealed that they found it hard to make cross-curricula links with what was happening within these specialist subjects. Often, they have little knowledge of what students cover within these subjects and fail to make connections. Consequently, these initial results helped us make a case for why we wanted to pursue the collaborative programming and teaching in science.

The pilot project gave us some initial insights into the potential impact of the collaborative approach on both teachers and students. In order to fully investigate the impact of this approach on student outcomes and to create a sustainable model for the programming and teaching of primary science within our school it was imperative for our school to source external funding. We felt that additional funding would allow us to scale the project and hopefully result in the diffusion of the project to other teachers within the school and lead to more students experiencing the project.

This led us to apply for an AISNSW SBRP grant in 2016. We were successful in securing $141,000 to undertake the project over a two-year period. This project aimed to build our primary teachers' confidence and competence in teaching inquiry-based school science by providing them with targeted specialist support and resources. We intended to achieve this by linking our primary teachers with specialist secondary science teachers for the programming and teaching of primary science. Given our initial pilot project findings, we anticipated that this collaborative approach to programming coupled with the team teaching of lessons would bring together the primary teachers' understanding of their students and various pedagogies and the secondary teachers' knowledge and skills in specific science discipline areas.

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Rationale and justification for the project

The National Curriculum for all years of compulsory education requires inquiry-based science to be implemented. We identified that our teachers needed support with the transition to the focus of the new syllabus that requires students to be involved in investigative science. The main outcomes we hoped to achieve through this project were to build the professional capacity (competence) and confidence of teachers within our school in relation to the programming and teaching of primary science. We anticipated that a collaborative approach to programming coupled with the team teaching of lessons would bring together the primary teachers' understanding of their students and various pedagogies and the secondary teachers' knowledge and skills in specific science discipline areas. We also felt that the collaborative programming and team teaching opportunities could assist in strengthening and deepening our current primary teachers' knowledge of science and hopefully equip them with the necessary skills to be able to develop and/or locate, modify and implement future inquiry-based science activities for their students. In addition, we thought the project would promote science relevance for students and strengthen and develop their engagement and knowledge in science.

A deeper understanding and respect for the importance of staff working collegially to improve student outcomes, and an examination and critiquing of the status quo at the school were also important to the project. We felt the approach had the potential to be a model of best practice for the programming and teaching of other subject areas of the National Curriculum at Kinross Wolaroi School. We also anticipated that this approach could be used as a model within other schools.

Our project embraced aspects of the Kinross Wolaroi School Strategic Plan, the research of Visible Learning and the NSW Science K-10 syllabus. It offered staff the opportunity to work more closely with the Australian

Professional Standards for teachers and the AIS Standard 8 – School Ethos and Values. We hoped to generate a teacher community of practice through the collaborative programming and teaching within science. We also felt it would provide opportunities for teacher reflection including a greater understanding of student engagement identified by the students' degree of attention, curiosity, interest, optimism and passion.

Our project would also contribute to the science education research on teachers' confidence and competence in primary science, and on the pedagogical approaches adopted to engage students. The project is significant to the current community debate in relation to declining numbers of students studying Science and the level of scientific literacy in society in general. Furthermore, the project would generate new insights into the generalist versus the specialist teaching of science in the primary school and share results of an innovative approach that aimed to capture and implement the benefits of both approaches. It may also prove to be a useful model for teacher professional learning in science that could be used in geographically isolated areas.

We also believe our project complements and adds to the work that was commissioned by the AISNSW and which was conducted by the University of Technology Sydney (UTS) (Aubusson et al., 2015). The UTS project was looking at quality learning and teaching in primary science and technology. Our project adds to this body of literature by investigating the impact of an innovative, collaborative approach toward the teaching of primary science.

Literature Review

Worldwide, science education is viewed as essential for a sustainable and prosperous future. Nations turn to science to meet the threats to our environment, the health demands of an aging population, and to ensure the security of our food, water and power supplies (UNESCO, 2017). Further, a scientifically literate citizenry is seen as key for a strong economy (OECD, 2018). Australian policy makers and business groups share this perspective, vigorously promoting Science, Technology, Engineering and Mathematics (STEM) education as a way to ensure Australia's security and international competitiveness (Australian Industry Group, 2015; Department of the Prime Minister and Cabinet, 2015; Office of the Chief Scientist, 2013). Australia's various jurisdictions have responded by initiating an array of STEM strategies with the aim to improve student engagement and achievement in STEM education, including science education (Murphy, MacDonald, Danaia, & Wang, 2018).

Australian science education performance

Despite the Australian emphasis on science education, Australian students' achievement in science appears to have stalled, and, at the same time, the science performance of students in many other nations have improved. According to the Trends in International Mathematics and Science Study (TIMSS) the achievement of both Year 4 and Year 8 Australian students in 2015 is not significantly different to that in 1995 (Thomson, Wernert, O'Grady, & Rodrigues, 2017). Over the same period, more countries participating in TIMSS have seen increases rather than decreased in the science achievement of their students. Similarly, Australia's National Assessment Program (NAP) shows a lack of growth in the scientific literacy of Year 6 students over the past decade (Connolly, 2017). The Programme for International Student Assessment (PISA) points to a decrease in the scientific literacy of Australian Year 9 students in absolute terms, and a relative decrease compared to other nations (Thomson, De Bortoli, & Underwood, 2017). In

a world increasingly dependent on scientific literacy and innovation, the performance of Australian students in science is concerning.

Also concerning is Australian students decreasing engagement with science. In Year 4, the majority of students report liking science and feeling confident in science, however, these proportions fall by Year 8 (Thomson, Wernert, et al., 2017). Further, students report a decline in how engaging science teaching is from Year 4 to Year 8. The late primary and early secondary years appear crucial to maintaining student engagement with science, given research suggests that student attitudes towards science become fixed by the first years of secondary school (Archer, Osborne, DeWitt, & Dillon, 2013; Wang, Chow, Degol, & Eccles, 2017). Ultimately, the declining student engagement with science education has resulted in reduced enrolments in the senior secondary sciences (Cooper, Berry, & Baglin, 2018; Kennedy & Odell, 2014).

Australian primary science curriculum

In 2009 Australia commenced the development of a national science curriculum with the aim of ensuring future citizens have the scientific skills to work and live in an increasing complex global environment (National Curriculum Board, 2009). The resulting Australia Curriculum: Science aims to build students' foundational science knowledge, skills of scientific inquiry and problem solving, as well as their understanding of the importance of Science to society and their personal lives (Australian Curriculum Assessment and Reporting Authority, 2016). Each state and territory has responsibility for the implementation of this curriculum in its jurisdiction.

New South Wales has opted for an integrated approach to primary science education, with both Science and Technology education combined in the one syllabus (NSW Education Standards Authority, 2018b). By combining these disciplines NSW hopes that its students will experience authentic and practical learning opportunities where they innovate, investigate and produce solutions when exploring personal, social or environmental issues. While the syllabus describes the content of the science and technology curriculum in NSW, schools and teachers are given the responsibility to determine the sequence of, and the emphases placed upon, content, as well as how to best adapt the curriculum to meet the needs and interests of their students (NSW Education Standards Authority, 2018a).

It is crucial to provide students with a strong grounding in science if our country is to continue to advance and contribute to the technological world. Many students develop negative attitudes toward school science and become disenchanted with the subject as they progress through the compulsory years of school (Krapp & Prenzel, 2011; Osborne, Simon & Collins, 2003). The way in which science is taught has been identified as a key element in engaging students (Danaia, Mckinnon & Fitzgerald, 2013; Logan & Skamp, 2013).

Overview of primary science teaching

Unfortunately, Australian primary school teachers may not have the confidence nor capacity to deliver the science curriculum as intended. In many countries, primary school teachers are reluctant science teachers, and this is often attributed to low self-confidence in science teaching and scientific knowledge (Appleton, 2008). Australian primary school teachers report a similar lack of confidence with science teaching (Aubusson et al., 2015; Burke et al., 2016), and, compared to other nations, Australian primary school teachers are less likely to have a qualification with a major in Science or Mathematics (Marginson, 2013). Research has found that primary teachers with poor science knowledge and science teaching confidence, teach science less often and use more traditional teaching methods (Alake-Tuenter, Biemans, Tobi, & Mulder, 2013; Aubusson et al., 2015; Tytler, 2007; Tytler, Osbourne, Williams, Tytler, & Cripps Clark, 2008). This may in part explain the 2015 TIMSS findings that Australian Year 4 students spend only 57 hours a year studying science, compared to an international average of 76 hours, and only 22% of teachers emphasised scientific investigation in the majority of their science lessons (Thomson, Wernert, et al., 2017).

This relatively poor state of Australian primary science education is exacerbated by the impact of inadequate resourcing and time for science education in Australian primary schools (Goodrum & Rennie, 2007; Thomson, Wernert, et al., 2017). Further, time to prepare for science teaching, and having access to adequate classroom time for science education, are commonly seen by teachers as significant barriers to effective science education (Burke et al., 2016). Goodrum and Rennie (2007) argue that appropriate resourcing, along with professional learning, is a requirement for improving primary school educators' science teaching capacity and confidence. So there seem to be a complex range of interacting factors resulting in science education not receiving the attention in requires in Australian primary schools (Albion & Spence, 2013). Access to appropriate resources coupled with competent, confident teachers capable of implementing engaging pedagogies are needed in order to engage students in school science.

Secondary science teaching in Australia fares better in terms of teacher content knowledge and resourcing, but still faces some deficits in science pedagogy. The 2015 TIMSS found that 84% of Year 8 students were taught by a teacher with a major in science, slightly higher than the proportion internationally (Thomson, Wernert, et al., 2017). Year 8 students spend 126 hours per year studying science, compared to an average of 144 hours per year across the countries studied. Only 10 per cent of Australian Year 8 students were taught by teachers reporting moderate to severe resourcing problems, compared to an average of 23 per cent internationally. Despite being better placed in terms of content expertise and resourcing, secondary teachers do not necessarily employ effective teaching strategies or represent the content in abstract ways and often fail to make cross-curricular links (Danaia, Fitzgerald, & McKinnon, 2013). It would seem that strong pedagogical content knowledge (PCK) is needed for the effective teaching of school science (Appleton, 2007; Houseal et al., 2014).

Pedagogical Content Knowledge

The construct Pedagogical Content Knowledge (PCK), was first coined by Shulman (1986), who defined it as

… the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations — in a word, the most useful ways of representing and formulating the subject that make it comprehensible to others … Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons … that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding. (p. 9)

In essence, the construct PCK is a model of teacher knowledge (Grossman, 1990). The knowledge base is something that teachers develop overtime and comprises much more than just knowing and delivering the subject content to students. Cochran, King, and DeRuiter (1991) defined PCK as "the manner in which teachers relate their pedagogical knowledge to their subject matter knowledge in the school context, for the teaching of specific students" (p. 1).

PCK encompasses the following components: knowledge of students and their conceptions; knowledge and beliefs about purpose; knowledge about the curriculum; knowledge of content; and, knowledge of appropriate teaching strategies (Shulman, 1986; van Driel, Verloop & de Vos, 1998).

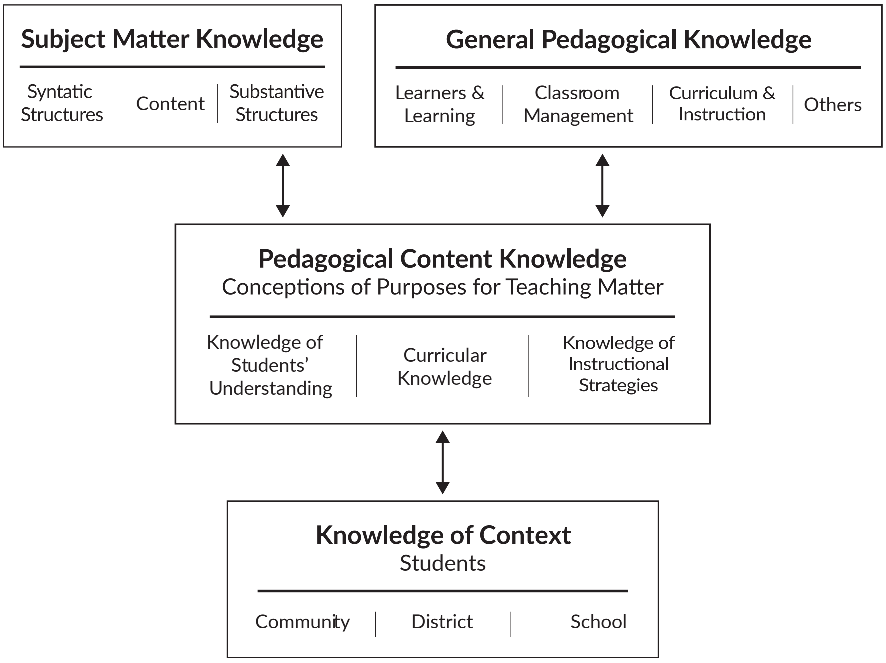


Figure 1: Model of Teacher Knowledge (Grossman, 1990, p.5)

Figure 1 outlines the key components of PCK.

PCK is essential for effective teaching and learning to occur. This requires teachers to be well adept at all of the components of PCK in their teaching. An effective teacher of science with high PCK would be experienced in moving through the various components of PCK and would make changes to their teaching based on their PCK to cater for the needs of their students.

Figure 2 illustrates a model of PCK related to teaching science. It highlights the interrelated nature of the components of PCK, explores how these elements interact and identifies all of the elements essential for effective PCK in teaching science.

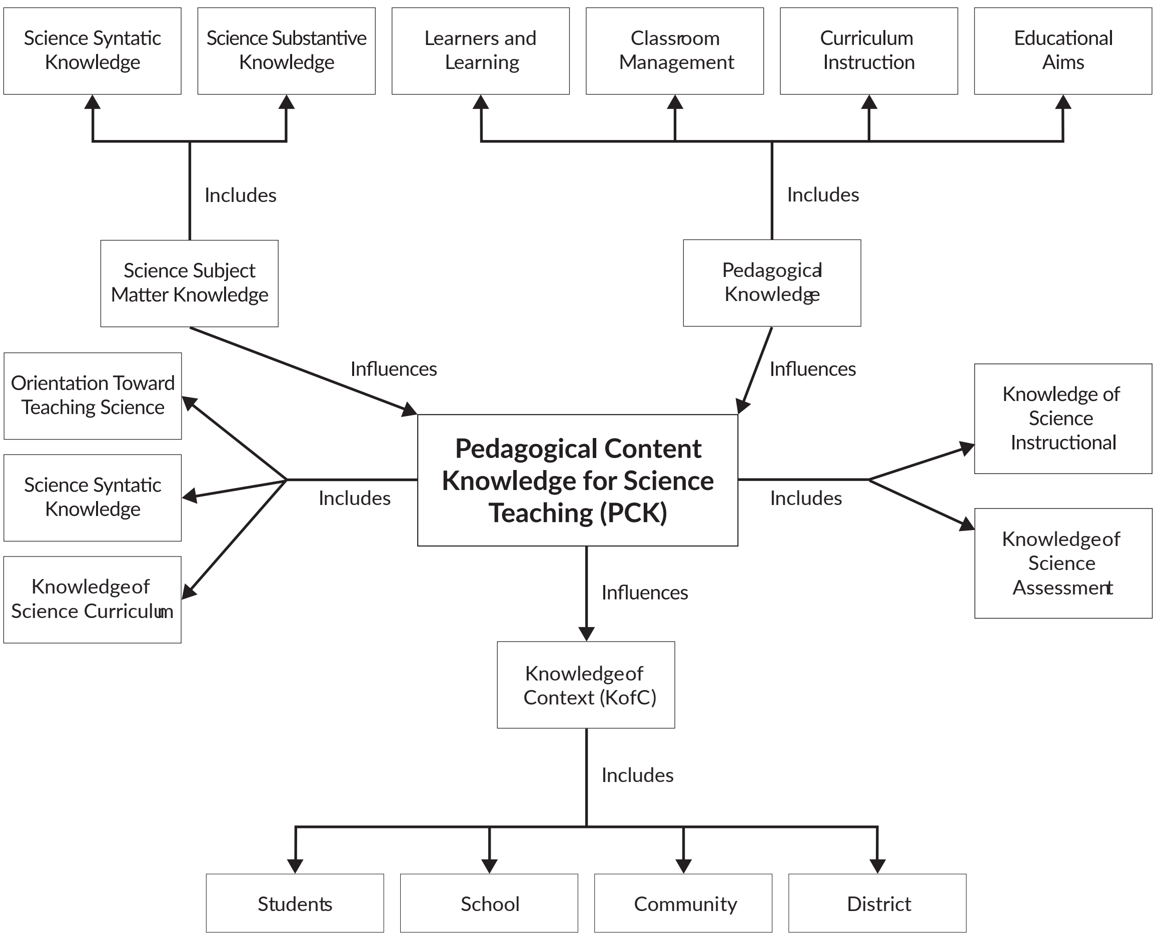


Figure 2: A model of science teacher knowledge (modified from Grossman, 1990 and Magnusson, Krajcik & Borko, 1999 and taken from Abell, 2007, p.1107).

Initiatives in Primary Science

There are some popular initiatives aimed at improving primacy science education. Holding science days or special events have long been a common Primary Science activity (e.g. (Campbell, 2013; Church, 2017; Craig, 2018; Flynn, Moore, & Tolar, 2005; Kepler, 1986; Klindworth, 1997). These days are held to stimulate student interest in science (Gabelmann, 2006) however there is scant academic literature investigating the impact of such events.

