Measuring the impact of CS Unplugged among New Zealand's Primary and High School teachers

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Abstract

Computational Thinking (CT) is taking an ever-growing role in education. In the context of fast curriculum change, incorporating CT with teaching CS in school requires new skill and knowledge that existing and upcoming teachers may not possess. A major challenge for improving participation in computing is the lack of trained teachers. As a result, Professional development (PD) is key to successfully improve the teaching of CS. In this paper, we describe how PD activities and teaching pedagogies like 'CS Unplugged' can help in changing how CS concepts are delivered effectively by increasing teacher confidence levels and reported programming knowledge within a time frame as small as two days.

The main goal of this research is to provide insights to professional learning and development leaders on the effectiveness of incorporating teaching pedagogies like 'CS Unplugged' as a part of their workshop demonstration. The secondary goal of this research is to reach pre-service teachers and provide them with first-hand experience from teachers who attended the PD workshops.

This paper describes results of an extensive qualitative study through survey and interviews of primary (elementary) and high school teachers who participated in PD workshops conducted in New Zealand, in preparation of integrating CT into existing modules. Survey results focused more on getting the generalised view from the teachers about their understanding of concepts and material introduced before and after the workshop. Interview protocol focussed on participants involvement in PD workshop, improvement in their skills, strategies learnt, whether or not they were able to use these skills in the classroom setting and what connections they could draw from it.

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1 Digital Technologies

Digital technologies have revolutionized our lives. They have changed the face of communication by replacing analogue technology making data transmission easier and faster in today's multi-screen world. All kinds of tasks in almost every discipline require some sort of digital proficiency. Keeping this in mind, in order to improve digital literacy, several strategies and approaches must be designed in order to target these skills. Many people typically start our day by hitting the alarm clock and turning on the coffee machine. What they often don't realize is that technology has slowly but steadily pervaded every facet of our lives. Digital Technologies have transformed not only our homes, our workplaces and our interactions, but also the way we live and think. Learning about technology and how it works will help students in becoming not only digitally proficient but also informed citizens in general. Digital Technologies not only give students an insight about the inner workings of technology, but also help them to use this knowledge for problem-solving. It has the potential to develop enthusiastic learners of today into inventors and innovators of a digital future.

Jobs involving technology are in high demand and are sometimes left vacant due to a shortage of skilled workers. For students to be digitally ready, they must be familiar with not one or two aspects, but should have a broad understanding of the core concepts of computer science or digital technologies. To achieve the desired competence level, many countries including the USA, UK, France, Australia and Italy are taking steps to make computer science a mandatory subject in their school curriculum Webb, (2019).

New Zealand has also been affected by the technological era and has revised its existing curriculum to introduce Digital Technologies as a discipline. The New Zealand Ministry of Education (NZMoE) announced the introduction of Digital Technologies and its extension to every year level beginning from the primary school in July 2016. The main goal is to produce digitally capable individuals who are not only users of technology but also actively engage in its development process (Parata, 2016). The new curriculum covers two areas: 'computational thinking' and 'designing and developing digital outcomes'. We will discuss these in greater detail in the next sections. The design and implementation process of the new curriculum started in 2014. All the conceptual ideas have been vigorously tested with students and teachers (NZMoE, 2018).

In 2017, a substantial consultation process ran within schools among teachers, students and industry stakeholders. Its aim was to successfully implement digital technology and professional learning development resources for teachers in Term 1, 2018 in all schools. It is expected that all schools will start teaching Digital Technologies from Term 1, 2020 (NZMoE, 2017).

1.2 Computational Thinking

The idea of Computational Thinking (CT) dates back to the 1950s and has been in debate since then (Tedre & Denning, 2016). The term CT was first used by Seymor Papert in 1980's (Papert, 1980). Jeannette Wing put this term in front of the computer science community, thereby giving everyone a glimpse of the importance of computational thinking and its role as an integral part of education. She proclaimed, ‘computational thinking is the thought process that goes on when a problem is being solved by expressing different solutions so that either humans or computers can perform the desired task effectively (Wing, 2006). Wing further added that computational thinking is a universal skill set for everyone, not necessarily only for computer scientists.

Practicing CT involves certain steps, starting with the breaking down of a problem into sub-parts that are easier to manage. Then, solving the problem with the help of certain steps (Algorithm), reviewing how the solution is transferable to other problems (Abstraction) and finally concluding if it can be done faster with the help of a computer (Automation) (Wing, 2017).

There have been several discussions about what CT incorporates. Since 2006, after Wing’s definition, it has received some contradictory views that challenge the definition. The vast diversity of the term depicts how successfully it has reached globally. Curzon et al (2019) have tried to explain the mixed views about CT in the form of a Venn diagram. They attempt to focus on the agreement about the views of CT by keeping different views (both broad and narrow) in mind. The general agreement that authors reached constitutes CT as, “the way of thinking which is used to develop a solution in a form that ultimately allows ‘information processing’ or ‘computing agent’ to execute these solutions (Curzon et al, 2019). The authors further add that CT focuses more on algorithmic solutions, hence, it stands out from other problem-solving approaches. Although programming is characterized as one of the most definite attainable skill sets from practicing CT, the development of computational system design is far more than just coding, it involves learning other skills like abstraction, generalization, automation, etc.

1.2.1 Computational thinking and other disciplines

Computational thinking directly relates to all science, technology, engineering and mathematics (STEM) disciplines. It is also a basic analytical skill that is directly applicable to other subjects. CT is a skill set that invokes problem-solving by logical thinking, not only limited to computer scientists but to anyone who is practicing it. There is no reason to necessarily link CT with only computer-related disciplines.

If we dig deeper, we’ll realize that we use computational thinking nearly every day of our lives. Any task that involves thinking about and planning for a solution, especially involving processes, requires our brain to use computational thinking. Let us take a simple example from our everyday life where an individual need to decide which line to take for the self-checkout in a grocery store. For example, do you join the line with fewer people, but they have more items or the line with more people but fewer items each? This involves thinking about the whole process logically. Similarly, computational thinking also relates directly to other subjects. Using statistics has now become much easier with the help of machine learning. A large amount of data can be easily stored and analysed with the help of graphical methods which then identify patterns (Wing, 2008).

Bell & Vahrenhold (2018) suggested computing to be a field that emerged from other disciplines like mathematics, science, engineering and design. They argued that CT doesn’t need to be a distinctive skill-set in order to be acquired as an important skill. Instead, CT is based on thinking about and solving a problem logically. This produces different modes of thinking from other subjects. In similar work, Denning (2017) suggest CT be assessed as a skill, not as a knowledge framework. He further argues that there is no such evidence that these skills are transferable beyond computing. On the contrary, Lee (2016) have claimed CT to be a transferable skill to more than just computer programming, laying more significance on how CT helps in tackling real-world problems by breaking them down into smaller problems and thinking about them logically.

1.2.2 Computational thinking in K-12

After learning about CT and its implications, the next step is to think about ways in which it can be taught to students in an effective manner.

After Wing (2006) introduced CT and strongly argued about its importance, CT has been in the limelight ever since. It has become one of the core skills to be introduced in any new curriculum. The introduction of CT has helped students in attaining a broader mindset towards computer science and problem-solving in general. The main idea is to develop these skills among students from the primary level of their education. Doing so would enhance creativity amongst them and change their mindset towards computer science and technology. We need to make sure that we are not addressing CT as a concept that teaches us about computer science and programming, rather as a skill that helps students in thinking and analysing problems in computational terms. It is not set out to be learned in one go, it is a skill that develops with time and practice. As part of the NZ curriculum, CT has been adopted to be explicitly taught to students with its own progress outcomes from the age of five years or older.

NZ has revised its curriculum to position CT as one of the core parts of its curriculum, aiming to ensure that all students get an equal opportunity to become digitally capable. New Zealand's Ministry of Education (NZMoE) aims at helping students learn how technology is the result of human activity. This is supported by learning about cultural heritage and its current association with technology. As part of the new curriculum, the NZMoE has introduced two new areas, Computational Thinking for Digital Technologies (CTDT) and Designing and Developing Digital Outcomes (DDDO). These are two additions to the existing areas in the Technology curriculum. From, year one to year ten students learn from all the technology areas and develop their knowledge in CS as well. Once students reach year 11 (approx. tenth grade), they specialize in a few subjects in greater depth according to new curriculum standards (NZMoE, 2018).

Stigler & Hiebert (2009) conducted a study where authors gathered data from different countries and examined their state of CS learning. The results showed there is a lot of work in progress worldwide. They can enrol themselves and assess their knowledge and competency towards CS and learn more about how their understanding can be improved. In general, authors were trying to convey that countries like the US, Germany, Japan etc. have started making changes by introducing CS in one form or the other. CT is being addressed as one of the core skills in the new curriculum to be attained by students. The NZMoE provides professional support to teachers in the form of Nationwide Digital Readiness Program 'Kia Takatū ã-Matahiko' (can be retrieved from https://kiatakatu.ac.nz/), which introduces teachers to new content and teaching strategies. The MoE in NZ has partnered up with PD organisations, museums and the Ministry of youth development to offer further support and for teachers and learners. They have come up with opportunities like a national digital challenge and championship where learners solve digital technologies problems in their school and win prizes, which is available at 123technz.com. The NZ MoE also granted an equity fund available for 12,500 students across NZ every year to ensure equal learning opportunities. This include curriculum aligned workshops available at digitalignition.co.nz. A range of programs led by the Museum of NZ 'Te Pa Tongarewa' like class visits to museums and curriculum relevant use and learn of technologies are available at rarangamatihiko.com.

1.3 Computer Science Unplugged

The term CS Unplugged has been mentioned in many papers about CS education. To analyse its efficacy, we need to clearly understand how it came into existence and what goals it enunciates.

Bell et al (2012) have explained Computer Science Unplugged (CS Unplugged) as a “widely used collection of activities and ideas to engage a variety of audiences with great ideas from computer science, without having to learn to program or even use a digital device.” The term CS Unplugged came into existence in the early 1990s. It started with a few activities being shared online, which were later picked up and published in a book in the late 1990s. The classic edition of this book is called “Computer Science Unplugged: Offline activities and games for all ages” co-authored by Tim Bell, Mike Fellows and Ian Witten (Bell, 1999). During the early publication, it only included a few CS Unplugged activities with some connection to the curriculum. Later, as it became more popular, activities started to be more relevant to the curriculum. Recently, lesson plans have been created for classroom teaching that directly applies the course material to the classroom. It also includes activities that have a direct relation to computers, called ‘plugging it in’, where students can take their ideas and learnings from the unplugged activity to the actual use of computers. All the material is readily available online at csunplugged.org. CS Unplugged was originally conceptualized as an outreach tool among primary and high schools to engage students to understand the benefits CS can provide and to promote the idea that it is not just about programming (Bell et al, 2012).

We can define CS Unplugged as ‘Computing without computers’. CS Unplugged is a set of free learning activities that teach Computer Science through fun and engaging games, puzzles and playful activities. One of the main reasons to develop this kind of activity is to attract students at a young age into computer science so they can understand how a computer works. All of this can be carried out without learning actual programming (Bell, 2018).
CS Unplugged clearly enunciates that its goals and principles are based on:

- Promoting CS and its principles from a young age as most of the activities involve just a pen, paper and a lot of running around. The activities motivate students to discover answers on their own rather finding them in a book or reappropriating a given algorithm. This has an additional benefit of thinking about a problem logically.
- Helping in the development of soft skills like communication, teamwork, problem solving, taking responsibility, etc.
- Activities that are flexible in nature, meaning that even if students make errors, they still understand the concept. Unplugged activities do not let students stop because of minor mistakes and force them to start all over again; making it an open-ended approach.

CS Unplugged has become popular because of its simplified approach. Activities or short programs outside of CS Unplugged can require effort and commitment from the very beginning where they need to be monitored by several people for the entire duration which seems like a tedious task. In the case of CS Unplugged, you just need a pen and paper and you’re good to go. Moreover, programming activities are readily available online for easy access so that no one has to carry handouts instead see instructions on screen. With the huge success of CS Unplugged worldwide, Bell & Vahrenhold, (2018) pointed out that it should be referred to as a general pedagogical approach and not be intended as a curriculum or a program of study and offers several benefits such as:

- No prerequisites for learning programming.
- Pedagogy offers spiral curriculum meaning, students first learn about basic facts of a subject or a topic and as the learning progresses, more details are introduced. For e.g. Unplugged to ‘plugging it in’ exercises.
- Tackling misconceptions about CS in general including ‘how CS is not just about programming’
- Easy deployment of activities, as no computers are required, hence, no technical issues.

CS Unplugged has had a lot of international exposure in the past few years. It gained significance in countries like the USA, UK, Australia, France, Singapore, etc. Later, CS Unplugged was granted sponsorship from Google Inc. and Microsoft Philanthropies, which helped them in developing new material including activities, games, and puzzles. These were made available publicly as open source (available at csunplugged.org).

1.3.1 CS Unplugged and Computational Thinking

CS Unplugged not only helps in learning computer science concepts but fosters the idea of breaking down a problem into subsections and consequently solving them side by side or one after the other. This helps students in thinking like a computer scientist and directly relates to the skill of Computational Thinking. CT has been recognized as one of the essential skills in the 21st century, as it not only involves problem-solving with the help of computers but gives a simple idea about how to solve problems in real life.

CS Unplugged is available as an open source online repository. It includes lesson plans and explains their direct relation to computational thinking. Activities cover a vast range of different techniques like role-playing, puzzles and games to illustrate different CT concepts. CS Unplugged has been successful over the years with both primary and high school students and even teachers (Curzon & McOwan, 2017). These activities are available as an online open-source repository at csunplugged.org, teachinglondoncomputing.org etc.

Bell (2018) describes when CT is taught in general, it teaches the practitioner how to:

- describe a problem,
- identify the important details needed to solve that problem,
- break the problem down into small, logical steps,
- use these steps to create a process (algorithm) that solves the problem,
- evaluate this process.

Let's look at an example in order to understand how Unplugged activities relate to different CT skills. Kid-bots is one of the activities available at CSunplugged.org which helps in understanding the basic fundamental principles of programming. A device in the shape of a Bee is used, in which instructions are given to catch a target. It is based on a sequence of four possible commands i.e.

left, right, forward and backwards. When commands are given to the device, they are stored in a list called source code.

The implications of coupling Kid-bots with CT are as follows:

- Computational algorithms are based on output and sequencing. In this exercise, students focus on sequencing instructions.
- Students write basic instructions using a simple programming language that supports their understanding of the importance of following one step after another in proper order while writing code.
- Students develop different patterns while executing instructions.
- Students can evaluate which instruction is more efficient by going back and forth and making changes. This helps in picking the most efficient and effective instruction with the least time and steps (debugging).

It's a prevalent notion that programming is only for highly skilled people. Instead, programming is a skill that develops over time and learning can occur through mistakes. Programmers need important skills like communication because while writing codes they often have to go back and forth to debug errors. So problem-solving skills are important to programmers. We will see in detail how far other researchers have come by using the CS Unplugged approach and what insights they have to offer, in our ‘literature review’ section.

1.3.2 CS Unplugged and Professional Development

We have already discussed the interactive nature of CS Unplugged and how it can help in teaching a new curriculum. In this section, we will discuss how it can help teachers in growing professionally.

Many workshops, programs and seminars have been conducted worldwide where teachers and students are educated about the unplugged approach. These programs typically include a wide variety of activity demonstrations. Useful resources are also shared among teachers at these events. These workshops range from two hours to several years. In the latter case the presenters want to see the long-term effect and have the luxury of time.

As seen from many of these workshops (which we will talk about in detail in our literature review section), many teachers were attracted and showed an interest in learning about ways to teach the new curriculum with different pedagogies. Teachers were quite impressed and believed it to be a really informative session (Pokorny & White, 2012), (Price et al 2016), (Curzon et al, 2014), (Lee et al, 2017) etc. The whole idea behind these workshops was to upskill the teacher’s knowledge and attract an even greater mass of teachers into computer science. PD workshops have proved to be really advantageous for teachers who had been in the teaching profession for an extended period of time. Even with no computer science or technology background, they were able to understand and were even willing to demonstrate these concepts in their classroom.

1.4. My Research Questions:

To date, there have been relatively few studies that actually examine a teacher’s mindset and readiness in delivering CS concepts confidently in a classroom setting. There has been a large increase in professional development activities available for and undertaken by teachers. Introducing CT through different pedagogies (like CS Unplugged) Computer science is a relatively new idea and there are a few questions and grey areas that need to be evaluated with rigorous evidence. Our research tries to answer some of these questions which are explained as follows. Using both in-depth surveys and interviews of primary, intermediate and high school teachers, we will attempt to clarify some of these issues in detail.

Research Questions:

1. What are the benefits of teaching CT using the CS Unplugged approach? How far can the Unplugged approach be applied in order to implement the new curriculum?
2. Do in-service teachers prefer teaching CS Unplugged first, followed by programming or the other way around? How does this decision affect their confidence level and concept delivery in a classroom setting?
3. Can teachers establish a connection between 'unplugged' and 'plugging it in' exercises? Does 'plugging it in' have a positive impact?
4. How can the Unplugged approach help in resolving prevalent issues such as concerns about screen too much 'screen time' for primary and secondary high school students while making them 'digitally ready'?
5. What are the primary factors responsible for encouraging teachers to engage with this type of learning?

In section 2, we will attempt to provide a background about PD workshops designed for teachers by looking at some prominent case studies that evaluates its positive effects. This will be followed by different types of initiatives that promote CS as a discipline with the help of activities and engaging learning material. CS's direct relation with programming will be studied next and the role of CS Unplugged in laying a solid ground for understanding its core concepts. We will also discuss briefly the need for 'plugging it in' exercises by highlighting their role in establishing a tangible relation with computers. In section 3, we will chart the methodology used for this study, beginning by establishing the reasons for choosing qualitative research and then moving onto the detailed process of data collection. After this, we will discuss the approach used in data analysis for both surveys and interviews. In Section 4, we will lay out the survey results (both pre and post) and statistical analysis for our results. The results of the interviews with teachers will be taken up in section 5 which will emphasize the impact of PD workshops on teachers where we will also get to know about teachers first-hand experiences while using new strategies in a classroom environment. Section 6 incorporates a brief discussion on our results with some concluding remarks. Finally, the scope of work in future will be presented in section 7.

