# TEACHER-CREATED VIDEO INSTRUCTION IN THE PRIMARY SCHOOL CLASSROOM

***How does using teacher-created video instruction impact on students and teachers?***

Jodie Torrington

Thesis submitted for the degree of Master of Research

Faculty of Human Sciences
Macquarie University

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## List of Abbreviations

| | |
|---|---|
| AET | Academic Engaged Time |
| ASD | Autism Spectrum Disorder |
| CBVI | Computer-Based Video Instruction |
| CLT | Cognitive Load Theory |
| ICT | Information and Communications Technology |
| LL | Live Lesson |
| LMM | Linear Mixed Model |
| MLT | Multimedia Learning Theory |
| SV | Stranger voice |
| TV | Teacher voice |

# Abstract

The purpose of this study was to investigate the effect that teacher-created computer-based video instruction (CBVI) using iPads had on students' academic, behavioural and affective learning in primary school classrooms. Despite the proliferation of multimedia devices into primary school classrooms, there is limited evidence examining teacher-created video instruction in this context, particularly regarding its effect on academic growth and holistic engagement. The video instruction created for this study applied both Cognitive Load Theory (Kirschner, Sweller, & Clark, 2006; R. E. Mayer, 2004) and multimedia design principles (Fiorella & Mayer, 2018; R. Mayer, 2014; R. E. Mayer, 2008). This aimed to optimise student cognitive engagement with the video instruction and provided a solid theoretical and evidence-based justification for CBVI to be used as a pedagogical method in the primary school classroom.

The study used a repeated-measures design with counterbalancing to measure the effects of using CBVI during mathematics lessons on student mathematical achievement scores, time-on task and attitudes towards learning in mathematics. Three Year 3 classes ($n = 49$) completed three mathematics lessons, each one using a different mode of instruction: CBVI created by the regular class teacher, CBVI created by a stranger, and a traditional live lesson delivered by the regular class teacher. Results were statistically analysed using a Linear Mixed Model. No significant growth in learning was detected during the video modes of instruction, however a significant growth result was achieved for the traditional live teaching mode ($p=0.000$), which was unexpected. Behavioural engagement was considerably higher during the CBVI lessons than traditional live lessons and students preferred their teacher's voice on the video. The three teachers were also interviewed to examine how CBVI in mathematics changed the dynamics in the classroom and affected their teaching. Two main themes emerged from these teacher perceptions: 1) The impact of CBVI for students; and 2) the impact on teacher wellbeing. This research provides evidence to contribute to educational technology research, specifically, that there are benefits for students and teachers when using teacher-created CBVI. Further research is needed to better understand the factors that influence cognitive development of students using CBVI and to also explore the effect of utilising this pedagogical method on teacher wellbeing.

## Statement of Originality

*This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself. I have complied with the terms of the Human Research Ethics Committee. The approval reference number is:* 5201952748520 *(Appendix 1)*.

(Signed)

Date: 19/12/19

Jodie Torrington

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# Chapter 1: Introduction

As Information and Communications Technologies (ICT) have developed, so too has the expectation and obligations of primary school teachers to integrate and use them effectively in the classroom to support and enhance learning. Curriculum documents clearly outline the expectation to use ICT throughout the learning process, supported by the teacher accreditation process that requires proof of this integration and use (Australian Institute for Teaching and School Leadership, 2019). Researchers have identified the barriers that impact the adoption of ICT by teachers, resulting in schools ensuring staff have access to adequate technical support and professional learning and that infrastructure capability is reliable (Bower, 2017; Minshew & Anderson, 2015).

In 2019, ICT are ubiquitous in schools and teachers are expected to become more confident with their purpose and application in the classroom. The challenge for teachers is how to effectively utilise the ICT available to them in order to support the range of learning and behaviour needs of a mainstream classroom, while also delivering quality instruction. Sometimes, however, the simplest use of the ICT can be a most effective solution. Current mobile technologies, found in classrooms, have the capability to make and access videos. Video is not a new pedagogical method in education, however the ability for the class teacher to design and create their own differentiated video instruction for their students, accessed by the student using their device, is an area that has been overlooked in primary school educational research. In essence, video is a standard, in-built feature of ICT devices. This means the one device can be used to film, edit, upload and access the created video. Teacher-created video is a simple method of delivering instruction to individuals or groups within a classroom.

The research presented in this thesis explores the impact of using teacher-created computer-based video instruction (CBVI) on students' learning, attitudes and behaviour in the primary school classroom. It is proposed that specific, personalised teacher-made instructional videos are an effective method to afford differentiation in a diverse mainstream classroom, and also to engage students behaviourally and affectively. Additionally, using videos during class time allows the teacher to modify their role into a support/ facilitator capacity, supporting individually as required. The issue of personalisation of the video is explored – that is: Does it make a difference to student learning if the teacher or a stranger creates the video? Mathematics lessons were chosen for the content in the videos in the study, because it enabled objective empirical assessment data to be collected, and therefore the learning growth of students to be reliably measured.

## Research questions:

In the context of using computer-based video instruction (CBVI) as a mode for mathematics lesson delivery, the research questions of this study are:

1) **What effect does CBVI, compared to traditional face-to-face instruction, have on student learning, attitudes and behaviour?**
2) **Does a change in video-creator voice (teacher or stranger) of the CBVI produce a change in student learning, attitudes and behaviour?**
3) **How do teachers perceive that different aspects of CBVI influenced classroom activity and their practice?**

Using a repeated-measures design with counterbalancing, the thesis investigates the effect of teacher-created videos on student learning, behaviour and attitudes of three Year 3 classes. It also examines the perceptions of CBVI of the three participating teachers. Data collected from a range of sources (mathematics pre and post-tests, video-recorded teaching sessions, student questionnaires and teacher interviews) is presented and analysed in order to uncover the impact of teacher-created video in the classroom.

The thesis is structured as follows: A review of literature that informs the thesis is detailed in Chapter 2. In this chapter literature on the use of video as an instructional tool, the use of mobile technologies and their affordances is evaluated and interpreted. Research on the theoretical frameworks that underpin the CBVI design in this study: Cognitive Load Theory and Multimedia Learning Theory are outlined and synthesised. Chapter 3 outlines the methodology for the thesis. This section describes the information and justification behind the participant selection, study design, data instruments, collection and analysis methods, and ethical considerations. Generalisability issues and limitations are also discussed. Findings are reported in Chapter 4 and discussed in Chapter 5. The conclusion and future research suggestions are also included in this final chapter.

# Chapter 2: Literature Review

## 2.1 Using video as an instructional method

Video has been used in educational settings to deliver content to learners for over 40 years. Traditionally, video has provided a means of delivering education to reach an extended field of learners, cheaply and fairly efficiently (Gibbons, Kincheloe, & Down, 1977). This has been primarily for the purpose of distance education, where lessons can be viewed without requiring the teacher (or video creator) to be present. Learning through video instruction is enjoying a resurgence of interest and popularity, particularly due to the dynamic development in video technology and personal device capability in recent years. The Internet has transformed 'distance education' into 'online learning', where the use of video for instruction is ubiquitous (Kim & Thayne, 2015). Other factors such as the accessibility of online services such as YouTube; the ease of usability of personal devices that allow video creation, storing and uploading; and increased Internet reliability have also rejuvenated the use of video instruction for educative purposes (Heintz, Borsheim, Caughlan, & Juzwik, 2010; Odhabi & Nicks-McCaleb, 2011; Weng, Savage, & Bouck, 2014).

### 2.1.1 Definitions of Computer-Based Video Instruction (CBVI)

Definitions for video-based learning and teaching vary, depending on context and intent. Common themes emerge, however, to create a general understanding of CBVI used in educational settings. CBVI is created by instructors for their students, has a clear purpose, complete with learning objectives; has an intended audience; and the learning effectiveness can be assessed after viewing (Gibbons et al., 1977; Kim & Thayne, 2015; Mechling, 2005; Raynor, Denholm, & Sigafoos, 2009). Early pioneers included the distinction that videos made by an instructor would be unrehearsed and unedited, reflecting traditional classroom instruction (Gibbons et al., 1977). The definition taken for this study incorporates the above specifications and also includes

Mechling's (2005) stipulation that CBVI is both created by, and accessed through, a digital device.

### 2.1.2 Using Computer-Based Video Instruction (CBVI) as an instructional method

Research is scarce on using teacher-created CBVI for academic content during school hours, with the supervision and support of the teacher, in a regular primary school classroom setting. Commercially made videos are commonly used to supplement and reinforce information in schools, or assigned for viewing as homework as part of a blended learning strategy, that is, the "thoughtful integration of classroom face-to-face learning experiences with online learning experiences" (Garrison & Kanuka, 2004). Research on purpose-made videos by the class teacher is somewhat limited. However, there has been substantial research in the Special Education and Higher Education fields about the use of teacher-created video instruction within their contexts.

### 2.1.3 Computer-Based Video Instruction (CBVI) and Special Education

Considerable research has been completed in the Special Education field regarding custom-made video instruction, especially as part of a holistic treatment approach, to model and teach desirable behaviours and skills for students diagnosed with Autism Spectrum Disorder (ASD) as well as other developmental disabilities (Bennett, Aljehany & Altaf, 2017). A major reason for promoting the use of video instruction for students with disabilities is because of the ability to provide visually cued instruction. It is well established that individuals with ASD respond well with visual stimuli (Rayner, Denholm & Sigafoos, 2009). Several systematic reviews have been conducted since 2007 that all conclude that video instruction has been successful in teaching or improving targeted skills and behaviours (Bennett et al., 2017). However, due to the individual nature of purpose and creation of the various videos, it has been difficult for researchers to effectively compare studies, or determine precisely what components or video characteristics ensured success for students (Bennett et al., 2017).

Bennett et al.'s (2017) review aimed to compare video instruction studies for students with ASD, based upon the strategies used in the video instruction: Video Modelling (VM) (the video demonstrates the desired skill/behaviour, then the student replicates it); Video Self-Modelling (VSM) (students are videoed demonstrating the desired skill/behaviour, then watch themselves do it) or; Video Prompting (VP) (imitating a behaviour/skill sequence shown, and using the video as a support until the entire sequence is successfully demonstrated). There were 24 studies that each used a comparative single-subject design compared in Bennett et al.'s review, with the intent of pinpointing whether one strategy was more successful than others in fostering student improvement. Bennett et al. concluded that it was difficult to compare given the lack of overall standards and criteria to determine the level of success of the different approaches. Recommendations were made to address experimental design to aid future research and facilitate comparative studies. All studies showed that learning had taken place due to the video instruction strategies used and the overall conclusion by the authors was that video instruction was an effective strategy for teaching skills to individuals with ASD.

Plavnick, Sam, Hume and Odom's (2013) research on video-based instruction (video modelling of social skills) for adolescents with ASD found that this mode of instruction allowed the personalisation of content for individual needs, with teachers having the ability to control extraneous stimuli and capture the targeted skill in the presentation. This reduced distraction for ASD students. The authors found that engagement was increased due to the preference of viewing video through mobile technology. Although their sample size was small (n=4), results indicated that the video instruction substantially improved the targeted social skills. They concluded that video instruction was "effective and efficient methodology" (p. 81), a viable method that provides support to assist the often limited resourcing in schools, with their study demonstrating a successful outcome with a 1:4 staff to student ratio instead of a traditional 1:1 ratio when supporting social skill development.

These studies of video instruction in Special Education focus on CBVI as a methodology to teach and reinforce behaviours and skills, rather than as a tool to impart differentiated academic content to students. Weng, Savage and Bouck's (2014) practical "iDIY" for special education teachers about how to create video instruction espouses the benefits outlined by Rayner et al. (2009) of incorporating video instruction into the classroom: students are more independent and less reliant on adults for assistance, and adults who assist with the video instruction need minimal training as the teaching has already been prepared and recorded. Weng et al. (2014) however highlight the obstacles that may prevent teachers from adopting this approach, such as the preparation and actual video making being time-consuming, particularly if technological knowledge and self-efficacy is low. External barriers such as lack of time, professional development, technical support and connectivity concerns mirror those found in general education technology literature (Minshew & Anderson, 2015; Penuel, 2006; Bower, 2017). Weng et al. (2014) promote the use of an iPad as a useful mobile device that can be used to film, edit, watch and upload teacher-created videos easily and efficiently. A device such as the iPad assists teachers to keep the task of video-making achievable.