Forging partnerships with industry or tertiary institutions is a common policy recommendation for improving STEM education (Murphy et al., 2018). A range of STEM education projects make use of scientists and other STEM professionals as one element of a multifaceted approach to enhance science teaching and learning (e.g. English, King, & Smeed, 2017; Lee, 2014; Llewellyn, Pray, DeRose, & Ottman, 2016; Molina, Borror, & Desir, 2016) however few focus on the impact of these partnerships. One study that did consider the impact of teacher and scientist partnerships was conducted by Houseal, Abd-El-Khalick and Destefano (2014) where they explored the impact of Student-Teacher-Scientist-Partnerships (STSPs) finding that the partnerships resulted in more positive teacher attitudes towards science and scientists, as well as changes in teacher pedagogical strategies. Despite these encouraging findings, this research also noted that this work was not without its challenges, highlighting the significant planning and flexibility required to establish and maintain effective partnerships.

There are other initiatives in Primary Science education with more significant support in the research. Educators believe that preservice or inservice professional learning help to build confidence in teaching science and technology (Burke et al., 2016; Deehan, Danaia, & McKinnon, 2017). Primary Connections is an example of a large scale professional learning program aiming to improve the teaching of science through encouraging the uptake of inquiry based pedagogies (Skamp, 2012). The program has been extensively implemented and evaluated in Australia since 2005. Primary Connections has been found to impact positively on participant teachers' beliefs about inquiry based learning and their general enthusiasm for science teaching in primary schools (Albion & Spence, 2013; Skamp, 2012).

Other factors that can contribute to building teacher self-efficacy and pedagogical content knowledge in science education include opportunities for collegiate collaboration and participation in effective science teaching practices (Mansfield & Woods-Mcconney, 2012). Conversely, a lack of time and opportunities to collaboration with colleagues is seen by primary school teachers as a significant impediment to effective science teaching (Burke et al., 2016). Mentoring is one form of collaboration suited to the development of improving the practice of science teachers (Bradbury, 2010). Mentoring between teachers has also been shown to contribute to teacher confidence and science pedagogical knowledge (Forbes & Skamp, 2016; Koch & Appleton, 2007). Forbes and Skamp (2016) investigate a mentoring arrangement not prominent in research, where secondary school science teachers mentor primary school teachers as part of the MyScience program. The findings of this research suggest that these mentoring relationships can positively impact on the beliefs and practices of mentor and mentee (Forbes & Skamp, 2014, 2016). The Primary school teachers reported a changed understanding of what science education looks like in a primary classroom, as well as increased adoption of student-centred inquiry pedagogies (Forbes & Skamp, 2014). Similarly, the Secondary science teachers involved in the project reported trialing more student-centred approaches with their Year 8 students, as well as developing a deeper understanding of the primary education context that then informed their work with Year 7 students (Forbes & Skamp, 2016).

Collaboration can extend beyond mentoring to include co-teaching. Effective co-teaching involves shared preparation, instruction, assessment and reflection, and requires strong communication and conflict management skills (Brown, Howerter, & Morgan, 2013). McDuffie, Scruggs and Mastropieri (2007) conducted a review of 32 qualitative studies of co-teaching finding that teachers and administrators alike view co-teaching positively, with perceived academic benefits for students and professional benefits for teachers. Co-teaching may take several forms, including: Teach and assist (one teacher leads instruction while the other assists students as required); Station teaching (teacher's take responsibility for delivering different parts of the instructional content); Parallel teaching (teacher's divide the class and deliver the same instructional content); Alternative teaching (one teacher instructs most of the class while the other withdraws a small group for support or extension); and Team teaching (teachers collaborate to deliver the instructional content

together) (Lusk, Sayman, Zolkoski, Carrero, & Chui, 2016). Research suggests the Teach and assist model of co-teaching is most common, with Team teaching occurring least often (Pancsofar & Petroff, 2016). This is despite Team teaching being viewed as a highly recommended practice (McDuffie et al., 2007). There is limited research into the impact of co-teaching in science education.

Research suggests that effective professional learning that builds science pedagogical knowledge and allows teachers to experience successful science instruction could help redress some of the current deficits in primary science education (Burke et al., 2016; Deehan, Danaia, & McKinnon, 2017; Mansfield & Woods-Mcconney, 2012). One promising but under researched mechanism for delivering this professional learning is through establishing mentoring arrangements between primary and secondary teachers (Forbes & Skamp, 2014, 2016) where primary teachers may have stronger pedagogical knowledge and secondary teachers may have stronger content knowledge (OECD, 2018a). There is potential to extend this mentoring arrangement to include co-teaching (Lusk, Sayman, Zolkoski, Carrero, & Chui, 2016). While there is evidence supporting the positive impact of co-teaching in general classrooms (McDuffie et al., 2007), there has been minimal research into the impact of co-teaching on science education.

Our school based project is informed by the aforementioned research and will investigate a collaborative approach to the programming and teaching of primary science that will hopefully build both primary and secondary teachers' PCK in the science curriculum area and in turn increase our primary teachers' confidence in teaching science and improve student outcomes in science.

Aims and Research

This research aimed to investigate the impact of a school based science research project on teachers' confidence and on students' knowledge outcomes in, and perceptions of, science at school. The school based project aimed to build primary teachers' confidence and competence in teaching inquiry-based school science by providing them with targeted specialist support and resources. We intended to achieve this by linking our primary teachers with specialist secondary science teachers for the programming and teaching of primary science. Primary teachers would also have access to a science laboratory and specialised resources for the teaching of science.

At the time of applying for funding, the secondary school science department had a focus on improving the instructional strategies employed to teach science in an attempt to try to make secondary science more engaging for students. We felt this school based project could also result in positive outcomes for the secondary science teachers involved. That is to say, by teaming-up the primary and secondary teachers we though the primary teachers would help inform the secondary teachers of different instructional approaches and cooperative learning strategies that they tend to employ within their primary classrooms and which could be used and/or adapted for the secondary school context. Consequently, we also investigated the impact of the project on the secondary science teachers involved.

In particular, we were interested in finding out whether or not their involvement in the project informed or changed their practice of teaching science in the secondary school.

In essence, this research aimed to investigate the impact of the school based project on:

- primary teachers' confidence and competence in teaching science
- students' knowledge outcomes and experiences in school science
- the pedagogical approaches adopted by secondary school science teachers.

In the school based project, students would still be taught the Primary Connections curriculum materials designed by the Australian Academy of Science and which are mapped to the content of the National curriculum. The materials were supplemented with lessons that were constructed in the collaborative programming of the science content. It was anticipated that by having the primary and secondary teachers work together it would hopefully ensure a developmentally appropriate continuum of learning in science within the school. The collaborative programming and team teaching approaches in implementing science were to be investigated to see what impact this had on student outcomes so that ultimately, improvements could be made to the way in which science was implemented and experienced at school.

As part of the school based project, students would be conducting experiments and practical experiences both within their classroom and within a science laboratory. The junior school has access to a science laboratory that is onsite (one-minute walk from their classroom). The location of where experiments and practical experiences were conducted was dependent on the lesson focus and content to be covered. The decision was up to the teachers implementing the experiences.

The purpose of the research underpinning this project was to investigate the impact of these approaches on both teachers and students. Specifically, we investigated the following research questions:

1. What impact does the collaborative team teaching and programming have on primary teachers' confidence and competence in teaching science?
2. What impact does this approach have on students' knowledge outcomes and experiences in primary school science?
3. What impact does the project have on the pedagogical approaches adopted by science teachers in their secondary school science lessons?

Methods and Data Collection Approaches

The context for this research is a school based science project implemented within our primary school. Our research team comprised the project lead who was also the Director of Staff Development within the school, a secondary science teacher and primary teacher and an academic mentor from Charles Sturt University. We were responsible for the research underpinning the school based project. This section of the report describes the methodology and outlines the data collection procedures used in this research project.

Research design

A mixed methods approach was adopted for this research. Specifically, a Type-II Case Study (Yin, 2003) employing a pre-test/post-test design was used to investigate the impact of the project on teachers and their students. A Type-II Case study involves collecting multiple sources of data at one location (Yin, 2003). This design was appropriate for our research as questionnaires, semi-structured interviews, teacher programs and student work samples were used to collect data from participants who were based at one location; Kinross Wolaroi School. Certain data were collected at different time intervals throughout the project (pre, during and post). This allowed comparisons to be made at different points in time across the project.

Within this research design, participating teachers also employed action research (McAteer, 2013) to reflect on the approaches they were using and to make changes to how they programmed, and team-taught future science units. In essence, results from the research coupled with information from teacher reflections were used to inform future cycles of implementation. The action research component was key in trying to ensure the sustainability of the project and in better informing future implementation through an iterative process.

Intervention design

A phased implementation approach was adopted to conduct this research project. This enabled us to introduce the project to different year levels and classes in different terms. Implementing a phased approach meant we were gradually able to bring on more classes and teachers over the course of the project. This had two key advantages:

1. It allowed us to make comparisons between and within implementing and non-implementing classes to try to get a sense of the impact of the collaborative approach to programming and team teaching.
2. It provided a means by which to make the project scalable by gradually rolling it out across other classes.

Initially, we had intended to reach all primary classes by the end of the two years. Unfortunately, this was not possible due to restrictions in the number of secondary science teachers available to participate in the project coupled with trying to align the primary and secondary school timetables.

In 2017 Years 1, 2, 3 and 4 were involved while in 2018, Years 2, 4 and 6 were involved. To protect the identity of teachers and classes, pseudonyms are used within this report to represent the classes and teachers involved.

Table 1 outlines our phased approach to implementation. We included Years 1 and 3 in the first year of implementation as the teachers who were teaching these year levels in 2017 were involved in the initial pilot project. It was our intention to then introduce the project to a new class each term to allow comparisons to be made across and within year levels to see what impact the project has on both students and teachers. Where possible this happened. We had hoped to involve all classes in the project (Kindergarten to Year 6) by the end of the two-year funding period.

In 2018, we made a pragmatic decision to focus on three year levels to keep the research manageable. This allowed us to target the project resources to support six classes in implementing the project. Over the two-year funding period, 14 different class groups were involved in the project.

TABLE 1

Phased implementation of the project across classes

Term 1 2017	Term 2 2017	Term 3 2017	Term 4 2017	Term 1 2018	Term 2 2018	Term 3 2018	Term 4 2018
Year 1a ✓	Year 1a ✓	Year 1a ✓	Year 1a ✓				
Year 1b ×	Year 1b ✓	Year 1b ✓	Year 1b ✓				
Year 2a ✓	Year 2a ✓	Year 2a ✓	Year 2a ✓	Year 2a ✓	Year 2a ✓	Year 2a ✓	Year 2a ✓
Year 2b ×	Year 2b ✓	Year 2b ✓	Year 2b ✓	Year 2b ×	Year 2b ✓	Year 2b ✓	Year 2b ✓
Year 3a ×	Year 3a ✓	Year 3a ✓	Year 3a ✓	Year 4a ✓	Year 4a ✓	Year 4a ✓	Year 4a ✓
Year 3b ×	Year 3b ×	Year 3b ✓	Year 3b ✓	Year 4b ✓	Year 4b ✓	Year 4b ✓	Year 4b ✓
Year 4a ✓	Year 4a ✓	Year 4a ✓	Year 4a ✓	Year 6a ×	Year 6a ✓	Year 6a ✓	Year 6a ✓
Year 4b ×	Year 4b ✓	Year 4b ✓	Year 4b ✓	Year 6b ×	Year 6b ✓	Year 6b ✓	Year 6b ✓

✓ Implementing the collaborative approach.
× Teaching how they would normally teach science.

In the school based project, students experienced the Primary Connections Curriculum materials designed by the Australian Academy of Science and which are mapped to the content of the National curriculum. Teachers were involved in a number of collaborative programming sessions that involved the primary teachers working in collaboration with the secondary science teachers. During these sessions, some of the lessons were extended and/or changed to try to make them more inquiry focused and involve students in investigative science. The collaborative programming was often done during professional learning days that were organised throughout the project. These were typically held before the start of a new school term.

Participants

The participants for this research comprised three groups: primary teachers; secondary science teachers; and, primary school students. Over the two year period, 10 primary school teachers and three secondary school science teachers participated in the research. Table 2 presents the number of student participants in each year level who agreed to participate in the research. Sixty two students were involved in the project for two years. This means that over the two-year period, 234 individual students participated in the research.

TABLE 2

Number of student participants in each year level

Year Level	2017 Number of students	2018 Number of students
Year 1	37	
Year 2	42	35
Year 3	42	
Year 4	44	44
Year 6		52
Total	**165**	**131**

Recruitment

Initially, a meeting was held with the Academic Mentor, Team Leader and the school Principal to discuss the proposed research. The research components were outlined to the Principal and permission to conduct the research within the school was obtained before approaching teachers and students about the research. Teachers were informed about the project during a primary school staff meeting. The Academic Mentor attended the staff meeting and gave a presentation that outlined the purpose of the project and which contextualised the research in relation to the existing literature. Teachers were given an information sheet (See Appendix 1) explaining the research and were invited to participate by giving their informed consent (See Appendix 2).

Information sheets and consent forms (see Appendices 3 and 4) were distributed to students by the school research team. The research team verbally explained the research to students. Students were also given an information sheet and consent form for their parents/guardians (see Appendices 5 and 6). Parents and guardians were asked to complete the consent form if they agreed to their child participating in the research underpinning the school based project.

Ethical considerations

We obtained ethical clearance to conduct this research from the Human Research Ethics Committee at Charles Sturt University. Our protocol number is H16108 (See Appendix 7 for our approval letters). Our research was conducted in light of the AISNSW Ethical Guidelines and the National Statement on Ethical Conduct in Human Research guidelines (2007). All participants were treated with appropriate respect and were invited to take part in the research. It was made clear to participants that they were free to withdraw from the research at any time. If a participant wanted to withdraw from the research there were no foreseeable repercussions.

It is important to note that teacher participation was integral to the implementation of the school based project. They still, however, had the option not to participate in the research or could withdraw from the research component. If teachers chose to withdraw from the research they would continue to teach the science anyway because of the curriculum demands, but they would not need to provide any research data and if any research data was collected from them it would be discarded.

A further ethical consideration related to how we protected the confidentiality of participants in this research. Especially given the school based nature of the research and the fact it was being conducted within one school setting. This research is not concerned with presenting an individual participant's results though it was necessary to collect information in a re-identifiable form as we needed to match post-occasion (end of term) student responses to their pre-occasion (start of term) responses. Class data have been aggregated and de-identified. Furthermore, all participant data have been de-identified and pseudonyms are used for teacher, student and class names when presenting the results of this research.

Data Collection

Multiple quantitative and qualitative data sources were collected from participants over the two-years of the project. Specifically, interviews were conducted with both students and teachers. Teachers also completed an online reflection and feedback form on two occasions while students completed questionnaires about their perceptions of science lessons at school. Students also completed pre and post-occasion questions related to the science content covered over the course of each school term.

Teacher and student interviews

All interviews were semi-structured where the research team had a list of pre-prepared questions to guide the interviews. The academic mentor conducted the teacher interviews while one of the teachers from the research team conducted the student interviews. The interviewer could ask the questions in any particular order and was able to rephrase questions to suit the context and flow of the interview. The interview schedules of questions that were used to guide the teacher and student interviews are presented in Appendices 8 and 9 respectively.

Teacher interviews were conducted in two different grouping situations that is, on an individual basis or in focus groups based on the composition of the teaching team. The length of teacher interviews ranged from approximately 20 to 30 minutes.

Student interviews were conducted in small groups comprising four participants. It was thought that conducting interviews in group situations would be more conducive in providing students with a supportive and comfortable environment with which they would feel safe in sharing their thoughts as opposed to an interview situation where they were on their own. Student interviews varied in length but averaged approximately 20 minutes each.

All interviews were digitally recorded and were transcribed by a transcription agency. The interview data are used to gain insight into participants' thoughts and feelings about school science and to depict student and teacher perceptions of what was happening in science lessons during the project.

Teacher reflection and feedback form

Teachers completed an online reflection and feedback form on two occasions. This form comprised the following six questions:

1. What has worked for you in the collaborative science project (what have you liked)?
2. What has not worked for you in the collaborative science project (what have you disliked)?
3. What could be improved for you?
4. List three things you have learned during the project.
5. List three things you need to know more about.
6. Write five words to describe how you feel about the project at this point in time.

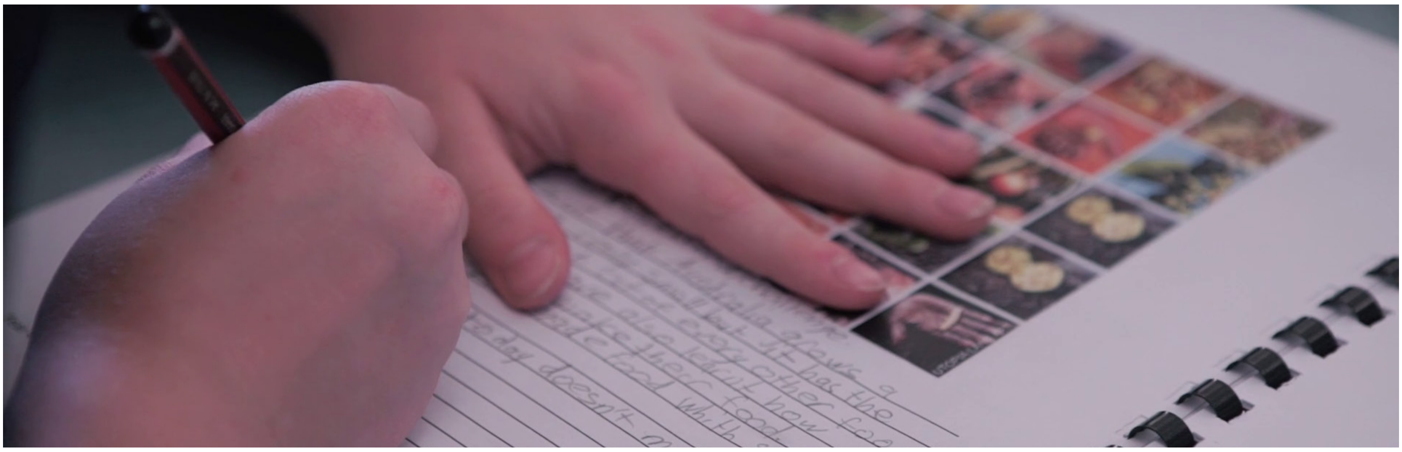
The form was accessible via a survey monkey link and distributed to teachers during Term 4 of 2017 and Term 3 of 2018. We asked teachers to complete the form based on their experiences in the collaborative science project in each of the respective years. Appendix 10 contains a copy of the form.