2. Literature Review

2.1 Why is there a need to introduce PD for teachers?

In order to deliver new subjects, teachers require some sort of training and professional development (PD) to teach the new curriculum. As the curriculum focuses on making students digitally ready from a younger age, training primary school teachers is our main concern. Primary school teachers are responsible for instilling and nurturing a student's interest at a young age. But in order to engage students with computer science and computational thinking, it is more important to make teachers understand these concepts first. If the teacher finds any subject or any concept hard or difficult to grasp, then teaching the same is nearly impossible. The teacher might not be very motivated and involved in teaching the concept, which will have a critical impact on the students learning. If students feel that teachers are not really passionate about what they are teaching, then there's a strong possibility that they might find the subject boring and lose interest in it gradually, resulting in complete failure of the new curriculum.

Sometimes when teachers, as well as students, hear the word computer science, they associate it with programming and the use of computers. Although this understanding is somewhat correct, it is rudimentary and learning to teach these concepts can be a bit intimidating. Hence, for teachers with little or no experience in this area, CS Unplugged can help to break down the core concepts of CS and help in learning them in a more fun and engaging way. Before we dwell further into this approach, let us see what constitutes PD activities and how they have proved to be a huge success.

First, we will talk about several studies that emphasize on the need for PD activities for teachers. For example, Bower & Falkner (2015) address the urgent need of introducing computational thinking among students and pedagogy strategies among teachers. Authors laid emphasis on 'notional machine' and how important they are for understanding and learning CS concepts. Authors here surveyed several pre service student teachers who were completing their course 'Digital Creativity and Learning' at Macquarie University. Survey results reveals that student teachers had a weak understanding of computational thinking. Moreover, they differed in confidence levels and most of them were quite unsure and hesitant about introducing these concepts to students. Student Teachers were more interested in understanding those ideas which relate to the curriculum and link to examples that are relatable. A few of them also responded that they need to focus more on the technology used and content of the learning aspects. Authors here really calls for professional development exercises that focus on a better understanding of what computational thinking is, with the help of appropriate pedagogical strategies (notional machine, unplugged etc.) and experience with the relevant technology or environment used.

Funke et al, (2016) believe that teaching CS Concepts to students at an early age might help in forming positive beliefs around the subject. The authors conducted an interview of primary and high school teachers to plan a curriculum on the basis of their ideas and opinions. Information was gathered in the form of interviews. Most of the teachers agreed to the point where they wanted to engage their class and focus on the implementation of CS and its concepts. Teachers further added that they lacked confidence and didn't feel capable enough to teach these concepts explicitly and required teacher training practices. Veletsianos et al (2016) argue that technology used by teachers for problem-based learning has a lot of impact in teaching CS principles. They conducted research wherein six experienced teachers went through a two week long professional development workshop. Further, teachers were told to implement several ideas from the workshop in their classrooms. Findings from the results depicted that teachers were not really comfortable with the technology they had to use. The authors highlighted the point that the implementation of these pedagogical strategies requires immense assistance. The authors here clearly raises the concern that technology and education don't go hand in hand. There is a need to introduce these concepts to teachers in a more accessible way, which raises the possibility of the use of CS Unplugged activities. Similar research has been done in NZ where Thompson et al (2013) talk about the importance of teachers and their perspectives in implementing curriculum changes. In order to carry out this study, the author surveyed ninety-one teachers who were a part of research in which new standards (NZMoE, 2017) were adopted to teach Computer Science concepts in NZ high school students in February 2011. The first part primarily focused on the role of the teacher in implementing the new curriculum in high school to see how teachers felt to be a part of new curriculum i.e. 'Digital Technologies'. The authors reported that only a three-day brief training was provided to the teachers that most of them could not attend due to several reasons. It was followed by NZ Association of Computing Digital and Information Technology Teachers (NZACDITT) which is a local New Zealand (NZ) association that set up workshops and developed a website (nzacditt.org.nz) for sharing teaching resources online. Teaching participants were from various backgrounds and only half the population was aware of programming concepts. Most of the teachers reported that the new curriculum will help in providing better opportunities for students as it is more flexible with the course design. Many teachers also put in voluntary work to make the most of this rare opportunity. The authors further added that this is only feasible for the short term as they require well organized professional development activities to upskill the teachers knowledge. In the later part, the author explained that the main reason why teachers didn't follow the standards was because of a lack of confidence, clearly reiterating the need to implement professional development activities like workshops that are easily accessible and resourceful for teachers.

Prieto-Rodriguez & Berretta (2014) argue that there is no prior work done to investigate the perception of computer science among teachers. To eliminate this, the author carried out a research-based study which includes a series of professional development workshops for Australian Digital technologies teachers. The main goal of this workshop was to provide teachers with the necessary skills and material to use it in their classroom. The teachers were introduced to CS Unplugged activities and given demonstrations on ways to use them in a high school setting. Results from this research show that most of the teacher found these activities worthwhile and it helped to dispel their incorrect belief that computer science is all about programming. Graph theory and hands-on robotic exercise became most teachers' favourite as they have a direct implication on grade 11-12 student and these activities might help students to think about a problem logically. The author ends by concluding that PD activities for teachers play a key role in clarifying core concepts and helping them learn the fundamentals of a subject to be taught to students in the same engaging way.

2.2 Prior results focusing CS Unplugged with teachers

The CS Unplugged approach essentially involves learning new ideas with the help of activities that cover the core concepts of CS in a different way altogether. The learner is supposed to think critically and not rely on any machine to complete any of the tasks. Many studies that have been carried out that introduced the CS Unplugged approach in their workshops for teachers, showed remarkably positive results. For example, Curzon et al (2014) infused CS Unplugged concepts with unplugged storytelling to increase the understanding of teachers in a more constructive and harmonious way. The workshop included a variety of unplugged activities ranging from teaching concepts about computational thinking, algorithms and programming linked with storytelling. Results from this study show that the teachers felt more confident after these activities. Teachers reported having a better understanding of the subject and ways to use it in the classroom. Sentence et al (2014) talks about the importance of professional development in inculcating knowledge and pedagogical skills among teachers. The authors led an initiative under 'Computing at School' organisation where they trained masters teachers to deploy hands-on activities on school teachers in order to eliminate their fear of curriculum changes. During the initial feedback period, all teachers reported that unplugged activities helped in boosting their confidence level. Most of the teachers felt that it was a good value for money and claimed that it was really exciting to deploy these in classrooms. To check the long-term impact, the teachers were contacted again after 10 weeks for a follow-up survey. More than half of the teachers reported that observed a moderate impact on their classroom teaching and their subject knowledge increased immensely.

Schofield et al (2014) describes the implementation of the new curriculum which encourages middle year students and teachers to use computational thinking, led by the initiative ‘MyCS’. The main aim of this workshop was to focus on teachers, the ways in which they can contribute towards curriculum development and encourage active participation of middle year students by building confidence towards computer science concepts. The post-survey result states that the teachers were ready to deploy unplugged activities immediately. Most of the teachers agreed with the fact that these activities helped them in widening their CS knowledge.

Pokorny & White (2012) talk about how a CS4HS workshop can prove to be beneficial in engaging computational thinking concepts among K-12 grade teachers. The workshop included presentations from CSTA (Computer Science Teachers Association) on teaching standards, several hands-on sessions that largely included activities from CS unplugged and scratch programming. Prior to the workshop, it was found that most of the participating teachers were not familiar with computational thinking and computer science concepts. Post-workshop, teachers felt confident about incorporating these activities into their classrooms. They responded by saying that they have a better understanding of the concept and few even indicated that they would plan activities for “fun Fridays” or use it as part of the core curriculum. Participants explicitly mentioned that they really enjoyed hands-on activities like CS Unplugged and felt that more such activities should be included in the workshop in future. Five months after the workshop another survey was carried out to check the impact it had on teachers. Several teachers reported that they had incorporated hands-on activities which helped in sparking student’s discussion around computer science.

Blum & Cortina (2007) talk about broadening the idea of CS education by providing professional development workshop to teachers. The authors conducted a workshop i.e. CS4HS, highlighting the importance of computational thinking in the US school curriculum. The workshop included a number of hands-on activities. At the end of the workshop, insights from the survey depicted that most of the teachers believed the practical implication of the exercises in the classroom was easy to demonstrate and learn. CS Unplugged was the most second most selected exercise by the teachers. Researchers believe that teachers had a better idea and clear understanding of the discipline which helped them to see the bigger picture and not restrict the discipline of CS as just programming for students.

Yadav et al (2014) conducted research where they focused on training teachers by introducing some core concepts of computational thinking. They conducted a week-long workshop, where both the teachers and students were introduced to some CT concepts. Participating teachers had no prior CS background, so they were taught using day to day examples. In the next half, teachers were educated on how CT can be implemented in classroom settings and its benefits. Examples include role-playing activities (CS Unplugged) and the simulation environment (Scratch). Post-workshop, a control group and workshop teachers were appointed to fill a survey in which teachers with workshop experience responded majorly by stating, 'Computational Thinking as a problem-solving technique with or without computers' whereas the Control Group majorly responded by saying, 'Computational thinking only works with computers?' This gives us a clear idea of how the teacher mindset changes drastically after attending the workshop. The author further commented that a few of the participants' attitude didn't change very significantly due to a lack of understanding. Hence, they concluded by saying that professional development exercises to help teachers in increasing their knowledge and developing a positive interest in the field of computer science.

Lee et al, (2017) provide a detailed explanation of professional development exercises for teachers in New Mexico led by the program New Mexico Computer Science for All (NM-CSforAll). The main goal of this event was to give an opportunity to teachers to gain new knowledge on teaching pedagogies and methods to deploy them effectively in classrooms, as they are the ones responsible for delivering them to students. Sessions included activities from CS Unplugged, working on programming environment like NetLogo and lecture portions which were delivered online; making it a "flipped classroom" model. At the end of the workshop, the teachers 'felt really good' and 'highly supported' by the activity. After a year, another survey was carried out to check how beneficial these teaching pedagogies were in the classroom setting and the teachers commented that activities like these helped them in learning computer science concepts in a comfortable way and kept the students occupied.

Pollock et al (2015) raised a concern about the lack of trained teachers in the computer science discipline and how professional development activities help to eliminate them. In order to address this issue, the authors conducted a workshop wherein undergraduate participants co-planned and co-taught computing lessons with the help of a practice teacher. Resources mainly included: CS Unplugged material, lesson plans and new teaching pedagogy to improve teacher experiences. Findings from the workshops reveal that it had a positive impact on both the students and teachers by increasing their level of confidence and knowledge about learning CS teaching pedagogy. Pollock et al (2017) conducted a follow-up study after two years to find out how teachers were implementing the new strategies and what are the outcomes and learning from the classroom setting. Researchers interviewed teachers who had participated in a week-long activity of the professional development Partner4CS project. Teachers reported that they had implemented some principles of computer science with the help of unplugged approach like 'collaborative based learning and kinaesthetic activities'. On implementation of these activities, many teachers noted an increase in student learning and excitement towards CS. Overall, it turned out to be a success, but the teachers requested additional support resources like blogs, google drive or MOOC to help them teach better.

Chiu (2015) followed a different strategy besides unplugged to teach programming concepts to preschool teachers. Researchers used a game creation approach to motivate teachers who had no programming experience whatsoever. After introducing CS concepts and its implication on the Scratch programming language, the teachers were asked to design a project to replicate what they have learnt. Teachers were able to understand the concepts better and showed a positive response overall. The authors added that teachers felt more confident in learning and applying these concepts in their classroom teaching. (Granor, DeLyser, & Wang, 2016) also introduced a Professional Development workshop among teachers with no CS background. The main aim of this workshop was to train teachers successfully, get them ready in a short amount of time and familiarize them with the CS concepts. This workshop basically introduced industry professionals as volunteers who interacted with classroom teachers and provided new techniques programs on how to teach CS. The teachers were provided with more than 300 hours of work throughout this workshop which took place over the span of two years. Post-workshop, both the teachers and volunteers in the program clearly manifested a high rate of interest in CS and an increase in knowledge.

Morreale et al (2012) evaluated the result of two CS4HS workshops to find out which tools and knowledge teachers find helpful and easy to implement in their classrooms. The main aim of the workshop was to introduce teachers to different teaching methods such as Google Sites, Java Simulations, CS Unplugged activities, etc. The author conducted two workshops in the gap of 8 months and repeated attendees were asked about the methods and activities they used in the classroom setting. Responses mainly included google sites and CS Unplugged activities (Algorithmic Thinking) as they were immediately deployed in their classroom. Teachers favoured these activities because they require minimal or no time for preparation, no funding and no extra curve for implementing the software.

In similar work, Al-Duwais et al (2012) described how they conducted a three-day workshop called CS4HS@KSU (King Saud University). Their workshop primarily focused on female high school teachers and exposed them to new concepts and teaching practices that can be deployed easily in a classroom setting. The workshop included four sessions that ran for three days in total, most of the topics were picked up from CS Unplugged activities, Scratch as a programming environment etc. Post evaluation result shows that teachers were a hundred per cent satisfied with the content of the course. The activity that teachers liked the most was CS Unplugged as most of the teachers reported it to be a fun way of learning concepts by actually participating in it. Most of the labs were not equipped with computers so these activities seemed to be a perfect fit in that case. Overall, the teachers were quite excited and showed tremendous growth and an inclination towards learning computer science concepts and extending these ideas to classroom teaching.

Similarly, Koning et al (2017) introduced the concept of computational thinking among teachers and students in Dutch primary schools. The researchers focused on how primary school students can develop basic CT skills and how teachers can deliver them effectively. The authors developed a lesson plan to be deployed in schools which included a detailed version of CS Unplugged activities and the use of smartboard which was highly admired by both teachers and students. The teachers also commented that the instructions given to them were clear, precise and the exercises aligned perfectly with the curriculum.

2.3 Boost in Confidence

There are a lot of studies that tell us how important professional development activities are and how they help in **b** participation of participants own knowledge and understanding. After the end of the workshop, the author mentions that teachers who were not confident enough felt an increase in their confidence levels and subject knowledge in comparison to their peers.

In other work, Duncan et al (2017) talk about their research study that involves primary school teachers implementing computational thinking in NZ classroom. Teachers were given complete training of professional development and how to teach through Unplugged activities involving CS. Teachers were supported throughout the study in case they required any assistance regarding the new course material and teaching practices. In order to teach the new curriculum, teachers used the activities in the classroom which were mostly part of CS Unplugged. Through feedback, teachers reported that there was an increase in the level of confidence in teaching computer science and they even believed that these activities posed a good challenge for students. Teachers were happy to see the student engagement and teamwork that came out in an extraordinary way. The author further reported that there were some misconceptions which can arise due to the vast material and terminology it brings but these can be eliminated by addressing them in the future professional development exercises.

Neutens (2016) describe the implementation of STEM and CS education which is being introduced in the Flanders curriculum. The author explains that there are no particular STEM teachers available in Flanders but there's a lot of course material that has been lying around, ready to be introduced to students. Researchers here were trying to train teachers with the help of the professional development workshop by introducing several CS concepts in the form of hands-on activities(Unplugged). Teachers reported an increase in their confidence level within a time frame of two days. The author added that assisting students in completing the activity also engaged teachers and helped them in understanding the concepts better. The author suggests that professional development activities should be for more than two days and extensive material should be provided as most of the teachers felt that they gained a lot from these programs.

Leyzberg & Moretti (2017) conducted a content-knowledge focused professional development exercise for teachers in order to make participants comfortable with teaching these concepts in the classroom setting. The workshop included a mixture of video lectures and hands-on activities. Teaching participants did not have a strong background in computer science. The teachers were quite impressed by the workshop. Many teachers even commented that the material and unplugged teaching pedagogy is quite exciting and challenging. A few teachers even reported that these workshops helped in increasing their confidence and observed an increase in active participation of the class. Price et al (2016) introduced a workshop called BJC PD which ran for three straight years starting in 2012. A huge population of teachers attended this professional development workshop. The main aim of this workshop was to introduce teachers to the new pedagogy which could then be easily adapted for classroom teaching. The workshop included lectures, discussions and hands-on activities (CS Unplugged) which took place over a span of three years wherein every year, six weeks were given per workshop for demonstrating and sharing the experience of teachers and demonstrators. Most of the teachers felt quite confident about adapting these activities and moreover more than half of them adopted these principles in classroom teaching in the following semester; making this workshop a success.

Bower et al (2017) address the strategic issues faced by teachers while teaching the new digital curriculum introduced in Australian schools. Workshops were held at an Australian university focusing on K8 teachers. Teacher computational thinking and pedagogical capabilities were the main focus of these professional development workshops. The workshops included modules followed by unplugged activities which were followed by videos demonstrating the concept. The post-workshop survey revealed that teachers who had knowledge of computational thinking were able to get the basic idea of its content and its relativity. Further, it helped in increasing teacher's confidence and self-efficacy towards teaching these concepts and practices. Hence, it is clearly seen how computational thinking can be fostered among teachers within a short duration of time, showing positive results.

2.4 Initiatives

In this section, we will talk about several initiatives that took place over an estimated period in order to enhance the growth of CS and deliver its core concepts to students and teachers. These initiatives consisted of numerous workshops that ran from a few days to several years. The workshops comprised of a number of mixed activities which basically involved teachers learning about the new teaching pedagogy and providing them with the learning material. The main aim of these workshops was to arouse curiosity among teachers and students regarding the discipline of CS. Several initiatives include CSInside, CAS, MyCS, NM-CS4All. We have grouped these initiatives according to their type, some of which are discussed in the following section.

2.4.1 'Georgia Computes'

Bruckman et al (2009) talk about an alliance called the "Georgia Computes" which was funded by the National Science Foundation's Broadening program in the USA. This initiative had numerous goals, primarily it focused on improving computer science education throughout Georgia by offering workshops to high school students during summer camps, colleges, university and teaching faculty. Teachers and students were trained in these workshops wherein a mixed material of CS Unplugged activities was taught and demonstrated, different programming environments were introduced, lectures, talks and discussions were carried out. The main agenda was to improve the teacher understanding of these concepts and increasing student participation with the availability of appropriate teaching material. This initiative ran for six years and was carefully examined by an external team that suggested improvements and tabulated detailed results for evaluations making these workshops more effective. Ericson et al (2005) reported about one of the workshops that were a part of the "Georgia Compute" initiative that was offered and led by the Institute for Computing Education. This workshop was solely aimed at teacher professional development. It included two sets of activities CS-AP and Programming and system management. Post-workshop results clearly depict that the teachers learned quite a lot from the workshop even those teachers who had no prior background in computer science and programming. They ran their first workshop in 2004 and hope to improve in future with the help of the feedback given by the attendees. Furthermore, Ericson et al (2014) wrote that these workshops have been in the run for the past 10 years and now have been in continual development. One of the most remarkable results of the ICE initiative was that AP CS is now considered as the fourth science subject in high school in Georgia. After six years of "Georgia Computes" initiative, Guzdial et al (2014) did a follow-up study and described step by step how the initiative helped in broadening both the teacher and student mindset, and increased participation. The author states that one of the most striking things that made Georgia Computes (GaComputes) successful was its professional development among teachers. This was done with the help of a program in association with the Institute of Computing Education. This helped teachers to gain expertise and confidence in teaching CS concepts to students and implementing those strategies in a classroom environment. Moreover, it encouraged the underrepresented and minority groups towards computer science. The author concludes by mentioning that it was a success because of several reasons including readily available material and interesting activities that attracted a larger crowd.