Despite CBVI in Special Education revolving around modelling appropriate behaviours rather than academic content, these findings could have relevance and application to regular inclusive classroom settings.

### 2.1.4 Computer-Based Video Instruction (CBVI) and Higher Education

Research from the Higher Education field has explored the application, benefits and effects of online video instruction for students. Use of online videos, whether as a core component of a formal education course, or through platforms such as massive online open courses (MOOCs), YouTube (https://www.youtube.com/) or instructional sites such as Khan Academy (https://www.khanacademy.org/), has grown in popularity both with educators and students (Kim & Thayne, 2015). This type of video instruction produced for unknown audiences is slightly different to the CBVI approaches investigated in this study: that of a teacher creating specific instruction for their students, using a natural, unedited presentation format, where the achievement gained from the learning is measurable. Based on studies of video learning in higher education settings, Miner & Stefaniak (2018) categorised video instruction into two main groups: 1) video that conveys knowledge to students, customarily in a slide-share format where the student is a passive recipient (for example lecture content) or

2) video that demonstrates skills, procedures or problem-solving situations (for example medical procedures for medical students).

Studies by university researchers of the impact of recording their own university lectures (Chandra, 2007; Odhabi & Nicks-McCaleb, 2009) reported positive benefits for students. Chandra (2007) provided some anecdotal comments from the student survey he conducted that highlighted positive feedback about the videos allowing students to revisit concepts and clarify understandings in their own time, although no statistical data of these perceptions was reported. Odhabi & Nicks-McCaleb (2009) concurred, espousing the benefits of self-paced student learning using the recorded videos. Although dated, both studies were at the forefront of the transition to online learning for universities. Nowadays, offering recorded lectures through an online platform is commonplace (Kim & Thayne, 2015).

The Higher Education video literature has developed to acknowledge the importance of rapport building strategies, used by the video-creator in order to foster a connection between them and their students with the aim of reducing psychological distance. Researchers are aware that a learner's emotions impacts both their cognitive and behavioural engagement in learning tasks (Kim & Thayne, 2015) and is therefore a significant component in overall student engagement. Strategies for video making for online or distance learning in higher education institutions have been identified that aim to reduce the psychological distance between teacher and student and build rapport. These strategies have positively correlated with student learning, despite the one-way communication limitation of video, and include using humour, making instructions clear, asking questions to involve the learner, praising students where possible, using vocal variety rather than a monotone voice, and including personal anecdotes to provide self-disclosure (Chatham-Carpenter, 2017; Hackman & Walker, 1990). The strength of rapport between a teacher and student can also influence the student's affective experience. In their study on online video instruction used in a higher education context, Kim and Thayne's (2015) research findings provided quantitative evidence to show that relationship-building strategies promote a strong teacher-student rapport, despite video being the mode of delivery. They found three behaviours that develop this rapport are:

*1)* Viewing the instructor as a role model,

2) The approachability of the instructor; and
3) The respect the instructor shows for his/her learners (p. 101).

The application of these findings to the primary school setting is reasonable: teachers know their class, are guaranteed to be trained educators and are available for support if the CBVI is used during class time. Similarly, primary school teachers are also able to infuse their CBVI with familiar nuances, such as their style of humour, tone of voice and personal anecdotes in a more familiar and relaxed manner, as they know the learners and their context. CBVI made by strangers, therefore, would potentially not be as successful in creating rapport with students, which could impact overall learning and engagement.

## 2.2 Designing effective video instruction

Depth of learning and learning growth of students can be influenced and promoted by well-designed instruction. There are numerous pedagogical perspectives that educators can adopt when working with technology including Behaviourism, Cognitivism, Constructivism, Socio-Constructivism and Connectivism (Seel, 2012). The approach to using technology in this thesis principally adopts a cognitivist approach to instruction and learning. Within the Cognitivism paradigm, the frameworks of Cognitive Load Theory and Multimedia Design Theory are drawn upon as a lens to examine and design video-based instruction.

### 2.2.1 Cognitive Load Theory

Cognitive Load Theory explores the architecture of human cognition, that is, the specificity of how the brain inputs, stores, retrieves and outputs information. In essence, cognitive theory provides a scientific, evidence-based explanation of how humans learn. This theoretical framework is rooted in the educational psychology field and has been developed since the 1980s (Sweller, Merrienboer & Pass, 2019). The characteristics of both working memory and long-term memory and the relationship between them are of particular focus to cognitive scientists (Sweller, 2019; Kirschner, Sweller & Clark, 2006; Wong, Leahy, Marcus & Sweller, 2012).

Cognitive Load Theory proposes principles designed to manage cognitive load through instruction so that any extraneous processing required of working memory is minimised or eliminated, and to optimise the cognitive capacity of students (Sweller et al., 2019). Sweller (2019), a leading expert in Cognitive Load Theory, proposes two instructional strategies to reduce working memory load and promote the transfer of information into long-term memory. One strategy is to provide explicit, detailed instruction to students. Additionally, teachers can use evidence-based instructional procedures ('effects') to deliberately reduce any unnecessary cognitive load on a student's working memory, thus maximising the opportunity for information processing and transference (see Appendix 2 for a more detailed explanation of CLT principles and its effects). These instructional recommendations are based on the results of hundreds of randomised, controlled studies that have focused on human cognitive architecture (Sweller et al., 2019).

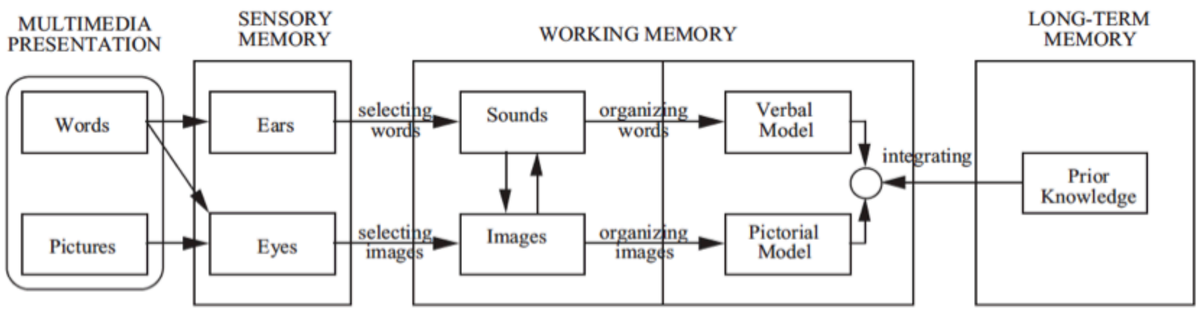
Cognitivists argue that the volume of empirical research that explains the way the brain processes and stores information provides "overwhelming and unambiguous evidence that minimal guidance during instruction is significantly less effective and efficient than guidance specifically designed to support the cognitive processing necessary for learning" (Kirschner, Sweller & Clark, 2006, p. 76). A recurrent theme for instructional design is for teachers to aim to keep the total cognitive load within the student's working memory limits otherwise the learning will be ineffective (Sweller et al., 2019; Wong et al, 2012). This overall cognitive load includes both intrinsic (the cognitive load within the information) and extraneous (the cognitive load resulting from the instructional design, which is within the control of the teacher) factors.

The principles of Cognitive Load Theory can be used in the design of instruction for both regular and multimedia lessons (Chen, Woolcott & Sweller, 2017; Sweller, 2019; Sweller et al., 2019), with the ultimate goal to enhance learning by designing instruction using cognitive load effects that is appropriate and beneficial for human cognitive architecture.

### 2.2.2 Multimedia Learning Theory

Multimedia learning, in its simplest form, is defined as "learning from words and pictures" (Mayer, 2014, p.1). Multimedia Learning Theory originated from Cognitive Learning Theory, in particular from the Modality Effect, which has shown that learning is more effective when a combination of sensory inputs are used. Mayer's cognitive theory of multimedia learning is shown below (Mayer, 2008).

*Cognitive Theory of Multimedia Learning*




*Note.* Reprinted from "Cognitive Constraints on Multimedia Learning: When Presenting More Material Results in Less Understanding," R. E. Mayer, H. Heiser, & S. Lonn, 2001, *Journal of Educational Psychology, 93,* Figure 2, p. 190. Copyright 2001 by the American Psychological Association.

**Figure 1. Cognitive Theory of Multimedia Learning (Mayer, 2008)**

Multimedia Learning Theory is comprised of several evidence-based principles of multimedia instructional design (Mayer, 2008). These principles apply the science of instruction (how to design instruction) to the science of learning (how humans learn) and provide explicit direction on how to accomplish this. The principles draw from Cognitive Load Theory in that extraneous material or processing required by working memory should be avoided or eliminated so that maximum cognitive capability can be used to process, organise and transfer the information to long-term memory. However, Multimedia Learning Theory is concerned with how best to use technology as a medium to achieve this. The principles have resulted from "multiple experimental comparisons that generally yielded large effect sizes" (Mayer, 2008, p. 763). Mayer's evidence-based approach is based on control and experimental group design, with learning outcomes measured using transfer tests.

Five major principles aim to reduce extraneous processing by learners. These are:

1) *Coherence* (reduce unnecessary material)
2) *Signalling* (highlight fundamental information)

3) *Redundancy* (not adding on-screen text to narrated animation)
4) *Spatial contiguity* (words are placed next to related graphics)
5) *Temporal contiguity* (related narration and animation presented simultaneously)

Three principles aim to manage essential processing for learners.

6) *Segmenting* (breaking the narrated animation into learner-paced segments)
7) *Pre-training* (pre-teaching key components (names/ locations/ characteristics) prior to engaging with the narrated animation)
8) *Modality* (presenting graphics with spoken rather than written text)

Two principles aim to cultivate generative processing.

9) *Multimedia* (use words and pictures rather than just words)
10) *Personalisation* (using a conversational style rather than a formal style when speaking) (Mayer, 2008).

The combination of reducing extraneous information to reduce cognitive overload, managing essential processing of the information to encourage schema creation, and building generative processing to develop deep learning and connections provide a comprehensive and practical approach for the design of effective multimedia instruction.

As a multimedia instructional tool, video has the capability to combine both visual and auditory information, which has been confirmed to be more effective for learning than when only one sensory channel (either visual or auditory) is used (Fiorella & Mayer, 2018; Mayer, 2008). This combination of sensory input can assist learners to create schema of their learning more effectively, which is considered a critical attribute of video instruction (Choi & Johnson, 2005; Miner & Stefaniak, 2018). Although the modality effect is an important aspect of video superiority, all principles of Multimedia Learning Theory would be applicable to create a successful design of video instruction.

### 2.2.3 Direct Instruction

Cognitive load theorists promote Direct Instruction (DI) as an effective pedagogical method, compatible with human cognitive architecture. DI is defined as 'explicit and systematic instruction' (Stockard, Wood, Coughlin & Rasplica Khoury, 2018, p. 479). DI complements theory-based research on how people learn, and provides the optimum opportunity for mental schema creation, transfer to and retrieval from long-term memory (Kirschner et al., 2006; R. E. Mayer, 2004, 2008). Stockard and colleagues review of 50 years of DI research concluded that DI impacts student learning positively, and the evidence collected over 328 studies was "substantial and consistent" (p. 501). They surmised that their results concurred with earlier reviews of the DI effectiveness research, finding the estimated effects of reviewed studies were regularly positive and considered medium to large (substantially larger than 0.25) (p. 500). The meta-regressions and sensitivity analyses "indicated that the results were robust, with no systematic impact of variables related to the nature of the publication, methodological approach, or sample" (p. 500). Their evidence supports Cognitivist theory: that learning is enhanced when instructional information is designed and presented in a well-structured, logical and clear manner.