Student perception questionnaire

An online questionnaire was used to collect information from students about their perceptions of science lessons at school. The questionnaire comprised eight rating scale items that focussed on what happened in science lessons. These items were taken from the Primary School Science Questionnaire (Goodrum, Hackling & Rennie, 2001) that had previously been used in a national study. There were four rating scale items related to their enjoyment of science lessons. There were also three open response items that asked students to comment on what they liked about their science class, how it could be improved and they were asked to list three words that described how they felt about science lessons at school. There were three options in the rating scale: never; sometimes; or, always. Appendix 11 contains a copy of the questionnaire.

The questionnaire was administered to students within one of their science lessons during Term 1 2017 and in Term 2 2018. Having students complete the survey during the first term of their involvement in the project and then again part-way through the second year would allow us to get a sense of whether there were differences in how they felt about science and to find out more about their experiences in science during the project.

"The interview data are used to gain insight into participants' thoughts and feelings about school science and to depict student and teacher perceptions of what was happening in science lessons during the project."



Student knowledge questions

As part of the collaborative programming approach, teachers worked together to design a set of questions that related to some of the content to be covered within each of the science units that were to be implemented over the course of the project. The questions were created during the programming sessions that happen before the start of a term. Teachers put together three or four questions that required written explanations from students and/or a drawing response. They were administered to students at the start of a term (pre-occasion: before undertaking any work on the science unit) and then again at the end of the term (post-occasion) at the completion of the unit of work.

It is important to note that the questions did not assess everything covered within the units of work. Rather, they were targeted at key concepts. We wanted to use them as a diagnostic tool to see what students already new about the content to be covered and to get some baseline data on the pre-occasion. On the post-occasion, we wanted to get a sense whether or not there had been any changes in students' explanations based on what they had learnt within the unit of work. We also compared responses across classes to see if there were any differences.

We coded student responses to each question using a SOLO code. A SOLO code and was based on the Structure of the Observed Learning Outcome taxonomy (Biggs & Collis, 1982). The SOLO taxonomy provided a structure or classification system that helped make judgements about the complexity of students' written explanations. Biggs and Moore refer to the SOLO taxonomy as "a way of categorising levels of learning in terms of increasing cleverness" (1993, p.67). The SOLO taxonomy consists of five levels ranging from prestructural, at the least competent end, through unistructural, multistructural, and relational through to extended abstract at the most competent end (Biggs & Collis, 1982; Biggs, 1991; Biggs & Moore, 1993). Each level of the SOLO Taxonomy, as described by Biggs and Moore (1993), is presented in Table 3 below.

TABLE 3

Levels in the SOLO Taxonomy (adapted from Biggs & Moore, 1993, p.71)

Structural Level (SOLO)	
Prestructural	The task is engaged, but the learner is distracted or misled by an irrelevant aspect belonging to a previous stage or mode.
Unistructural	The learning focuses on the relevant domain and picks up one aspect to work with.
Multistructural	The learner picks up more and more correct or relevant features, but does not integrate them together
Relational	The learner now integrates the parts with each other, so that the whole has a coherent structure and meaning.
Extended Abstract	The learner now generalises the structure to take in new and more abstract features, representing a higher mode of operation.

The SOLO taxonomy provided an ordinal method of classifying students' explanations and allowed the level of complexity of the respondent's explanation to be recognised. The criteria used to determine the level of complexity of students' responses and the codes used to represent such responses are presented in Table 4 below.

TABLE 4

SOLO Coding System used for students' explanations

Code	SOLO Level	Criteria
0	Blank	The explanation section has been left blank and no explanation is provided.
1	Prestructural	The response does not appear to answer the question or may simply be stating the question.
2	Unistructural	One piece of information was evident in the response. Responses at this level contain one fact.
3	Multistructural	More than one piece of information was provided in the explanation. Responses at this level contain several facts, but consider the facts in isolation; no clear links are made amongst the facts.
4	Relational	Pieces of information have been presented and related together. Various facts are linked together and are related to a main concept, the explanation is valid only for the given context.
5	Extended Abstract	A response of this type goes beyond what is asked in the question however the explanation presented by the respondent clearly indicates how the additional information relates to the question. The response generalises across contexts.

Data Analysis

Thematic analysis was used for interview data and open-responses (in surveys and feedback forms). Interview transcripts were read and coded for common themes within and across responses. NVivo software was used to support the thematic analysis. Themes, counts and examples of responses are used to illustrate participants' thoughts and perceptions of what was happening in science during the project.

Descriptive statistics are presented for the student survey data and for the knowledge questions. Patterns of responses to items are compared and where possible, comparisons are made between those students who were involved in the project and those who experienced science how they had normally been taught.

A total SOLO score was computed for students' explanations to the knowledge questions for each occasion of testing. Mean SOLO scores for individual classes are graphed across occasions to allow comparisons to be made from the pre to the post-occasion of testing.

Results and Findings

The results and findings of this research are presented in relation to the teacher and student data that were collected. The first section is concerned with findings from the teacher while the second section focuses on student-related findings. The discussion discusses the results in relation to the research questions.

Teacher Results and Findings

Analysis of the teacher interview data followed by the analysis of the teacher reflection and feedback forms are presented below. Teachers were interviewed on two occasions part-way through 2017 and mid-2018. They also completed a teacher feedback and reflection form in 2017 and 2018.

The results below compare and contrast teacher perceptions and responses. The sub-headings used represent the areas that were discussed in interviews or covered within the teacher refection and feedback forms. Where appropriate, direct comments from interview scripts and feedback forms are presented to illustrate teacher perceptions of and experiences in the project.

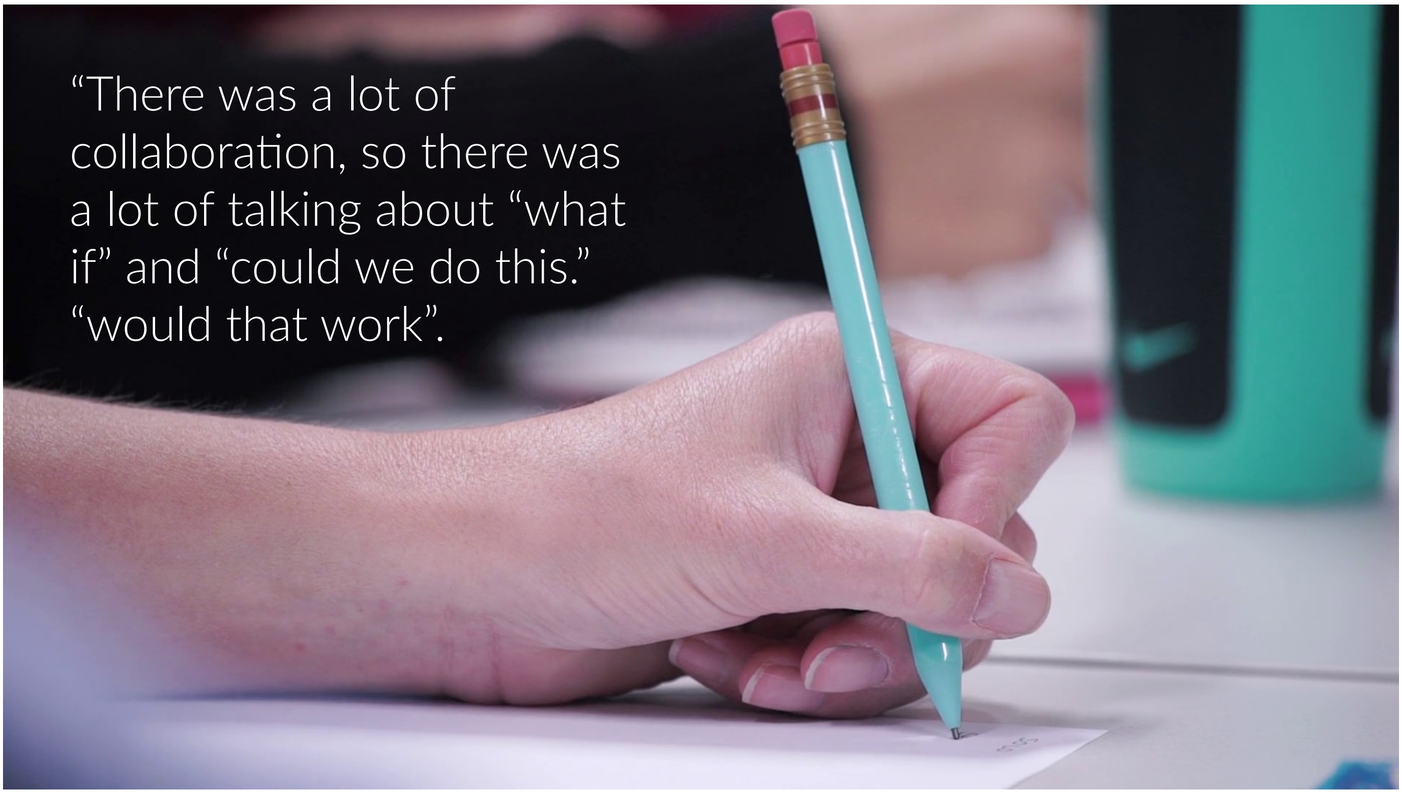
Teacher Interview Results and Findings

In order to get a sense of the main themes contained across the teacher interviews, we have broadly categorised them into positive and negative aspects and present them in Table 5 below.

TABLE 5

Broad summary of themes from teacher interviews- positives and negatives

Positive aspects identified by Teachers	
Primary Teachers	**Secondary Teachers**
Collaborative programming	Collaborative programming
Consultation with secondary teachers	Student engagement and enjoyment of science
Planning/programming sessions	Opportunity to work with primary teachers
Student engagement and enjoyment of science	Finding out what primary students cover/know
Scientific language of students	Reflection on teaching practice
Improved confidence in teaching the content	
Negative aspects identified by Teachers	
Primary Teachers	**Secondary Teachers**
Time constraints	Timetabling
Timetabling	Size and/or number of classes
Primary Connections Units can be restrictive	Primary Connections Units can be restrictive
Not covering the technology aspects	Resourcing and resource management
Sometimes language used to explain concepts is pitched too high	



Things that seemed to be working

Collaboration was a key theme identified as something that was working well within the project. During the project teachers collaborated on the programming of science units and in the teaching of them. The collaborative nature of this process is reflected in the following teacher quote: "there was a lot of collaboration, so there was a lot of talking about "what if" and "could we do this" and "would that work".

In the 2017 interviews, four teachers made 10 references to how well-received the consultation and collaboration elements of the project had been while in 2018, four teachers made reference to the collaborative elements of the project that were working well for them. Table 6 presents a sample of quotes from the teacher interview transcripts that reflect the nature of this theme.

TABLE 6

Consultation and collaboration example quotes from teacher interviews

2017 Examples of Quotes
We've had a consulting day which was, I just found that fantastic so I got an overview of what this term's session's science unit's going to be about which was really good.
I love the whole secondary, prep collaboration. I think that's fantastic!
We've had the two collaborative days which have been fantastic. Yeah, we've enjoyed that and just having the opportunity to bounce ideas off each other.
I like teaching with other people and I think it makes you a better teacher by bouncing off other people and sharing ideas.
2018 Examples of Quotes
The collaborative planning, I think, is something that I think the time has been really worthwhile.
The collaborative planning I think's important as well.

Confidence and knowledge were two themes often used interchangeably within teacher interviews. It was evident across the 2017 and 2018 interviews that many of the primary teachers involved felt they had increased confidence in teaching science and that their knowledge and/or science vocabulary had improved as a consequence of working with the secondary science teacher in the project. The following quote from a primary teacher reflects how they felt the team teaching approach was helping to build their confidence in teaching science and their knowledge of content.

For me, it's just like me feeling more confident. I feel … and the fact that I feel like I've learnt something and I am able to now confidently talk about heat and it being produced by certain sources and all of that sort of stuff. I feel the highlight for me is that I have grown so much this term and when I see the kids using the language that they're using, just in … and not even necessarily just in science lessons. They are using the word transferring and conduction and just things like that in different situations, not necessarily in science. It's really great to hear the language and see the understanding and the sorts of things that they're coming up with in science. That sort of excites me because you think, oh, … they're actually … it's sinking in, whatever we've been teaching them. I would say that that's a highlight too.

Table 7 presents a selection of interview quotes from the primary teachers that related to improved confidence and/or competence in teaching science. In the 2017 interviews, six teachers made seven references to improved confidence and/or competence in teaching science while five teachers made seven references in the 2018 interviews.

> “Many of the primary teachers involved felt they had increased confidence in teaching science and that their knowledge and/or science vocabulary had improved as a consequence of working with the secondary science teacher in the project.”

TABLE 7

Confidence and improved knowledge example quotes from teacher interviews

2017 Examples of Quotes
I think my confidence with teaching the subject area. I’m really confident to pick up that material and know that I’m telling them, sort of scientifically I’m telling them the correct thing
I saw myself as being a bit hopeless with the whole science thing and just listening to the language and the vocabulary that they used was really helpful for me.
I really like having [secondary science teacher] come into the room and hearing the sorts of the correct language or the vocabulary to use. But it’s been really useful too, particularly with last term, our mixtures topic, [secondary science teacher] was able to bring in a whole lot of vocabulary that probably would have gone over my head, or not necessarily over my head but maybe just not…
I think that [secondary science teacher] enthusiasm for science has certainly got me a bit going, because really science wasn’t something that I loved to teach, so I think that that’s been useful.
And the other thing is the language, the language that we’re using, we’re talking about chromatography, we’re talking about heterogeneous and homogenous solutions and some mixtures.
2018 Examples of Quotes
I'm certainly loving having [secondary science teacher] - that expertise, that real science knowledge, that’s great. That’s helping me, I feel, with questioning and working with the children, so that’s a good thing.
If you’ve got someone else coming into the room that can help explain that and that’s their field of understanding, it helps you then understand
I think my confidence has definitely grown. I probably make sure that I fit the Science in, whereas before, prior to the project altogether, I may have gone, “Well, I can't fit that in so we won't actually do that this week,” and then you're catching up, I guess.
I know for myself now I’m teaching science a lot better than what I was.

Student engagement and enjoyment was also identified as an important theme under what was working within the project. In the 2017 interviews, five teachers made six references to student engagement and enjoyment while six teachers made five references to this theme within the 2018 interviews. Table 8 presents a sample of teacher quotes from the two interview occasions that reflect this theme.

TABLE 8

Student engagement and enjoyment example quotes from teacher interviews

2017 Examples of Quotes
There were some things that the kids just loved. I really find that, in general, the kids in year [class removed] still are really enjoying science.
I think it's put a spark of excitement into it.
The students, they seem to have been quite engaged in the activities which has been good.
I just found that they were little scientists basically and I found that really exciting to, and they were excited about what they were doing
…it's just great having [secondary science teacher] there because he can pose questions and give information that I wouldn't necessarily have thought of, not being a science teacher. And that's what I have found really, really good. And the kids love working with [secondary science teacher]
2018 Examples of Quotes
There's a definite interest in the children, you can see they're very focused on the task and the investigations and they're loving … I think they see themselves working as scientists.
Certainly, the levels of engagement are very good. They're excited by it.
So they [students' really are doing what they're supposed to be doing and even though it is chaos a lot of the time, there is actually engagement, discourse - the kids are talking.
But, I said the other day, there's no science today, and [sigh] so it was a negative response, which is a positive really.

Things that were not working

Time was identified as a major theme across both teacher interview occasions. Teachers seemed to want more time to work on the collaborative programming before the start of a unit. It was also interesting to note that teachers wanted time at the end of a unit to be able to critically reflect on what had happened over the term and to allow them to make changes to the program for future implementation. The following three quotes illustrate the nature of this theme.

I think trying to do too much has been the biggest problem, so I'll find that there's no time for consolidation.

I think, really, just having that time to program and we were having a conversation earlier about when is a good time, we don't, I don't want to be away from my class any more than I already am.

We went and printed the unit off and I remember looking at things, thinking, “The students, they seem to have been quite engaged in the activities which has been good.”

“Oh, no, that didn’t work. We needed to change that,” and we didn’t have the opportunity to do that.

Timetabling was also a theme that was identified as a constraint or was of concern across the teacher interviews. The scheduling of science lessons within the primary school had to fit within the constraints of the secondary school timetable given some of the secondary science teachers were involved in the team teaching of lessons. The following quotes capture what teachers were saying in relation to this theme.

I think the main thing that probably inhibits people is probably the flexibility with timetable.

Fitting in with a secondary timetable but also fitting in with a secondary Executive member that we’re sort of sitting in limbo sometimes waiting.

I think timetabling is a huge roadblock and the time allocated to be able to do this, so I guess it would be nice to see a little bit more importance placed on it.