2.4.2 Partner4CS

Pollock et al (2017) have addressed the issue of lack of trained teachers in the computer science discipline and how professional development activities help to eliminate the same. In their workshop, Partner4CS, undergraduate participants co-planned and co-taught computing lessons with a practice teacher. Resources included CS Unplugged material, examining lesson plan and teaching pedagogy to improve teacher experiences. Findings from the workshops depict that it had a positive impact on both students and teachers by increasing their level of confidence and knowledge about learning CS teaching pedagogy. After a year of designing and introducing the workshop, Mouza et al (2016) talk about the Partner4CS model which was launched in 2012 and how it focused on enhancing professional development among teachers. The authors aimed for three main goals of the workshop including week-long activities and lesson plan for teachers to use it in the classroom and follow up support for teachers (online). Teachers were introduced to CS unplugged activities and programming environment in the week-long session. Post-workshop results clearly depicted that teachers learned various strategies and became confident about their teaching ability. Most of the teachers indicated that they liked CS Unplugged activities, pair programming and real-life examples as a favourite acquired pedagogical skill during the course of their workshop.

2.4.3 Professional Certification

Sentance & Csizmadia (2017) started a new certification course for in-service computer science teachers that would give teachers professional recognition. Certification incorporates three parts including the mixture of activities ranging from learning to program and different approaches that will help them teach computer science in the classroom setting and a variety of projects that relate directly to their own teaching experience. After the completion of the course, results revealed that more than half of the teachers wanted to achieve a professional recognized qualification and attain a certificate for themselves. Moreover, most of them were impressed by the fact that we could get constructive feedback and guidance easily. More importantly, teachers learned about new GUI's and Unplugged activities and gained confidence in presenting them to students.

Goode & Margolis (2011) talk about how participation in schools can be enhanced through teacher PD activities and curriculum development. Authors here talk about initiative Exploring Computer Science (ECS) professional development model which includes coaching programs for teachers and building teacher community. Authors here argue that PD should be accompanied with inquiry based approached (which is a major part of ECS model). ECS PD workshops were attended by several teachers across different high schools in Los Angeles in the year 2008-2009.

Results after the workshop indicate that teachers adopted these strategies and ended up teaching ECS course in the following year. In general teacher participants reported that they had a better understanding of concepts through Unplugged activities like role playing, jig saw activities, collaborative learning etc. Results were not limited to just teachers, students were introduced to ECS course where promising results were seen. Students largely reported that they were more likely to take computer science courses after high school and pursue computer science as an academic major after enrolling in the course. Hu et al (2017) introduced a set of teaching practices for teachers in Utah by the name of Exploring Computer Science (ECS). The main aim of this program was to make teachers ready for teaching computer science concepts in a quick manner by using techniques like unplugged. It not only gave an opportunity to the teachers but also outreach to students who were now able to take CS as a course without using an elective credit. Teachers were able to finish the ECS course in half a year with the help of a few professional development activities on the side and could easily start teaching in the next semester. Teacher participation was a mixture of both experienced and inexperienced computer science teachers. Post-program, there was a significant increase in confidence levels among teachers as well as students studying CS. The author points out that schools can adopt these strategies to successfully staff their classes by teachers with no prior CS background. In addition, the author concludes that teachers also helped in fostering an evolving mindset among students and made a remarkable improvement with them.

2.5 CS and Programming

In this section, we will discuss how computer science has a direct relation to programming and how material besides unplugged can help in developing new concepts that are prerequisite for learning programming. Not all successful PD programmes use Unplugged, of course, and in this section we look at other elements of workshops that also engage teachers.

Cortina et al (2012) developed a project titled ACTIVATE (Advancing Computing and Technology Interest and innoVAtion through Teacher Education) for high school STEM teachers. The main aim of this project was to educate teachers on how to introduce programming concepts into the existing curricula. After introducing teachers to programming concepts in week-long activities, teachers were told to design an application in Alice, Python or Java that should relate directly to the topics they taught. Through the follow-up survey and interviews, teachers were really positive about the concepts taught. Most of the teachers strongly felt that these workshops gave them a better understanding of the concept of programming. A year after the workshop, teachers filled in a follow-up survey and results showed that a high percentage of teachers used these activities and material in their new or existing courses. Liu et al (2011) planned a one-week computing workshop to improve computer science education in school students by focusing on developing interest among teachers first. The workshop mainly focused on introducing Scratch and Alice to a wide variety of teachers including computer, math and science across all K 12 levels. A Post-workshop survey depicts that confidence among teachers drastically increased by a factor of two. Perhaps, most of the teachers felt a certain increase in their knowledge related to CS concepts. During the workshop, teachers also developed curriculum material to be deployed in the following semester.

Vieira & Magana (2013) designed a new backward process (teacher’s guide for designing learning modules) and demonstrated how its implementation on any programming software, in this case, Scratch can be used to measure student’s performance. The target audience was teachers from high school and college level teachers who will be designing computational thinking activities. The backward design process includes the main steps that guide the teacher in designing learning programming experiences and highlighting problem areas that students find difficult and require more attention. Post-workshop, the teachers were given two weeks' time to develop an activity on Scratch linked to the current curriculum. The result shows that teachers improved their understanding of the concept and the idea was quite clear in their head. Researchers further reported that participants deployed these activities in the classroom and a positive impact on students could be seen which encouraged the teachers to implement these activities at other elementary and secondary levels as well.

Chiu (2015) came up with a different strategy to teach programming concepts to preschool teachers. Researchers used a game creation approach in order to motivate teachers from a different background, even those with no programming experience. Another reason to use this approach was to engage students as it would be fun and exciting for them to learn what they enjoy playing the most and create something new with it. After introducing CS concepts and its implication on Scratch, teachers were asked to design a project to replicate what they had learnt. The findings indicate that with the help of this new strategy, teachers were able to understand the concepts better and showed a positive response overall. Authors further added that teachers felt more confident about learning and applying these concepts in their future teaching. Liu et al, (2013) used a new technique to introduce programming concepts to teachers with the help of the drag and drop program i.e. App Inventor. App Inventor is basically used to create applications in the Android environment. Teachers went through a week-long workshop which included the introduction of CS concepts through App Inventor for a variety of teaching disciplines. At the end of the workshop, teachers developed a curriculum related to their field which can be directly deployed in the classroom. A Post-workshop survey and face to face interviews with the teachers depicted that there was a significant increase in the confidence among teachers and a higher percentage of increase in knowledge.

Subramaniam & Cateté (2017) did a follow-up study of Price et al (2016) BJC's Professional development workshop. Subramanian et al focused on only one part of the study i.e. programming concepts that were introduced in the workshop, they believed a limited exposure and training time was given to teachers to get familiar with the programming concepts, even to those who have no knowledge of CS principles. The author here introduces new rules that allow teachers a better understanding of the concept by focusing on programming. Data from two groups of students were collected and compiled by external raters, one with the new rules and one without. After being carefully rated externally, the authors modified the set of rules so that it is more understandable and easier to adapt from the teacher's perspective.

Kay & Moss (2012) introduced a new set of teaching methodology i.e. robot programming for teachers to learn to program. The workshop focused on K 12 teachers and it ran for three days. Teachers formed a variety of backgrounds and teaching disciplines. The result shows that after the completion of the workshop, even teachers with no programming experience and discipline other than computer science were extremely confident about programming a robot. They also showed a high interest while using these materials with the students. Dodero et al (2017) developed a new programming language that was based on block-based programming called Scratch and tools available from MIT App Inventor to develop teacher's skill for mobile applications, by the name of VEDILS. Participant population was future students of a master's degree. They were introduced to several exercises and were told to develop an application from the knowledge they had gained.

As teachers had no prior experience in programming, they were able to follow the instructions without any problem. The author recommends the use of this application as one of the programming environments to introduce programming to students. Haden et al (2016) introduced two professional development workshops for high school in-service teachers in a course of two years. They focused on new pedagogical strategies for teaching programming in the classroom environment. The workshop essentially covered introductory material to programming and tools associated with it. They were successful in delivering CS concepts and their implementation on Scratch. Preliminary result depicts that teachers showed a positive response and were able to implement them in the classroom setting. Authors here highlighted one important result that teachers need ongoing support, especially high-quality material for the classroom.

2.6 What engages teachers?

In order to assess student achievement and concept understanding of the subject, it is important for teachers to be familiar with the topic beforehand. Teacher's engagement with the subject is directly proportional to the student's interest. In the following section, we will talk about how CS Unplugged approach redefines learning.

Prieto-Rodriguez & Berretta (2014) argue that no prior work has been done to investigate the perception of computer science beliefs among teachers. To address this, the author carried out a research-based study in the form of a professional development workshop for Australian digital technologies teachers. The main goal of the workshop was to provide teachers with necessary skills and material so as to use it in their classroom. Teachers were introduced to CS Unplugged activities and were given demonstrations on how it can be used in a high school setting. The result from this research shows that most of the teachers found these activities worthwhile and helped to overcome the misconception that computer science is all about programming. Graph theory and hands-on robotic exercise were the teacher favourite and teachers felt really engaging as they had direct implication to grade 11-12 students and these activities can help students in thinking about a solution logically. In the end, the author concludes by reiterating the importance of professional development for teachers as it helps in clarifying concepts and establishing a solid foundation for the subject.

Bort & Brylow (2013) talk about how computational thinking concepts can be redefined as lesson plans which can be deployed in classroom teaching for high school students. In order to demonstrate this, the participant teachers were recruited from both computer science and non-computer science background having minimal or no experience in programming. Workshops were structured in such a way that it consisted of a mixed variety of sessions that covered most of the CS topics which were followed by panel discussions. On the final day, teachers were asked to develop an activity related to the curriculum and which could easily be used in the classrooms. The other aim of the workshop was to discuss computer science education standards of the Wisconsin state and launch a chapter on "Computer Science Teachers Association". Participant's feedback was collected in the form of a survey. Most of the teachers gave a positive response by saying they would recommend it to their colleagues and for its implementation in classrooms. Their study also specifically focused on non-computer science STEM teachers who were attending their first professional development workshop, demonstrating a firm grasp of computational thinking concepts but not as well as those teachers who have experience in the field.

Cutts et al (2007) presented a new initiative i.e. Computer Science Inside. This initiative provided information to teachers about methods to incorporate CT among secondary school students and facilitate learning. This initiative mainly focused on teachers delivering concepts with the help of hands-on activities to students and promoting professional development among themselves. The result shows that teachers wanted workshop packs to be deployed into classrooms immediately. They also encouraged academia to demonstrate these activities more frequently. It was seen that even with little or no training, teachers were able to demonstrate these concepts and it was supported by teachers on a broad scale captivating the importance of new teaching pedagogies (hands on activities) that engaged teachers at a greater level . Schofield et al (2014) describe the implementation of the new curriculum with the help of an initiative, MyCS which focuses on middle year students and teachers to encourage the use of computational thinking. The main aim of the workshop was to focus on teachers and how they can contribute towards curriculum development with the help of active participation of middle year students by building their own confidence about teaching computer science concepts to students. The post-survey results clearly state that teachers were ready to deploy demonstrated unplugged activities almost immediately. Most of the teachers felt that these activities helped in widening their knowledge of CS and really engaged them to learn more. It was also seen that teachers who couldn't attend the workshop were able to access the material online.

Fontenot et al (2013) describe how computational thinking can be introduced among school students and teachers with the help of some simple and playful activities. The main approach followed by the researchers was of the CPATH project which included an environmental control activity. Vertical integration of students from all level of school and teachers were collectively involved in this project. Teachers were first educated about computer science ethics which was followed by the CPATH activity, where they were paired with the students. After completing the activity, the teachers were really positive about introducing computational thinking concepts and correlating them with the regular class curriculum. They were also impressed by its intrinsic relation to math and technology. Teachers further commented that even weak students got involved in pair activity and students seem to have acquired a higher level of thinking skills with the help of this project.

Corradini et al (2017) describe the outcome of a two-year program called “Programma il Futuro”, initiated in order to raise awareness among primary and secondary school teachers towards Digital Technologies. Recruited teachers and students were introduced to the learning material from “code.org”. There was active participation of both teachers and students throughout the project. The program included CS unplugged activities which were readily available online for easy access by participants who couldn't attend the event. The teachers found these activities very useful and easy to operate in a classroom setting. Teachers were quite fascinated by the fact that all the students participated in the activity equally. The authors further added that in a short time span, a significant difference in knowledge and high interest in both teachers and students was seen. Hence, the project was seen as an overall success as it attracted both teachers and students towards the new curriculum development.

Similar work has been done by González & Muñoz-Repiso (2017) where simple programming concepts were introduced to kindergarten teachers for curriculum implementation. Kindergarten teachers performed an activity using programmable robots called bee bots. Movements, sequences were some of the fun activities performed by the teachers. Post teacher training, teachers showed high interest and motivation while performing these activities. They also agreed about using them while developing curricula for students.

2.7 Continual Professional Development

In order to use CS Unplugged activities in the classroom, teachers need some kind of additional support and guidance that they can fall back upon when stuck somewhere or need any assistance. During the professional development workshops, teachers often address their need and how the timely recurrence of these programs would help in building their confidence by providing them with constant support and act as a backbone for their learning.

Martinez et al (2016) reported results for a two-year long professional development workshop for primary and high school teachers which took place in the year 2014 and 2015 in Argentina. Teachers learned about CS concepts and its basics with the help of CS Unplugged activities, programming simulations environment (Alice) and inquiry-based lessons. Findings from this study reveal that teachers gained a lot of content knowledge about CS which made them feel confident about answering questions and teaching CS concepts to students in classroom setting. Teachers utilized a mixture of strategies taught in the workshop for their classroom teaching while laying more emphasis on inquiry-based teaching and Unplugged activities. The authors further commented that teachers with no CS background need more time and continuous professional development exercise.

Cabrera et al (2018) demonstrate the result of a survey of high school teachers who experienced professional development workshop in the past four years. Professional development workshops included hands-on activities, for e.g. CS Unplugged and working on a programming environment like Scratch. Participants who attended professional development workshops at the public university for four years were considered. Post survey results show that most of the teachers had a positive impact on their career. The most important finding the researchers included was that teachers tend to lead the initiative for implementing computer science in their school and they require a rigorous long-term solution for professional development exercises.

Rich et al (2017) report a year-long study that understands self-efficacy and beliefs about teaching computing and engineering. Researchers here conducted a week-long workshop throughout the year. The faculty was provided training which included designing unplugged activities and challenges that could be deployed for their school curriculum. Post-workshop, teacher's beliefs were affected by their own background, experience and training. The results of this study suggest that the year-long training helped in improving their teaching abilities and understanding core concepts. Results from the school under study were compared to another school with the same demographics. The comparison result depicted a drastic increase in the self-efficacy of teachers in technology and engineering. This showed a significant effect of the year-long training and how teacher's confidence built up tremendously during the workshop. Hence, this research strongly corroborates the point that continual professional development among teachers can be drastically improved by demonstrating new concepts through unplugged activities and interactive programming environment, so as to increase teacher's confidence level regarding these subjects. To have a better understanding of teaching pedagogies and beliefs among teachers, authors designed a study to assess teacher's self-efficacy towards the integration of CS concepts. Authors here conducted a comparison study wherein teachers in one elementary school went through a professional development workshop throughout the year while the others didn't.

Teachers in both the schools show similar beliefs and self-efficacy towards science and mathematics subjects but there was a huge difference towards technology and engineering. The school on which the study was conducted showed a remarkable improvement in understanding concepts and teaching pedagogy among teachers which clearly states how the year-long professional development activities can benefit teachers and boost their level of confidence. The authors' further comment that all the teachers who had previous STEM knowledge demonstrated higher self-efficacy as compared to those who were entirely new to it.

2.8 MOOC

Although it is clear that there is a need for continual professional development for teachers, it is not possible for the PD providers to be available at all times and to be within physical reach of teachers. One of the best possible solutions is to make the material available online. The availability of making a course/workshop and the learning material in one place has a lot of benefits. We will be talking about this same in the following section.

As a follow-up study by Bower & Falkner (2015) similar work has been done by Falkner et al (2015) where the author introduced the CSER Digital Technologies MOOC, which helps K-6 teachers by assisting them to develop their concepts of computational thinking and understand the digital technologies curriculum in Australia. The curriculum includes a lot of opportunities like CS Unplugged activities lessons and programming environment like Scratch that teachers from any field can easily get familiar with. Teachers who participated in this online workshop were introduced to all these concepts and material. Post-workshop, the majority of teachers showed a positive impact on developing an understanding of computational thinking. Concurrently, researchers also found that teachers were happy when they were introduced to these concepts with day to day examples and fun activities, which made them understand the concept in a more comfortable manner. The author further adds that more long-term solutions are needed, and MOOC courses are one of them.

Partanen et al (2016) introduced the racket language course for elementary school teachers in Finland. The author recommends that these insights can be used to develop a curriculum for the primary level as well. The author introduced an online professional course called Koodiaapinen MOOC. The course was developed in such a way that unplugged exercises were restructured for their easy implementation in the classroom environment and simultaneously the material was also available online for easy access. In general, the course received positive feedback and teachers reported difficulty level to be rational. Teachers were also seen as highly motivated, making it an interesting event altogether.

Curzon et al (2009) describe three university projects which used unplugged activities to describe concepts to a large variety of people. One of their aims was to have an open source community available for everyone. The author reports that CS Unplugged activities are available online and have seen an increased usage on the online portal. Similarly, CS Inside project aims at developing concepts for teachers where the survey reported that teachers find reading material to be adequate and encouraging. It helps to generate interest and increase pupil participation in understanding the concepts in a challenging way. The online availability of the courses and activities has been a huge help to teachers.