Hattie (2009), respected for his synthesis of over 800 meta-analyses relating to the influences on achievement in school-aged students, also rates guided, explicit instruction (Teacher Clarity and Direct Instruction) as having a positive impact on student learning, with effect sizes of 0.75 and 0.59 respectively. Specific teaching programs attributed to a cognitivist perspective: Mastery Learning and Worked Examples also had effect sizes that were in the zone of desired effects – 0.58 and 0.57 respectively. All four of these influences ranked in the top 30 (of 138) influential factors.

The prescriptive nature of DI has made it a controversial pedagogical method in education, enduring criticism and debate from constructivist and socio-constructivist theorists (Adams & Engelmann, 1996). Stockard et. al (2018) also acknowledge this criticism and attributes this in part to a lack of understanding about the theory that underlies DI.

> *DI shares with constructivism the important basic understanding that students interpret and make sense of information with which they are presented. The difference lies in the nature of the information given to students, with DI theorists stressing the importance of very carefully choosing and structuring examples so they are as clear and unambiguous as possible* (p. 502).

Hmelo-Silver, Duncan, and Chinn (2007), critics of DI, contend that popular constructivist pedagogies (for example Independent Learning and Problem Based Learning) do in fact "provide very strong forms of guidance that seem to us to be indistinguishable from some of the forms of guidance [i.e. Direct Instruction] recommended by Cognitive Load theorists" (p.102). They highlight that teachers are actually providing explicit, scaffolded instruction and learning experiences in line with a DI approach while maintaining that their style is 'constructivist'. Educational technology experts agree that the reaction against DI can go too far. The black and white thinking of either instructivism or constructivism can be detrimental to teaching and learning effectiveness. Rather, it is important for educators to structure the opportunities for optimal learning and scaffold the process of learning in order to achieve best results (Dalziel et al., 2016).

Computer-Based Video Instruction (CBVI) delivers one-way multimodal communication that can be interpreted as a type of DI, and can be used a method of delivering explicit, systematic instruction to students, differentiated to groups or individuals as needed to maximise cognitive engagement and learning of students. Despite strong evidence as to the effectiveness of DI on student learning and achievement, it is seen as a controversial pedagogical topic by some educators.

## 2.3 One-to-One Technology in Schools

Effective one-to-one technology integration requires that external barriers such as access to technology, support with implementation, adequate professional development about how, what and why to use it, sufficient Internet connectivity and infrastructural support – which are commonly cited as hurdles to technology integration in schools (Bower, 2017; Minshew & Anderson, 2015) – have been sufficiently overcome. Research is emerging on the impact technology is having on student learning, motivation and engagement in the primary school although planning models and frameworks such as the TPACK framework (Mishra & Koehler, 2006) and m-learning framework (Kearney et al., 2012) have been in use for some time.

There are a variety of ways 1:1 devices are used in the classroom. Some identified uses are to provide differentiated opportunities or challenges for students, or as a mode to engage with content, processes and presentation of learning in unique ways (Harper & Milman, 2016; Milman, Carlson-Bancroft & Boogart, 2014). Even though commercial videos are used in classrooms as a method of supplementing student learning material as part of a blended learning approach (Bonk & Graham, 2006), research on teacher-created video instruction in the primary school context is relatively unexplored.

There is evidence to suggest students are behaviourally engaged while using mobile devices. For example, research of 10 primary schools by Pegrum, Oakley, and Faulkner (2013) found students were 'motivated and engaged' (p. 74) when completing their learning using technology. These findings were similar to the Tay (2016) 3-year longitudinal study of secondary students that provided empirical evidence to show using iPads increased learner motivation and engagement.

In contrast, a two-year longitudinal study of a 1:1 iPad initiative in a middle school (n=602) in the USA produced results that indicated that the technology did not impact student achievement or engagement, and had a negative impact on student behaviour (Johnson, 2017). Common themes such as teacher self-efficacy, external barriers, and effective and exciting planning of programs that integrate the technology emerge from this dissertation. Effective 1:1 technology integration needs a motivated, technically knowledgeable teacher who is well planned and supported by capable infrastructure.

Harper and Milman's (2016) review of 10 years of literature exploring 1:1 technology in schools examined empirical research from 46 relevant articles, using the constant-comparative method to analyse, code and induce themes. Overall, these were: the impact on student achievement, motivation and engagement, classroom environment changes, use within classrooms, and integration challenges. Although the authors claim in their findings that using technology definitely improves student achievement, there were some inconsistent results in their presented data. Some research showed positive trends for improved student learning, although they were not statistically significant, and others showed no effect of technology on student learning. They concluded that 1:1 technology has the ability to reduce achievement gaps relating to socio-economic status and ability level and increase student engagement and achievement. A 1:1 ratio changes the teaching and learning environment, in that collaboration can increase between groups and also between student and teachers. Careful planning and programming can facilitate sophisticated, deep learning opportunities using creative multimedia tools. Instructional approaches can change with 1:1 device availability, with teachers more likely to differentiate instruction according to student needs. They found there were mixed effects of technology on students' classroom engagement. Harper and Milman recommended that future research focus not solely on the impact on student achievement, but rather on the holistic picture of 1:1 programs that are planned, designed, implemented, evaluated and promoted in effective, engaging and efficient ways (p. 140).

Milman, Carlson-Bancroft and Boogart's (2014) examination of iPad use in an American elementary school found that teachers integrated the technology within lessons in order to enhance or supplement information presented or to provide deeper learning opportunities. Technology was also used to differentiate content, process and products for students. Their small mixed-method study provides percentage results for their qualitative results, with the conclusion that 86.7% of surveyed teachers (n=33) agreeing that iPads positively impacted students' academic performance, and 83.9% agreeing that the iPad improved both student motivation and engagement (p. 127). There was no indication of how these improvements were measured by participant teachers.

There have been enormous changes in terms of personal and cultural usage and acceptance of technology in schools since these early studies. In the 10 years since the iPad's inception, 1:1 programs have become more prevalent in schools (Minshew & Anderson, 2015) and the device has become ubiquitous in primary school classrooms. A recent study of 1:1 iPad integration (Retalis et al., 2018) acknowledges that mobile technologies are firmly integrated into the lives of both students and teachers. Their mixed-method study concluded that using iPads in the classroom positively influenced students as a tool to both organise and understand their learning.

## 2.4 Summary

Research from a range of education fields can be used and applied to teacher-created CBVI in the primary school, despite the paucity of evidence specifically addressing this topic. Findings from the special education field about the benefits of using video to provide differentiated, targeted instruction to students, and the increased behavioural engagement that this mode provides for ASD students can be relevant to the mainstream classroom. Higher education research about the types of video instruction, developing rapport strategies through video and the benefit of student autonomy that video affords is also applicable with primary school-aged students. Digital technologies can behaviourally engage young learners and offer opportunities to manipulate the pace and style of the learning, offering student ownership, as educational technology research is discovering. Adopting educational psychology research about how to design instruction that acknowledges and accommodates human cognitive architecture and therefore optimises student learning adds a theoretical, evidence-based layer to the creation of CBVI. Consideration and utilisation of multimedia design principles provides a practical, evidence-based approach to the creation of the video, again with the intent of maximising student learning. CBVI can be considered a form of direct instruction using one-to-one devices, and hence the background research in each of these fields provides a degree of context to the current study. Due to the limited literature surrounding using video instruction as a pedagogical method in the primary school, further research is needed to investigate the effects of CBVI on student engagement and learning. This study aims to provide initial evidence to contribute to this research area in the primary school context.

# Chapter 3: Methodology

## 3.1 Methodological approach

A repeated-measures design with counterbalancing was chosen for this study in order to measure the effect of CBVI on student learning, behaviour and attitude. This design enabled every participant to partake in all three treatments: CBVI using the teacher's voice (TV), CBVI using a stranger's voice (SV), and a normal 'live lesson' (LL) of the teacher, all conducted under experimental conditions. The key advantages of using a repeated-measures design are that fewer participants are required and also that participant groups do not have to be equated. Both of these factors are due to the participants completing all treatment conditions, so in effect, they "serve as their own control" (Johnson, 2017, p. 746). This meant that established classes could be used for this study, and the researcher did not have to reconfigure classes or create specific participant groups. Threats to the internal validity were controlled by the counterbalancing technique, which required each class to receive treatments in different orders (see Table 1). Johnson explains that this technique negates any sequencing and order effects by "averaging out" (p. 746) the effects. This is a crucial consideration with a study involving young children, where results could vary considerably depending of the time of day or the activities prior to the formal testing and observation session.

**Table 1**

***Treatment order for classes***

TV – Teacher voice
SV – Stranger voice
LL – Live lesson (no CBVI)

| | **Day 1 (Mon) – Lesson 1** | **Day 2 (Tues) – Lesson 2** | **Day 3 (Thurs) – Lesson 3** |
|---|---|---|---|
| **Class 1** | TV | SV | LL |
| **Class 2** | SV | LL | TV |
| **Class 3** | LL | TV | SV |

Mixed methods of data collection were employed in order to collect substantial data with the purpose of triangulating this empirical evidence, thus enhancing the credibility and reliability of the findings (Chow, Quine, & Li, 2010). In addition to the quantitative behavioural observations, student questionnaires, and pre and post mathematics content tests, structured qualitative teacher interviews were conducted in order to provide deeper insights into the nature of CBVI in the classroom. The data sources and analytic methods are described later in the chapter.

## 3.2 Participants

A K-12 independent, coeducational Anglican school, located on the outskirts of Sydney, was purposely selected in order to meet the requirement of a 1:1 student to mobile technology ratio. According to the My Schools website (myschool.edu.au), the school Index of Community Socio-Educational Advantage (ICSEA) value is 1099, which is higher than the 1000 average. The website identifies 44% of students in the top quarter, which is considerably higher than the average of 25%. Only 2% of students identify as Indigenous and 10% speak a language other than English. The researcher has worked in the Junior School campus of this school previously and although is not currently connected with the students or staff in the Junior School, the ICT protocols and resourcing were known. The school also utilised an explicit, directed mathematics program, which aligned with the nature of the intervention being proposed. This selection decision also meant staff were familiar with CBVI creation and application.

After formally consenting to involvement in the study, the Principal recommended Year 3 as the participants due to their 1:1 iPad resourcing and familiarity with teacher-created video making and use in the classroom. Of the possible Year 3 students (N=70), 49 were granted permission by their parents to participate (see Appendix 3). Thus, the final sample used in data analysis was composed of three teachers (all female, with ages ranging from 23 to 53) and 49 Year 3 student participants (N=49), 27 females and 22 males. The participants from the three classes are shown in Table 2.

**Table 2**

***Participants in each Year 3 class***

| Class | Participants |
|---|---|
| 1 | 16 |
| 2 | 15 |
| 3 | 18 |
| Total | 49 |

## 3.3 Procedure

The study contained three phases: preparation, implementation and summative reflection, as shown in Figure 2. The first preparation phase, a teacher professional development session, was facilitated by the researcher on Thursday 20th June 2019, and attended by all three Year 3 teachers (details about this session are provided below). The implementation and summative reflection phases were conducted in the natural setting of each of the three classrooms over the course of one week (24th – 28th June 2019). The school allocated this week as it was the only whole week uninterrupted by scheduled events and enabled the three mathematics treatment lessons of the study to be conducted as per usual timetable scheduling on the Monday, Tuesday and Thursday. Wednesday was unavailable due to school sporting commitments. Unfortunately, one of the teachers was absent for the Thursday lesson, therefore it was conducted on her return to work the following Tuesday. A total of 7 school days were used for the complete data collection, including the teacher preparation session and the post-experiment teacher interviews (20th June-1st July 2019).