Things teachers would like to see continued

During the project, we used feedback from teachers to help inform the next iteration of the project. In the 2017 interviews with teachers, it was evident they wanted the collaborative programming to continue. Many of the primary and secondary teachers asked for additional time to be devoted to collaborative programming. This also seemed to be a top priority for respondents across the 2018 interviews. The majority of teachers in the 2018 interviews indicated that going forward, they wanted to see the collaborative programming continued and more time devoted to this before the start of a unit and at the end of a science unit to allow reflection and feedback to inform the next iteration of the unit of work.

The 2017 interviews revealed that two of the primary teachers and two secondary teachers involved in the project indicated that they would like better access to the science laboratories for their primary classes.

There were two reasons offered for why these teachers wanted more access to the labs. First, they felt students would be more excited if they went to the labs. Second, the labs contain the equipment needed for lessons so there would be less time spent on sourcing and organising equipment. It is interesting to note that in the 2018 interviews, teachers did not mention the science laboratories as a priority going forward. Rather, their responses focused on the collaborative programming, extending the project to other year levels (continuum of learning- including the transition to high school) and continuing with aspects of the collaborative teaching.

Team teaching approaches

During the interviews the teachers gave descriptions of their team teaching approaches. It was evident that there were different approaches used across the classes. Not all classes adopted the same approach. There were some who appeared to work collaboratively together on all aspects and felt comfortable building on each other's ideas and approaches during lessons. This relationship seemed to develop and prosper overtime.

[Secondary teacher name] and I are very comfortable with each other so we just jump in and take off from wherever we left and I'm finding that easier and easier as it goes along but I'm also far more confident just to go, "Well hang on a minute, let's just come back a bit," or you know because sometimes [Secondary teacher name] jumps in at a level that's a bit higher or sometimes even ask, "Where will we start?" and you know then I will say, "Now where are we going from here?" So we're sort of gauging the lesson. So I'm finding the team teaching really, really good, like I think, I think it's quite … The kids love it and we're able to split in the groups and both give really solid feedback to the kids. (Primary Teacher)

There were those who highlighted the benefits their expertise brought to the lessons. Some of the primary teachers indicated they felt the secondary teachers helped with the content while they helped translate this content to an appropriate level for their primary students.

We really have bounced off each other in terms of the information that we both get I think in terms of delivering the lesson. I've sort of, in terms of talking with the kids and pitching it at their level, there's a few things that I've been able to bring to [Secondary teacher name], so I talk about tools in the classroom. (Primary Teacher)

Some of the secondary teachers indicated that the team teaching experience really made them stop and think about the purpose of their lessons. Some also felt there were things they could apply to their secondary science classes.

It certainly makes you refocus on what the important point of the lesson is.

"Some of the secondary teachers indicated that the team teaching experience really made them stop and think about the purpose of their lessons. Some also felt there were things they could apply to their secondary science classes."

What's your main point. So therefore it makes you stop and think about what's your main point in the lessons you're teaching up in senior school or are you just going all over the place that the kids in senior school can't connect the dots? So it's paring it down is what is the main point of your lesson. So I think that's been really good. I think it's been really good because it actually makes you stop and think about how you explicitly instruct things, because I'm so much with senior kids you forget that you actually have to have a sequence of instructions (Secondary Teacher)

A reflection from a participating secondary teacher indicated that their involvement in team teaching made them think about how they teach their secondary students. They have started to reconsider some of the scaffolding and pedagogical approaches that could be employed within their secondary science classes. The following quote is from one of the secondary science teachers who was involved in the team teaching.

These kids were using, we were using words like homogenous, heterogenous, words like that, that when kids get to Year 7 we assume that they don't know. So that's been a real eye opener for me at the other end. We just kind of assumed that the kids get to Year 7 pretty much not knowing anything but there is scope and there is a fair bit that the kids do know, well from what I've seen at least at the primary level.

Over the years you build up this picture of what kids are like when they come into Year 7 without really knowing where they've come from. Yeah, and sort of getting my head around that has been probably the most valuable thing for me I think.

I see a completely different angle to the kids and I think I just made assumptions about kids in primary schools without having ever really experienced it. And it's given me a few things to think about, and it kind of changes my approach to my Year 7 class. Because like I said I've probably made a few assumptions over the years that haven't really been warranted or justified. So I'm getting just as much out of it as [the primary teacher] is.

Teacher Reflection and Feedback Form Results and Findings

The teacher reflection and feedback forms were also coded based on common themes. Table 9 represents the main themes identified within the forms. It is interesting to note to similarities within the interview themes identified earlier.

TABLE 9

SOLO Coding System used for students' explanations

What worked	What didn't work	What could be improved
Collaborative programming	Timetabling	Reflection time
Team teaching	Laboratory access	Collaborative planning time
Discipline expert/knowledge	Not enough time	Learning environment (i.e. spaces and smaller class size)
Impact on practice	Class size	
Impact on students		
Personal satisfaction		

In analysing teachers' responses to the feedback forms, we have collated responses from teachers that highlight the key aspects they felt worked well during the project. We have grouped the comments based on the type of teacher participant involved (i.e. primary or secondary teacher).

Primary teachers- examples of what worked during the project:

- Collaborative programming, team teaching, benefiting from an expert in the field, access to Science Labs, children see themselves as scientists.
- I liked team teaching with the Science high school teachers as they were able to give more scientific definitions and information. It also helped me to understand some of the content better.
- I have enjoyed the collaborative planning and having a specialist science teacher to build the correct vocabulary.
- Programming and teaching with the secondary teacher.
- I have enjoyed having two adults in the room to be able to allow more investigative science and instant feedback for students to take place. Having the secondary science teacher available to re-direct or to ask questions of has been invaluable.
- Enjoyed working with a peer and enjoyed blending ideas to come up with a great programme.
- I have loved having the expertise of a specialist science teacher. [Teacher] is so passionate about science and students learning from involvement. I personally have learnt so much from [Teacher] in terms of using scientific vocabulary and not directing the students too much but letting them work it out themselves.
- Having time to spend with a group of teachers has been very beneficial for programming units. I think that this has impacted on the joint ownership to direct the lesson when team teaching. I really enjoy the team teaching and having the scientific knowledge of the secondary teacher to answer questions or explain a concept that I may not be confident with during the lesson. I think my lessons are far more exploratory than they used to be and I have definitely noticed an increased level of scientific understanding in the students as the year has progressed.

It seems the primary teachers felt the collaborative programming coupled with the team teaching aspect was invaluable. Having access to a discipline expert appeared to worthwhile and beneficial for many. Similarly, the secondary teachers felt the collaborative programming worked well within the project. Evident in some of the secondary teachers' responses was also an element of personal satisfaction that related to teaching the primary students.

Secondary Teachers - examples of what worked during the project:

- Co-programming with teachers.
- Loving teaching in the prep school.
- Learning to teach [primary – Year level removed] students. Loved their excitement and thirst.
- I have loved the fact of seeing the sophisticated vocab the kids can learn. I am always surprised by them.
- Prep staff have helped me to understand progression from prep-high school.
- Programming was invaluable. Having the time to collaborate and plan together is the best part of this project, as we all learn from each other. By planning together, we all have buy in and understand where the program is going and what we are doing.
- The scope for inclusion: the teachers I have worked with were willing to try anything available and were incredibly accommodating.

The Teacher Reflection and Feedback Form also provided opportunities for teachers to share their thoughts on what was not working during the project. This allowed us to reflect on responses and use them to adjust aspects of the project where possible. There were some differences in the sorts of things that primary and secondary teachers identified. These are outlined within the dot points below.

Primary teachers - examples of what did not work during the project:

- Matching up times with secondary timetable and having to reorganise lessons to fit in with fortnightly lessons.
- The timetable is so rigid there was no room for flexibility.
- I don't think the science project has been made a priority for others that are not directly involved.

Secondary Teachers - examples of what did not worked during the project:

- Too many students in the one room.
- Communication of roles for each person not always clear.
- Too many classes for me to take.

Teachers were also asked to comment on what could be improved within the project. The need for 'more time' was a prominent response across feedback forms. It is interesting to note some of the similarities between the primary and secondary school teacher responses to the reflection form and the key themes that emerged from the interviews. We present some of their responses to illustrate the key things they would like to see improved within the project.

- More time to collaborate with the high school teachers.
- More timetable flexibility, an opportunity to review units at the end of the teaching period.
- It would be great to look at new units to teach from each learning content, particularly areas of interest for the students. We are currently using units from Primary Investigations. It would be timely to look at some new units to replace others that may not spark the students' interest completely. Learning spaces. The units that I have taught don't need a science lab, but a multi-functional space with desks at the right size, appropriate flooring and an assistant to source equipment and somewhere to store resources for science would be dream like.
- Smaller classes. It would be wonderful to have the time to teach just one class at a time.
- Perhaps planning time would be the greatest benefit.
- Time!!! More time to follow up on practical work and assess student progress.
- More collaborative planning time and time built in to review the data collected to be able to shape the direction of learning for different cohorts would be beneficial. Even time allocated to review units of work while they are fresh - to add in or take out activities would be helpful. Time to gather and prepare resources for topics would also be great!

Teachers were also asked to reflect on things they had learned during the course of the project. It is interesting to note that many of the primary teachers commented on knowledge or competence related aspects that they felt they had learned. Examples of the primary teacher responses for what they learned during the project are listed below.

- Improved subject content.
- My scientific knowledge base has increased.
- New science vocabulary and terminology.
- The importance and infectious nature of "scientific language" which science teachers use all the time and rub off on the students.
- Better understanding of scientific diagrams.
- Deeper knowledge of science outcomes.
- My knowledge of using data for teaching has increased.
- Ideas for practical activities.
- The mind of a secondary science teacher.
- How to draw and annotate a science diagram.

Secondary teachers identified aspects that related to how they teach and would often make links with the secondary school context. The following list provides examples of some of the secondary teachers' responses of what they learned during the project.

- Prep teachers ability to provide learning across faculties, we need help in this area for secondary school.
- Teaching methods for Prep kids.
- More of an idea of high school transition needs.
- Need to have clear communication at all times.
- How hard it is to teach primary students!
- Need to keep focus of each lesson for primary students clear and simple.
- Admiration for persistence and behaviour management.
- Importance of allocating time for programming.

The final question in the Teacher Reflection and Feedback Form asked teachers to list five words that described how they felt about the project. We have analysed these stream of consciousness words based on whether they were positive, neutral or negative. Results are presented for 2017 and 2018 in Table 10 below. Words that were mentioned in 2017 and 2018 are shown in italics. If a word was mentioned by more than one respondent, we have provided the count in brackets.

TABLE 10

Words teachers used to represent how they felt about the project

2017			
Positive		**Neutral**	**Negative**
Excited (3)	*Reflective (2)*	Different	*Frustrated*
Informed	*Hopeful*	Ambivalent	Apprehensive
Enthusiastic (2)	Engaged	Technical	Restricted
Increased confidence	Encouraged	Still more to do	Time consuming
Collaborative	*Happy*		Time poor
We have direction	Pleased		Rushed
Fun (2)	*Satisfied*		
2018			
Positive		**Neutral**	**Negative**
Beneficial	Practical (2)	Busy	*Frustrated (2)*
Content	*Enthusiastic*	Complete	Concerned for the future of the project.
Enjoyment	*Excited (2)*	In-depth	
Fun (4)	Exciting (2)	Ongoing?	
Happy (3)	Interesting (2)	Routine	
Encouraged	Interested	Anticipation what next?	
Collaborative	*Hopeful*		
Keen	Knowledge		
Confident	Motivated		
Reflective	Positive		
Rewarding (2)	Helpful		
Satisfied	Worthy		
Fortunate to have been part of this study.	Building rapport with colleagues.		
Proud that we have seen some good science happen.	It was a good experience for professional development.		
Good team teaching.			

Student Results and Findings

As outlined earlier, three main sources of data were collected from students: a perception of science questionnaire; student knowledge questions; and, student interview data. The following sections present the analyses of these data. All data have been aggregated and de-identified to protect the confidentiality of participants. Actual year levels and class names have been replaced with pseudonyms to protect the identity of teachers and students in the participating classes.

Student perception questionnaire

The student perception questionnaire was administered on two occasions during the project. In the analyses below, we present the patterns of responses to each of the questions as percentages in stacked bar graphs. This allows us to look for similarities and differences in the patterns of responses over the two years of implementation.

Figure 3 presents the patterns of student responses to the items concerned with the sorts of things they do within science lessons. It is evident that the 2018 cohort seemed to experience more group work in science lessons with 40% of the 2018 participants indicating they always worked in groups compared with 11.5% in 2017. Practical work appears to be common place in science lessons across the two years with the majority of students from both cohorts indicating this happens more often than not.

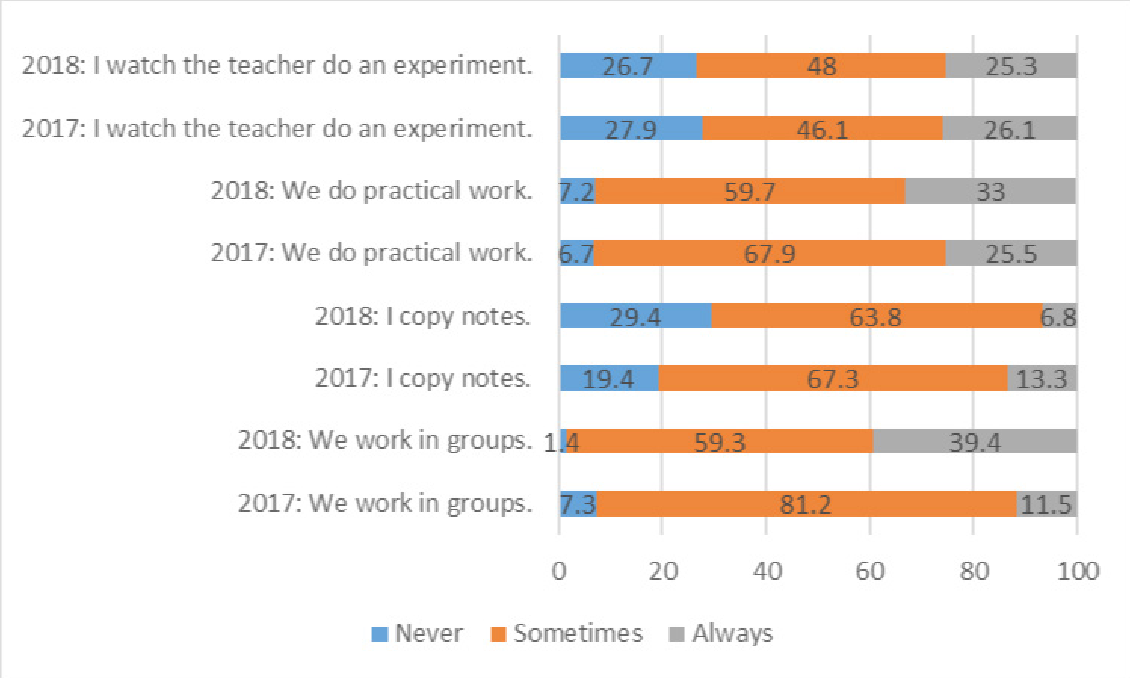


Figure 3. Experiences in science lessons

Figure 4 presents the patterns of student responses to items concerning their teacher's role in questioning and explaining things in science. It is really positive to see that across the two years, the majority of students felt their teachers explained things really well in science. Similarly, teacher questioning was a prominent feature in science lessons across the two years.

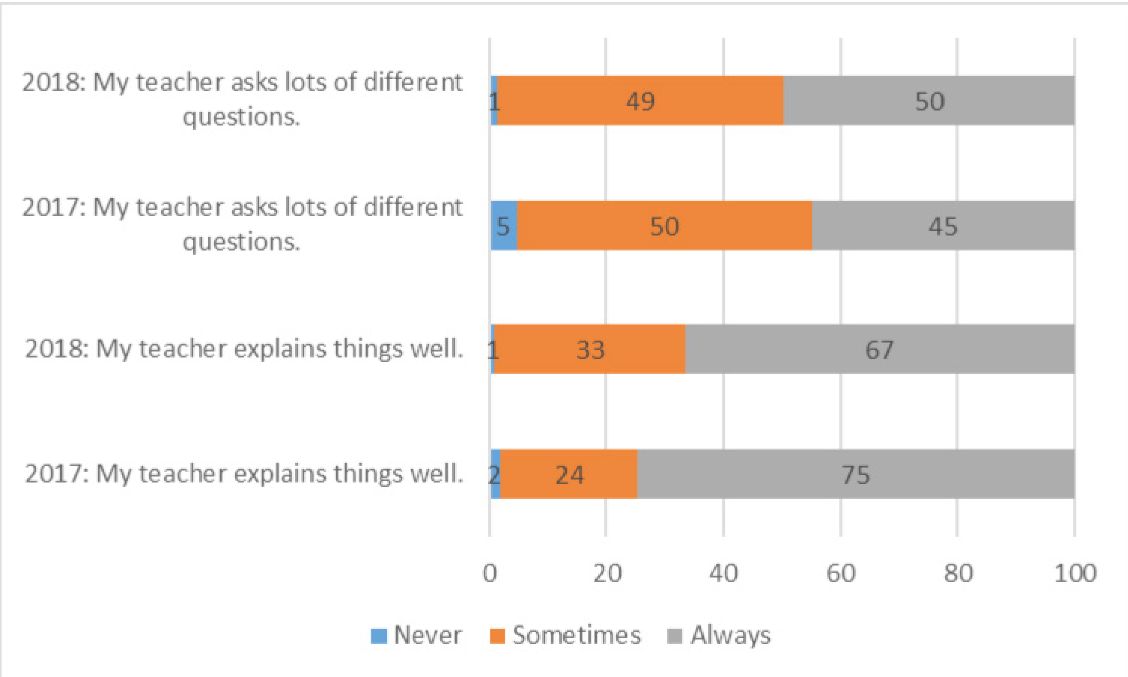


Figure 4. Students' perceptions of their teacher's role in questioning and explaining

Figure 5. presents the patterns of student responses to the items concerning their excitement in science lessons. The majority of student responses fell into the sometimes category for the item related to how often they were excited about what they were doing in science lessons. More than 90% of students indicated that they were never or sometimes bored in science lessons.