2.9 Integration of CS Unplugged with other subjects

As CS Unplugged is easy to use and demonstrate, it is quite interesting to see how it intertwines with other disciplines besides Computer Science. STEM subjects do have a direct relation, but it is also connected to disciplines such as music, art etc. Teachers from other disciplines seem quite fascinated and intrigued by the use of CS Unplugged in their curricula.

Hart et al (2008) describes a three day workshop entitled ‘Linking Mathematics and Computer Science’ aimed at mathematics teachers with some interest in computing. This workshop was a part of continuing series of summer workshops hosted by the Purdue University. The workshop consisted of innovative activities that link mathematics with computer science. Two main tools that were used during the workshop were Computer Science Unplugged activities and Google SketchUp. The post-workshop feedback clearly reflects that the teachers had a greater understanding of what computer science entails as a subject. All the participants agreed on the fact that these sessions would help them in teaching computing concepts to students in a modernistic way.

Ahamed et al (2010) talk about how computational thinking activities foster an interest in students towards computer science and how teachers play a key role in delivering them. The authors here conducted a three-day workshop with a mixed number of teachers (grade 9 - 12) from different backgrounds primarily from the science area. Nine technical sessions were created, starting from foundation courses and moving on to more deep related concepts through both simulation development like VPython and unplugged activities. Teachers were introduced to computer science unplugged activities first when a new topic was to be introduced, this helped teachers to understand the activity in a much more interesting way. Teachers developed activities to foster computational thinking through VPython simulations as a part of the project for the workshop. Results show that most of the teachers felt more confident and more familiar with the concepts that were taught. Even with little programming experience, teachers believed CS Unplugged and simulation development activities can increase the interest of students towards Science.

Hildebrandt & Diethelm (2015) focused their study on teachers with informatics background and how they respond for new teaching practices being implemented in the new curriculum. Teachers were introduced to new programming environments like Scratch, CS Unplugged activities for their active involvement. The researchers reported that in-service teachers showed a remarkable increase in subjective knowledge of the topic with their active engagement. The researchers further added that with the help of these teaching incentives, teachers who were non-specialist were able to gain more confidence about teaching students and helping them attain core CS skills. Similarly, Adler & Kim (2018) introduced computational thinking concepts to teachers in the science curriculum and showed how it can be incorporated in other disciplines as well. Pre-service teachers were a part of the study, which was comprised of two parts. The first part introduced the basics of coding with the help of Scratch, where teachers designed a solar system. In the second study, a web-based simulation was created to understand the laws of motion with the help of a simple game. Post-workshop results reveal that more than 90% of teachers agreed that programming helps in removing misconceptions and invoking critical thinking. The second study results showed that most of the teachers agreed that computational thinking is a good education tool.

2.10 Unplugged into Plugging it in: The Need

Surprisingly, there's a lot of research reported on how to improve and deploy Professional development activities for teachers. As CS Unplugged is becoming more and more common and is used globally, new activities to introduce core CS concepts are being generated every day. But sometimes it is misunderstood that they are just activities and have no direct implication on computers.

DePryck (2016) talk about how introducing computer science concepts have become one of the important aspects of the new digital curriculum. Teachers play a key role in delivering these concepts to students and are needed to be trained on new teaching pedagogies. Teachers come from a variety of backgrounds and the author argues that there is no requirement of STEM background in order to teach CS concepts to students. In order to validate their argument author talks about results of an initiative namely TACCLE3 which supports primary school teachers in teaching and learning concepts of computer science in the form of games and activities and a complete set of instructions. The author strongly encourages that TACCLE3 initiative has successfully created a link between computational thinking and coding which makes it an overall successful approach to be used as a form of classroom teaching. Due to the introduction of new curriculum and teaching pedagogies like unplugged, there’s a lot of contradiction among many authors about whether CS Unplugged activities should be taught before the actual understanding of the concept or after.

One of the researchers, Hermans & Aivaloglou (2017) compared whether students should be made to sit in front of a computer and be asked to code or a conceptual understanding should be made with the help of these activities and then allow students to gain their knowledge and explore their options on an actual computer. Basically, focusing on unplugged with plugging it in or just plugged in lessons. In this study, the author conducted research on 35 elementary school students and introduced the concept of both unplugged and plugged activities to students. Post lessons, students who did unplugged first and plugged it in later were seen to be more confident in what they were doing with higher self-efficacy. With this research, it becomes quite clear that there is a strong connection between unplugged and plugging it in activities.

Furthermore, Shelton, (2016) published an article stating the importance of plugging it in after unplugged activities in schools by pointing out how beneficial CS unplugged activities are and their direct impact on fostering computational thinking among students. But the author further added that students will get a better understanding of a concept when they see it being implemented on a machine and help them develop something useful. The author concluded by stating that CS unplugged activities are important but plugging them back is even more important.

The importance of PD activities for teachers can be gauged by the change in their mindset after attending these workshops. The CS Unplugged approach can work as an ideal tool in establishing a solid ground for the discipline with its interesting activities and engaging learning material. At the same time, we must not forget the need of ‘plugging it in’ to computers in order to have a better understanding of the concepts to learners and develop something practical from the knowledge obtained. In this research, we will attempt to address some of the issues that haven’t been looked into and try to gain more insight through teacher’s first-hand experiences.

3. Methodology

3.1 Introduction

This study was run with participants from two different conferences i.e. DT4HS and DT4PS which are a part of the Kia Takatū ā-Matihiko (Digital Readiness) program. They are based on CS4HS and CS4PS, Google-funded professional development workshops for teachers to help them prepare for the new Digital Technologies curriculum (technological area). Kia Takatū ā-Matihiko (Digital Readiness) program is designed especially for educators in New Zealand. One of the main components of this program is a self-review tool which will help teachers to identify their level of 'readiness', which will further suggest a personalized pathway for implementing the new subject matter by instilling confidence in them. The participants are teachers who are teaching students between years 1 to 13 (5 to 18-year-olds).

3.2 Why qualitative research?

Qualitative methodology refers to the research that produces descriptive data - people's own words, both written and spoken. The reason we chose qualitative research over quantitative research is that our research essentially involves studying real-world settings that generate substantial narrative descriptions. We are dealing with words and understanding people's mindset; while quantitative research deals with numbers, figures and statistical data. Here we are free from any predetermined category of analysis which makes room for flexibility, resulting in in-depth information about the topic. Research questions are vaguely formulated, giving participants room to talk about their experiences. Rather than using statistical and logic models, qualitative research uses multiple systems of inquiry for the study of participant's behaviour (Merriam, 1988). As it focuses on everyday life, collected data is comprehensive and provides different ideas which emerge into new theories. Moreover, subjective knowledge obtained from the participants helps us to understand their mindset, in a much accurate manner.

Although qualitative data can be derived from many sources, but in our research, we first collected data with the help of pre and post workshop survey. Using surveys helps in gathering data on a one-shot basis, making really economical. It generates numerical data which helps us in processing statistical analysis of the data. Surveys were followed up by semi structured interviews, which were audio recorded as interviewing teachers on phone was much easier as teachers were spread all across the NZ. Telephone interviews are much cheaper and quicker to administrate instead of face to face interviews. In, semi structured interview all questions are open ended which gives greater flexibility to the interviewee to speak about a topic with freedom and interviewer can prompt and probe in between, pressing for more clarity and checking for the clear understanding of the issue being addressed or talked about.

3.2.2 Data collection

Data is collected using a number of methods and is entirely dependent on the nature of research. Several factors such as time, funding, experience, etc. are considered to determine the best suitable fit for the project. Generally, when conducting qualitative research, researchers use at least two different methods. In our research, we will be using two methods: an open-ended survey and semi-structured interviews. The reason for their selection will be discussed in the following sections.

3.3 Designing Survey

Choosing the type of survey depends on several factors like depth of information needed, time available, number of participants, etc. In our research, we have used a mixture of both open and closed-ended (Likert type) questions (Groves et al, 2011). There are many types of survey questions with their own advantages and disadvantages.

3.3.1 Open-ended questions

Open-ended questions ask respondents to formulate their own answers. We included open-ended questions because they helped us in gathering additional information about the question, thereby providing further insight on what exactly the participants think, giving them space to express their feelings freely. The freedom of space potentially will help us to learn something unexpected from the responses which could be something extremely valuable.

3.3.2 Closed-ended questions

Close-ended questions help in making comparisons and statistical analysis of the data. They help in collecting precise amounts of data with ease and in less time.

Closed-ended questions are of several types, for example, rating scale questions, multiple type questions, rank order questions and dichotomous questions. In our research, we will be using rating scale questions, more precisely, a Likert type scale. This method provides a balanced scale. It allocates an equal number of positive and negative responses. A balanced scale will allow the participants to choose freely between the responses rather than forcing them to choose something that they don't relate to.

As we have included a mixture of both open-ended and closed questions, we don't want to make the participant feel disheartened, instead, we are trying to make it easy and less painful so that they can tell us exactly what they are thinking.

As part of this study, a pre and post workshop survey form was shared with the volunteer participants. The use of the survey form and the data collected was approved by the University of Canterbury Educational Research Human Ethics Committee. Every research activity undertaken at the University of Canterbury must obtain ethics approval. A detailed version of the ethics application content is attached in the form of an Appendix A .

The survey responses reported in this paper are based on answers given by teachers to the following questions:

- Which age group do the participants teach?
- What are their major subjects?

- Comparing their feelings before and after attending the workshop.
- Change in their confidence level before and after the workshop.
- Comparing the change of knowledge about Computational Thinking and its concepts.
- Comparing change in confidence level towards computer programming.
- Which concepts and ideas do the participants think will be easy to understand for students and most likely to be used by them in a classroom setting.

3.4 Formulating Semi-structured Interviews

We selected semi-structured interviews as a means of collecting data for several reasons. They are considered as the best option for examining the perceptions and opinions of participants. They also help in dealing with sensitive issues which are not covered in surveys and help in gaining more information. Participants here share a common vocabulary and semi-structured interviews recognize that different words have a different meaning for every participant. The meaning of the questions remains the same, but answers are unique to each participant (Wengraf, 2001). The validity and reliability of survey results depend on the equivalent meaning of the words used by the respondents. This helps in facilitating standardization and making comparisons for the responses.

Our semi-structured interviews were audio recorded, transcribed, and notes were taken throughout. The main reason for recording the interviews was to check our notes and find any missing information. Another reason for audio recordings was to transcribe the interviews so that participant's views and opinions about the topic could be collected in one place to draw out patterns and relationships between them. The responses reported in this paper are based on asking participants questions related to computational thinking and computer programming. Participants are teachers from primary to high school in New Zealand, primarily in Christchurch.

We started by asking teachers the following set of questions:

- What benefits were seen using unplugged activities for teaching computational thinking?
- If they have used the unplugged approach, how was their experience?
- What makes teachers more prepared, teaching unplugged activities first or programming? Can they support their argument with an example?
- Did they see any connection between unplugged activities and learning programming? (this will help us to understand if teachers realize that it provides authentic context to learners and how to show keen they are to use follow up 'plugging it in' exercises.)
- Thoughts, beliefs and any concerns around the new Digital Technologies area as a part of the curriculum.
- Any further comments they would like to add.

3.5 Data Analysis

Analysing qualitative data includes a range of processes and procedures which are carried out by modifying data into more a readable and understanding form. The main idea is to extract meaningful content from bulk data collected during the data gathering phase. It is easy to design and collect questions but analysing them is the tricky part.

3.5.1. Approach to analysis

As part of our research, we are collecting data through surveys and interviews. We are conducting a separate approach of data analysis for both of them which will be explained in the following section. As the data collected is totally non-numeric and the information is collected in the form of both surveys and semi-structured interviews, we need to follow different approaches for each one.

3.5.1.1 Approach for Survey analysis

As our survey includes data from both pre- and post-workshop questionnaires, we need to make comparisons of the collected information. Here we are using the concept of Grounded Theory. Grounded Theory was developed to provide a systematic data analysis that would parallel the techniques of quantitative social research (Strauss & Corbin, 1994). It involves a constant comparative technique where there is a comparison between:

- Similarities and differences between coded fragments
- Coherence and incoherence within categories
- Concept indicators with existing and each other categories.

Most of our questions are Likert type and free text. This is followed up by dividing texts into categorical data and finding similarities and differences, changes in their level of knowledge, skill etc. We start off by collecting both pre- and post-workshop surveys and aim to categorize data. Categorization is done by forming a theme or an idea which corresponds to the text entered in the surveys. After all the data has been categorized into themes and different ideas, we start to identify relationships. Relationships are formed by grouping data together under one categorical theme, predefined in the early stages. After relationships have been identified, we start to summarize our data and identify major themes and patterns seen and report them in our findings.

We follow the exact same steps for Likert type questions but instead of categorizing the data we created a relative frequency table or contingency table of the responses. We allow the readers to read the distribution of results directly, intentionally avoiding calculating averages and focusing rather on describing the data in the form of comparison.

3.5.1.2 Approach for Interview analysis

For analysing the interviews, we are using a narrative approach (Riessman, 1993) for a number of reasons.

- As our interviews are semi-structured and participants are engaged in a conversation rather than a formal interview, it gives a lot of opportunities for the researcher to dig deep into the stories of participants and draw out useful insights.
- As every participant has different experiences and perception, narrative analysis helps in making sense of the data as there is a lot of ambiguity.

The narrative approach is considered as one of the most common transcribed methods for interviews or observations. They are basically participant experiences that are presented in a revised shape to the readers. Answers were re-formulated as different people have different experiences and context to their stories. After collecting data and transcribing interviews, our next step is to import the data to one place with the help of using software, NVivo in our case.

3.5.2 Transcription process

After the data is imported, we used emergent thematic coding and aim for thematic analysis. Emergent coding is simply a quality data analysis approach in which themes are generated from the data. Patterns and relationships are then identified from the themes and grouped together in the form of a report. One of the environments to do this sort of job is NVivo. It provides a place to organize, store and retrieve data so work can be done more efficiently, it saves time and rigorously backs up findings with evidence. With data management, query and visualization tools; NVivo helps in asking complex questions of the data so that more can be discovered (Bazeley & Jackson, 2013).

3.5.3 Statistical Analysis

Statistical analysis is considered a powerful tool for analysing numerical data. It helps in finding out whether there are any statistical differences between the two groups of subsamples. The difference can be calculated in a number of ways, depending on the type of data. Statistics are usually divided into two categories of parametric and non-parametric sets of data. Decisions on these matters affect the choice of statistics used, whether or not the difference is measured between two or more than two groups. If there are more than two groups, are they related or independent and so on.

There are several types of tests available for researchers to help them make an analysis of their population. The Mann-Whitney and Wilcoxon tests are non-parametric tests for two independent samples and dependent samples. Both these tests are used with one categorical variable and one ordinal variable to determine any statistical differences Cohen et al (2002).

3.5.3.1 Approach

In our research, we are going to use 'Wilcoxon Test', as it is used to determine statistical differences between the two sample groups under two different conditions. The 'Wilcoxon Test' technique holds several safety checks and we will discuss how it fits with our research.

We are going to compare our pre- and post-survey responses of the same population. The collected data will be dependent on the same (continuous) variable (e.g. determining the confidence level for CT and programming), on two different occasions (before and after the workshop). All of the test data is non-parametric, so it should give the correct results for any random sample of data drawn from our surveys, making it an ideal choice.

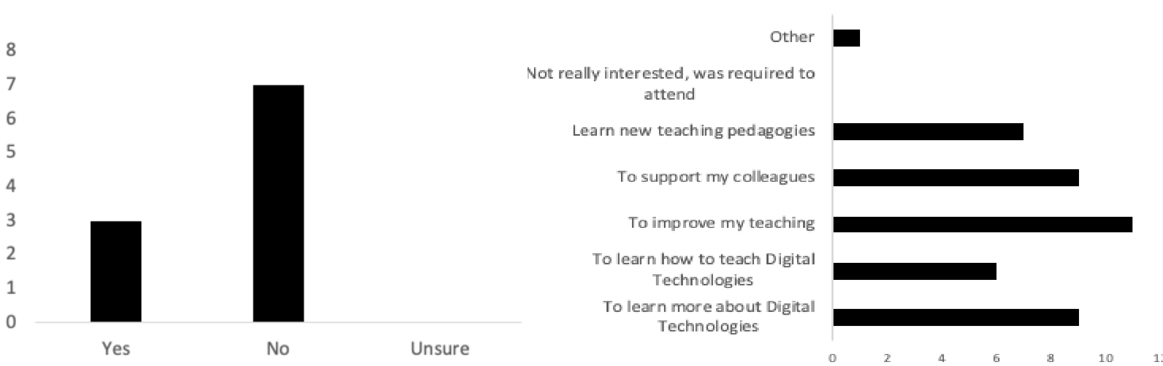
4. Results

Digital Technology for Primary School (DT4PS) and Digital Technology for High School (DT4HS) workshops were conducted as part of the Kia Takatü initiative to teach primary and high school teachers' new pedagogies for introducing CT among students in a classroom setting. These workshops ran for two days in the month of July 2018 and December 2018 respectively. A third workshop was also conducted at Oxford school, Christchurch at the end of November 2018. It ran for two days and was aimed specifically at primary school teachers. The sessions included thirty to forty minutes of unplugged activity demonstration (Kidbots and sorting network) along with the teachers' active participation throughout the day. The DT4HS workshop brought together many teachers from different backgrounds and levels, with common intertest of learning about the new curriculum and taking an active part in it. Activities demonstrated in DT4PS and DT4HS workshop included sessions on both Unplugged and programming concepts including Kidbots, Scratch, Python, Muddy City, Makey Makey, Micro bits, Binary Search Tree, Fitness Unplugged, Run length coding and a session on Kia Takatü self-reviewing tool for teachers. DT4HS had a few extra activities like Parity magic barcode checker and participants were also briefed about new changes (introduction of CT) in the curriculum.

As part of the survey, two of the twelve responses were discarded for the DT4PS workshop, as both the participants filled the pre-survey but not the post-survey and it was best not to use the incomplete results. Eight out of the twenty-six responses from DT4HS had to be discarded for the same reason. Before the start of the workshop, pre-survey forms were distributed amongst teachers and responses were noted. In the following section, we will talk about responses to the survey questions and the themes that emerged.