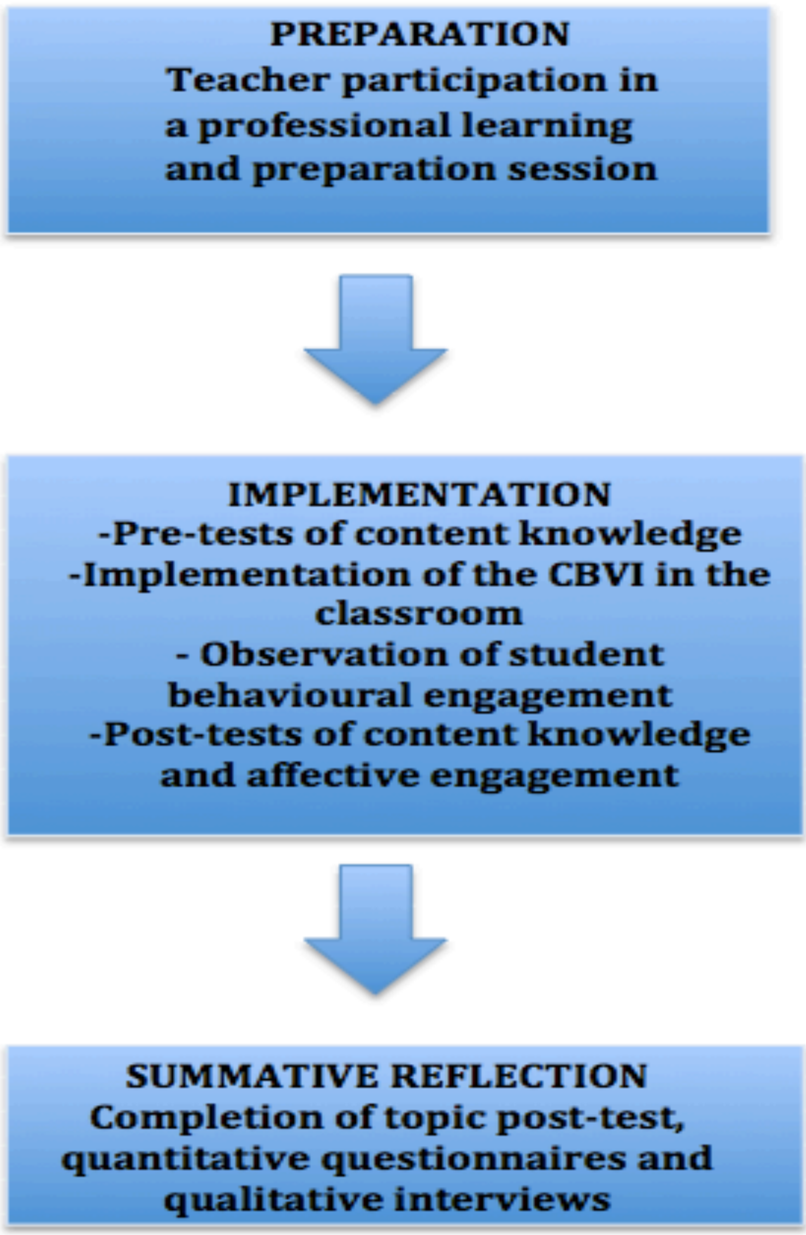



**Figure 2.** *The three-phased study*

### 3.3.1 Preparation

**Lesson Instruction Design**

The three subtraction lessons were designed adhering to Cognitive Load Theory (CLT) and Multimedia Learning Theory (MLT) principles. The aim was to create instruction that was suitable for human cognitive architecture and optimal for reducing extraneous cognitive load, thus maximising learning potential for students. This study did not have the scope to provide differentiated content to students, though students did have the ability to play and replay the videos according to their ability level.

Key considerations of both CLT and multimedia learning effects were applied to the lesson designs, aimed to reduce extraneous processing. These were:

1) *Coherence* - making sure any unnecessary information was reduced
2) *Signalling* – highlighting fundamental information using coloured notations
3) *Redundancy* – not adding on-screen text to narrated information
4) *Spatial Contiguity* – making sure words were placed next to graphics
5) *Temporal Contiguity* – related narration and graphics/diagrams presented together.

Principles to assist managing the processing of information were also considered. These were:

1) *Segmenting* – students were directed to press pause and complete examples as directed. The *Show Me* app that was used to create the videos unfortunately did not have the affordance of a stop/continue button, however students had the ability to use pause, re-watch the video if needed to hear/watch the instructions again;
2) *Modality* – using both auditory and visual information.

Finally, two principles were incorporated to cultivate generative processing:

1) *Multimedia* – using both words and pictures;
2) *Personalisation* – the script written with informal, conversational style speech

Scripts for all three lessons are attached in Appendix 4. IPads were the technological devices used for the video making and watching.

### Teacher Preparation Session

The teacher preparation session provided the opportunity to brief all participant teachers on the purpose and expectations of the study in a dedicated time away from the distractions of the classroom. A summary of research findings about CBVI, general use of video in classroom contexts, Cognitive Load Theory and Multimedia Learning Theory was also presented, meaning that the session also constituted professional learning for the participating teachers.

The detailed scripts for the three treatment mathematics lessons were given to teachers and discussed, including the use of bold to indicate voice emphasis, blue italic prompts to indicate to write something on the screen, and the inclusion of the actual written examples to notate in order to match the voiceover script. The app for the video lesson creation, called '*Show Me*', was discussed and teachers had the space to experiment with the app and its affordances on their iPad, being guided by the researcher as needed. Two of the teachers were familiar with the *Show Me* app, as they had experience creating videos for their class prior to this study. The third teacher had not used '*Show Me*' before, although was familiar with a similar app to create videos. '*Show Me*' was selected for video creation, as it is a whiteboard-style tutorial app that affords visual images, and allows a 'whiteboard-style' write-ability, including annotations of mathematical content (e.g., example questions, modeled solutions) with the teacher's voice overlaid. It is simple to use, store and share created videos using this app.

The importance of following the script verbatim, including voice emphasis and written examples for the visual screen material, was stressed, in order to allow consistent comparison between classes. Treatment order for the lessons was presented and discussed, and teachers were each given a folder with scripts marked with the expected treatment type. The teachers used the remainder of the session to record their specified 'teacher-voice' video lesson, which was checked by the researcher for consistency. This session occurred on Thursday 20th June 2019.

### 3.3.2 Implementation

Mathematics was the Key Learning Area (KLA) chosen for this study for two reasons: 1) progress with learning can be discerned quantifiably and objectively, and 2) the school uses a mathematics program that is prescriptive and tightly directed, making it suitable for adaption to video instruction. The program comes with script-like lesson plans and comprehensive formative and summative assessment, which were modified for this study so that the expected school programming could continue during the study. Students were able to complete the lessons using their usual textbook, although the scripts and mathematics tests used in this study were rewritten to avoid copyright issues. Consequently, the count-back, split and jump subtraction strategies for 3 digit subtraction problems was agreed by the school to be the content topic for the study as this was what was scheduled for Year 3 during the data collection week.

Students completed three sequential mathematics lessons developing their subtraction strategies. These lessons followed the outlined school program for mathematics in Year 3. The outcomes: MA2-5NA, MA2-1WM, applied to all three lessons, however the focus developed incrementally with each lesson.

> ***Lesson 1:*** *To use strategies (jump and split) to subtract two- and three-digit numbers (without bridging)*
>
> ***Lesson 2:*** *To use strategies (jump and split) to subtract three-digit numbers (without bridging)*
>
> ***Lesson 3:*** *To use strategies (jump and split) to subtract one-digit numbers from three-digit numbers (with bridging)* (Appendix 4).

Students completed the lessons using either a) CBVI using the teacher's voice (TV), b) CBVI using a stranger's voice (SV) or c) a normal non-CBVI live lesson with the teacher (LL). The stranger voice was the researcher's and videos were provided to the participant teachers prior to the SV treatment. The counterbalanced treatment order table (see Table 1) identified which lesson corresponded with which treatment for each class. Lessons were completed in the morning session each day and did not have a specified duration. The expectation for teachers was to complete the entire lesson script including all practice exercises and textbook requirements. This meant the LL took longer in duration as each teacher had to wait for the class to complete the specified example questions, before marking them and moving on to the next section. During the video lessons, students were able to self-pace their learning by pausing or re-watching as needed, thus fostering differentiation. The LL lessons took on average 15 minutes longer than the video lessons to complete.

Each lesson applied a pre-test post-test design to measure evidence of learning during each treatment. Prior to each lesson commencement, students completed an 8-question pre-test of the lesson content (see Appendix 5). Students repeated the same test at the conclusion of the lesson. Included in this post-test were two questionnaire questions for students to measure their attitude towards the treatment method. This meant post-tests had to be carefully constructed to ensure the questionnaire questions reflected the treatment that each class was completing, as each class had different treatments for each lesson. This was designed to capture the immediate reactions of the Year 3 students towards the treatment.

Three video cameras were used during every lesson to capture footage of students who had been given additional parental permission for the behavioural observation aspect of the study. These students were organised prior to the study and grouped at the same table for convenience and to prevent recording students who did not have parental permission. Teachers organised this seating change a week prior to the study to avoid any last-minute changes or disruptions for students and to reduce the likelihood of a changed seating plan affecting lesson completion or behaviour. These recordings were used to complete behavioural observations over a 15-minute period, commencing 5 minutes into the start of the lesson (after the pre-test completion). This gave time for all students to access the video lesson, organise their books and equipment and begin the actual lesson. The cameras were positioned to capture different angles of the identified students, and were placed in the same positions each lesson. This meant the researcher could view different recordings for the same student to confirm identified behaviours. Students were instructed by their teachers to remain in the same seat each lesson.

### 3.3.3 Summative reflection

The next day following the conclusion of the experimental observations, students completed an additional six questions for the questionnaire about their attitudes towards each of the treatment modes and the use of video as a pedagogical method. This was completed at the conclusion of the study for two reasons: 1) students would not have the fatigue of having completed a mathematics lesson, and 2) students would have time to reflect holistically on the treatments and their feelings towards each one. The participant teachers were also interviewed using structured questions at the conclusion of the experiment. These occurred during break times and were recorded as voice memos on an iPhone8 to aid transcription, coding and analysis accuracy.

## 3.4 Methods of data collection

An intermethod mixing approach to data collection was used for this research study (Johnson & Turner, 2003). Educational psychologists recommend a holistic overview of student engagement be collected and analysed in order to draw robust conclusions. The three identified aspects of student engagement are cognitive, behavioural and affective engagement (Pilotti et al., 2017; Fredericks et al., 2004; Chapman, 2000). Too often, conclusions about student engagement are made based solely upon academic achievement, neglecting important student behavioural and attitudinal data. Students may achieve well, but be behaviourally or affectively disengaged (Pilotti et al., 2017).

Therefore, in order to gather comprehensive data about student engagement in this study to measure all three domains, three instruments were designed to collect data relating to each specific dimension of student learning and engagement as shown in Table 3.

**Table 3**

***Student learning domains***

| STUDENT LEARNING AND ENGAGEMENT | | |
|---|---|---|
| **COGNITIVE** | **BEHAVIOUR** | **AFFECTIVE** |
| ↓ | ↓ | ↓ |
| **Pre and post testing after each lesson** | **Quantitative observation during lessons** | **Quantitative questionnaire following lessons** |

The tools used to measure each aspect are described below.

### 3.4.1 Measuring the cognitive domain

Each lesson was designed with an accompanying pre-test to capture initial student understanding of the lesson content, and an identical post-test to measure student learning and achievement from the lesson. Thus, the pre-test post-test design measured the academic knowledge of students for each subtraction lesson (see Appendix 5). The sequencing, content and assessment were taken from the mathematics program implemented in the school, endorsed and supplied by the participant teachers to the researcher for this study. Thus, it was assumed to be appropriate for the Year 3 participants. The lesson content in the scripts, and pre and post-test assessment were reworked to maintain the original learning intention, but avoid copyright concerns. Students were able to use their textbooks to consolidate the lesson after the teaching and worked examples were completed.