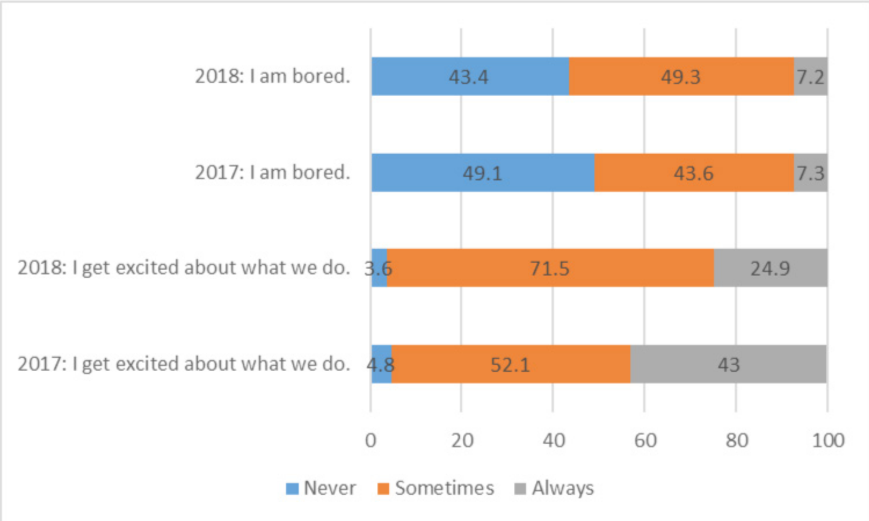


Figure 5. Students' excitement about science

Figure 6 shows the pattern of student responses to the items related to enjoyment of science based on the location of science lessons. The 2017 and 2018 student cohorts appeared to be responding similarly in relation to the item concerning enjoyment of science lessons in the classroom where the majority of responses fell in the sometimes category. Over half of the students in each cohort always enjoyed science lessons that were located in the laboratory. It is interesting to note that approximately 30% of the students in the 2017 cohort did not enjoy science lessons that were based in the laboratory.

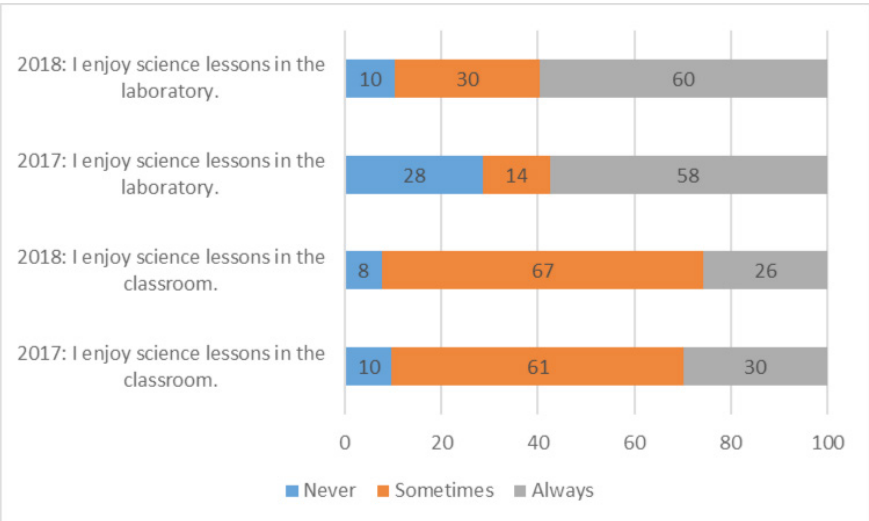


Figure 6. Enjoyment of science based on location of lesson

"The majority of students felt their teachers explained things really well in science."

In the 2018 version of this questionnaire, we added two items that related to the 'team teaching' aspect of the project as the 2017 version of the instrument focused more on the location of lessons and did not really capture students' reactions to having more than one teacher. Figure 7 presents the pattern of student responses to the two items concerned with their enjoyment of science lessons based on the number of teachers involved. The majority of student responses to these items fell into the sometimes category. However, there were more students who selected the always category for enjoying science lessons where they have two teachers (45%) compared with one teacher (37%).

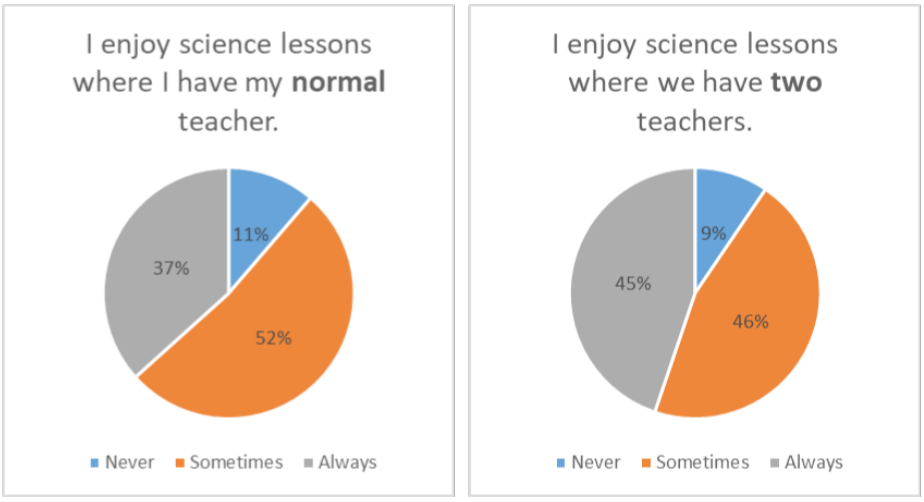


Figure 7.
Individual teacher versus team teaching scenario

The student perception questionnaire also contained an open-ended question that asked students to comment on how their science class could be improved so that they could learn more. Students' open responses were coded for themes and response categories were created based on the themes identified.

Table 11 presents the percentage of student responses that fell into each response category for the open response item How could your science class be improved so that you could learn more? It is interesting to note that there were more response categories evident within the 2018 data compared with the 2017 categories. Wanting more practical work was the most common response across both cohorts (48.1% and 35.3%).

TABLE 11

Students' perceptions of how science lessons could be improved

Response category	2017 %	2018 %
More experiments/practical work	48.1	35.3
More group work	3.9	5.3
Like it as is	17.8	8.2
Access to more information about the topic	3.9	2.9
Go to the science laboratory	5.4	14.7
Make it more fun and/or exciting	10.9	2.4
Make it harder or more challenging	4.7	1.8
Have more science lessons	5.4	4.1
Using more equipment		4.7
Better explanations		2.9
Having the teacher ask more questions		2.4
Continue having two teachers		5.9
Do STEM instead of just science		4.7
Just have my normal teacher		0.6
More individual work and less group work		4.1

The final item in the student perception questionnaire asked them to list three words to describe how they felt about science lessons at school. Given the number of different words used across the student cohorts, we decided to present these results in a word cloud. The word clouds overpage have been generated to highlight the diversity of the words used by students across both cohorts and to get a sense of the frequency these (the larger the word, the more frequent the word was across the student responses).

It is important to note that a number of students offered two positive words followed by a negative word. For example, happy, excited, sometimes bored was an example of this. For the purpose of this analyses, responses that had two words were 'split' into one word. For example, very excited was replaced with excited and sometimes bored was replaced with bored. This approach was applied consistently across student responses before generating the word clouds.

Figures 8 and 9 present the results of the words students used to describe how they felt about science in 2017 and 2018 respectively. There are some similarities in the sorts of words being used across the two occasions: happy, excited, fun, bored. There are also some apparent differences where there seemed to be a greater diversity of words used by the 2018 cohort compared with the 2017 set of responses.

←

Figure 8. 2017 Word Cloud – student words to describe how they felt about science

←

Figure 9. 2018 Word Cloud – representing how students felt about science

Student knowledge questions - complexity of their responses

Students were asked to complete three or four questions at the start and end of each unit of work. These questions were developed by the teachers and related specifically to the content covered within the units of work. The pre-occasion questions were designed to be used as a diagnostic tool where they identified what students already knew about the topic/content that was to be covered for the relevant term. In essence, they provided some baseline data before teaching. Administering the question to students at the conclusion of the unit of work allowed us to see if there had been any differences in students' responses to the questions.

As indicated earlier in the report, the questions were coded based on the complexity of the response using the SOLO Taxonomy. A mean scale score was generated for each class. One on the scale represents a prestructural response, two unistructural response (one chunk of information), three multistructural response (multiple responses) and four represents a relational response. This set of analyses were used in the broad sense to see if there had been any changes in the complexity of student responses across each term of implementation.

Given the phased implementation approach of the project within specific year levels, there were four occasions where we could compare student responses in team teaching classes with those in the corresponding year level that experienced science with their normal teacher. All classes have been de-identified to protect the confidentiality of student and teacher participants.

Figure 10 presents the mean scale SOLO class scores from the pre (start of term) to the post (end of term) occasion of testing. Classes with the numeral 1 after them experienced science with their normal teacher while classes with the numeral 2 after them experienced the team teaching approach. All class mean scale scores increased over the two occasions. All the team teaching classes achieved higher mean scale SOLO scores compared with the classes where science was taught normally.

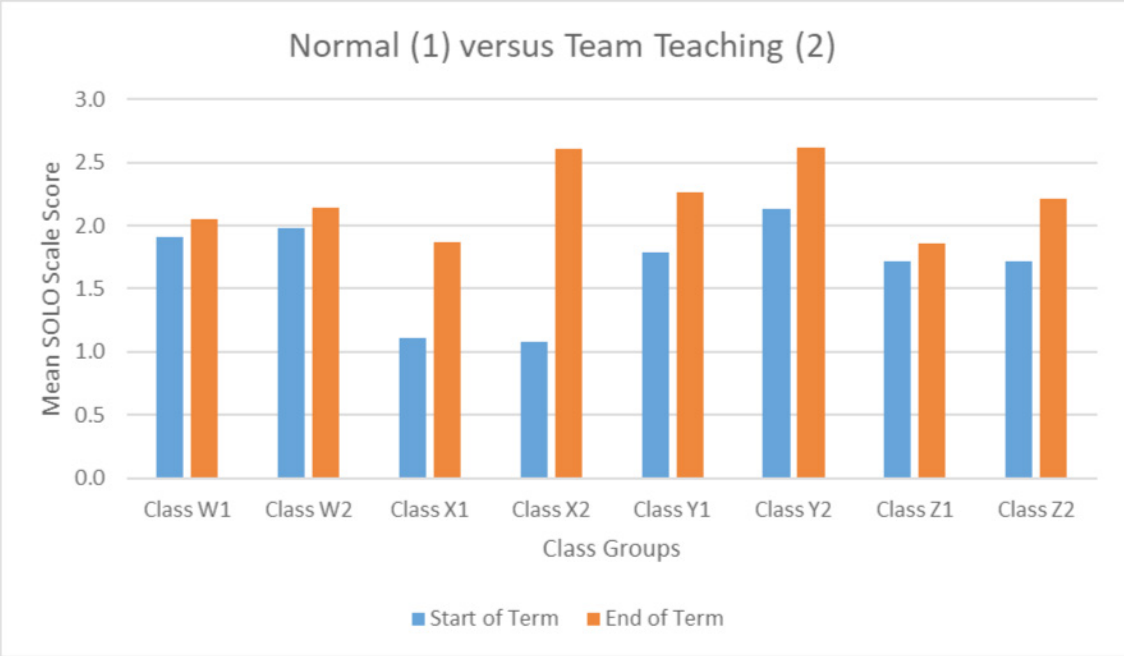


Figure 10.

Mean scale SOLO class scores from the pre (start of term) to the post (end of term) occasion of testing

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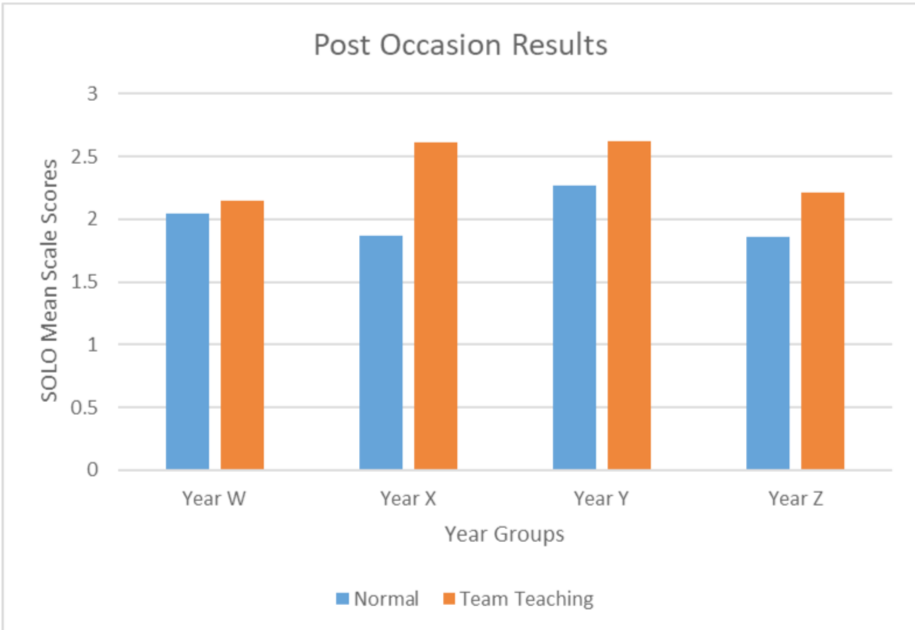
Figure 11 presents only the post occasion mean scale SOLO scores for the normal and team teaching classes. We examined the differences in mean scale scores between classes in the same year level (normal versus team teaching). When we looked at this more closely, Class X1 normal teaching (M = 1.87, SD = .45) and Class X2 team teaching (M = 2.61, SD = .24) had a significantly different mean scores where a very large effect size was observed on the post occasion of testing (Cohen's d = 2.06). There was a moderate effect size (Cohen's d = 0.51) observed between Class Z1 normal (M = 1.86, SD = .71) and Class Z2 team teaching (M = 2.2, SD = .70) for their post occasion mean scores. There was little difference between the SOLO mean scale scores for the classes in Year W where both classes mean scale scores reflected a unistructural SOLO level.



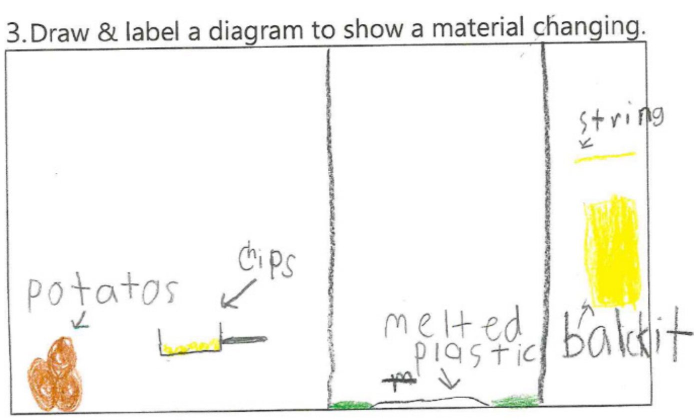
We also examined the SOLO Mean Scale Scores for terms where both classes in each year group were involved in the collaborative programming and team teaching. On all post occasions there has been growth in the complexity of students' responses. Unistructural and multistructural responses appeared to be the most common levels achieved by students. That is to say, they were providing one or more chunks of information to answer each question. As part of the collaborative programming, teachers examined the sorts of questions they were asking students and found that some of the question only required students to list a response. So at best, only a multistructural response could be achieved. Question development was something that needed to be considered throughout the project.

In the set of knowledge questions, some of the questions required students to draw and label a diagram. In comparing pre and post occasion diagrams, we found that the post occasion diagrams tended to reflect a more scientific accurate diagram and appeared to be at a higher level of complexity than their pre occasion diagram. We have provided some examples from different year levels in Table 12 to illustrate these changes.