4.1 Pre-Workshop Results

4.1.1 Reason for attending the conference



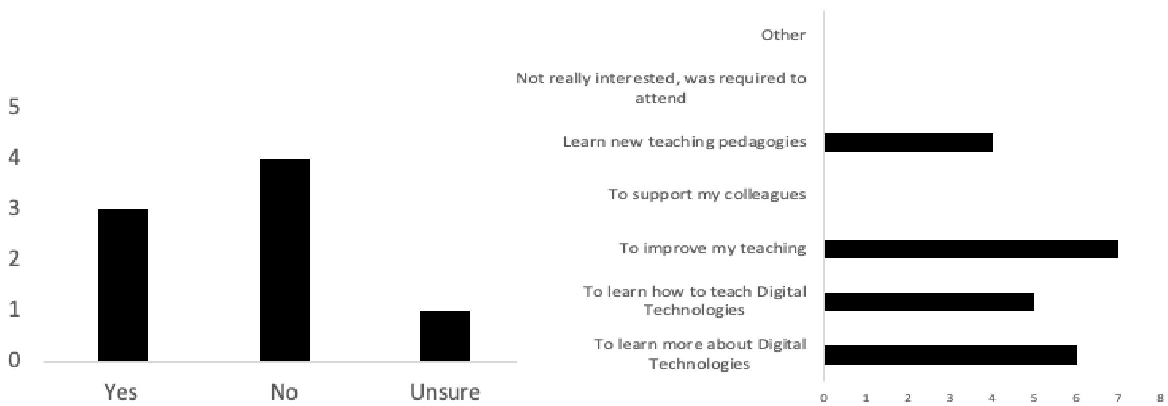
(a) (b)

Figure 1: (a) Have teachers ever attended DT4PS workshop before (b) Teacher's reason for attending the workshop

For the DT4PS workshop, Figure 1(a) shows that most of the teachers attended the workshop for the first time and had never been part of any DT4PS before. The teachers seemed both excited and curious to attend this workshop.

As seen from Figure 1(b), seven out of ten teachers responded that they were attending the workshop to learn more about Digital Technologies and new methods to teach them. Five out of ten teachers responded that they were interested in learning new pedagogies that could be useful for them in the classroom setting. Seven out of 10 teachers answered that they were attending the workshop because it was recommended by their colleagues. Two teachers further commented that they were attending the conference to support their colleagues and share ideas with others.

The teachers were a mixed group of primary (n=8) and intermediate (n=2) school teachers, who taught every subject in the NZ curriculum (as at this level most teachers are generalists).

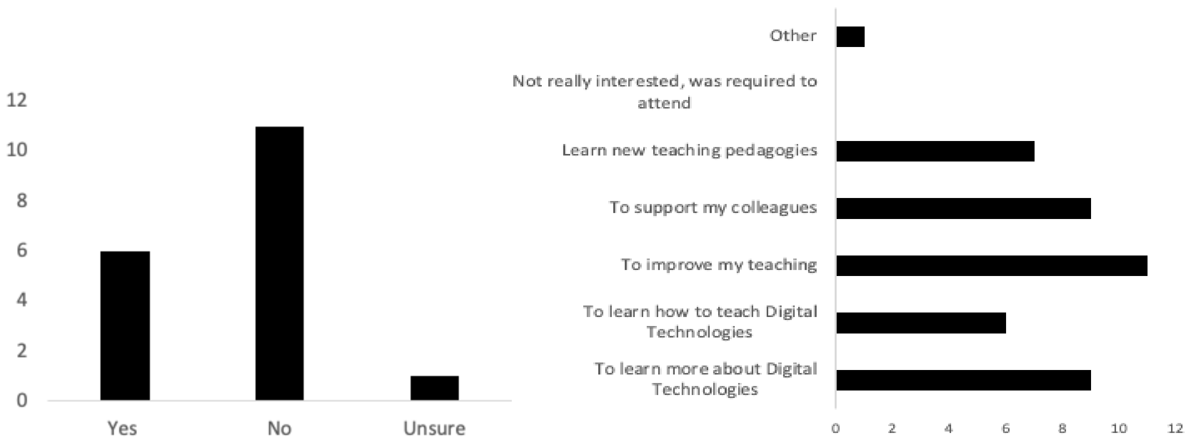


(a) (b)

Figure 2 Oxford Workshop: (a) Have teachers ever attended PD workshop before (b) Reason for attending the workshop

For the Oxford workshop, Figure 2(a) displays that four out of eight participants indicated that they were attending this workshop for the first time. These participants were also extremely excited and seemed interested in being a part of the workshop.

This workshop was attended solely by teachers from primary school. Figure 2(b) indicates that most teachers were attending this workshop to learn more about Digital Technologies and ways to improve their teaching. Five out of eight teachers indicated that they were interested in learning new methods to teach the new curriculum and to know more about the new teaching pedagogies. Primary teachers have a lot of responsibility as they are expected to teach every subject in the NZ curriculum. This requires a lot of management and preparation.



(a) (b)

Figure 3 DT4HS workshop: (a) Have teachers ever attended dt4ps workshop before (b) Reason for attending the workshop

For the DT4HS workshop, participants in this workshop were high school teachers. As seen in Figure 3(a), eleven out of the eighteen teachers reported that they were entirely new to these concepts and teaching pedagogies.

In Figure 3(b), teachers largely indicated that the main reason they were attending the conference was to improve their teaching. This was similar to another set of nine participants who were simply there to learn more about Digital Technologies and support their colleagues.

4.1.2 Theme

One of the recurring themes that emerged from the teachers' comments was their expectations from the DT4PS workshop. Teachers were really curious and felt responsible about learning the new Digital Technologies curriculum. They were also very interested in learning methods to implement the same in a classroom setting.

Here are some of the comments made by teachers about attending the workshop:

- *"More clarity on what computational thinking is, how it reflects."*
- *"Learn about curriculum changes and how to support proper implementation."*
- *"Ways to incorporate Digital Technology into the everyday timetable and apps available etc."*
- *"Linking Digitech to other NZ curriculum areas and teaching pedagogy."*
- *"Digital technologies information, pedagogy"*
- *"Explore ways to leverage Digital into 'Everyday Curriculum'"*
- *"Covering new technology curriculum with some outlines of Digital technologies. Units that could be taught in schools."*
- *"Learn more about the new DT curriculum and practical activities to use in the classroom"*

Teachers' expectations from the Oxford workshop were similar. Nearly every teacher responded that they wanted to take back new ideas into their classrooms to support their student learning and to bring something new to the diverse learners in their classrooms.
Some of the reasons these teachers gave for attending the workshop are as follows:

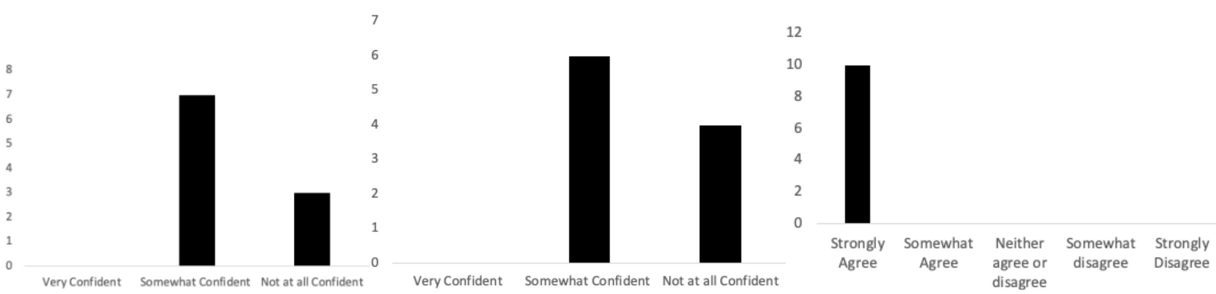
- *“Get new ideas to support my children's learning.”*
- *“To have practical ideas to help me personally and also my teaching.”*
- *“To gain new ideas to take back to the classroom.”*
- *“To come away with new ideas that I can use in my diverse (learners) classroom.”*
- *“To bring something new into my classroom.”*
- *“To get some practical ideas to use in the classroom immediately.”*

Teachers’ expectations from the DT4HS workshop were quite positive. Teachers were curious about the workshop and how it would circulate information about different teaching ideas. Teachers also indicated that they were excited about meeting new people and increasing their network as well as seeing what others were up to. Teachers indicated that they were keen to learn about the new Digital Technologies curriculum and develop a deeper understanding of learning outcomes.

Their responses relating to their workshop expectations can be seen as follows:

- *“Networking with other teachers Ideas for teaching DT.”*
- *“Have a deeper understanding of the new assignment as well as lower levels of the curriculum.”*
- *“Network and see different ways to teach concepts.”*
- *“Ideas how to integrate new curriculum, what to teach at what levels.”*
- *“Ideas integration across learning areas Ideas promotion DT to the school curriculum.”*
- *“Refresh and further develop my knowledge.”*
- *“Start learning some hands-on ideas for teaching basic computational thinking and how to use CT PD03 standards across the curriculum in years 9 and 10.”*

4.1.3 Confidence Level



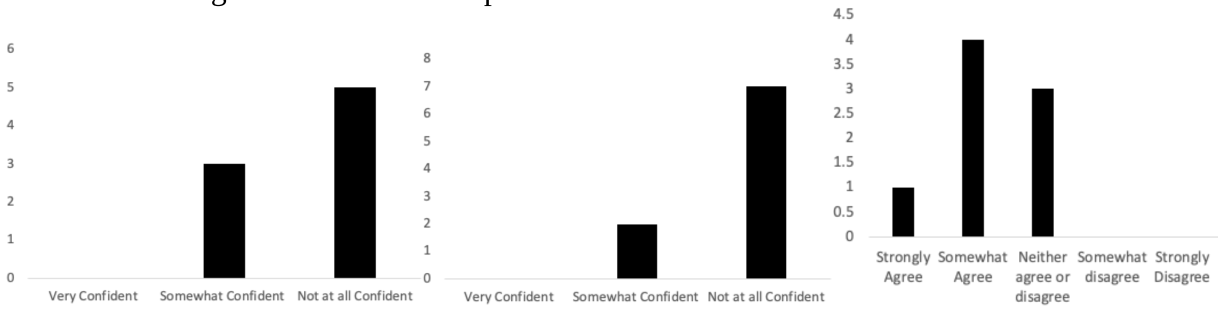
(a) (b) (c)

Figure 4 DT4PS: (a) Teachers’ confidence level in teaching CT concepts (b)Teachers’ confidence level in teaching programming (c) Teachers thoughts on teaching CT without computers

As indicated by (Figure 4(a)), 70% of the DT4PS teachers felt that they were somewhat confident and 30% believed they were not at all confident about teaching CT concepts to students. It was very motivating to see that teachers did not shy away from introducing these concepts despite the fact they needed to be trained in it. This also depicts how positive a teachers’ mindset is towards the new curriculum.

In contrast, Figure 4(b) displays that only 60% of the participants felt that they were somewhat confident about teaching programming, whereas 40% believed that they were not confident at all. This also shows positive results as these responses were coming from teachers who were totally new to programming and CT. We also expected a higher percentage of teachers showing confidence before the workshop as a few of them had attended these sessions before where they got a chance to familiarize themselves with these concepts.

Figure 4(c) shows that every teacher strongly agreed with the statement when asked about if CT can be taught well without computers.



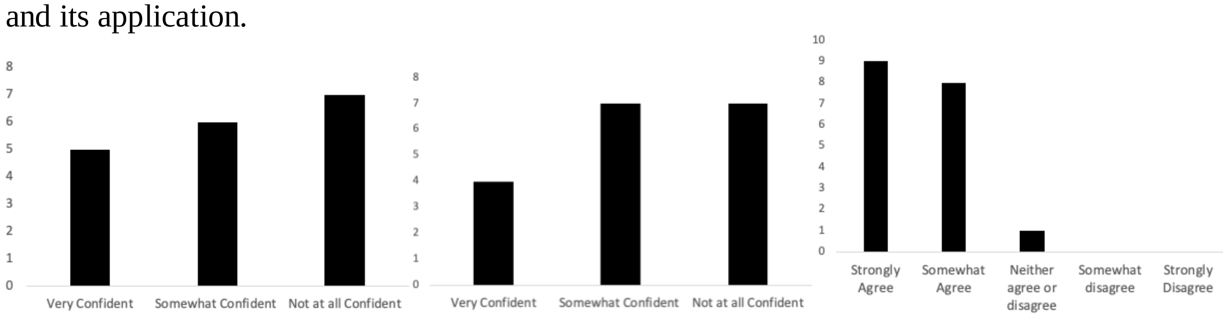
(a) (b)

Figure 5 Oxford Workshop: (a) Teacher's confidence level in teaching CT concepts (b) Teacher's confidence level in teaching programming (c) Teacher's thoughts on teaching CT without computers

Figure 5(a) indicates that more than half the Oxford participants, (62.50%) were not at all confident about teaching Computational Thinking concepts in their classroom.

Figure 5(b) displays that 87.50% of the teachers were not at all confident about teaching programming in the classroom. These results are not surprising as many of the teachers were entirely new to the concepts introduced in the workshop. These results would also help us in understanding how the workshop has affected teachers' confidence level when we will compare them with the post-survey results.

Figure 5(c) shows mixed responses from the participants when asked about teaching some aspects of CT without computers. Three out of seven respondents gave a neutral response while the other four respondents reported that they somewhat agreed with this statement. This clearly points out that participants were a bit fuzzy about the actual definition of computational thinking and its application.



(a) (b) (c)

Figure 6 DT4HS: (a) Confidence level in teaching CT concepts (b) Confidence level in teaching programming (c) Teachers' thoughts on teaching CT without computers

According to Figure 6(a), over one third of the DT4HS participants i.e. (38.90%) indicated that they were not at all confident about teaching CT concepts in a classroom setting whereas two thirds of the population indicated that they were somewhat confident and the rest (27.80%) agreed that they were quite competent about taking CT to their students.

On the other hand, Figure 6(b) displays that teachers felt less confident about teaching programming as participants indicated the same number (38.90%) for being somewhat and not at all confident in teaching these concepts. While only 22% of them indicated to be very confident. These results are understandable because teachers specified that they were from a variety of backgrounds and only a few of them had any computer science qualification or experience with the new curriculum.

Figure 6(c) displays that half of the respondents strongly agreed with the fact that some aspects of CT could be taught well without computers while the rest of them somewhat agreed. One of the respondents was neutral about it. Results indicate that most of the teachers had a clear understanding of the new curriculum and what constitutes CT. They just need some training to deliver these concepts effectively.

4.2 Post-Workshop Results

When the program ended, the post-survey was distributed to identify any changes in their mindset, confidence level, experiences and understanding of concepts. In this section, we'll discuss the questions asked in the survey in detail.

4.2.1 Program review

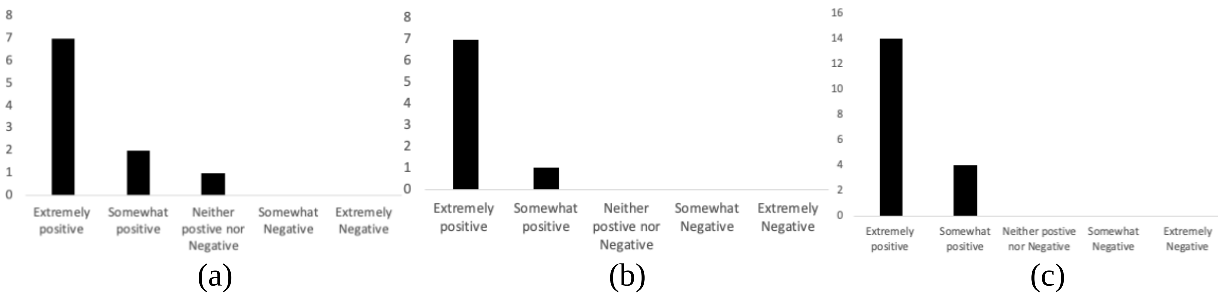


Figure 7 Teachers feeling towards the workshop: (a) Teachers feelings post DT4PS workshop (b) Teachers feelings post-workshop at Oxford (c) Teachers feelings post DT4HS workshop

Figure 7(a) points out that seven out of ten teachers responded that they felt extremely positive after the DT4PS workshop. Two teachers responded they were somewhat positive while the other teacher responded neutrally.

Figure 7(b) displays that every teacher felt extremely positive towards the workshop at Oxford, which directly relates to their increase in confidence and knowledge after the program. This will be taken up at length in the next section.

Figure 7(c) depicts that fourteen out of the eighteen teachers felt extremely positive after the DT4HS workshop whereas the other four teachers responded to be somewhat positive, leaving all attendees feeling same level of enthusiasm about this whole program.

4.2.2 Change in Confidence Level

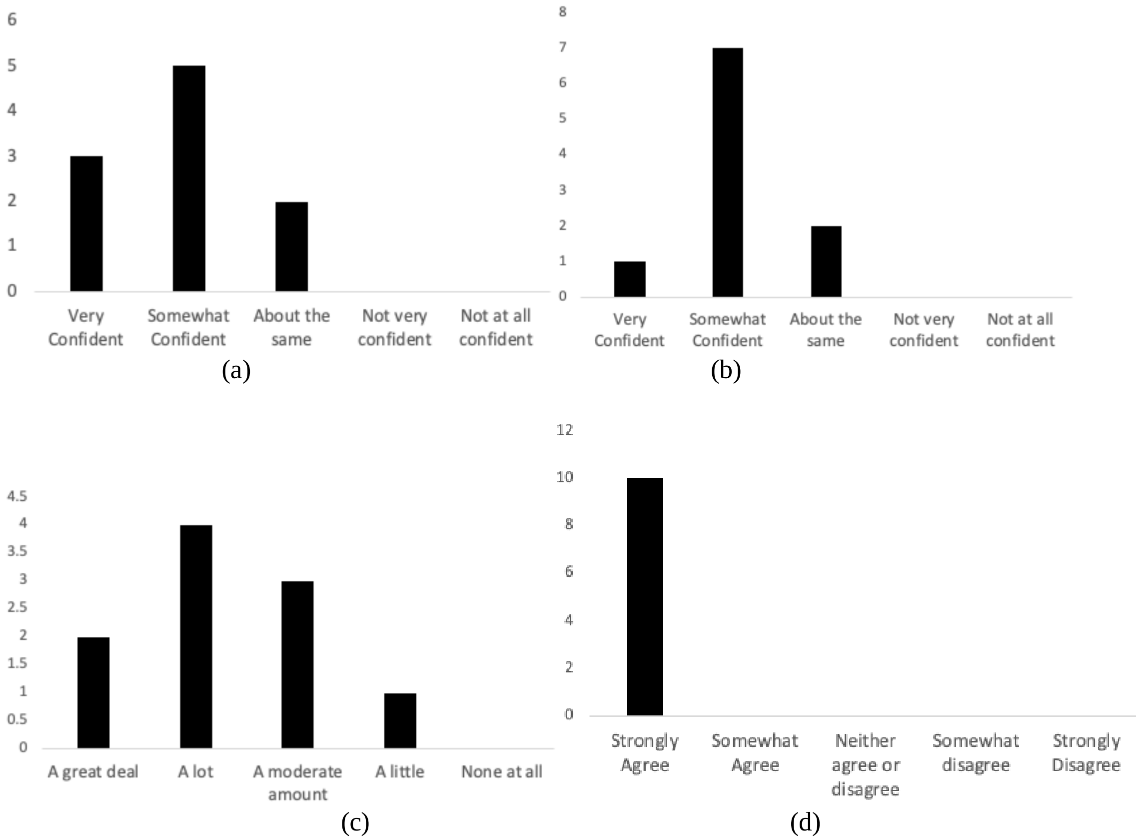


Figure 8 DT4PS: (a) Teacher confidence level teaching CT post-workshop (b) Teacher confidence level teaching programming post-workshop (c) Increase of knowledge in programming (d) Teacher thoughts on teaching CT without computers post-workshop

Figure 8(a) depicts a significant shift in the confidence levels of teachers teaching CT after the DT4PS workshop. Thirty per cent reported to be very confident, fifty percent felt somewhat confident and only two teachers reported that they were neutral about teaching CT concepts.