### 3.4.2 Measuring the behavioural domain

The behavioural checklist this study used was modelled from the Academic Engaged Time Code of the Systematic Screening for Behavior Disorders (AET-SSBD) (Volpe, DiPerna, Hintze, & Shapiro, 2005), which is a standardised quantitative observational protocol designed to measure the amount of time a student is engaged in academic material during independent seatwork in the primary school classroom. Their identified observable behaviours, such as ‘remaining in seat’, ‘completing work as required’, ‘leaving seat’, ‘calling out’ and ‘talking to others’ formed the basis of the checklist. For this study, additional engaged behaviours were included to reflect the nature of the study: ‘focusing on the screen’, ‘talking to others about the learning task’, and additional disengaged behaviours of: ‘looking around the room rather than keeping attention on the screen’ and ‘nothing to do/ wait time’. Volpe et al. (2005) encouraged teachers to modify their list to include specific observable targeted behaviours if needed. This established observation protocol was followed to determine behavioural engagement. A behavioural observation checklist was printed for each of the observed students and used to record off-task behaviour and any other relevant comments. The researcher viewed the video footage with each student observed for a total of 15 minutes. A stopwatch was used to time on-task behaviour, and paused when off-task task behaviour occurred. If the stopwatch was paused during the observation due to disengaged behaviour, the researcher noted the reason on the checklist. The total amount of time of engaged, on-task behaviour at the end of the 15-minute observation time was divided by the total observation time (15 minutes) to determine the percentage of total academic engaged time. These formal observations were designed to provide data on the behavioural engagement of students (Pilotti et al., 2017) (see Appendix 6) although the remaining procedures for Volpe et al.’s protocol (using standardised tables) were not followed as this study does not have the intention to screen for, and identify, behaviour *disorders*. Students selected for behavioural observations are dependent on parental permissions granted, although the researcher randomly selected a subset of 5 students per class for the duration of the experiment.

### 3.4.3 Measuring the affective domain

Students completed a quantitative questionnaire cumulatively, by answering two questions after each treatment, and the remaining six questions at the conclusion of the final treatment. The two questions included with each treatment post-test related to students’ immediate perceptions and the final six questions compared between the treatment approaches and measured feelings regarding the affordances of using video (having the autonomy to pause, rewind and self-pace as needed). The questionnaire measured self-evaluated affective engagement using a Likert five-point rating scale with the anchor: strongly disagree, disagree, neutral, agree, and strongly agree. This provided the third and final dimension to the consideration of whether students were engaged using CBVI by focusing on affective engagement (Pilotti et al., 2017) (see Appendix 7). Including two questions in the post-test of each lesson enabled affective engagement data to be collected immediately following the treatment, which was an important consideration for Year 3 students who may easily forget their perceptions, and allowed affective engagement comparisons of means between treatments.

### 3.4.4 Characterising the teacher response

The three participant teachers were interviewed separately after the conclusion of the final treatment. This provided an opportunity to collect more in-depth, personalised opinions and feedback about the impact of CBVI in the classroom (see Appendix 8 for interview protocols). The average length of each teacher interview was 15 minutes. The open-ended questions encouraged teachers to address their opinions and extrapolate into related areas such as the impact of using CBVI on student behaviour and behaviour management, achievement and working habits of students. Personal reactions towards using CBVI in the primary classroom were encouraged, particularly with relation to how CBVI affected their role and work practices. The qualitative interviews were transcribed, collated and thematically analysed in order to provide evidence for the final research question: *'How did teachers perceive that different aspects of CVBI influenced classroom activity and their practice?'*

These tools provide 'multiple sources of evidence', which is recommended for research to be effective (Johnson, 2017, p. 499).

## 3.5 Data Analysis

Due to the mixed methods research of this study, data was organised and analysed using both quantitative and qualitative statistical software. Statistical Package for the Social Sciences (SPSS) version 25 was used to process and code quantitative data, provide descriptive statistics and run a Linear Mixed Model (LMM) analysis of the statistical data. NVivo12 software was used to code and thematically analyse qualitative data.

### 3.5.1 Analysis of quantitative data

#### 3.5.1.1 Data Screening Outside SPSS

The process of organising the quantitative data of student cognitive learning commenced with the marking and collating of pre and post-testing for the three lessons. This learning data was initially entered on an Excel spreadsheet both for convenience and to provide an initial view of the distribution and frequencies within the data. The quantitative responses student questionnaires were also entered on an Excel spreadsheet where distribution of the responses to each question could be viewed both numerically and visually using graphs.

The behavioural observation data for all three lessons was entered onto an Excel spreadsheet where distributions for each treatment could be summarised.

#### 3.5.1.2 Data Processing Inside SPSS

**Descriptive Statistics**

Learning performance pre and post-test data and related Likert questionnaire were analysed using SPSS 25.0 for Windows. Descriptive statistics, used to summarise and visualise the data set of each of the three treatments, are provided in Appendix 9. Frequency distribution graphs were created so that clear visual representations and comparisons of the treatments and cohorts could be made.

**Data Format**

Quantitative data was restructured from wide to long form in preparation for the LMM analysis. This required the pre- and post-test result for each lesson to be coded as either "1" or "2" respectively in the "Time" variable, and the Likert student responses to be represented numerically. At the conclusion of the data stacking and restructuring, each participant was allocated six rows of data (a pre- and post-test result for each of the three treatments).

#### 3.5.1.3 Using a Linear Mixed Model in SPSS

**Linear Mixed Model justification**

Analysis of the treatments was completed using a Linear Mixed Model (LMM). This was used as a test to establish a cause-effect relationship between the independent variables including the method of instructional delivery treatments used in the study, and the dependent variable of learning, as measured through topic tests. Learning as measured from the topic tests and Likert scale ratings of the different modes from the quantitative student questionnaire were also examined to determine whether statistically significant relationships existed. One question per lesson from the student questionnaire was chosen to be included in the LMM. These were:

**TV:** *I feel that hearing my teacher's voice helped me to stay focused on my work to complete it.*

**SV:** *I feel that hearing the stranger's voice helped me to stay focused on my work to complete it.*

**LL:** *I feel like completing my work when my teacher teaches me without a video.*

The Linear Mixed Model was chosen for the analysis as it can simultaneously account for both fixed and random effects. In this study the model considers the impact of random effects caused by student ability in and between pre-formed classes and therefore controls the threat to the internal validity caused by differential selection (Johnson, 2017).

Due to a smaller sample size (n=5 per class) for the behavioural engagement collected from the observational data, this data was not included in the Linear Mixed Model analysis.

**Fixed Effects and Random Effects in LMM**

The Linear Mixed Model considered students and classes to be fixed effects. The dependent variable was the test scores that students achieved. The factors that were included in the model were the mode of instruction that was being used ("Mode", either Live Lesson, Stranger Voice or Teacher Voice), whether the test was pre- or post- (“Time”), where in the instructional sequence the lesson occurred (“Lesson”, either lesson 1, 2, or 3), whether the student was female or male (“Gender”), and students’ Likert scale rating of the mode of instruction that they had just received (“LikertRating”).

As a starting point for the model, all possible factors and their factorial interactions were included in the model, except for those involving interactions between Time and LikertRating (as the Likert scale rating of the mode for each lesson was only taken at the time of post-testing making this interaction redundant). Thus, the model consisted of all possible interactions between Mode, Lesson, Gender and Time unioned with all possible interactions between Mode, Lesson, Gender and LikertRating. The student and class were both considered to be random effects, and an intercept was included in the model. A restricted maximum likelihood estimation was used. The tolerance for the analysis was set to 95% confidence intervals, and a Bonferroni correction was used to account for the large number of tests that were being simultaneously conducted.

The resulting table of fixed effects showed that the following variables were significant predictors (see Appendix 10 for full table of fixed effects):

- Time
- Lesson
- Gender*Mode
- Time*Mode
- LikertRating
- Mode*LikertRating
- LikertRating*Lesson
- Gender*Mode*LikertRating*Lesson

As well, the estimates of fixed effects showed that Time, Mode, Lesson, Gender, and LikertRating were all at some point involved in significant interactions, indicating that the inclusion of each in the model was warranted.

The Akaike's Information Criterion (AIC) for the model was 698.12. Alternative (simplified) models were examined, for instance excluding LikertRating, however, these models always resulted in a higher AIC score. Therefore, the complete model described above was used for the analysis.

Reporting of means in the Results section uses the estimated means rather than the actual means (which is typical for Linear Mixed Model reporting). All aspects of the research design and quantitative analysis were reviewed and endorsed by the Faculty Statistician to confirm the validity and veracity of the approach.

### 3.5.2 Qualitative data

The qualitative teacher interview data was organised firstly by transcribing the audiotaped interviews into text. These documents were then analysed thematically using NVivo 12 for Windows. The process for analysis involved identifying common themes, topics or text segments, which were then grouped and coded (Johnson, 2017). Further grouping into subsets within coded topics provided additional clarity. The researcher used both *a priori* and inductive codes during the analysis (Johnson, 2017; Pham, 2019). The *a priori* codes were developed prior to the analysis and were based on the interview questions (originating from the actual research question) of student engagement, attitudes and the impact of the stranger voice (Table 4). Inductive codes were generated from the additional comments made during the interviews about the perceived benefits or drawbacks of using CBVI that arose organically. Common phrases and words were found and analysed using the "visualisation" feature of the software, which aided the identification and summary of underlying themes. The word frequency query was run to list the most frequently occurring words in the data material, and these results were also displayed in a word cloud (Appendix 11).

**Table 4**

*Node coding scheme for teacher interviews*

| *Nodes* | *Number of references* |
|---|---|
| Considerations/ drawbacks to using CBVI | 12 |
| Effect on mathematics lessons | 4 |
| Impact of teacher voice verses stranger voice | 4 |
| Student attitude towards using CBVI | 7 |
| Student engagement | 8 |
| Teacher benefits | 22 |
| Use of CBVI for differentiation | 8 |
| Use of CBVI with special needs students | 5 |

## 3.6 Ethical Practice

The researcher accorded with all aspects of the "National Statement on Ethical Conduct in Human Research 2007 (updated 2018)", as required by the Macquarie University Human Research Ethics Committee. Permission from the Macquarie University Ethics Committee was gained prior to research commencement (Reference No: 5201952748520, Project ID: 5274, see Appendix 1). Written permission from parents and the school was required for students to participate in the research project (see Appendix 3). The students themselves were made fully aware of the research, consent to be involved was granted and they retained the right to withdraw at any time. The anonymity, confidentiality and safeguarding of participants was maintained at all times.

## 3.7 Validity

Multiple strategies to enhance the trustworthiness of this study were considered and implemented as recommended by Johnson (2017). The purposive sampling contributed to the reliability of the study by using teachers at the same school who use a common technology infrastructure and protocols, and who demonstrate a similar teacher capacity regarding the use and application of the iPad in their classrooms. In terms of validity, the chosen school uses a guided, specific direct instruction oriented mathematics program that teachers are required to follow. This meant that student participants completed CBVI mathematics lessons that followed the progression and content of the normal school program and were therefore similar in pedagogy, language and expectation to their usual mathematical lessons. The instructional scripted mathematics lessons for teachers to follow were constant and reflective of both the required school program and the NSW primary mathematics curriculum (Stage 2). The intervention was consistent with an instructive pedagogical approach and the core NSW primary mathematics curriculum potentially promotes transferability to other contexts.