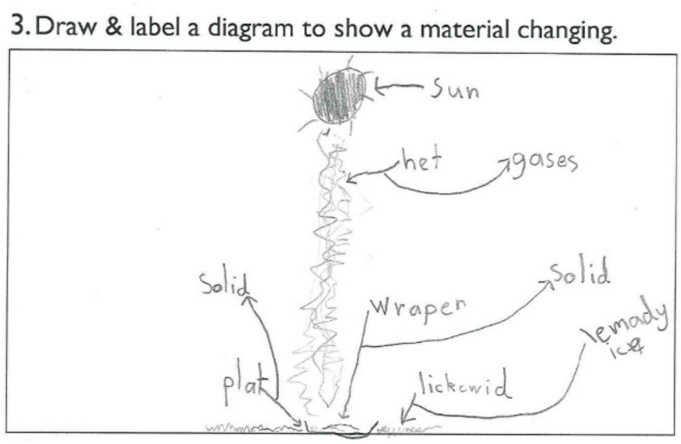
TABLE 12

Examples of changes in students' drawings from the pre to post occasion

Year 1 Pre Occasion



Year 1 Post Occasion

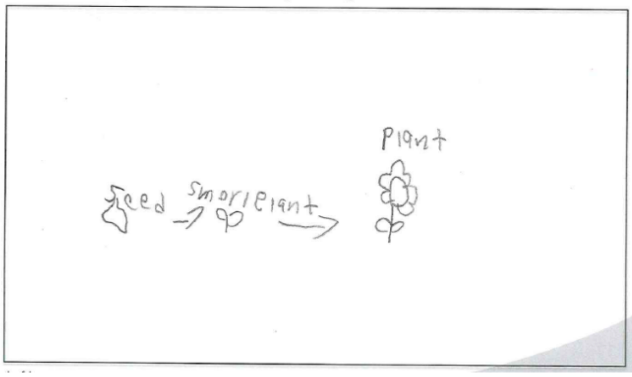


Year 2 Pre Occasion

2. What do living things need to grow?

food

3. Show the life of a living thing.

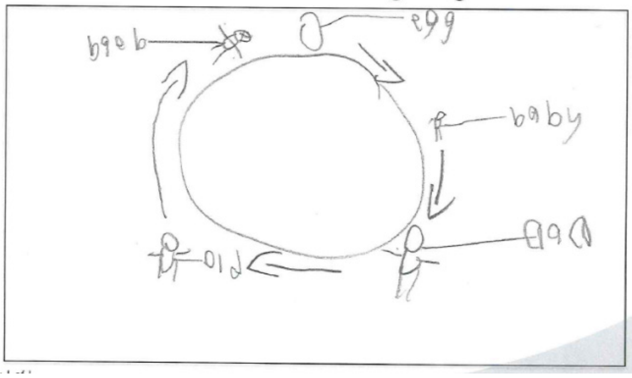


Year 2 Post Occasion

2. What do living things need to grow?

sh eter whrter food

3. Draw and label the life of a living thing.

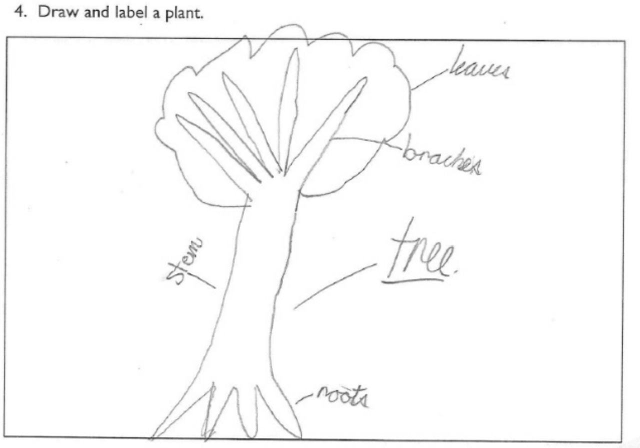


Year 4 Pre Occasion

3. Why are plants important?

Some plants can be used for food like carrots, wheat, potatos and letter. plants can also provide shade for the summer days.

4. Draw and label a plant.

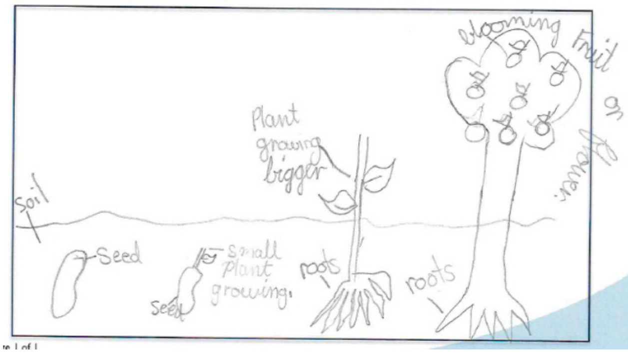


Year 4 Post Occasion

2. What do plants need to survive?

They need soil or sand, water and sunlight.

3. Draw and label a plant.



Year 6 Pre Occasion

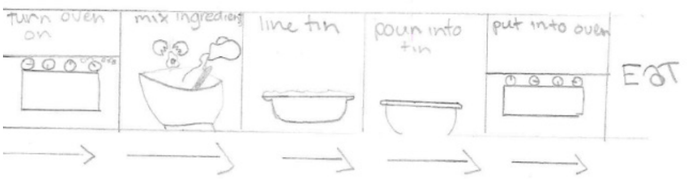
What is a micro-organism?

a small organism ??

Why do you think some bread 'rises'?

yeast. it ~~expands~~ "comes alive" in a way it ~~achvates~~ in heat.

B. Draw a FLOW CHART to show the process of making bread:

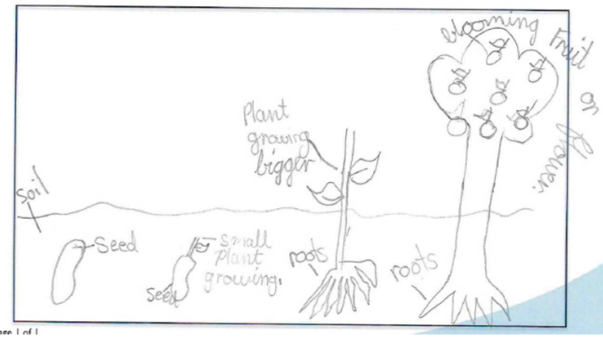


Year 6 Post Occasion

2. What do plants need to survive?

They need soil or sand, water and sunlight.

3. Draw and label a plant.



Student Interviews

Our analysis of the student interviews is presented below. The sub-headings represent the areas that were discussed in interviews or that were themes. Where appropriate, direct comments from interview scripts are presented to illustrate student perceptions of, and their experiences in, the project.

Differences in science lessons

More practical and active science lessons was a common theme across the student interviews. Students perceived science lessons to be more practical in nature during the project. They also felt there was more interaction in science lessons which involved them doing more. Table 13 present some examples of student interview quotes that illustrate how they felt science was more practical and interactive during the collaborative project.

TABLE 13
Example student quotes related to science being more practical

Examples of student quotes - science more practical
Well it's just like last year in Science we would normally do writing but now in Science, like we have to look after pets and stuff. (Year 2 student)
I think it's different by quite a lot because we have animals, like bugs to look after and feed them. We have lots of responsibilities in Science this year. And last year we just needed to know some things to actually get to be good at Science. (Year 2 student)
My understanding has changed because I used to think science was just like a boring topic, and you basically did nothing in it. It's, like, really fun because, well not really fun, but it's better because we do more things, and … The doing of things, like, when we experiment, not just when we're watching videos and stuff. (Year 4 student)
This year's been more fun because we're sort of doing experiments instead of just writing everything down. (Year 6 student)
It's kinda different cause at our old school we didn't do proper science. We just did really simple stuff. Well now that I'm at Kinross it's actually umm… really helpful. Umm, I like the scientific terms cos they'll be very useful. (Year 6 student)

Students also highlighted the differences in how teachers were explaining concepts in science and felt that they were understanding science better during the collaborative project. There also seemed to be an element of challenge for some of the students. Table 14 illustrates students' comments about having better explanations and more understanding in science during the project.

TABLE 14

Example student quotes related to better explanations and more understanding

Examples of student quotes- better explanations and more understanding
It has changed because when I had [two teachers] it was making it easier but when we stopped to have [secondary teacher] it was getting harder and harder for me, because she was like, talking about it more and making it more understanding for me. Because she was explaining it a lot, so it made it easier for me to get what we were doing. (Year 2 student)
I thought science was just about, like, blowing stuff up, and putting stuff into places. Now I think science is, like, experimenting and figuring out stuff, like, plants, you can figure out how they grown, and like, you have evaporation, and it evaporates from the sun. (Year 4 student)
I think it changed because when we were little we didn't really understand it and now that we're older we're understanding it more. But I think when we were little the teachers sort of didn't explain it for kindies. Like they didn't explain it very well. Like they... Yeah, they explained it as if we were understanding it a lot, like really well. Like if we were a lot older than we were. Now the teachers are explaining it really well but we can get, like we get it but they're explaining it really, really well. Like I think they should have done that in kindy. (Year 4 student)
I used to think science was it's really just, like, not that fun, just really boring, but now I know there's actually a lot more to science than just, like, just looking at something, you can actually go and investigate and examine things a lot harder, and you can find out how they work. (Year 4 student)
Well a couple of years ago I wasn't very good at science cause I didn't really understand. But I think this year I'm understanding more because of the way different teachers have taught me. (Year 4 student)
What has been helpful is how they explain it. They explain it much easier, even if it's like a big project, they break it down and they explain each little bit easier – then you sort of 'get it' more than just having it a whole pile on top of you. (Year 6 student)
I think that my scientific knowledge has changed because at my old school we didn't much science and now we do like lots of it, and it's a lot more understanding. (Year 4 student)

Reactions to having more than one teacher

Most students appeared to react positively to having more than one teacher in their science class. It seems the team teaching approach was helpful in providing students with more support during science lessons. There were some students who indicated they did not mind either way. During the interviews, there was one student who indicated they preferred just having one teacher as it would mean they would get to do science for longer (at the time the student was observing mealworms throughout the school day). Table 15 presents examples of some of the students' responses to having more than one teacher during the project.

TABLE 15

Student reactions to having more than one teacher

Year 2 Examples of Quotes
...so one teacher can help the kids and then one teacher can actually do the board and tell us what to do, and the other teacher can help us understand it... with one teacher she has to do two things at, she has to be at two places at once and do it and actually rush.
One is better because then it's a bit longer; we don't get as long as a time on science, and so we check on them usually once a day...[talking about checking mealworms]
Year 4 Examples of Quotes
I found it quite helpful, because ... if one teacher is helping another one, they can help you instead of waiting for the other teacher to finish helping the first person... we have three teachers so it's even better.
It is helpful because if one teacher is with a group there would be another teacher to help you, if there, and we can do things a bit quicker because there's more teachers to help with stuff.
I think it's very useful to have three teachers because it's extra help. So if there was only one teacher in Science and everybody had a question, it would take them about maybe like half an hour to answer all of them. It's also not very good because there's like a lot of help. If you just want to do something, sort of want to learn about it and then a teacher comes up to you and says "that's not how you do it".
Year 5 Examples of Quotes
I think it's good 'cause sometimes they can explain it differently.
To be honest I don't really care.
Year 6 Examples of Quotes
Two teachers was easier than one because if we got stuck we could go and ask one of them if one of them was busy or something.
Well it's easier with two teachers because both of the teachers had different opinions.

“Practical experiences in science appear to be invaluable in helping students with their learning.”

Things that helped students learn in science

During the interviews, students were asked to comment on things that helped them learn in science at school during the project. There seemed to be a practical element present in a number of student responses. Students feel that practical work and doing experiments help them understand and learn in science lessons. Table 16 illustrates the sorts of things students were saying across the year levels. Practical experiences in science appear to be invaluable in helping students with their learning.

TABLE 16

Things that helped students learn in science

Year 2 Examples of Quotes
I think that the mealworms helped us because when we looked at how mealworms and what would they turn into, I looked close up onto it and I thought it would turn into a centipede or a millipede.
Well at the first start, like I thought I was going to get everything wrong until [teacher] said there's no wrong or right answers. [So] I like it. (Year 2 student)
Year 4 Examples of Quotes
It really helps to not just, like, I don't remember when this is, but we've been doing, like, word walls every year, and it actually helps not just to learn the word but actually, like, really understand what it means, not just say oh, this is a word and this is, we're just going to use it now, but we actually understand what it means and we learn what it means, and that's really helpful.
I like last year more because we got to go to the science labs and use, like, the equipment, and we got, because we did evaporation we used a Bunsen burner last year, and we saw that we got to see the water evaporate, and there was this machine, it had, like, a big tube, and then water went in … it helped me understand, like, how science things work, like science equipment work, and I did figure out a lot last year, and I'm not really interested in plants, so I don't really like this topic this term. Year 4 student)
Year 5 Examples of Quotes
A time in science where it helped me is when we get to actually do the experiment, not just having the teacher say do this, write it down, and then like you don't know anything about it when you have to go over it and then write it down so you get it in your head.
Sometimes they're really good when we get to go outside and look at things and like make experiments. But sometimes it's kind of boring when you need to write lots and lots down. (Year 5 student)
Year 6 Examples of Quotes
Something that was helpful was the experiments because you can actually see what's happening. And you just trying to imagine it but maybe not imagining it right and with the experiments, you can actually see what's happening.

Discussion

While most OECD countries require both primary and secondary teachers to hold a similar tertiary qualification, a larger share of primary teachers' education is dedicated to pedagogical and practical training than lower secondary teachers. This may leave primary teachers insufficiently trained in the content they are expected to teach and lower secondary teachers underprepared for the daily practice of teaching. (Excerpt from: Education Indicators in Focus January 2018 #58 OECD)

This research aimed to investigate a school based collaborative science project that teamed up primary and secondary teachers for the teaching of primary science. The research aimed to investigate what impact the project had on: primary teachers' confidence and competence in teaching science; students' knowledge outcomes and experiences in school science; and, the pedagogical approaches adopted by secondary school science teachers. The discussion is framed in relation to the three overarching research questions for this study. The main findings are discussed in relation to the existing research literature. Limitations of the project are identified and implications for practice and recommendations for further research are outlined below.

Research Question 1: What impact does the collaborative team teaching and programming have on primary teachers' confidence and competence in teaching science?

The teacher interview results coupled with their reflections on the feedback forms suggest that the collaborative approach to team teaching and programming positively impacted their confidence and competence in teaching primary science. Many of the primary teachers reported that they felt they had increased confidence in teaching science and that their knowledge and use of science vocabulary had improved as a consequence of working with the secondary science teacher in the project. These findings are consistent with other literature (Forbes & Skamp, 2016; Houseal, Abd-El-Khalick & Destefano, 2014) where collaboration and mentoring between primary teachers and secondary teachers or primary teachers and scientists has contributed to increased confidence and science content knowledge for primary teachers.

It was interesting to note some of the student findings that revealed they felt their teachers were explaining things better in science during the team teaching classes. Many students also felt they were better supported during lessons and were understanding more. These findings might be a consquence of teachers' increased confidence and competence in teaching primary science.

Research Question 2: What impact does this approach have on students' knowledge outcomes and experiences in primary school science?

The student results and findings suggest that the collaborative approach to primary science appeared to positively impact their complexity of responses where higher class means were achieved on the post occasion testing. Students also seemed to be drawing more scientifically accurate diagrams and were using more scientific terminology in describing concepts in science.

Similarly, students' experiences in the team teaching classes appeared to be well-received where they enjoyed the practical nature of science lessons and appreciated having two teachers to support them in lessons. Many of the students who were interviewed indicated they felt they were understanding science better during the project.

Like other studies (Danaia, Mckinnon & Fitzgerald, 2013; Osborne, Simon & Collins, 2003), our research found that students valued practical work

“Consistent with other research, how lessons are taught appears to remain a key element in engaging students in science.”

that involved them doing things in science. Consistent with other research, how lessons are taught appears to remain a key element in engaging students in science (Danaia, Mckinnon & Fitzgerald, 2013; Logan & Skamp, 2013).

Research Question 3: What impact does the project have on the pedagogical approaches adopted by science teachers in their secondary school science lessons?

The teacher interview results revealed that for some of the secondary teachers, involvement in the project made them reflect on the purpose of each science lesson they taught – both in the primary and secondary school context. Another also indicated they were planning to make some changes to how they would normally work with their Year 7 students as they were now aware of the content covered within primary school and how capable primary students were in learning science. These findings are consistent with others that have been reported in the literature where secondary teachers who have mentored primary teachers have reported having a deeper understanding of the primary education context that then informed their work with Year 7 students. (Forbes & Skamp, 2016)

Limitations of this project

There are a number of constraints that may have limited aspects of this research. There were timetable challenges in trying to align our secondary science teachers' timetables with the preparatory school. Even though the preparatory and secondary school are located on the same site trying to organise common times for team teaching and programming days were difficult and required advanced planning.

There were varying levels of team teaching and collaborative planning. There were also limited numbers of secondary science teachers who could be released to participate in the project. Furthermore, the cost of teacher release and timetabling two teachers on classes was expensive so limited the number of classes and teachers who could be involved in the project.