Figure 8(b) displays that seventy percent of the teachers were somewhat confident and one teacher reported to be extremely confident about teaching programming to students. Similarly, two teachers reported being neutral about teaching programming but commented that it has helped them in increasing their knowledge of programming to a certain extent, which is still an improvement.

Figure 8(c) displays a significant increase in reported knowledge of programming after the workshop. Six teachers reported increase in knowledge more than a moderate amount whereas three of the teachers reported just moderate increase. One teacher indicated only a little improvement. No one indicated that there was no improvement. This data reveals how with the help of combining unplugged and programming demonstrations, the knowledge of programming can be increased significantly in a short period of time.

Teaching CT Concepts	
Z	- 2.36[a]
Asymp. Sig. (2 Tailed)	.025

a. Based on positive ranks

(a)

Teaching Programming	
Z	-1.732[a]
Asymp. Sig. (2-Tailed)	.083

a. Based on positive ranks

(b)

Table 1: (a) Wilcoxon signed rank test difference in teaching CT concepts before and after the DT4PS workshop (b) Wilcoxon signed rank test difference in teaching programming concepts before and after the DT4PS workshop

Table 1 displays, the group was more positive about the variable, ‘Increase in level of confidence among teaching CT concepts’ ($p = 0.025$) than ‘Increase in level of confidence in teaching programming’ ($p = 0.083$). Result for the latter is not statistically significant but an increase in the level of confidence was seen.

Figure 8(d) indicates how every teacher felt 100% sure about teaching CT concepts without computers even before the workshop. This shows that the teachers were not completely new to unplugged teaching, although the results show that they had some understanding and their knowledge increased during the workshop.

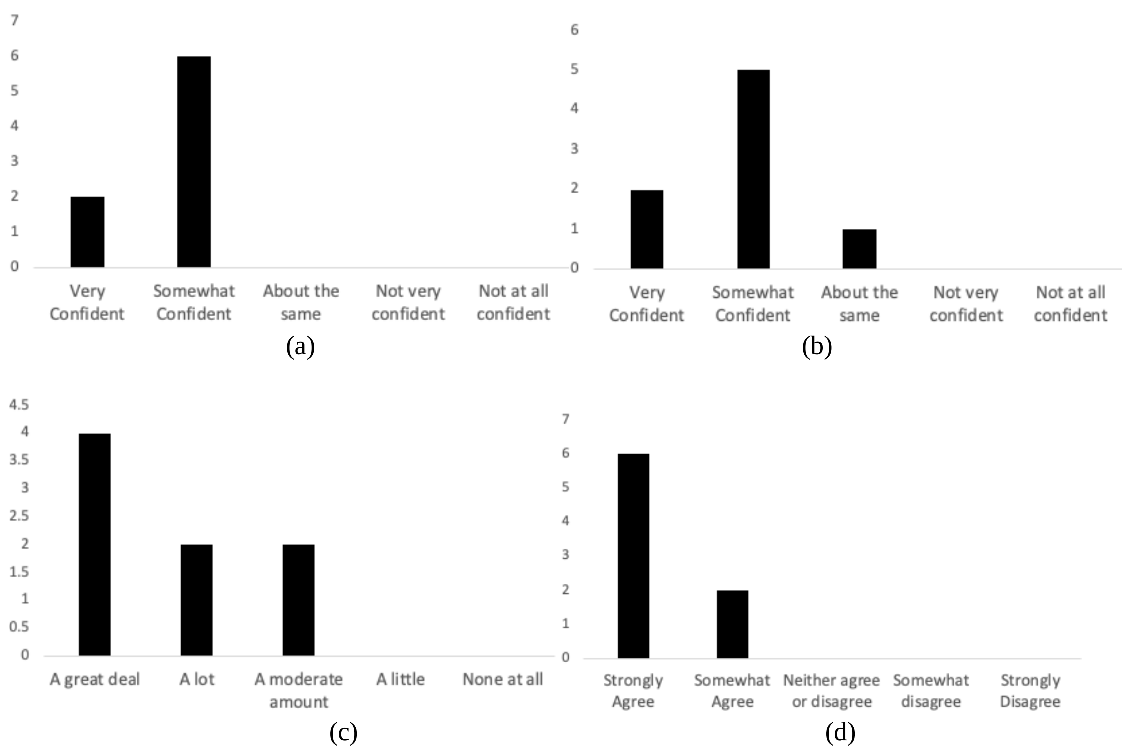


Figure 9 Oxford:(a) Teachers’ confidence level in teaching CT post-workshop (b) Teachers’ confidence level in teaching programming post-workshop (c) Increase of knowledge in programming post-workshop (d)Teachers’ thoughts on teaching CT without computers p

The results also show a change in the participant's confidence level for the Oxford workshop. As seen in Figure 9(a), 75% of the participants reported that they felt somewhat confident about teaching computational thinking concepts and 25% of them reported to be very confident after the Oxford workshop.

Figure 9(b) shows that five out of the eight teachers with no programming experience and with little or no confidence reported being somewhat confident and two teachers felt very confident. They also indicated that they felt confident about taking programming to their classroom straight away. One of the teachers indicated to be neutral about it but reported that it has helped in increasing their knowledge about programming by a moderate amount. This seems to be a significant improvement as the respondent had no programming background whatsoever.

Figure 9(c) displays that the workshop helped in increasing reported programming knowledge among four teachers by a great deal. Two teachers reported their knowledge to be increased by a lot and the other two in a moderate amount. For a two day event, the results seemed quite reasonable.

Teaching CT Concepts

Z	- 2.333[a]
Asymp. Sig. (2 Tailed)	.020

a. Based on positive ranks

(a)

Teaching Programming

Z	-2.530[a]
Asymp. Sig. (2-Tailed)	.011

a. Based on positive ranks

(b)

Table 2: (a) Wilcoxon signed rank test difference in teaching CT concepts before and after the oxford workshop (b) Wilcoxon signed rank test difference in teaching programming concepts before and after the oxford workshop

Table 2 shows that group was more positive about the variables, 'Increase in level of confidence among teaching CT concepts' ($p = 0.020$) and 'Increase in level of confidence in teaching programming'($p = 0.011$). Results show a significant improvement in terms of both of the variables.

Figure 9(d) displays participant change in knowledge. The teachers were asked if CT can be taught without computers and six out of the eight participants agreed strongly and two of them somewhat agreed. This tells us that even though before the workshop, teachers were not sure about CT, their knowledge increased significantly; making them confident enough about teaching these concepts.

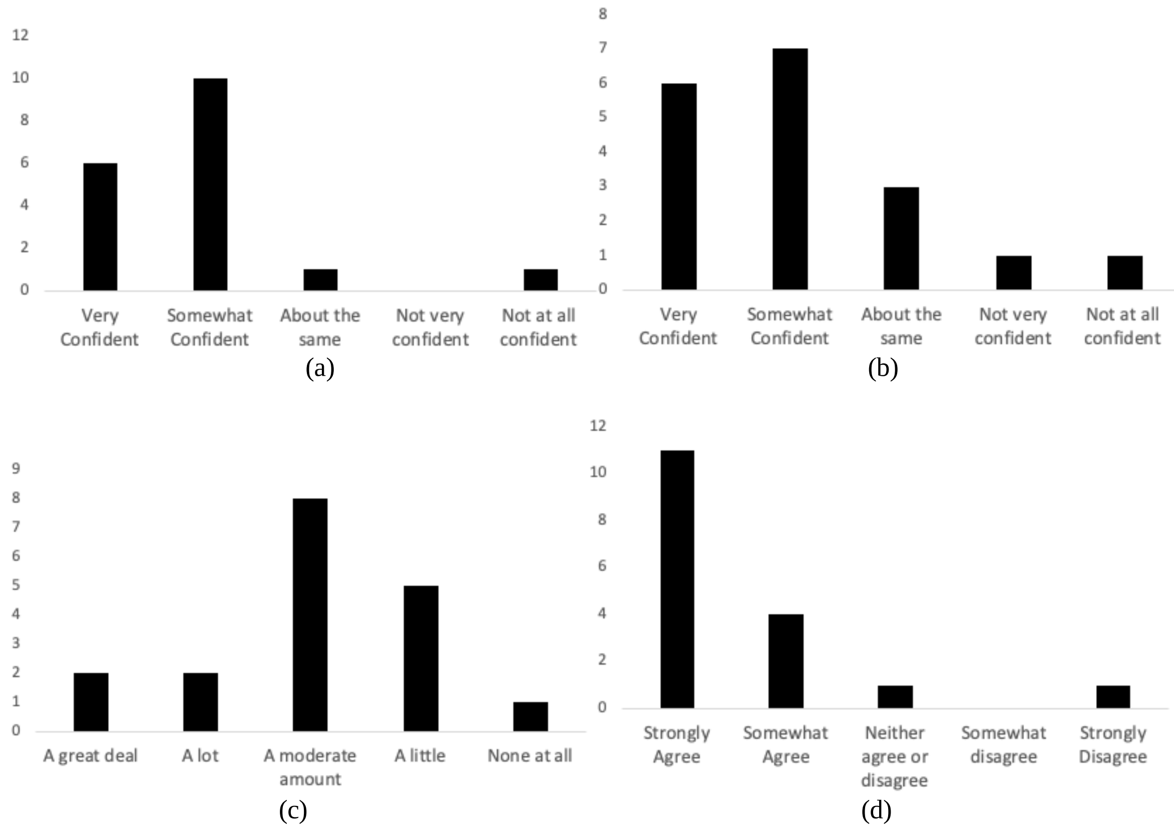


Figure 10 DT4HS: (a) Teachers' confidence level towards teaching CT concepts post-workshop (b) Teachers' confidence in teaching programming post-workshop (c) Teachers' increase in knowledge about programming post-workshop (d) Teachers' thoughts on teaching

Figure 10(a) displays a substantial level of confidence in terms of teaching CT among teachers at the DT4HS workshop. 55.56% of the teachers reported being somewhat confident which gives us a 22% average increase in confidence level from the pre-survey results. Only one teacher reported to be not at all confident, which still gives us a 33.30% increase in confidence on average.

Figure 10(b) depicts a 22% increase in the confidence level, leaving only a small population of teachers (n=3) who were not at all confident about teaching programming. But there was an 11% increase in being very confident about teaching programming. Only one of the teachers reported being not very confident. One of the factors responsible for this result could be that participants were from a variety of backgrounds and disciplines and we can't expect them to be so confident within two days, but still there were some promising results. Several programming activities like Scratch were demonstrated and room for self-exploration and links to online material were provided in the form of a google document.

Figure 10(c) exhibits that eight out of eighteen teachers reported a moderate increase in their reported knowledge of programming. Four teachers reported increase their knowledge more than a moderate amount whereas five teachers said it has helped in increasing their programming knowledge but only to a little extent. One of the teacher reported no increase at all.

Teaching CT Concepts	
Z	- 2.333[a]
Asymp. Sig. (2 Tailed)	.020

a. Based on positive ranks

(a)

Teaching Programming	
Z	-1.633[a]
Asymp. Sig. (2-Tailed)	.102

a. Based on positive ranks

(b)

Table 3: (a) Wilcoxon signed rank test difference in teaching CT concepts before and after the DT4HS workshop (b) Wilcoxon signed rank test in teaching programming concepts before and after the DT4HS workshop

Table 3 displays that the group was more positive about the variable, 'Increase in level of confidence about teaching CT concepts' ($p = 0.020$) than 'Increase in level of confidence in teaching programming' ($p = 0.102$). The result for the latter is not statistically significant but a slight increase in confidence was seen among the participants.

Figure 10(d) indicates twelve out of the eighteen participants agreed strongly while four only somewhat agreed with the fact that CT can be taught adequately without computers. One of the respondents was neutral while another disagreed. This also tells us that before the workshop, teachers were not even sure about their understanding of CT, their knowledge increased significantly: making them confident and better prepared for the new curriculum.

4.2.3 Teachers' favorite activity(s)

After the DT4PS program, the majority of the teachers reported that they really enjoyed the workshop and the activities demonstrated. We asked the teachers which activity they enjoyed the most and would like to use in their classroom. Teachers' favourite activities were Binary Code, Sorting Network, Binary Search Tree Scratch Jr and Treasure Island.
Here are some of the comments that the teacher made about their favourite activities:

- *"Love how simple the activities for binary code are and how you can do these sorts of activities without devices. I think kids really connect to these sorts of activities too because they make the connections and see the patterns for themselves and this gives them confidence in their thinking. I could definitely use this in my classroom...with some scaffolding for new entrants"*
- *"Orange Game, Offline fitness app, Binary tree, Music + Art activities. Also, see applications for Scratch Jr and Scratch in Junior classroom."*
- *"Resources/plans from Unplugged using practical activities - in break out groups activities scratch etc."*
- *"Unplugged computational thinking: Network circle, colour pixels, scratch, bee-bots, treasure island, 'fitness programming app' and Binary music code. Trying to link it all in the current curriculum program and working in a collaborative teaching environment."*

As the workshop at Oxford had lesser participants, only two unplugged activities were demonstrated i.e. KidBots and Sorting Network. Every teacher reported that they enjoyed both the activities and liked their direct implication to the curriculum. Teachers were quite keen to try these activities in their classroom.

Some of the comments made by the participants are as follows:

- *"The Sorting Network sheet was a strategy that I can implement in my program. A fun and interesting way to get kids thinking and learning."*
- *"Keen to give both things a go back in the classrooms. Can see real benefits for Maintenance activities the sorting network."*
- *"The Sorting Network sheet was a strategy that I can implement in my program. A fun and interesting way to get kids thinking and learning."*
- *"Kidbots Sorting Networks can be used in a multitude of ways."*

After the DT4HS workshop, the majority of the teachers reported that they really enjoyed the workshop and activities demonstrated. We asked the teachers which activity they enjoyed the most and would like to use in the classroom. Teachers' favourite activities were Binary digits and Exploring Barcodes. Every teacher looked forward to seeing how well these activities would fit with the cross-curricula implementation. This seems fair as most of the teachers came from diverse backgrounds and had participated in the workshop in order to gather ideas to link them across different subjects and disciplines.

Here are a few comments that the participants made:

- *"Some of the unplugged ideas even to teach kids randomly in afternoon classes just to get them thinking eg: RGB etc Allow binary cards and games that go with it. I like scratch and will play around with this. Keen to start up a code club with a colleague."*
- *"Photo pixel viewer to link binary/graphics/compression program a barcode checker I have been teaching some of these ideas in isolation but wasn't able to put them in context."*
- *"Integrating computational thinking with other projects i.e. foods/digital technologies new teaching ideas planning & explaining /practising more before using the computer"*
- *"Binary digit exercises Pixel coding at RGB values. Many other useful ideas just need to consider how I will integrate with other subjects' areas"*
- *"Cross-curricular - Binary Possible trips to visit companies Python CS Field guide"*
- *"Barcode checking, useful websites to learn more such as CS Field guide and CS Unplugged"*

5. Interview Results

Six weeks after the workshop, we contacted the participating teachers to organize follow-up interviews. We wanted to give them enough time to get familiar with the concepts and gain some experience of utilizing them in a classroom setting so as to provide useful insights by reporting their positive and negative responses. As participation in these interviews was voluntary, only a few teachers agreed to do them and even fewer appeared in the end. Some teachers did not respond despite being followed up for weeks, possibly due to their packed schedule at the end of the term. We could only get three teacher interviews from DT4PS workshop and four from DT4HS workshop and none from Oxford.

Sr. No.	Interview questions.
Question 1	So now you're familiar with CT and new teaching pedagogies, What benefits you can see using unplugged approach for teaching computational thinking?
Question 2	How long have you been in teaching line for? • Have you used the unplugged methodology in teaching? • If YES, how was your experience using the same?
Question 3	What makes you ready as a teacher, teaching unplugged activities first or programming? • Can you please elaborate with the help of an example?
Question 4	Do you see any connection between unplugged activities and learning programming? • Does it provide an authentic context for students?
Question 5	As we know the new digital technology curriculum is focussing on students to be ‘Tech Ready’, what are your thoughts, beliefs and any concerns around the new Digital Technologies area as part of the curriculum? • How does ‘Screen Time’ should be monitored?
Question 6	What is the real motivation behind teaching through unplugged material? • Do you actually enjoy/like it? • Do you have any instances which you can share? For e.g. student responses during classroom activities. • Or are you being forced to use this?
Question 7	Overall how would you say in terms of learning new concepts, Unplugged activities and pedagogies, how has the workshop helped you in providing all of this information?

Table 4: Interview Questions

Table 4 shows the questions used the basis of a semi structured interview. Relevance of these questions can be understood as follows. Question one addresses in determining how teachers feel that the Unplugged approach can be applied in the new curriculum which also directly relates to our first research question. Question two determines if the teacher is experienced in teaching through Unplugged or if have started using unplugged recently. Question 3 and 4 determines teachers' mindset, if they can see a connection between Unplugged and programming and how it links back to their readiness in teaching through new pedagogies; this also relates back to our second and third research question. Question five addresses teachers' thoughts both positive and negative towards new the Digital Technologies curriculum and how Unplugged helps in monitoring it, linking back to our fourth research question. The Last question focusses on providing insights to activity leaders and organizers if these workshops needs any improvement and better preparation for future events.