As mentioned in section 3.1, the use of counterbalancing in the study design controlled threats to the internal validity by negating any sequencing or order effects. A distinctive feature of this study is that it occurred in a naturalistic, rather than lab-based setting, using the class teacher, classroom equipment and usual environment. The pre- and post-testing design for each lesson aimed to capture the cause-and-effect relationship between the treatment mode and the learning impact and minimise any confounding factors, including history and maturation effects. The provision of scripts for each lesson, identical pre- and post-tests for each lesson, consistent class seating and continuation of usual class mathematics lesson time and textbook program were controls implemented to reduce the influence of any extraneous variables.

The use of mixed methods established a wide variety of data and perspectives to be collected and analysed, providing more substantive evidence for the findings. The choice of data instruments supported data triangulation (Chow, Quine, & Li, 2010), further enhancing reliability. The use of the Linear Mixed Model in the statistical analysis of quantitative data accounted for the differential selection threat to internal validity, as mentioned in section 3.5.1.3.

## 3.8 Limitations of the Design

It is acknowledged that both the sampling method and the small sample size restrict the transferability and generalisation of this study's findings. Due to a smaller sample size for the behavioural engagement collected from the observational data, this data was not included in the Linear Mixed Model analysis. As a requirement of the degree, the data was collected, analysed and interpreted by only one researcher. However, to minimise potential bias, reflexivity was applied by the researcher as well as extensive discussions with both the thesis supervisor and the university statistician throughout the duration of the study.

## 3.9 Summary

This chapter has outlined the methods used to address the research questions of the study. The study design, a repeated-measures design with counterbalancing, was justified and a rationale for the participant choice presented. Data collection instruments and their analysis methods were explained. The Linear Mixed Model, used to analyse the quantitative data, was outlined, including the process of determining the equation and model formulation to be used. Ethical considerations were acknowledged, in particular the right for student participants to withdraw from the study at any time. A variety of validity strategies considering the study design, implementation procedures and data collection instruments were described. The limitations of the study, notably the small sample size and the use of purposeful sampling, were also acknowledged.

# Chapter 4: Results

This chapter outlines the quantitative and qualitative findings from the study. The quantitative data includes the results for the three domains of student engagement: cognitive, affective and behavioural. These are the mathematics pre- and post-testing for each treatment mode as analysed using the Linear Mixed Model, student questionnaire responses according to each of the modes, and behavioural observations in each lesson. Qualitative findings from the teacher interviews are organised and presented thematically. The summary section outlines the key findings of the cognitive, affective and behavioural engagement data relevant to the research questions about the impact of CBVI.

## 4.1 Quantitative findings

### 4.1.1 Cognitive findings

Preliminary analyses using descriptive statistics in SPSS were performed to explore the pre- and post-test mathematics test results based on the mode of delivery of the instruction: Teacher Video (TV), Stranger Video (SV) or Live Lesson by the teacher (LL). The pre- and post-tests were the same for each lesson, but tailored for the content of each lesson (see Appendix 5). These tests were scored as a mark out of 8. Means and standard deviations are presented in Table 5, and descriptive statistics in Appendix 9. Due to the counterbalanced design, each class completed each lesson using a different treatment.

**Table 5**

*Summary of test results for each mode*

| Mode of instruction | N | Range | Pretest | | Posttest | |
|---|---|---|---|---|---|---|
| | | | *M* | *SD* | *M* | *SD* |
| **Teacher video (TV)** | 44 | 8 | 5.82 | 2.49 | 5.98 | 2.40 |
| **Stranger video (SV)** | 45 | 8 | 6.13 | 2.22 | 6.07 | 2.16 |
| **Live lesson (LL)** | 39 | 8 | 5.54 | 2.45 | 6.51 | 1.50 |

Initial analysis revealed that students improved slightly after the TV treatment, but performed slightly worse after the SV treatment. The LL treatment did result in a greater improvement than TV or SV, however this could have been because these lessons took a longer time than the video based lessons. This will be examined in greater detail in the Discussion chapter.

### 4.1.2 Linear Mixed Model results

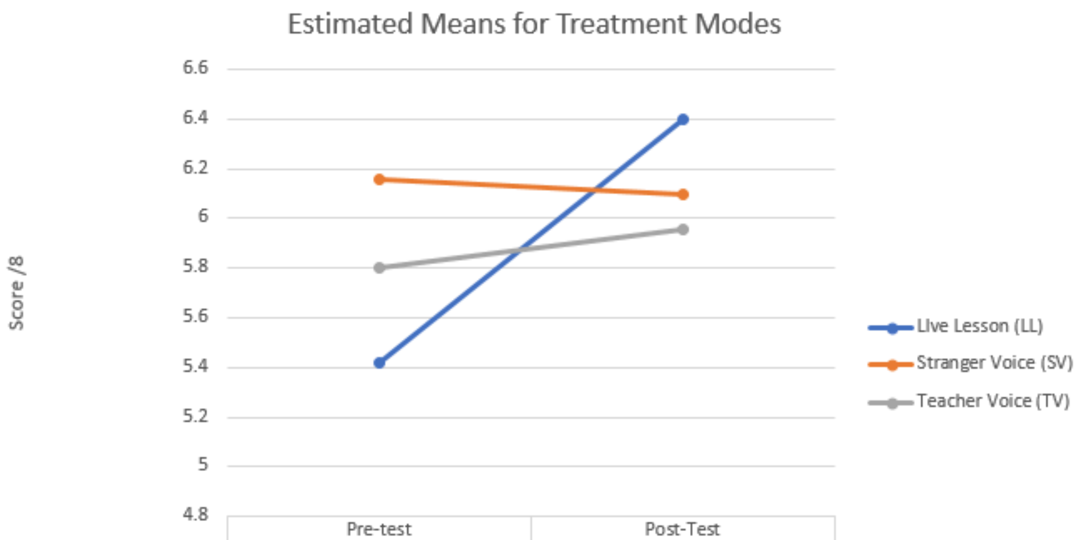
A Linear Mixed Model (LMM) analysis was run in order to establish the interactions between the variables of mode of instruction, lesson, pre and post test scores for each lesson, gender and the student attitude of the mode of instruction. The results of the LMM are included in Appendix 10.

In the estimates of fixed effects, the following contrasts were shown to contain significant results:

- Gender [Females] (p=0.004)
- Gender * Lesson [Females, Lesson 1] (p=0.043)
- Mode*Likert [Live Lesson, Strongly Disagree] (p=0.018)
- Mode*Likert [Stranger Voice, Strongly Disagree] (p=0.027)
- Likert*Lesson [Strongly Disagree, Lesson 1] (p=0.028)
- Likert*Lesson [Strongly Disagree, Lesson 2] (p=0.007)
- Likert*Lesson [Disagree, Lesson 2] (p=0.034)
- Gender*Mode*Likert*Lesson [Females, Live Lesson, Neutral, Lesson 2] (p=0.010)

Note that more in-depth discussion and interpretation of the findings is deferred to the Discussion section.

According to the model, the largest mean improvement was observed for the Live Lesson (M=0.978 marks out of 8), which was a significant change (p=0.000). The Teacher Voice treatment also resulted in an improvement (M=0.157), however this was not significant (p=0.514). The Stranger Voice treatment resulted in a slight decrease in marks (M=0.063), though this decrease was not significant (p=0.790). These changes from pre-test to post-test scores for the different modes are shown on Figure 3 below.




| | Pre-test Estimated Mean | Post-Test Estimated Mean |
|---|---|---|
| Live Lesson (LL) | 5.421 | 6.399 |
| Stranger Voice (SV) | 6.159 | 6.096 |
| Teacher Voice (TV) | 5.8 | 5.957 |

**Figure 3** ***Estimated Means for Treatment Modes***

Pairwise comparisons were run for all three lessons (Lesson 1, Lesson 2 and Lesson 3) to gauge whether lessons resulted in a significant improvement in student scores from pre- to post-test. None of these results were significant (p=0.129, p=0.242 and p=0.111 respectively).

Across the testing the mean score for Males (M=6.450 out of 8) was higher than for Females (M=5.513), which was a significant difference (p=0.032).

Across all testing the mean post-score (M=6.158) was higher than the mean pre-score (M=5.805), which was also a significant difference (p=0.013). This indicates that there was some learning that took place across the lessons, though the size of this growth was only 0.353 marks out of 8 on average.

The mean score for Lesson 3 (M= 5.037) was lower than for Lesson 1 (M=6.439), with the difference being significant (p=0.000). The mean score for Lesson 3 (M= 5.037) was also lower than for Lesson 2 (M=6.577), which was also a significant difference (p=0.000). However there was no significant difference between Lesson 1 and Lesson 2 (p=1.000).

The mean improvement for students who completed the Live Lesson mode in Lesson 3 increased their means scores by 1.310 marks, which was a significant difference (p=0.003). This finding is explored in Section 4.3. All other combinations of Mode and Lesson did not result in a significant improvement in student scores.

When combinations of Mode and Lesson were examined for both the pre- and post-test scores, the Lesson 3 post-test score for the Live Lesson was found to be 1.876 marks higher than the Stranger Voice score. This was a significant difference (p=0.012), with no other comparisons of Mode, Lesson and pre-post testing found to be significant. However, care needs to be exercised when interpreting this result because it is a between-classes difference on post-scores only.

Female students who completed the Live Lesson in Lesson 2 had a pre-score mean that was 2.363 marks lower than the male students, which was a significant difference (p=0.022), whereas the post-score mean difference for these two cohorts was only -0.306, which was not significant (p=0.763). This appears to indicate the Females benefited from the Lesson 2 Live Lesson more than Males for the Lesson 2. For the Live Lesson mode conducted in Lesson 3 Female students improved by 1.286, which was significant (p=0.030), and Male students improved by 1.333, which was also significant (p=0.037). For the Live Lesson mode conducted in Lesson 2, Female students improved by 1.857 marks, which was significant (p=0.002), however, the mark of Male students slightly decreased by 0.200 marks (which was not a significant result, p=0.773). Putting the results from the previous two sets of findings together for the class who completed the Live Lesson in Lesson 2, the Female students who were of lower pre-test scores responded better to the Live Lesson than the Male students. However, these Mode and Gender class interactions are all characterized by small sample sizes so need to be interpreted with caution. These results are further explored in Section 4.3.

The different LikertRating scores for different modes were examined to investigate whether there were any trends that emerged according to different genders or lessons scoring significantly higher means according to their ratings (from Strongly Disagree to Strongly Agree). While the LikertRating data did appear to improve the model fit, the uneven distribution of ratings across the five-point scale made it difficult to draw any firm conclusions about the relationship between LikertRatings and performance. For this reason, the Likert Scale rating results have been reported based on actual means in the following descriptive section.

### 4.1.3 Affective findings

The results of the Likert ratings of the two questions measuring the affective perceptions of each treatment are presented in Figures 4, 5 and 6. These were completed as part of the post-test of each lesson.

For the TV questions (see Figure 4), over half of the participants (52%, n=23) agreed/strongly agreed that hearing their teacher's voice on the video made them interested in completing the video, while 36% (n=16) were neutral in their opinion. Approximately 12% (n=5) disagreed/strongly disagreed that hearing their teacher's voice made them interested in completing the video. The SV questions gained similar results to the TV perceptions (see Figure 5). Over half of the participants (53% n=24) agreed (with 29% n=13 strongly agreeing) that the stranger voice did not affect them completing their work. One third of participants, 31% (n=14), responded neutrally, indicating the voice type either was not an issue, or they were not sure what to answer, and 16% (n=7) indicated that the stranger voice did affect their work completion.

When asked whether hearing the voice on the video helped them to stay focused, results were more favourable for the TV rather than the SV treatment. 53% (n=23) agreed it did, 30% (n=13) were undecided and 19% (n=8) indicated it did not help them to stay focused on their work. This is contrasted with the stranger voice, where only 24% (n=11) of participants thought it helped them stay focused, more were undecided (38%, n=17) and the result doubled for those who perceived the stranger voice did not help (37%, n=17).