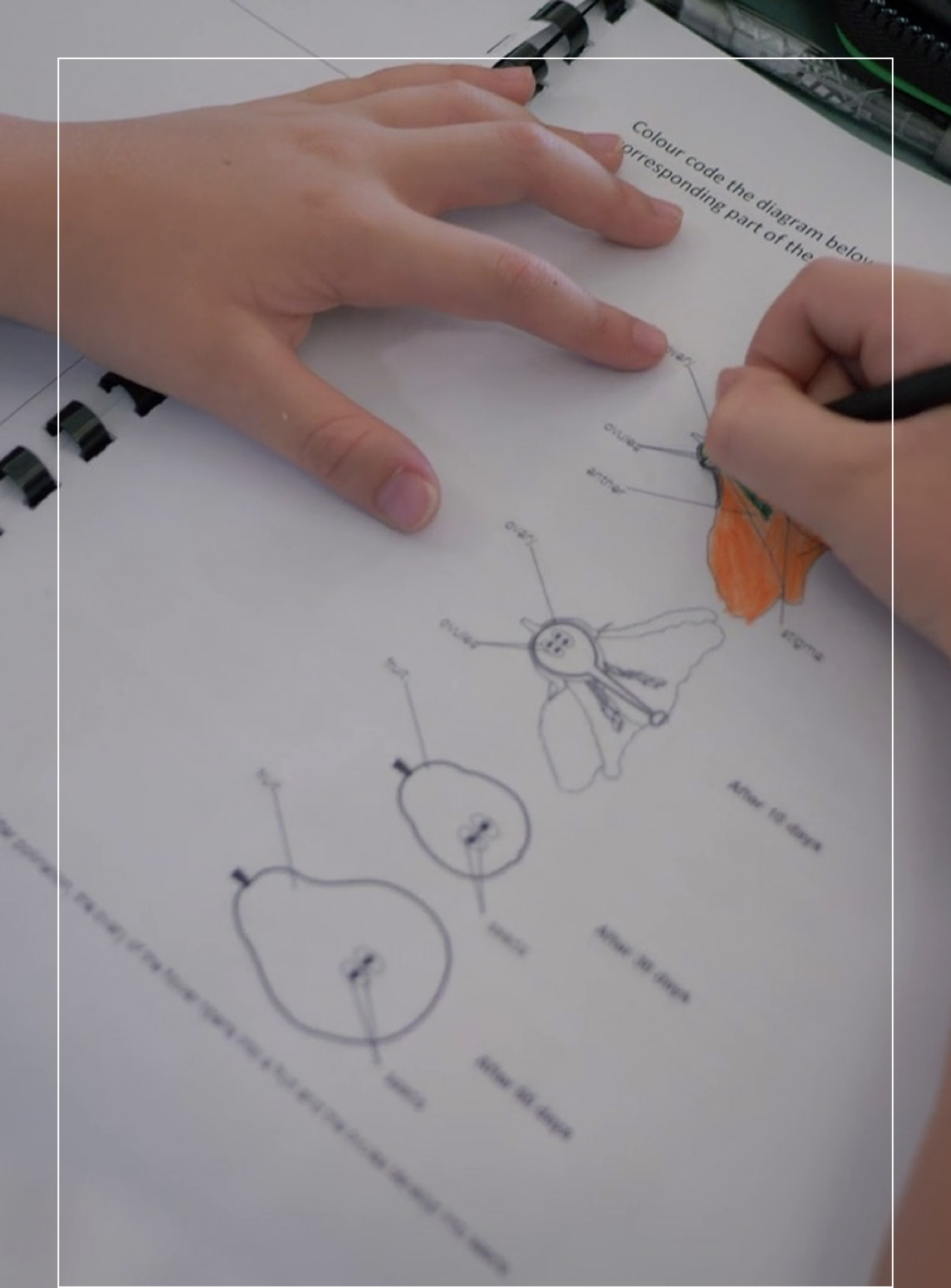
There was also some difficulty in obtaining complete pre and post occasion data from all classes and from all student participants. This resulted in incomplete student data for some of the school terms.

Implications, recommendations and directions for future research

This project promoted conversation and collaboration across the school. There is scope to expand this project into other curriculum areas (K-12). Similar projects could run with a different primary curriculum area as the focus. There could certainly be collaborative partnerships formed with other discipline areas within the secondary school. There could also be more time devoted to pre-unit and post-unit programming. Teachers indicated the need for more time to collaboratively program and then to reflect on their programs and make changes based on what had happened. This is something to consider if the project is rolled-out to other curriculum areas. There is also scope for this research to be conducted in other K-12 schools to see if there are similar results.

Further research could explore the types of team teaching in action and their impact on students and teachers. In this research, it was evident that there were different models of team teaching in operation but it was beyond the scope of the research and data collected to examine them in detail.

Given this project was set in the context of the primary school, more research is needed in the secondary school context to see how these secondary teachers translate some of what they have learned in this project into their lessons. It would also be interesting to see the impact of this on secondary students. Tracking primary students into the secondary school science context would be interesting to explore. It would be interesting to see if there are any differences in their content knowledge and perceptions of science compared with students who arrive at the school in Year 7.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Conclusion

Collaboration creates a community working to achieve a common goal through the sharing of practice, knowledge and problems. Effective collaboration encourages ongoing observation and feedback among colleagues where a culture of professional sharing, dialogue, experimentation and critique becomes common place. (Excerpt from: Australian Institute for Teaching and School Leadership The Essential Guide to Professional Learning: Collaboration)

“There was evidence of improved teacher confidence and competence.”

This project allowed us to implement a collaborative approach toward programming and teaching science that brought together our primary teachers’ understanding of their students and various pedagogies and our secondary teachers’ knowledge and skills in specific science discipline areas. There was evidence of improved teacher confidence and competence. The project was also well-received by students who enjoyed the practical elements of science and felt they were understanding more in science lessons. This project has provided new insights into the programming and teaching of science at our school. Strong relationships have been formed between the primary teachers and secondary science teachers who continue to engage in professional dialogue about science. We have created a teacher community of practice centred on the programming and the teaching of primary science. We hope this collaborative work will be continued and sustained in the coming years.

Research to Practice Impact

Participation in the school based research project has certainly increased our awareness of research and helped build some of our teachers' research capacity within our school. We have noticed more professional dialogue in staffrooms, during meetings and in professional learning experiences. There is more of an awareness of the importance of assessment for learning not just assessment of learning. As the project progressed, teachers were certainly more inclined to share their thoughts on how things were going and were more willing to provide suggestions on what was needed. So there appeared to be a stronger teacher voice. We also observed teacher 'buy-in' over the course of the project where many embraced the research through the practical application of aspects of it such as the SOLO Taxonomy. We began to see personal ownership of the work and teachers were well aware of the importance of evidence-based practice.

More generally, teachers are more receptive to embedding research as part of their practice. As a consequence of our involvement in this project, we have established two other research partnerships with external institutions. We have also had staff undertake research training and further upskilling by undertaking some of the courses and training offered by AISNSW. Given the positive outcomes of this training, we now have other teachers wanting to participate in this. At present, we have 12 action research projects being conducted by teachers within our school.

Given the results and findings of this project, we intend to continue this work post project funding in 2019. Our school has committed to implementing the collaborative science approach in some of our primary classes next year. More time has been made for teacher collaboration as a consequence of engaging in the project. We will continue to use the data we collect to inform our practice and to make changes to the way in which we implement science within our school. We also hope to explore other curriculum areas in 2020. We have also started to look at the project in relation to other initiatives happening within our school. We have started to make some links across projects so that we can maximise the overlap and hopefully extend the work across the continuum of learning into other year levels.

To date, we have disseminated our research findings at two AISNSW conferences. We have also presented at the Conference of the Australian Science Teachers' Association (CONASTA) in 2018. We have had feature articles in our school's magazine. We intend to distribute a brochure to parents and the wider school community to share the main findings of this work. We have an article planned for a professional journal and we will also write one for the academic literature. We also hope to present our findings at an international conference in 2019.

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Appendix 1

Charles Sturt University

SCHOOL OF TEACHER EDUCATION
FACULTY OF EDUCATION

Panorama Avenue
Bathurst NSW 2795

Tel: +61 2 633 84410
Fax: +61 2 63384117
www.csu.edu.au/faculty/educat/teached/

TEACHER PARTICIPANT INFORMATION SHEET

Research Project: Collaborative approaches to programming and teaching primary school science: Opportunities and Impacts

Chief Investigator:

Dr Lena Danaia
BEd Hons, PhD
Charles Sturt University

Invitation

You are invited to participate in a research project called Collaborative approaches to programming and teaching primary school science: Opportunities and Impacts. The research aims to investigate the impact of your school-based science project on your science teaching efficacy and on students' knowledge outcomes in, and perceptions of, science at school.

The research is being conducted by Dr Lena Danaia from the School of Teacher Education at Charles Sturt University.

Before you decide whether or not you wish to participate in this study, it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish.

1. What is the purpose of this study?

This research aims to investigate the school-based science project that is being implemented within your school and which involves collaborative programming for, and team-teaching of primary science. The research will focus on the impact of this project on your science teaching efficacy and on students' knowledge outcomes and experiences in school science.

2. Why have I been invited to participate in this study?

I am seeking primary students and their teachers (you) who are involved in the school-based project to participate in this research. Your principal has allowed us to make contact with you to invite you to participate in this project.

3. What does this study involve?

Participation in this research project involves your class undertaking two surveys, one survey before the implementation of the project and one survey at the conclusion of the project. Each survey will be completed in class and should take approximately 20 minutes.

Student work samples will be collected at the start and at the conclusion of the school-based project.

You will also be invited to be interviewed about your experiences when teaching science. This is also optional. Interviews would take approximately 30 minutes and will be digitally recorded with your permission.

www.csu.edu.au
CRICOS Provider Numbers for Charles Sturt University are 00005F (NSW), 01947G (VIC) and 02960B (ACT). **ABN: 83 878 708 551**

I will also ask to come and observe one of your science lessons during the school-based project. This is also optional.

The research is separate from the school-based project. If you choose not to participate in the research that is fine. You will still continue to be involved in the school-based science program that involves you implementing the Primary Connections Science materials in conjunction with Emma Bylsma, the secondary science teacher. Your class will also have the opportunity to access a science laboratory and specialist equipment during some lessons.

4. Are there risks and benefits to me in taking part in this study?
There are no foreseeable risks associated with you taking part in this research. The research is being conducted to help determine the benefits associated with the school-based project within which you are involved.

I anticipate that the school-based project will increase your confidence and competence in teaching primary science. I also anticipate that the collaborative approaches will allow lessons to be more inquiry-based and engaging for your students. The research will help determine whether or not this is the case.

5. What if I don't want to take part in this study?
Participation in this research is entirely your choice. Only those people who give their informed consent will be included in the research. Whether or not you decide to participate, is your decision and will not disadvantage you.

If you do decide to participate, you may withdraw from the research at any time without giving a reason and have the option of withdrawing any data you have supplied.

As I indicated earlier, if you decide to withdraw from the research you will still be involved in the school-based project.

6. What if I participate and want to withdraw later?
You are free to withdraw your participation in the research at any time. Any information that has been collected will be removed from the research data. This also means that your class will no longer be involved in the research and all pre-occasion data will be removed and discarded.

7. How will my confidentiality be protected?
Any information collected in the research which might identify you will be stored securely and only accessed by the Chief Investigator unless you consent otherwise, except as required by law. No identifying information will be made public.

Names will be replaced with numerical codes. Pseudonyms will be used in interview transcripts and publications.

Data files will be retained for at least 5 years at Charles Sturt University on a password protected computer.

8. What will happen to the information that I give you?
I will de-identify the information. I will analyse this information and write articles based on the findings. Information will be published in peer-reviewed educational journals and presented at a

National conference. Please note that individual participants will not be identified. Your school will have access to these peer-reviewed articles. I will also write a report for your school. Once again, you will not be identified within this report.

9. What should I do if I want to discuss this study further before I decide?
If you would like further information please contact myself: Dr Lena Danaia on (02) 6338 4372 or email ldanaia@csu.edu.au.

10. 'Who should I contact if I have concerns about the conduct of this study?'
If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through the Executive Officer:
The Executive Officer
Human Research Ethics Committee
Tel: (02) 6338 4628
Email: ethics@csu.edu.au
Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.

Thank you for considering this invitation!
This information sheet is for you to keep.

Appendix 2

SCHOOL OF TEACHER EDUCATION
FACULTY OF EDUCATION

Panorama Avenue
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TEACHER PARTICIPANT CONSENT FORM

Research Project: Collaborative approaches to programming and teaching primary school science: Opportunities and Impacts

Chief Investigator:

Dr Lena Danaia
BEd Hons, PhD
Charles Sturt University

I agree to participate in the above research project and give my consent freely.

I understand that the project will be conducted as described in the Information Statement, a copy of which I have retained.

I understand I can withdraw from the project at any time and do not have to give any reason for withdrawing.

I consent to (please tick if you agree):

- ☐ completing a Science Teaching Efficacy and Knowledge questionnaire both before and after my involvement in the school-based project.
- ☐ participating in a 25 minute interview about my experiences when teaching science.
- ☐ having the researcher come into my classroom to observe a science lesson.

I understand that my personal information will remain confidential to the researchers.

I have had the opportunity to have questions answered to my satisfaction.

Print Name:____

Signature: ____________________________________ **Date:**_______________________

NOTE: Charles Sturt University's Human Research Ethics Committee has approved this project. If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through the Executive Officer:

The Executive Officer
Human Research Ethics Committee
Tel: (02) 6338 4628
Email: ethics@csu.edu.au

Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.

Appendix 3

SCHOOL OF TEACHER EDUCATION
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STUDENT PARTICIPANT INFORMATION SHEET

Research Project: Collaborative approaches to programming and teaching primary school science: Opportunities and Impacts

Chief Investigator:
Dr Lena Danaia
BEd Hons, PhD
Charles Sturt University

Hello, my name is Lena Danaia.

I am doing a research study to find out what happens in science lessons at your school. This term you will have some science lessons in the classroom and some in the science laboratory.

I am inviting you to be involved in this research because I am interested in what you think about the science lessons you have at school. I am also interested in finding out about what you learn in science at school.

You can decide if you want to take part in the research or not. You don't have to it's up to you. If you don't participate in the research you will still get to experience science lessons in the classroom and laboratory.

This sheet tells you what I will ask you to do if you decide to take part in the research. Please read it carefully so that you can make up your mind about whether you want to take part. I have also asked your teacher to read this information sheet to you too.

1. What is the purpose of this study?
I am interested in finding out what you think about science lessons at school. I want to find out your thoughts about the science lessons you have in your classroom and about the science lessons you have in the science laboratory. I am also interested in finding out about what you learn in school science.

2. Why have I been invited to participate in this study?
Your school principal and teacher have allowed me to make contact with you to invite you to participate in this research.

3. What does this study involve?
If you decide that you want to participate in this research, it will involve the following things.

- I will ask you to fill in a survey both before you start science this term and at the end of your science topic this term.
    - The survey will take no more than 20 minutes to complete.
    - Mrs Cameron or I will give you the survey.

- We will read each question to you.
- Your answers to the survey will not contribute to your school marks in any way.
- Remember, you can decide to stop completing the survey any time you wish.

- I would like to invite you to share some of the work you complete in science so that I can see what you have been learning about.
- I would like to come in and watch one of the science lessons this term. I will not be asking you any questions. I will simply be in the room watching what happens in the lesson.

4. Are there risks and benefits to me in taking part in this study?
This research will take up some of your time, but I don't think it will be bad for you. You won't get anything for participating, but you will be helping me do this research.

5. What if I don't want to take part in this study?
You don't have to participate in the research if you don't want to. It is your choice. If you say no to participating in the research you will still get to experience science in the classroom and in the science laboratory.

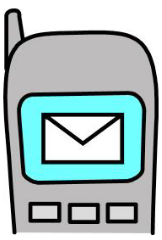
6. What if I participate and want to withdraw later?
If you do decide to participate in the research, and then you change your mind later, that's ok. All you need to do is tell me that you don't want to be in the study anymore.

7. How will my confidentiality be protected?
All of the information that I have about you from the research will be stored in a safe place and I will look after it very carefully. I won't tell anyone what you say except if you talk about someone hurting you or about you hurting yourself or someone else. Then we might need to tell someone to keep you and other people safe.

8. What will happen to the information that I give you?
I will write a report about the research and show it to other people but I won't say your name in the report and no one will know that you were in the study, unless you tell me that it's ok for me to say your name.

9. What should I do if I want to discuss this study further before I decide?
If you have any questions you can talk to me, Lena Danaia on +61 2 63384372 or write me an email ldanaia@csu.edu.au. You can also talk to your teacher, Mrs Cameron, family or someone else who looks after you.

10. 'Who should I contact if I have concerns about the conduct of this study?'



If you are not happy with how I am doing the research or how I treat you, then you or the person who looks after you can call or write to a contact person at the university. Here are the contact details:

The Executive Officer
Human Research Ethics Committee
Tel: +61 2 6338 4628
Email: ethics@csu.edu.au

Thank you for thinking about this invitation!
This sheet is for you to keep.

Appendix 4

Charles Sturt University

SCHOOL OF TEACHER EDUCATION
FACULTY OF EDUCATION

Panorama Avenue
Bathurst NSW 2795

Tel: +61 2 633 84410
Fax: +61 2 63384117
www.csu.edu.au/faculty/educat/teached/

STUDENT PARTICIPANT CONSENT FORM

Research Project: Collaborative approaches to programming and teaching primary school science: Opportunities and Impacts

Chief Investigator:
Dr Lena Danaia
BEd Hons, PhD
Charles Sturt University

Do you agree to participate in this research?

☺	☹
Yes, I want to be involved.	No, I do not want to be involved.

Please tick ✓ if you agree to:

- ☐ complete a survey before you start science lessons this term.
- ☐ complete a survey at the end of science lessons this term.
- ☐ share some of the work you have done in science this term.
- ☐ the researcher coming in to your classroom to watch a science lesson.

Remember, you can decide to stop participating in the research any time you wish.

What is your name? ______________________________________

Please sign your name or write your initials on the line below if you agree to participate in the research:

____

www.csu.edu.au
CRICOS Provider Numbers for Charles Sturt University are 00005F (NSW), 01947G (VIC) and 02960B (ACT). **ABN: 83 878 708 551**

Appendix 5

SCHOOL OF TEACHER EDUCATION
FACULTY OF EDUCATION

Panorama Avenue
Bathurst NSW 2795

Tel: +61 2 633 84410
Fax: +61 2 63384117
www.csu.edu.au/faculty/educat/teached/

PARENT PARTICIPANT INFORMATION SHEET

Research Project: Collaborative approaches to programming and teaching primary school science: Opportunities and Impacts

Chief Investigator:

Dr Lena Danaia
BEd Hons, PhD
Charles Sturt University

Invitation
Your child is invited to participate in a research project called Collaborative approaches to programming and teaching primary school science: Opportunities and Impacts. The research aims to investigate the impact of the school-based science project that your child's class will be participating in this term.

In science lessons this term, your child's class is involved in a school-based science project where they will be working through one of the Primary Connections Science Units. Lessons will be team-taught with their classroom teacher and a secondary science teacher. Students will also experience some science lessons in a science laboratory and will have the opportunity to use specialist science equipment.

I am interested in finding out what your child thinks about science lessons during this school-based science project.

The research is being conducted by Dr Lena Danaia from the School of Teacher Education at Charles Sturt University.

Before you decide whether or not you consent to your child participating in this study, it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish.