5.1 Benefits of using CS Unplugged

After the workshop, there was a drastic increase in the reported level of understanding of CS concepts and Computational thinking among teachers, as seen in the surveys. As we expected them to try out these activities and familiarize themselves with new teaching pedagogies, we started with these questions in order to understand what benefits teacher could seek.

All three DT4PS attendees responded that they were really pleased with the idea of teaching concepts without the actual use of computers. They liked how these types of activities engaged children and could see what each child achieved in a single attempt. One of the teachers commented on how these activities link across the curriculum and the other two teachers mentioned how easy it is to access material online. One out of the three teachers also commented that students really enjoyed role-playing. Example: being a robot, where they not only learnt about CS concepts but also developed soft skills such as communication.

All four of the DT4HS teacher attendees responded that they loved how different activities could help in teaching different concepts. One teacher commented on how it became a good starting point for primary school students as it involves a lot of running around and supports learning about CT effortlessly. One of the teachers pointed out that it would be quite interesting to see the results when deploying these activities in a girl school as the teacher said most of the girls are not interested in shaping their career in the field of IT. The teacher further suggested how real-life examples of girls in technology and their experiences could be beneficial.

5.2 Teacher Readiness: Unplugged or programming?

Teacher readiness can be determined by understanding how they would like to teach these concepts in the classroom. Do in-service teachers prefer teaching CS Unplugged first, followed by programming or the other way around? How does this decision affect their confidence level and concept delivery in a classroom setting?

The DT4PS cohort responded that learning through unplugged should be given first priority instead of jumping to a programming environment straight away. One of the teachers added that students learnt the idea and developed their vocabulary from the activities and it has the added benefit for their students of not being on a computer all the time. Another teacher commented that the activities are easy to set up, all they need is to give instructions and break down the problem, which really helps in learning programming.

The DT4HS cohort responded that CS Unplugged is better for younger students in the sense that it provides the background of the concept. One of the teachers gave an example of when secondary school students were taught algorithms, the teacher started by using an unplugged activity, going through it step by step and then writing the actual code. The teacher pointed out that students grasped the concept easily. In another response, a teacher mentioned that teaching DT learning through unplugged would be the ideal choice and then jumping on to computers, further adding how these activities can be used in the cross-curricula implementation. Another teacher addressed the fact that unplugged offers building blocks when learning how to program as it covers most of the base level concepts.

5.3 What's the connection?

We were curious to see if teachers could come up with a connection between learning programming with the help of unplugged activities or if they were just doing what they were told to do without making any connection to CT.

All three DT4PS teachers responded positively when asked if unplugged activities could provide a solid foundation for understanding different concepts. One teacher commented that while doing unplugged activities, one starts thinking about why this particular thing is not working; we get to ask the right questions to ourselves. Another teacher added that they were looking to start a buddy program to help them use Scratch and how Scratch provides an authentic environment for students. One teacher mentioned that it's less important to jump into programming straight away after doing unplugged activities but could see how they are helpful when students learn through unplugged material for several years and then implement that knowledge on computers.

All four DT4HS teachers saw a definite connection in the way unplugged activities go hand in hand with learning the basics of programming and then taking those concepts to the computer. One of the teachers explained that every program that is written is somehow related to binary (yes/no) decisions. Similarly, these activities can help in doing programming, which is purely following one step after another. Another teacher commented that unplugged has its own context for looking at concepts and explains its connection to CT for solving real-world problems.

5.4 Digital Technologies being part of the curriculum

Most of the teachers were aware that there had been a recent change in the curriculum (making CT an expected area). We wanted to see how teachers were responding to that by recording all the positive and negative emotions they experienced.

All three DT4PS participants were positive about the change in the curriculum and felt that it was long overdue. One of the teachers pointed out that sometimes students who use screens a lot struggle with activities and added how CS Unplugged will help them in getting on-board by providing them with a happy medium between theoretical concepts and practical knowledge of computers. One of the teachers also responded that the new curriculum seems a bit daunting at first but when you give it time and get familiar with it, you'll see how Unplugged provides the necessary skills required for the ever-changing technological advances.

In general, every DT4HS participant seemed satisfied or happy with the introduction of Digital Technologies and looked forward to the possibilities it would unfold for New Zealand. One thing that emerged from these responses was the teacher concerns. One of the four teachers was a bit sceptical about how it was going to be implemented and how primary school teachers will be expected to do a lot of secondary school teaching. Another teacher commented that introducing DT is great, but it shouldn't be overused because children need to be just children. Another teacher added that as per the implementation of DT and its aspect in school settings, their school has actually partnered with a local tertiary institution where, year 11 students will be doing a Computer Science course. Staff from the institution will be coming to their school to teach the course and students are also required to go to the institution for two hours per week. Their school has been taking up initiatives to promote learning and getting a taste of computer science concepts from a professional point of view at year 11. One of the teachers was concerned about how a big part of ethics for computer science was not addressed in the standards of the new curriculum. This same teacher was really impressed with the way Unplugged addresses the implications of different concepts in real life.

5.5 Is Screen Time Healthy?

We asked teachers if they had any concerns regarding 'screen time' and how it should be monitored in the classroom. In today's digital era, students are often seen staring at a screen in school as well as at home for completing their homework. Moreover, in this technology-driven era, students are seen glued to their smartphones and laptops for the entire day. This has a direct effect on students' health, so we wanted to capture teacher opinions and how they felt about its impact on student health.

DT4PS attendees didn't seem overly worried about the screen time in the classroom, but two teachers did raise a concern regarding eye health, posture and social interaction. One of the teachers added that CS Unplugged activities play a really big role in addressing these issues by offering less screen time and more running around time.

Three out of the four DT4HS teacher attendees seemed to be quite worried about the time children were spending on their devices. One of the teachers felt that students might be missing some basic skills like handwriting because most of the work is being done on computers. One of the more experienced teachers commented that their school had a lot of activities being demonstrated by industry professionals who used computers all the time. She said that "Students were getting sick of the idea of using iPads and computers all the time" and pointed out how unplugged can play a huge role in this as children can be away from these devices and use a textbook.

5.6 PD Workshop Benefits

We also asked the teachers if attending this workshop had any kind of benefits or if these workshops might need some improvement, ensuring better preparation for future events.

DT4PS teachers responded by saying that attending this workshop helped them in getting started in general by providing them timely experience with industry professionals on how to demonstrate these activities to students by giving them a concrete understanding of the new teaching pedagogies. One teacher also commented that it was a great way to meet other teachers and see how far they have come along.

Every DT4HS attendee felt extremely positive about the workshop as it provided them with a lot of material to look into. Two out of the four teachers commented that they liked how the activities were demonstrated by tinkering with things and leading with examples; making it more appealing for students to learn from. Another teacher pointed out that it was a great way to support other people and to find out new ideas to deliver CS concepts confidently to students.

6.Conclusion

The goal of this research was to provide insight to support teachers who are new to computational thinking and help us understand the value of Unplugged activities for implementing a new digital technology curriculum. We aim to establish what, according to in-service teachers, was more important. Especially whether unplugged activities should be introduced first or programming determining relationship between them. Learning about new teaching pedagogies (e.g. CS Unplugged) also has a direct impact on teachers' readiness; making them feel more confident about delivering these concepts in the classroom. We also looked at what connection teachers drew between unplugged and plugging it in exercises and established if there was a positive or negative impact. As the new digital technology curriculum would make students technology ready, there is also the concern among some teachers about issues such as ‘screen time’ for primary and high school students. We were also interested in how unplugged activities (without screens) can play a role in building concepts. Teacher motivation is also important, so we further investigated the main factors that motivate teachers to become engaged with this type of learning and asked them to share some first-hand experiences to support their views.

CT is an important part of the curriculum and modern science in society. Since Wing (2006) definition, CT has been widely accepted as an important general thinking and problem-solving skill to be acquired by every student. With the increased attention on integrating CS concepts in K-12 curricula, there has been a growing interest in teacher training programs and opportunities. This would help teachers in acquiring knowledge and skills for such an integration. Teacher training is important and one of the most overlooked areas which need to be carefully examined. Due to the curriculum shift in NZ and all around the world, there is an increase in demand to prepare teachers to help them introduce CT in schools and integrate CT into the curriculum smoothly.

Results from our workshop provide a sense of ideas for pre-service teachers about the simplicity of introducing CT and CS concepts with different teaching pedagogies, mainly focusing on CS Unplugged. It also provides insights from in-service teachers attending these workshops for the first time who may/may not have little or no experience in teaching CT and programming in a classroom setting.

Introducing CT through fine-tuned activities that focus on developing different skills and concepts makes it easier for pre-service teachers to learn how CT can be integrated practically and be interwoven into the curriculum with ease. Teachers, especially primary school teachers, face the burden of teaching a variety of subjects to students. Unplugged can actually help in easing the burden for teachers as it allows them to take students out in the playground to teach CS concepts instead of sitting in a class with their device all the time.

Nearly every teacher attending the workshops stated that these activities allow integration of the curriculum and help in developing collaborative learning among students. Teachers expressed their interest enthusiastically and motivation to use Unplugged as a resource within the classroom as it provides an appropriate level for the children learning abilities. Another reason teacher provided was how Unplugged makes every aspect of CT a part of the everyday educational activity which has the potential to show how different teaching pedagogies can help students to think about the problem logically.

Teachers attending the workshop were often found in an informal conversation in between tea/lunch breaks and even after the end of the workshop, either with the lecturer or other staff members, which was highly encouraging and pointed out the general increase in confidence among participants. This was backed by the formal pre and post-workshop survey for all the three workshops, the responses were in favour of using Unplugged as a part of their strategy.

The initial feedback from the survey results indicated that most teachers appreciated the idea of being offline and not using devices to teach and demonstrate any CS concepts. Teachers understood how unplugged offers building blocks for learning core CS concepts while practicing CT. It also helps them to learn and teach concepts in a fun and engaging way. Teachers indicated that they could see how unplugged material directly relates to concepts in programming and hence using Unplugged in professional development could encourage teachers to engage with teaching programming rather than give them an excuse for not teaching this important skill. It serves as a key ingredient in providing ideas on how to solve a problem and helps to demonstrate how computers work. Teachers also understood how unplugged can look at concepts without the use of screens and how these concepts relate in real life and provide a direct link to programming.

The significance of these workshops was measured in the form of follow-up semi-structured interviews, where interviewees mentioned ways in which they were able to use the material immediately in their classroom. Feedback such as this is an important measure of the success of this approach. It presented an increase of awareness among pre-service teachers and showed how great an opportunity it was. All of the interviewed attendees were currently implementing or were planning to implement newly developed lesson plans for their own classroom for the academic year that included unplugged activities.

Evaluated results indicate that teachers showed real excitement towards the material and new ideas that were presented to them in the workshops. Learning about Unplugged seemed to alleviate concerns about too much ‘screen time’ for students. Results also show that the ideas demonstrated (especially in the DT4HS workshop) were more appealing and helped in bridging the gap between how to roll out CS concepts in a more professional manner. It helped teachers by providing opportunities to practice new pedagogies and innovative ideas, hopefully, they will pass the same skills and excitement onto their students.

We hope this research will encourage activity leaders, PD providers and workshop organizers to adopt new teaching pedagogies like ‘Unplugged’ as a part of their workshop demonstration. Teaching a new curriculum involving CT requires a different way of approaching things. Our results show how “CS Unplugged’ delivers core CS concepts effectively by increasing teachers’ confidence levels and reported programming knowledge within a time frame as small as two days.

7. Future Work

This research focuses on providing insights about first-hand teachers' experience who were introduced to CS concepts with the help of new teaching pedagogies like CS Unplugged. Our study was limited by a few conditions which are duly noted. Starting with the sample size, future research could be on a larger scale. This research was conducted in the New Zealand environment; therefore, findings may not be generalized to other school content, although New Zealand educational standards are similar to most of the western countries like the US, France, UK, etc. Webb (2019), and other work reviewed here shows similar results. Future research could also examine teacher capability, confidence and self-efficacy over time, as in our research we didn't have the luxury of making a longitudinal study; another study can be carried out to see long term effects of the new materials.

As our research is purely based on teachers, it would be really interesting to incorporate students in a follow-up study. By taking this research as a reference, potentially the next step could be to evaluate the impact of Unplugged and new teaching pedagogies on students and getting familiar with their mindset. It would be even more important and beneficial to get feedback from students and whether or not these activities helped in providing enough understanding of the concept taught. Furthermore, while we saw really positive results from our observation with the help of survey and interviews, a control group comparison would have let us examine quantifiable results.

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APPENDIX A

Application Form for Ethical Approval of Research Projects

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Educational Research Human Ethics Committee (ERHEC)

- **All** research activities undertaken by staff and higher degree students at the University of Canterbury must obtain Ethical Approval unless they meet the criteria for an exemption as listed under the Principles & Guidelines, section 5.
- Before making an application to the ERHEC, all researchers should read the Principles & Guidelines found on their current web site http://www.canterbury.ac.nz/humanethics/
- The Principal Researcher must be a UC staff member or student. For collaborative projects, the principal researcher is responsible for all aspects of project management, including applying for ethical approval and re-applying should circumstances relevant to this application change. All correspondence will be undertaken with the principal researcher.
- Applications to the ERHEC must be received by the Secretary **at least ONE week prior to a meeting** in order to be considered at that meeting.
- **Please submit one electronic copy and one hard copy (written) application to the Secretary –**
  The Secretary, UC Educational Research Human Ethics Committee, Level 5 South, Matariki
  or Private Bag 4800, Christchurch 8140
  Phone: (03) 369 4588, Extension 94588;
  Email: human-ethics@canterbury.ac.nz

Project Details

Principal Researcher:	Rajat Arora
Email Address & Postal Address	Rajat.arora@pg.canterbury.ac.nz Rajat Arora Department of Computer Science and Software Engineering University of Canterbury Private Bag 4800 Christchurch 8140
Phone	+64 3 369 2777
University School / Department:	Department of Computer Science and Software Engineering
Associate Researcher/s:	NA
Name of supervisor/s: (where applicable)	Professor Tim Bell
Project Title:	Measuring the impact of CS Unplugged among New Zealand's Primary and High School teachers

Checklist

Please check the following items before sending the completed form to the Committee.

All the necessary signatures on page 1 have been obtained.	[YES]
All the necessary approvals under Question 4 have been obtained or are the subject of correspondence of which copies are attached.	[YES]
A copy of any questionnaire accompanied by an appropriate covering page is attached.	[YES]
A list of interview topics and, for a structured interview, a detailed list of questions, is attached.	[YES]
A copy of any advertisement, or notice, or informative letter asking for volunteers is attached.	[NA]
A copy of each information sheet required is attached.	[YES]
A copy of each consent form required is attached.	[YES]

Attention to the preceding checklist is intended to ensure that the application and its documentation have been thoroughly reviewed by the applicant and, where applicable, by the supervisor and that the preparation of the project is up to the standard expected of and by the University of Canterbury.

The signature of the applicant will be understood to imply that the applicant has designed the project and prepared the application with due regard to the Principles & Guidelines of the ERHEC, that all the questions in the application form have been duly answered and that the necessary documentation has been properly formulated and checked.

Signature of Applicant Rojar Vala *Date: 12/06/2018*

The signature of the supervisor will be understood to imply in addition that, in the judgment of the supervisor, the design and documentation are of a standard appropriate for a research project carried out in the name of the University of Canterbury or for training in such research.

Signature of Supervisor ______ *Date:12/06/2018*

Please note, applicant and supervisor signatures are also required on page 8.

1. What is the purpose of your research project?
(Please tick one box only)

☐ Staff Research
☐ PhD Research
☒ Honours or Master's Research

2. Description of the project
Please give a brief summary of the nature of the proposal in everyday language, including the aims/objectives/hypotheses of the project, rationale, participant description, and procedures/methods of the project including time requirements for the participants.

<u>Overview</u>
Various forms of curricula about computer science and programming are now being introduced all around the globe and have become the part of New Zealand national curriculum since January 2018. The main objective of this curriculum is to draw students' attention towards digital technology and develop computational thinking (CT) competency. In order to teach students, teachers are required to learn new concepts and techniques relating to introduction of Computational thinking and programming, and how to deliver them effectively in classrooms. Through previous research studies, we have found that teachers attending professional development workshops find "Computer Science Unplugged" activities as a useful tool to foster CT among students. Not only does it capture student interest, but it can have a direct effect on their learning and concept understanding. The aim of this study is to investigate primary and high school in-service teachers who are attending Professional Development workshops that use unplugged material to introduce them to the new curriculum, and how insights from their experience can be used to help teachers who are new to computational thinking.

<u>Details</u>:
<u>Aim</u>
The aim of this study is to provide insights for supporting teachers who are new to computational thinking and enable us to understand the value of Unplugged activities for implementing new digital technology curriculum. We aim to establish what, according to in-service teachers, is more important, and especially whether unplugged or programming activities should be introduced first. This has a direct impact on teachers' readiness, what makes them feel more confident delivering these concepts in classroom. We will also look at what connection teachers draw between unplugged and plugging it in exercises and establish if there is a positive or negative impact. As new digital technology curriculum makes students technology ready, there is also the concern among some teachers about issues such as 'screen time' for primary and high school students; we are also interested in how unplugged activities (without screens) can play a role in building concepts. Teacher motivation is also important, so we will also investigate what the main factors are that support teachers to become engaged with this type of learning and what are the key factors that support their view.

This study will involve working with both pre-service and in-service teachers who are attending Professional Development workshops, or the ones who have implemented CS and programming lessons using unplugged material in their classroom. Data will be gathered from participants in several interventions, particularly: CS4HS, CS4PS and equivalent programmes in the Kia Takatū ā-Matihiko (Digital Readiness) initiative.

Researchers will conduct a pre- and post-workshop survey followed by an interview (semi structured).

The information we will be gathering from the teachers will involve both secondary and high school teachers' perspective. We are doing this so that we can look at the effect of Computational Thinking on teachers' capability and understanding. CS4PS and CS4HS (and the Kia Takatū version of these) is the biggest in-person DT professional development initiative in New Zealand, primarily organised by University of Canterbury, CS Education Research Group, through Core Education. The CS4PS workshop focuses on helping primary/intermediate school teachers to learn about the Digital Technologies curriculum and a variety of practices like unplugged activities to effectively deploy them in classrooms. Similarly, CS4HS offers support for NCEA teaching to high school teachers. As the computer science education research group at the University of Canterbury is one of the partners to deliver Kia Takatū ā-Matihiko which is a digital readiness programme, it will be useful to get insights from teachers and access the progress outcomes for digital technologies area structure.