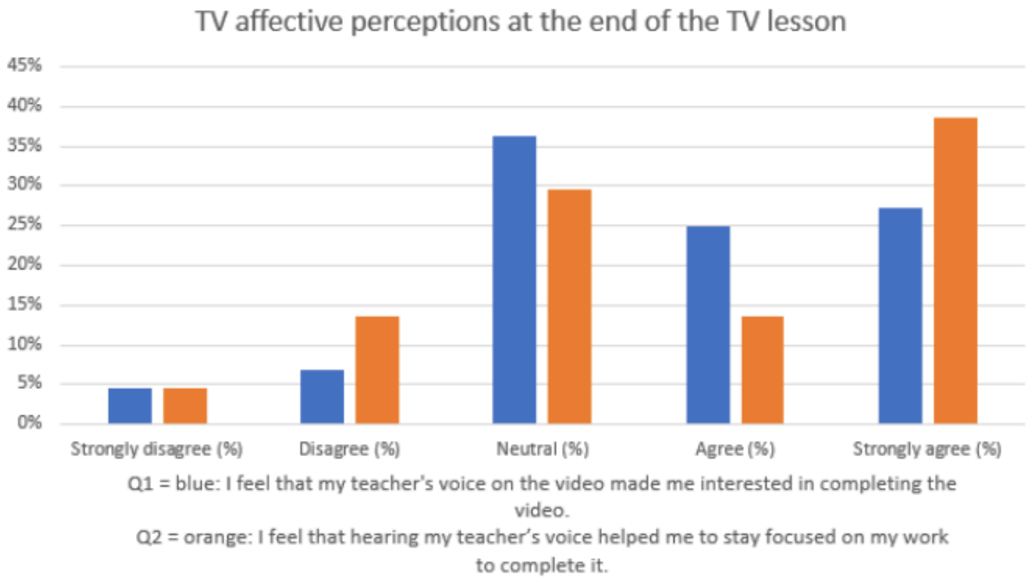



**Figure 4** *TV affective perceptions at the end of the TV lesson.*

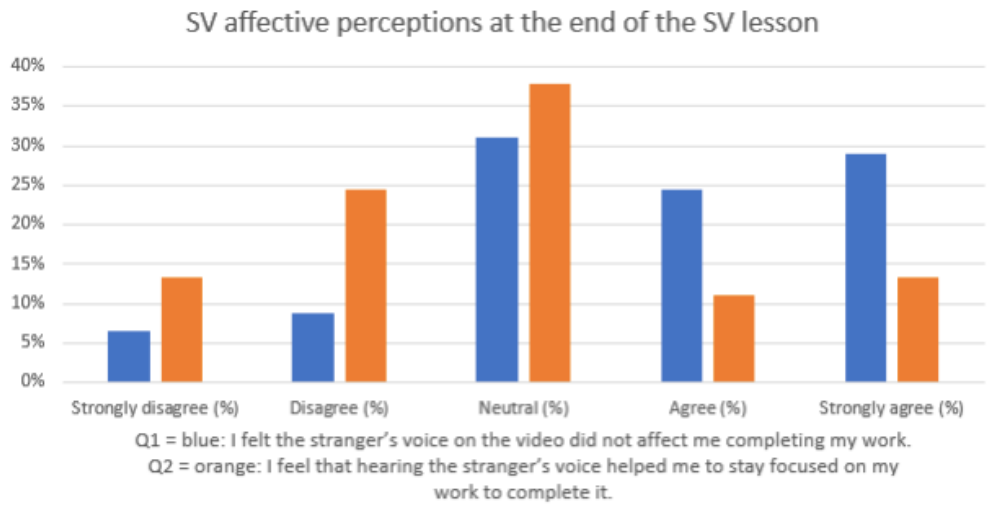



**Figure 5** *SV affective perceptions at the end of the SV lesson*

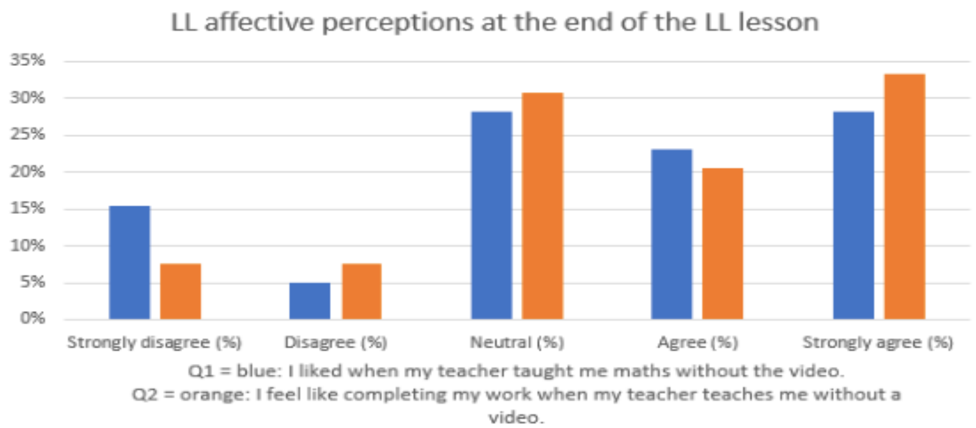



**Figure 6** *LL affective perceptions at the end of the LL lesson*

Comparative questions were asked at the conclusion of the experiment:

***Q.1. I prefer hearing my teacher's voice on the video rather than a stranger.***

Almost half (49% n=22) of students agreed that they preferred their teacher's voice on the video to the stranger's, and 42% (n=19) did not mind. 9% (n=4) disagreed, indicating that they preferred the stranger voice. Results are shown in Figure 7.

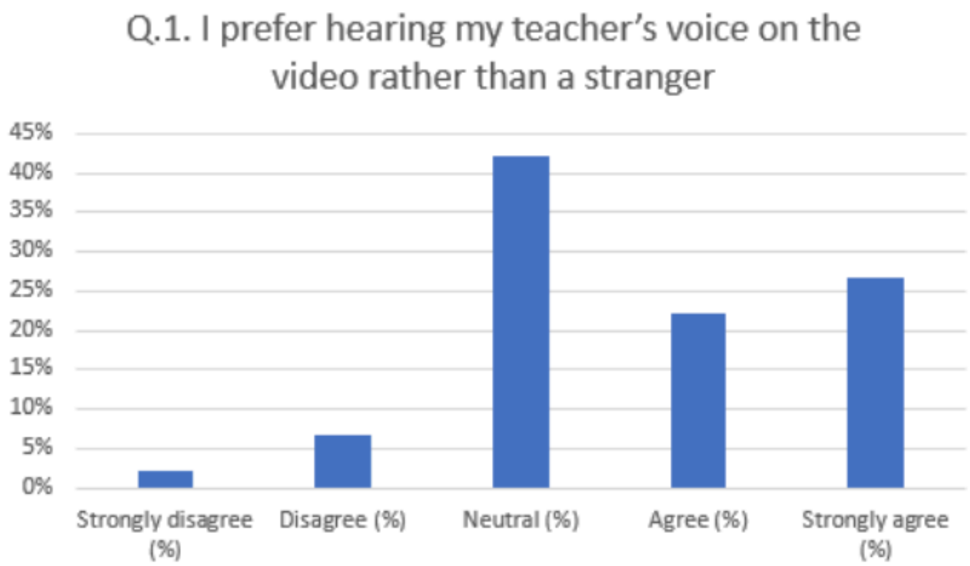



**Figure 7** ***TV verses SV preference***

A breakdown of these results by class was conducted to observe how the classes differed in their opinions (Table 6). The majority of Class 2 had no overriding preference for which voice was used (n=9). Class 1 and 3 preferred their teacher's voice.

**Table 6**

*Class responses – "I prefer my teacher's voice rather than a stranger"*

| | ***Number of students*** | | |
|---|---|---|---|
| | ***Class 1*** | ***Class 2*** | ***Class 3*** |
| ***Strongly agree/agree*** | *9* | *5* | *8* |
| ***Neutral*** | *3* | *9* | *7* |
| ***Disagree/ Strongly disagree*** | *3* | *0* | *1* |
| ***TOTAL*** | *15* | *14* | *16* |

Results were favourable for the perception of the LL mode (see Figure 6). Approximately 51% of participants (n=20) preferred a live lesson to a video to learn maths, with 28% (n=11) undecided. 20% (n=8) preferred using a video. Similar results emerged from question 2: 54% (n=21) felt like completing their work during the live lesson, 31% (n=12) undecided, and 16% (n=6) did not feel like completing their work without a video.

A similar question was presented at the conclusion of the experiment for comparison:

***Q. 2. I prefer my teacher doing a normal lesson for maths, with no video.***

**The results were similar to the previous results, indicating that this is representative of participants' opinions (see**

Table 7). 51% of participants (n=23) preferred a normal live lesson, whereas 29% (n=13) preferred using a video. 20% (n=9) were undecided. This was a simply worded question that was unambiguous for young students.

**Table 7**

*Class responses – "I prefer my teacher doing a normal lesson for maths, with no video."*

| % | *Q2* |
|---|---|
| ***Strongly agree*** | 38% |
| ***Agree*** | 13% |
| ***Neutral*** | 20% |
| ***Disagree*** | 9% |
| ***Strongly disagree*** | 20% |
| ***TOTAL*** | 100% |

Students rated the rapport building aspect of the TV CBVI in the final questionnaire:

***Q.6. I feel like my teacher is talking just to me when I listen to the videos.***

Of the 45 respondents, over half (53% n=24) agreed/ strongly agreed that they felt their teacher was talking just to them when they completed the TV CBVI. 18% (n=8) were neutral and 29% (n=13) disagreed/ strongly disagreed that they felt the teacher was talking just to them. Results are shown in Figure 8.


**Figure 8** *Rapport during CBVI*

The breakdown of the responses for each class for this question is also presented in Table 8 to explore how these results were distributed across the classes. Class 1 was evenly divided in their opinion, whereas Class 3 clearly perceived the teacher as speaking to them with 12 out of 16 students confirming this.

**Table 8**

*Class responses – "I feel like my teacher is talking just to me"*

| | *Number of students* | | |
|---|---|---|---|
| | *Class 1* | *Class 2* | *Class 3* |
| ***Strongly agree/agree*** | *7* | *5* | *12* |
| ***Neutral*** | *1* | *6* | *1* |
| ***Disagree/ Strongly disagree*** | *7* | *3* | *3* |
| ***TOTAL*** | *15* | *14* | *16* |

## Affective perceptions about video as a pedagogical method

Three questions were asked in the final questionnaire regarding the use of video for instruction and the affordances of video that encourage learning independence:

> ***Q.3 I like using videos to learn maths.***
>
> ***Q.4 I like that I can control the video – I can pause the video, watch it again if I don't understand and change the volume if I need to.***
>
> ***Q.5 I feel that using videos helps me to learn my maths.***

Results are presented in Figure 9.