1. What is the purpose of this study?
In this research, I am interested in finding out what your child thinks about science lessons at school, and the approaches used, during the school-based science project. I want to find out whether this experience is beneficial to your child's perceptions and/or understanding of science.

2. Why have I been invited to participate in this study?
I am seeking primary students and their teachers who are involved in the school-based science project to participate in this research. The principal of your child's school has allowed me to make contact with you and to invite your child to participate in this research.

3. What does this study involve?
Participation in this research involves your child undertaking two surveys. One survey before their interaction with the school-based science project and one survey at the conclusion of the project.

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CRICOS Provider Numbers for Charles Sturt University are 00005F (NSW), 01947G (VIC) and 02960B (ACT). **ABN: 83 878 708 551**

Each survey will be completed in class and should take approximately 20 minutes. Susan Cameron or I will be administering the surveys to students.

Your child's answers to these surveys do not contribute to, or alter, their school marks and participation is completely optional.

In between the two sets of questionnaires your child will experience the school-based science project. During this time I would like to go and observe a science lesson within which your child will be involved.

Your child may also be invited to share some of the work they have completed during the school-based science project.

4. Are there risks and benefits to me in taking part in this study?
There are no foreseeable risks associated with your child taking part in this project.

I anticipate that science lessons during the school-based project will be engaging for your child but the research will help find out your child's perceptions of the approaches used. It's also important to note that if your child chooses not to be involved in the research they will still participate in the school-based science project. So they will not be disadvantaged in anyway.

5. What if I don't want to take part in this study?
Participation in this research is entirely your choice. Only those people who give their informed consent will be included in the research. Whether or not you decide for your child to participate is your decision and will not disadvantage your child in any way. Your child will still be involved in the school-based science project.

If you do consent to your child participating, your child may withdraw from the research at any time without giving a reason and have the option of withdrawing any data, which identifies your child.

6. What if I participate and want to withdraw later?
You are free to withdraw your child's participation at any time. Any information that has been collected will be removed from the research data. Your child will continue to be involved in the school-based project.

7. How will my confidentiality be protected?
Any information collected by the researcher which might identify your child will be stored securely and only accessed by the researcher unless you consent otherwise, except as required by law. No identifying information will be made public.

Names will be replaced with numerical codes. Pseudonyms will be used in interview transcripts and publications.

Data files will be retained for at least five years at Charles Sturt University on a password protected computer.

8. What will happen to the information that I give you?
I will de-identify the information. I will analyse this information and write articles based on the findings. Information will be published in peer-reviewed educational journals. Please note that individual participants (your child) will not be identified. Your child's school will have access to

these peer-reviewed articles. I will also write a report for your child's school but your child will not be identified within this report.

9. What should I do if I want to discuss this study further before I decide?

If you would like further information please feel free to contact me, Dr Lena Danaia, on +61 2 6338 4372 or email ldanaia@csu.edu.au.

10. 'Who should I contact if I have concerns about the conduct of this study?'

If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through the Executive Officer:
The Executive Officer
Human Research Ethics Committee
Tel: (02) 6338 4628
Email: ethics@csu.edu.au
Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.

Thank you for considering this invitation!
This information sheet is for you to keep.

Appendix 6

Charles Sturt University

SCHOOL OF TEACHER EDUCATION
FACULTY OF EDUCATION

Panorama Avenue
Bathurst NSW 2795

Tel: +61 2 633 84410
Fax: +61 2 63384117
www.csu.edu.au/faculty/educat/teached/

PARENT PARTICIPANT CONSENT FORM

Research Project: Collaborative approaches to programming and teaching primary school science: Opportunities and Impacts

Chief Investigator:
Dr Lena Danaia
BEd Hons, PhD
Charles Sturt University

I agree for my child to participate in the above research project and give my consent freely.

I understand that the project will be conducted as described in the Information Statement, a copy of which I have retained.

I understand that my child can withdraw from the project at any time and does not have to give any reason for withdrawing.

I understand that if my child withdraws from the research they will still be involved in the school-based science project.

I consent to (please tick if you agree):

- ☐ my child completing a survey on two occasions (before the school-based science project and at the end of the project).
- ☐ science work samples being collected from my child.
- ☐ the researcher observing a science lesson within which my child will be involved.

I understand that my child's personal information will remain confidential to the researcher.

I have had the opportunity to have questions answered to my satisfaction.

Print Parent/Guardian Name:____

Signature: ______________________________**Date:**_________________________

NOTE: Charles Sturt University's Human Research Ethics Committee has approved this project. If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through the Executive Officer:

The Executive Officer
Human Research Ethics Committee
Tel: (02) 6338 4628
Email: ethics@csu.edu.au
Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.

www.csu.edu.au
CRICOS Provider Numbers for Charles Sturt University are 00005F (NSW), 01947G (VIC) and 02960B (ACT). **ABN: 83 878 708 551**

Appendix 7

Charles Sturt University

OFFICE OF GOVERNANCE AND CORPORATE AFFAIRS
ACADEMIC GOVERNANCE

Private Mail Bag 29
Panorama Avenue
Bathurst NSW 2795

Tel: +61 2 6338 4185
Fax: +61 2 6338 4194
Email: ethics@csu.edu.au
http://www.csu.edu.au/acad_sec

14 July 2016

Dr Lena Danaia
Charles Sturt University
School of Teacher Education
Panorama Avenue
BATHURST NSW 2795

Dear Dr Danaia,

Thank you for the additional information forwarded in response to a request from the Charles Sturt University (CSU) Human Research Ethics Committee (HREC).

The CSU HREC reviews projects in accordance with the National Health and Medical Research Council's *National Statement on Ethical Conduct in Research Involving Humans*.

I am pleased to advise that your project entitled **"Collaborative approaches to programming and teaching primary school science: Opportunities and impacts"** meets the requirements of the *National Statement*; and ethical approval for this research is granted for a twelve-month period from the date of this letter.

The protocol number issued with respect to this project is **H16108**. Please be sure to quote this number when responding to any request made by the Committee.

Please note the following conditions of approval:

- all Consent Forms and Information Sheets are to be printed on Charles Sturt University letterhead. Students should liaise with their Supervisor to arrange to have these documents printed;
- you must notify the Committee immediately in writing should your research differ in any way from that proposed. Forms are available at: http://www.csu.edu.au/__data/assets/word_doc/0007/963763/Report-on-Research-Project_20130503.doc (please copy and paste the address into your browser)
- you must notify the Committee immediately if any serious and or unexpected adverse events or outcomes occur associated with your research, that might affect the participants and therefore ethical acceptability of the project. An Adverse Incident form is available from the website: as above;
- amendments to the research design must be reviewed and approved by the Human Research Ethics Committee before commencement. Forms are available at the website above;
- if an extension of the approval period is required, a request must be submitted to the Human Research Ethics Committee. Forms are available at the website above;
- you are required to complete a *Report On Research Project*, which can be downloaded as above, by 16/06/2017 if your research has not been completed by that date;
- you are required to submit a final report, the form is available from the website above.

YOU ARE REMINDED THAT AN APPROVAL LETTER FROM THE CSU HREC CONSTITUTES **ETHICAL APPROVAL ONLY.**

If your research involves the use of radiation, biological materials, chemicals or animals a separate approval is required from the appropriate University Committee.

The Committee wishes you well in your research and please do not hesitate to contact the Executive Officer on telephone (02) 6338 4628 or email ethics@csu.edu.au if you have any enquiries.

Yours sincerely

Regan McIntosh
Executive Officer
Human Research Ethics Committee
Direct Telephone: (02) 6338 4628
Email: ethics@csu.ed.au

This HREC is constituted and operates in accordance with the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research* (2007)

ETHICS AND COMPLIANCE UNIT

Locked Bag 588
Boorooma Street
Wagga Wagga NSW 2678
Australia

Tel: +61 2 6338 4628
Email: ethics@csu.edu.au
www.csu.edu.au/research/
ethics_safety/human/

25 July 2018

Dr Lena Danaia
Email: ldanaia@csu.edu.au

Dear Dr Danaia,

Thank you for submitting your extension request to the Charles Sturt University Human Research Ethics Committee, which was considered executively.

The Charles Sturt University Human Research Ethics Committee is constituted and operates in accordance with the National Health and Medical Research Council's *National Statement on Ethical Conduct in Human Research (National Statement)*.

Based on the guidelines in the *National Statement* the Committee has approved your extension request. Please see below details of your approved research project:

Project Title:	Collaborative approaches to programming and teaching primary school science: Opportunities and impacts
Approved until:	16 December 2019 (subject to annual progress reports being submitted)
Protocol Number:	H16108 (to be included in all correspondence to the Committee)
Progress Report due by:	03 July 2019

You must report to the Committee at least annually, and as soon as possible in relation to the following, by completing the 'Report on Research Project' form:

- any serious and/or unexpected adverse events or outcomes which occur associated with the research project that might affect participants, therefore, the ethical acceptability of the project;
- amendments to the research design and/or any changes to the project (Committee approval required);
- extensions to the approval period (Committee approval required); and
- notification of project completion.

This approval constitutes ethical approval in relation to humans only. If your research involves the use of radiation, biochemical materials, chemicals or animals, separate approval is required by the appropriate University Committee.

Please contact the Governance Officer on (02) 69334213 or ethics@csu.edu.au if you have any queries.

The Committee wishes you well with your research.

Sincerely,

Ms Ellen Hannigan
Governance Officer
on behalf of Associate Professor Catherine Allan
Presiding Officer, HREC

Appendix 8

Semi-Structured Interviews with Teachers

Interview Questions

1. **What have you been focussing on in science this term?**

    a. What kinds of things have you been teaching?

    b. What else?

Probing questions

- Why?
- Why do you say that?
- What do you mean?
- What did it do for you?
- What gives you that impression?
- Why do you think that?
- What else?
- What other …?
- How else?
- How have you been doing that?

2. **Can you give me an example of a lesson you really enjoyed teaching this term?**

    What happened? Tell me about it.

    What were the students doing? What were you doing?

3. **Is science something you are interested in?**

    a. Do you enjoy teaching science? Why/Why not?

    b. How are you finding the new national curriculum for science?

        i. Do you feel confident in teaching all aspect of the science and technology syllabus?

4. **How do you normally program for science?**

    a. Have you been working with other teachers in your Stage level?

    b. Do you have the opportunity for team-teaching?

    c. Have you always done science this way? (Primary Connections materials)

    d. Do you use computers/technology in science?

    e. Where do you normally teach science?

    f. How well are you resourced for science? Do you have access to appropriate equipment and facilities?

    g. Do you access specialist science teachers to support you in teaching science?

5. **What are some of the things you really like about the way you teach science? And program for science?**

6. **If you could change anything about the way you program for science or teach science what would it be?**

Appendix 9

Student Interview Questions

I would like to ask you some questions about your learning in science lessons today.
There are no right or wrong answers, I am just interested to know what you think, so please answer honestly.

Probing questions to use during interviews:
Why do you say that?
Can you tell me more about that?
What do you mean?
Why do you think that?
How have you been doing that?
Can you add anything else?
Would you be able to give me more details?

Core Questions for each year group:

What sorts of things have you been learning about in Science classes lately?

How do you find/ feel about your science lessons?
Does having 1 or 2 teachers for science make a difference to your learning?

How has your understanding of science changed over the last couple of years?

Can you tell me about a time in science where something happened that helped or didn't help your learning?

Additional Question if students are new to KWS in the last 12 months:
Is Science at Kinross different or the same as Science at your previous school+?

Appendix 10

Collaborative Science Project- Teacher Reflection and Feedback Form

What has worked for you in the collaborative science project (what have you liked)?

Please reflect on the project so far and complete the relevant questions below. Your feedback will help inform the future direction of aspects of the project.

Role in the project?

What has not worked for you in the collaborative science project (what have you disliked)?

What could be improved for you?

Three things you have learned during the project:

1.

2.

3.

Three things you need to know more about:

1.

2.

3.

1

* Write five words to describe how you feel about the project at this point in time:

1.
2.
3.
4.
5.

Thank you for taking the time to complete this. Your feedback will help inform the project!

Appendix 11

School Science Questionnaire 2017

Dear student,

The following survey is to provide me with feedback about your experiences in science lessons. Please select the option that reflects how you feel.

There are no right or wrong answers.

Thank you for completing this survey!

First Name:

Surname Initial:

Class:

During science lessons:

	Never	Sometimes	Always
I get excited about what we do.	○	○	○
my teacher explains things well.	○	○	○
my teacher asks lots of different questions.	○	○	○
we work in groups.	○	○	○
I copy notes.	○	○	○
we do practical work (experiments).	○	○	○
I watch the teacher do an experiment.	○	○	○
I am bored.	○	○	○

1

I enjoy science lessons:

	Never	Sometimes	Always
in the classroom.	◯	◯	◯
in the laboratory.	◯	◯	◯

How could your science class be improved so that you could learn more?

List three words that describe how you feel about science lessons at school….

1.

2.

3.

School Science Questionnaire 2017

Thank you for completing this questionnaire!

3

School Science Questionnaire 2018

Dear student,

The following survey is to provide me with feedback about your experiences in science lessons. Please select the option that reflects how you feel.

There are no right or wrong answers.

Thank you for completing this survey!

* 1. First Name:

* 2. Surname Initial:

* 3. 2018 Class:

* 4. During science lessons:

	Never	Sometimes	Always
I get excited about what we do.	◯	◯	◯
my teacher explains things well.	◯	◯	◯
my teacher asks lots of different questions.	◯	◯	◯
we work in groups.	◯	◯	◯
I copy notes.	◯	◯	◯
we do practical work (experiments).	◯	◯	◯
I watch the teacher do an experiment.	◯	◯	◯
I am bored.	◯	◯	◯

1

* 5. I enjoy science lessons:

	Never	Sometimes	Always
in the classroom.	◯	◯	◯
in the laboratory.	◯	◯	◯
where we have two teachers.	◯	◯	◯
where I have my normal teacher.	◯	◯	◯

* 6. What do you like about your science class?

* 7. How could your science class be improved so that you could learn more?

* 8. List three words that describe how you feel about science lessons at school….

1.

2.

3.

School Science Questionnaire 2018

Thank you for completing this questionnaire!

3

Biographies

Susan Cameron is the Director of Staff Development and Project Leader of three school based research projects at KWS. She is a passionate advocate for teacher involvement in data driven educational research and the benefits that this can bring to the classroom. Susan holds a Masters of Educational Leadership (ACU) with extensive teaching experience in city, regional and overseas schools. She has been involved in HSC test development and marking; syllabus development; has published teaching materials and academic papers and presented at national conferences. Susan is committed to lifelong learning and driven to provide contextually relevant opportunities for KWS staff to engage with current educational research.

Emma Bylsma is Head of Wellbeing. She holds a Master of Science (Education) from Macquarie University where she was awarded the Vice Chancellor's Commendation for Academic Excellence in Postgraduate Work. She has taught in both city and regional schools and joined the staff of KWS in 2009 as a senior teacher of Biology and Chemistry. She wants Science to be engaging and fun for her students. Emma believes all students should leave primary school with a positive attitude to Science and a solid grounding in some of the basic concepts. Emma has been involved in the Science-based project since its inception and wants to ensure our primary teachers are comfortable with the curriculum they're teaching.

Rebecca Whiteley is an enthusiastic teacher, with 28 years of teaching experience. She has a Bachelor of Education (Early Childhood/Primary) from CSU Wagga. She has taught in Early childhood settings, Primary Schools and High Schools in the Riverina and Western areas. Rebecca joined the KWS teaching team in the Preparatory school in 2002. She is a passionate classroom practitioner who has been teaching Stage 1 for most of her time at KWS. Rebecca recently completed a 12-month Schools Leadership Colloquium with NESTLI. Along with Emma, Rebecca has been involved in the project from the beginning. She has co-ordinated the teaching team in the Prep School throughout the project. Her goal is to embed the scientific literacy, skills and content knowledge, using engaging and practical Science units that promote a continuum of development in these areas across K-6.

Associate Professor Lena Danaia is the Sub Dean Academic within the Faculty of Arts and Education at Charles Sturt University. Lena specialises in science and technology curriculum and in mixed methods research. Lena previously worked as a teacher in both Australia and the United Kingdom. In 2008, Lena was recognised nationally for her outstanding contributions to learning and teaching where she was awarded an Australian Learning and Teaching Council (ALTC) Teaching Excellence Award. Lena's research mainly focusses on student engagement in science and teacher professional learning and spans primary, secondary and pre-service teacher education sectors. She is currently involved in a number of school-based science education research projects.

Acknowledgement

We wish to thank the AISNSW for their financial support of this project. We acknowledge the assistance and guidance provided by Lesley Wright and Tiffany Roos from the AIS. We recognise the initial funding for the project provided under CSU Community-University Partnership Community Grants program.

This project would not have been possible without the ongoing commitment and engagement with the team from our critical friend Associate Professor Lena Danaia from CSU Faculty of Arts and Education. Lena's leadership has been instrumental to the success of this project. She has shared her knowledge and expertise; supported the learning and provided genuine friendship to KWS students and staff. Supporting Lena as research assistants we acknowledge the input from Mrs Hannah Deehan and Mr Steve Murphy.

The Research Team would like to acknowledge the support provided by Mr Brian Kennelly (previous Principal and initial driver of the project), Mr Rob McLean (Head of Preparatory School), Catherine Litchfield (2IC Science Faculty), Caroline Rich (Design and Publications Officer) and KWS Preparatory Teachers. Over the various stages of the research project these staff have been engaged in the research, provided encouragement to the team and supported the rollout of collaborative professional learning opportunities.

Dr Andrew Parry (Principal) and the KWS Senior Management Team extend their appreciation to the Research Team for their willingness to manage and drive the project's various stages through to completion.

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General inquiries should be directed to AISNSW Research and Data Division at randd@aisnsw.edu.au

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