<u>How data will be collected:</u>

Information collected from teachers will be in the form of pre- and post-workshop surveys followed by a semi structured interview after teachers have had a chance to use the new teaching ideas for a few months.
An initial survey includes questions around themes relating to teachers' belief around computational thinking. We suspect that most teachers don't have a deeper understanding of concepts in the new curriculum, and the surveys will help us to explore how their knowledge was reshaped and influenced during the workshop.

- We will compare how effective the workshop was for them by comparing pre and post workshop results.
- We will be asking teachers about their feelings and attitude towards the unplugged activities. This will connect to their positive or negative views on integrated learning.
- This will be segmented by which age groups the teachers are teaching and how much experience they have teaching the activities as different age groups.
- We will use participants' name and email address to match surveys with the responses we will get from the interview.
- All data will be kept confidential and to keep data restricted and ensure privacy, data will be kept anonymous for comparison and publication purposes.

The information we will be gathering from teachers through interviews will be obtained individually rather than in groups. We are doing this because every teacher has their own mind set and ability, and it will be helpful to examine and determining its implication impact on them. We are using a semi structured interview because the answers to our questions may need further questions to investigate ideas that may come up.

We will start of by asking teachers:

- What benefits they can see using unplugged activities for teaching computational thinking.
- If they have used the unplugged approach, how was their experience?
- What makes teachers readier, teaching unplugged activities first or programming? Can they support their argument with an example?
- Do they see any connection between unplugged activities and learning programming; this will help us to understand if teachers realise that it provides authentic context to learners and how keen are they to use follow up 'plugging it in' exercises.
- Thoughts, beliefs and any concerns around new Digital Technologies area as a part of curriculum.
- Any further comments they would like to add.

All of the questions are written by me and will be reviewed by my supervisor Tim Bell. We will ask each teacher to fill in the survey on their own and not to discuss any interview questions among peers, after the session is over they are all free to chat about the same.
Consent from all teachers and activity organisers will be acquired individually before the start of research.
Teachers have the right to stop at any point during the study and will not be penalised for doing so.

3. Which of the following categories best describe your research project?
(Please tick one box only)

☒ Educational or social science research involving humans
☐ Psychological research involving humans
☐ Scientific research involving humans
☐ Other (Please specify)

4.

(a) Will the project require approval for access to the participants from other individuals or bodies? (e.g., parents, guardians, school principals, teachers, boards, responsible authorities including employers, etc.) Yes

If Yes, please explain how this approval has been or will be obtained, enclosing copies of relevant correspondence.

(b) Will the project require Māori consultation? No

If Yes, please provide evidence that consultation has occurred or, if underway, provide a copy of approval once gained.

(c) Will the project require community consultation? No

If Yes, please provide evidence of appropriate consultation.

(d) Is the project commissioned by or carried out on behalf of an external body? No

If Yes, please identify the body and any Intellectual Property agreements. This includes ownership of data and reports arising.

(d) Will all or any part of the data be collected from outside New Zealand? No

If Yes, please provide details.

(a) Yes, it will require approval from the event organiser of Kia Takatū ā-Matihiko (Digital Readiness) initiative and School Principals. Information and consent form are included in this application.

5. What methods will be employed in conducting your research?
(Please tick more than one box if needed)

- ☐ Examination of normal educational practice or education instructional strategies, instructional techniques, curricula, or classroom management methods, journal, existing data, documents etc.
- ☒ Questionnaires or surveys
- ☐ Examination of medical, educational, personnel or other confidential records
- ☐ Observation (covert)
- ☐ Observation (overt)
- ☐ Video Recording (at any time)
- ☐ Structured interviews
- ☒ Semi-structured interviews
- ☐ Unstructured interviews
- ☐ Focus group interviews
- ☐ Deception – Explain why and how deception is used and provide a debriefing sheet
- ☐ Other (please specify below, stating any significant aspects)

(a) Does the project involve a questionnaire? Yes
If Yes, please attach a copy.
Note: The ERHEC does not normally approve a project which involves a questionnaire without seeing the questionnaire, although it may preview applications in some cases where the production of the questionnaire is delayed for good reason.

(b) Does the project involve a structured interview? No
If Yes, please list the topics to be covered and the questions to be used.

(c) Does the project involve a semi-structured interview, unstructured interview or focus group? Yes
If Yes, please list the range of topics likely to be discussed.

(d) If the project involves an interview of either type (individual or focus group), will it be recorded by:

audio-recording	Yes
visual recording	No
note taking	Yes
or other *(if Yes, please specify below)*	No

(e) Will the participants be offered the opportunity to check the transcript of the interview? Yes
This also applies to focus groups.
Note: it is normal practice to have participants review their transcription. If this is not to be the case, please explain why you believe it is not necessary.
Participants should be informed of interview recording and transcription review within the information letter.

a. This project involves a pre and post workshop survey to gather information about teachers' beliefs around Computational Thinking. The questionnaires are attached.
b. Topics to be discussed are:
   - Benefits of using unplugged methodology in classroom setting,
   - Their observation and effect on students and themselves,
   - Connection between unplugged and learning programming,
   - Views and attitudes towards new Digital Technologies curriculum
   - Any other advice and comments for teachers who are new to Digital technologies.

e. The interviews will be audio recorded, and will be transcribed, to maintain confidentiality and anonymity of the participant every identifying detail will be removed before sharing data with participant for review. If requested, all data including audio recordings and notes will be shared via email and will be private between participant and researcher. The only reason the interview is recorded to check whether the notes are correct and complete. However, participants are allowed to hear their recordings and view all notes taken, and if they request to discard all data and not include in our research.

6. (a) What are the ages of your participants?

☐ Children (under 14 years of age)

☐ Young people (14-17 years of age)

☒ Adults (18 years and over including College/University students

(b) How are they to be recruited?

If a selection from a group is necessary, how will it be made (e.g., randomly, by age, gender, ethnic origin, other)?

How many participants (of each category, where relevant) do you intend recruiting?

Participants will be strictly in-service and pre-service teachers from primary to high school in NZ, and primarily in Christchurch.

We plan on recruiting teachers from three interventions i.e. CS4PS, CS4HS, and Kia Takatū ā-Matihiko (which is replacing CS4PS and CS4HS). As the UC CSSE Computer Science and Education Department is actively involved in running these events, teachers who are signed up for this will be sent out all the information and consent forms so that they can confirm that they wish to be the part of the research. Participating in this research will not be required to participate in the programmes.

We plan on giving pre and post workshop survey to every teacher but will only be recruiting a subset of willing teachers for the follow up interview. There is no pre-determined limit to the number of participants for this study, but we will require sufficient information to draw out analysis for our study, effectively.

In **-** service teachers will be preferred for the semi structured interview as they have been working with the students and trying out different learning pedagogies in classroom setting. This will provide us with lot of useful information that will help us modelling answers for our research question.

For recruiting teachers for the follow up interview, we have included last question in post survey, open to all the teachers who participated in the workshop and ask them if they are willing to be interviewed. All information and the consent form will be sent in the form of an email drafted by me and reviewed by my supervisor, Tim Bell.

7. (a) Anonymity of participants and confidentiality of data

Please tick YES or NO for each

YES	NO	
☐	☒	Will complete anonymity of participants be guaranteed?
☒	☐	Will records remain confidential and access to data be restricted?

NOTE: See 8(a) and (b) for an explanation of anonymity and confidentiality.

(b) Voluntary participation and complaints procedure

Please tick YES or NO for each

YES	NO	
☒	☐	Are participants able to withdraw from the project at any time without penalty?
☒	☐	Have participants been made fully aware of the ERHEC's complaints procedure should they have any concerns regarding the researcher or the project?

If you answered ***no*** *to any of question 7 above, please provide additional information below explaining why these procedures are not being followed and how potential risks to participants will be minimised.*

7(a)
The names of participants will be known to the researcher to match responses of pre and post workshop survey and will also be needed to match interview recordings and transcriptions to the individual participants, and so will be recorded. The participants will be made aware that their names will be recorded in data files, and it will remain confidential to the researcher and his supervisor. Wherever it is necessary to discuss individual participants they will be given pseudonyms and complete confidentiality is assured.

8. How is informed consent to be obtained? Please tick one.

(a) The research is strictly <u>anonymous</u>; an information sheet is supplied, and informed consent is implied by voluntary participation in filling out a questionnaire (include a copy of the rubric for the questionnaire as in Appendix C of the ERHEC Principles and Guidelines) ☐
This means you do not know the identity of any of the participants and will not include any personal participant details.

or **(b)** The research is not anonymous, but is <u>confidential</u> and informed consent will be obtained through a signed consent form (include a copy of the consent form and information sheet) ☒
This means that while you do/may know the identity of the participants, with respect to the data provided, you will not make their identity public (e.g.in any presentations or publications).
Where confidentiality is promised, what will be done to ensure that the identities of participants cannot be known by unauthorized persons? (e.g. use of pseudonyms and disguising of identifying material).

or **(c)** The research is neither anonymous nor confidential and informed consent will be obtained through a signed consent form (include a copy of the consent form and information sheet). ☐

or **(d)** **Do you need an additional consent for any of your participants?** ☒

NOTE: Children and young adults under the age of 14 years (or 18 years if still at school) require parental/caregiver consent. Such participants should be provided with a suitable information sheet and an assent form where practicable.

If yes, please explain:

(a) Why they are not competent to give informed consent on their own behalf.

(b) How consent will be obtained

NOTE: Forms need to be provided to children to give own consent and parents' consent also needs to be obtained.

or **(e)** Informed consent will be obtained by some other method - please specify and provide details e.g. support people, whanau etc. ☐

(f) If information is being supplied orally, please provide a full description of the information provided.

8(b). Any data in this study submitted for publication in any way, will be anonymised and pseudonyms will be used if necessary. All data collected will be kept confidential and will only be viewed by the researcher and his supervisor. Data collected will be backed up on a private computer and UC server which will be password protected, only accessible by the researcher and his supervisor. Private password protected laptop will remove all information automatically if someone tries to access it with 10 incorrect tries. Hard copies of the notes will be kept in a secure storage of researcher's locked filing cabinet. All data will be anonymised before publication and pseudonyms will be provided if needed to discuss any individual participant detail.
8(d). Consent will need to obtain from the Kia Takatū ā-Matihiko organiser(s). An information sheet and consent form will be sent to inform them about the study and what data we will be collecting.

9. Are there any foreseeable risks or possible offence to the participants?
Please tick YES or NO for each

YES	NO	
☐	☒	Social risks
☐	☒	Legal risks
☐	☒	Psychological risks
☐	☒	Physical risks
☐	☒	Religious or moral offence
☐	☒	Cultural risks
☒	☐	Any other risks

If you answered Yes to any of the above, please provide additional information below explaining the nature of the risk or offence, how it will be minimised and access to support services.

The risk is very low level because the teachers will be giving their professional opinions and making judgements on these kinds of matters is routine for them. However, the situation may be new for some, so we have identified the following minor issues that might come up.

1. We will be interviewing participants individually, not focus groups, so there won't be a risk of other teachers seeing others' during the interview. When interviewing a teacher, in the unlikely event that it brings up negative emotions, they won't be pressured to continue with the issue they are concerned about. If appropriate, they can be reminded that there's no pressure to carry on.

2. The questions will be framed as helping to improve such courses and programmes, so that negative feedback is also received willingly. Also, the teachers are not graded on their participation, so there won't be a perceived impact on them if they offend someone from the University of Canterbury.

3. If any identifying information about students comes up in interviews, the transcription will anonymize the student's identity, so the only place the identity will be available is in the recordings, which are strictly available only to the teacher, the interviewer, and my supervisor.

10. Data Storage and Future Use

How will this be stored?

(a) Provide details of where the data with identifying information will be securely stored.

(b) Provide details of where the data with no identifying information will be securely stored.

(c) Who, apart from the researcher and their supervisor (where applicable) will have authorised access to the data?
Note: Research Assistants and Transcribers need their own confidentiality forms and their participation needs to be made known to participants.

(d) What will be done to ensure that unauthorised persons do not have access to the data?

(e) What will happen to the raw data at the end of the project?
Note: Up to master's level data is kept for 5 years and then destroyed; for above Masters and staff research, it is normal practice to keep for 10 years and then destroyed. Participants need to be informed of and consent to what is decided.

(a) Data will be stored on the researcher's private password protected computer and a backup copy will be kept on the researcher's private password protected external hard drive. The computer is setup so that all data on it can be erased remotely if necessary.
(b) The data will be stored on the researcher's private password protected computer and hard drive and will also be backed up in the UC Server. All locations where data will be stored will be securely password protected.
(c) Data will be only accessible by the researcher and his supervisor backed up on the UC server and researchers' private computer, which will be password protected. All locations where data will be stored will be securely password protected.
(d) The raw data will be securely stored for 5 years and then destroyed.

11. (a) What plans do you have for publication of the data?
Note: Master's and doctoral theses are public documents via the UC library database. Also, participants should be offered summary of results.

(b) Participant access to research summary
Have you offered to provide a summary? (rather than participants needing to request) Yes

(c) Have you provided opportunity for participants to provide an email address for future contact? Yes

(a) I intend to use the data and findings from this study in my masters' thesis, and if possible publish the results in conference proceedings and/or in journal articles.
(b) We offer to provide summary to participants, school principals and event organisers.
(c) We have provided opportunity for participants to provide an email address for future contact.

12. Are there any other ethical issues that should be drawn to the attention of the Educational Research Human Ethics Committee?

☒ **NO**
☐ **YES**

If you answered Yes, please provide additional information below explaining the ethical issue(s) and how it will be addressed.

13. Participant information sheet

Please attach a copy of the information sheet that you will provide to participants in your study.

The Educational Research Human Ethics Committee has strict but simple requirements for participant information sheets.

Information sheets attached for:

- Teachers,
- School Principals,
- Event Organisers/manager.

14. Consent Form

Please attach a copy of the consent form(s) that participants in your study will sign.

The Educational Research Human Ethics Committee has strict but simple requirements for consent forms. These guidelines must be followed, or your application will not be considered.

Information sheets attached for:

- Teachers,
- School Principals,
- Event Organisers/manager.

15. Declaration

I AM APPLYING FOR **ETHICAL APPROVAL** FOR THE RESEARCH PROJECT AS OUTLINED ABOVE.

I have read the ERHEC Principles and Guidelines and I am aware of the implications of my research project. I understand the details of the Privacy Act mentioned in these guidelines and how they influence the subjects I choose as participants in my research work.

The project has been accurately described in this application and I have included all the necessary documents and information to support my application.

I undertake to reapply should circumstances relevant to this application change.

Principal Researcher's Name:	Rajat Arora	**Date:**	12/06/2018
Signed:			

For Academic Supervisor - student projects only

Please note that applications for ethical approval **are not usually considered** if the student has not submitted their research proposal for registration.

Please check all that apply:

The student has submitted their research proposal for consideration. *Date submitted:*

OR

The student has successfully registered their research proposal. *Date registered:* March 2018

I have read the student's application for ethical approval including the information and consent forms.

I undertake to work with the student on any revisions required by ERHEC before these revisions are sent back to ERHEC.

Academic Supervisor's Name:	Tim Bell	**Date:**	12/06/2018
Signed:			

NB – THIS DECLARATION MUST BE HAND-SIGNED

University of Canterbury
Educational Research Human Ethics Committee

Applicant Checklist

SECTION 1 APPLICATION FORM

Researcher's name, role and purpose given	Yes
If applicant is a student, has their proposal been submitted?	Yes
Description of the project includes: - Aims - Rationale - Description of participants including sampling strategy - Procedures and methods	Yes
Description of the project matches what is in the information sheets	Yes
Anonymity assured or explanation	Yes
Confidentiality of raw data assured	Yes
Voluntary participation	Yes
Right to withdraw assured or explained	Yes
Complaints procedure	Yes
Risks identified and covered	Yes
Any other ethical issues	NA
Other	NA

SECTION 2 INFORMATION FORM(S)/LETTER(S)

CRITERIA **Letter to:**	Teachers	Activity organisers	School Principals
Researcher's name, role and purpose given	Yes	Yes	Yes
Title of project	Yes	Yes	Yes
Brief description of aim of project	Yes	Yes	Yes
Requirements for participants clearly spelt out. - How much time - The nature of the involvement - Any special meeting requirements - Etc	Yes	Yes	Yes
Voluntary participation	Yes	Yes	Yes
Right to withdraw assured or explained	Yes	Yes	Yes
Steps taken to ensure confidentiality are explained	Yes	Yes	Yes
Secure storage of raw data and data destruction assured	Yes	Yes	Yes
Anonymity assured or explanation of why this isn't guaranteed	Yes	Yes	Yes
Information about use for publication, etc	Yes	Yes	Yes
Any risks described including their remedies including conflicts of interest	Yes	Yes	Yes

Summary of results available to participants	Yes	Yes	Yes
Contact details for researcher (and supervisor if necessary)	Yes	Yes	Yes
In the body of the information form, complaints procedure as follows: Complaints may be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch, Email: human-ethics@canterbury.ac.nz	Yes	Yes	Yes
Consent procedure outlined	Yes	Yes	Yes
Forms on UC Letterhead (available on ERHEC website)	Yes	Yes	Yes
Information to participants in style appropriate to age, etc.	Yes	Yes	Yes
Other – e.g. compensation for participation, subsequent tasks or procedures	NA	NA	NA

SECTION 3 CONSENT FORMS

CRITERIA **Form for:**	Teachers	Activity organisers	School Principals
Title of project	Yes	Yes	Yes
Statement included that notes full explanation of project has been given on information sheet and understood	Yes	Yes	Yes
Statement included that participation is voluntary	Yes	Yes	Yes
Statement included that participants understand that they have the right to withdraw at any time	Yes	Yes	Yes
Agrees to publication of results with understanding that anonymity will be preserved where this has been a condition of participation	Yes	Yes	Yes
Summary of results available to participants	Yes	Yes	Yes
Forms on UC Letterhead (available on ERHEC website)	Yes	Yes	Yes
Information to participants in style appropriate to age, etc.	Yes	Yes	Yes
Place for participants to sign, if applicable	Yes	Yes	Yes
Information given for return of consent form to researcher	Yes	Yes	Yes
Other – e.g. covers any special provision such as waiver of confidentiality, publicly available storage of research material, or use of video and photographs	NA	NA	NA