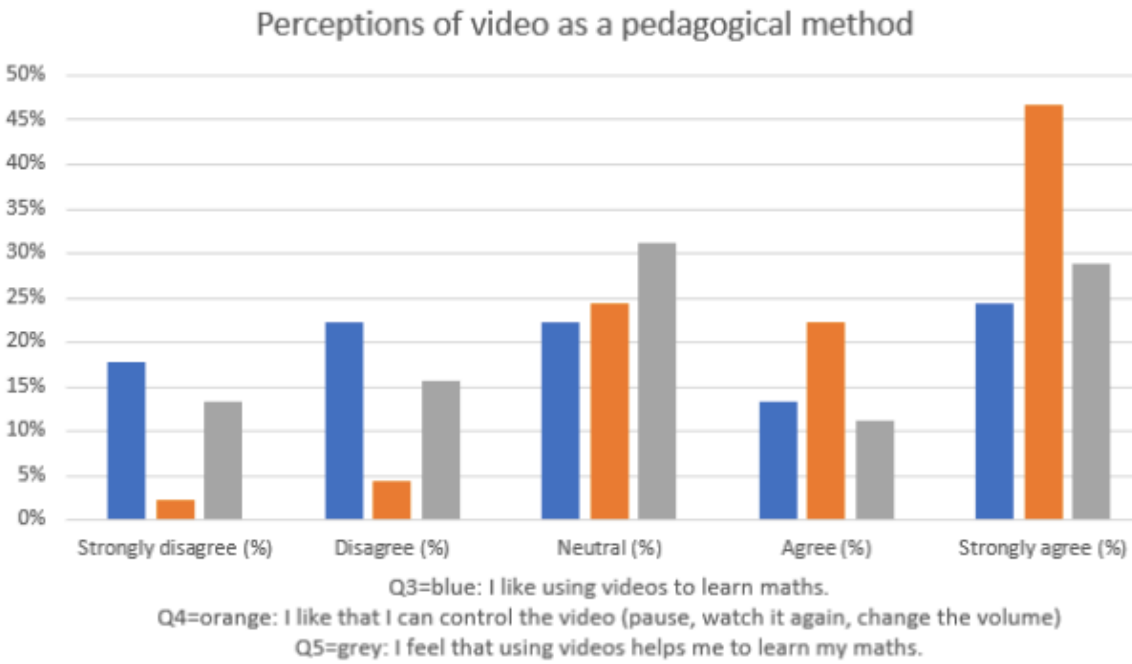



**Figure 9** ***Perceptions of video as a pedagogical method.***

Question 3 was a reversal of the previous question "I liked when my teacher taught me maths without the video", instead specifically stating "I like using videos to learn maths". It was simply worded to avoid ambiguity and designed to provide a comparative measure for Question 2. 37% (n=17) agreed positively that they like using videos to learn maths, whereas it was 29% (n=13) in Q2. 22% (n=10) were neutral about using videos, although 40% (n=18) preferred not to use video instruction for mathematics lessons. It was clear that students liked the self-control features of video, with 69% (n=31) agreeing they liked these affordances. Only 6% (n=3) did not like that they could control the video. Regarding attitudes about whether the video helped students to learn maths, 40% (n=18) agreed that it did, 31% (n=14) were undecided, and 29% (n=13) indicating that they believed the videos did not help them.

### 4.1.4 Behavioural findings

The results of the behavioural observations are shown in Table 9. On average, students were engaged for the highest percentage of the 15-minute period when using the TV video (90.8%), followed by the SV video (88.9%) and then a substantial drop with the LL (69.5%). The engagement of the students during the video lessons was impressive. Students were focused, interacting with the screen in accordance with the video directions (press pause and complete tasks) and consistently on task as expected. There were minimal disruptions such as looking around the room, chatting to others or leaving their seat. This was in stark contrast to the live lessons. Students were disengaged, shown by slumping down in their seats, looking around the classroom, talking at inappropriate times or just waiting, doing nothing. Even though their behaviour was not noisy, students were more often not academically engaged in their work as compared to the video lessons. Photographic evidence of the contrast between modes of instruction is provided in Figure 10.

**Table 9**

*Academic Engaged Time (AET) (%) during 15-minute observations*

| *Class* | *Student ID* | *TV (AET %)* | *SV (AET %)* | *LL (AET %)* |
|---|---|---|---|---|
| 1 | 57 | 88 | 96 | 79 |
| 1 | 60 | 87 | 90 | 65 |
| 1 | 37 | 90 | 97 | 83 |
| 1 | 51 | 92 | 83 | 81 |
| 1 | 66 | 86 | 92 | 60 |
| 2 | 31 | 95 | 93 | 83 |
| 2 | 69 | 92 | 92 | 72 |
| 2 | 35 | 94 | 90 | 85 |
| 2 | 10 | 91 | 87 | 41 |
| 2 | 56 | 87 | 88 | 62 |
| 3 | 14 | 90 | 69 | 56 |
| 3 | 16 | 99 | 95 | 53 |
| 3 | 26 | 77 | 78 | 57 |
| 3 | 6 | 100 | 98 | 92 |
| 3 | 45 | 94 | 86 | 74 |
| **TOTAL AVERAGE %** | | **90.8** | **88.9** | **69.5** |

**Class average comparisons between treatments are presented in**

. These show that the Academic Engaged Time percentage (AET%) was consistent for each treatment. Students from all classes were engaged actively in their academic work for an average of 13.5 minutes out of the 15-minute observation during the CBVI lessons. Whereas during the live lesson, this engagement fell to an average of 10.5 minutes, or almost one-third of the observation time being off-task.

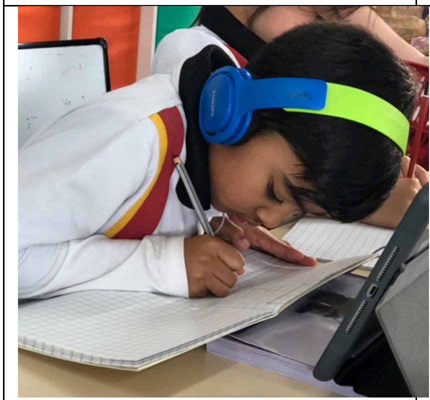
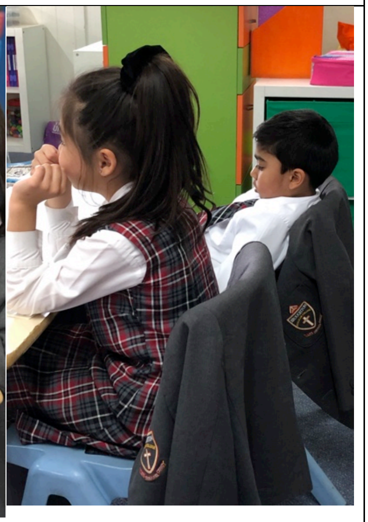
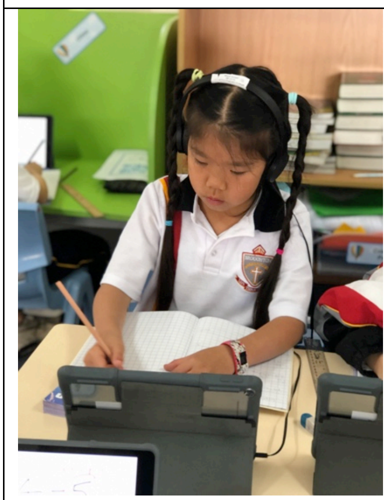
| *TV lesson* | *SV lesson* | *LL lesson* |
|---|---|---|
| <br>Student ID 26–TV (77%) | <br>Student ID 26–SV (78%)<br>Student ID 14-SV (69%) | <br>Student ID 26–LL (53%)<br>Student ID 14-LL (56%) |
| <br>Student ID 51-TV (92%) | <br>Student ID 51-SV (83%) | <br>Student ID 51-LL (81%) |
| <br>Student ID 69-TV (92%) | <br>Student ID 69-SV (92%) |  |

**Figure 10** *Student engagement pictorial comparison between treatments.*

**Table 10**

*Observational averages between classes*

| | *TV (AET%)* | *SV (AET%)* | *LL (AET%)* |
|---|---|---|---|
| **Class 1** | **88.6** | **91.6** | **73.6** |
| **Class 2** | **90** | **91** | **74.4** |
| **Class 3** | **91** | **91.4** | **75.8** |

## 4.2 Qualitative findings – teacher interviews

Two main themes emerged from these interviews:

1) The impact of CBVI for students, and
2) The impact of CBVI on teachers, their teaching and wellbeing.

### 4.2.1 CBVI impact for students

All three teachers spoke positively about the use of CBVI for students in their respective classrooms. Teacher 2 (T2) and Teacher 3 (T3) were familiar with CBVI and had been using it as a pedagogical approach for the past 18 months. It was a new technique for Teacher 1 (T1). She commented that it took a period of adjustment for both herself and her students to be comfortable using videos for instruction:

> *"…it just took, uh maybe a little bit of time of adjustment, and that's normal with anything new that we are faced with, really."(T1)*

**Student Engagement**

All teachers agreed that their students were engaged when using CBVI. T3 was adamant that *"you could tell that they were focused"* and *"you could see the level of concentration, because they were focused solely on their work in their time. You could really see that, that engagement" (T3).* This was reiterated by T2, who attributed the use of headphones to reducing possible distractions and retaining the attention of the student. She also linked their engagement to their ability to have autonomy over their learning.

> *" They're kind of in control of their learning. So, they're doing it at their own pace….this gives them, like, not more of the same, but more um, you know, guidance to complete it, at their level." (T2)*

T1 described the engagement evidence she had witnessed in her classroom while completing CBVI (Figure 11):

> *"I don't see too many distractions going on. I see them, you know, write down, head down, doing their work, they're not um playing around with a pencil" (T1).*

T2 noted that compared to regular lessons, *"there's less time off-task"* for students, while T1, being new to the CBVI experience was amazed that:

> *"…they just sit there, doing their work, they know what they're expected to do and they listen to the instructions and yeah they just carry on with their work."*


**Figure 11** *CBVI behavioural engagement.*

**Student Attitudes**

The teachers reported that their students had mixed perceptions towards CBVI, which was reflected in the student questionnaire. T3 was extremely enthusiastic about her class' reaction to using CBVI: *"they loved the video lesson"*, adding that her students *"loved the fact that they could go at their own pace, and they didn't have to wait for other people to complete questions"*. She also explained that students enjoyed the CBVI because they had the ability to re-watch the instruction if they did not understand, thus saving the embarrassment of *"putting their hand up and admitting that they really didn't understand"(T3).* This class had been the most exposed to CBVI prior to this study and the attitude of this teacher was the most positive towards the pedagogical method.

T2 commented that her class had mixed reactions to using CBVI, although she concluded that *"video-based instruction is really positive, when I teach it in my class"*. She pointed out that the students who were not so enthusiastic were the confident mathematicians who felt that they did not need a video to complete the work.

> *"There are some kids in my class who don't like video-based instruction, but I feel like they still complete the work to a good standard." (T2)*

Overall, T2 felt that students were enthusiastic about CBVI *"… 'cause they love technology"*.

T1 also had mixed reactions to CBVI from students in her classroom, although she attributed this to the self-efficacy of the students using and interacting with the actual video, adjusting to the approach. *"Some of them…adapted to it quite well and they were happy to do it. Others didn't like the notion [of using CBVI]" (T1).* This class had minimal experience with CBVI prior to the study.

**Teacher versus Stranger Voice on CBVI**

The two teachers familiar with CBVI were confident that their own voice on the video was more beneficial and powerful for student learning. T3 clarified this by stating that her students had often told her that they preferred her voice to anyone else's.

> *"I think it does make a little bit of difference…the teacher voice, they have that authority, they know my expectations, and that's something that some of the students had said to me…they knew what I wanted, so they were able to focus on that, and do that." (T3)*

T2 reiterated this:

> *"…they're used to my voice, they're used to my instructions, they're used to the little quirks that I do, when I teach them normally, without a video" (T2)*

She joked that she wished it weren't the case, so that she were able to use other people's CBVI to save her time and effort!

T1, being new to CBVI, was unsure whether the voice used on the video had any affect on her students.

### 4.2.2 CBVI impact for teachers and their teaching

All three teachers were in agreement that CBVI was a positive addition to a teacher's pedagogical toolkit. *"I rave about video-based instruction",* T3 declared, *"I think it's absolutely essential in my classroom now."* T2 was also enthusiastic: *"I think it's, altogether, a good way to teach maths".* T1 concluded her interview with the comment about CBVI: *"I just think it has a place, and should be encouraged in all schools".*

**Lesson design**

The teachers commented that preparing for, and making, the video in a non-pressured environment allowed them to create well designed and thought out lessons, that provided explicitly sequenced instruction for their students. T2 stated:

> *"I've pre-prepared it, I'm organised. Because I've made it, I know the content a little bit better as well"*

She added:

> *"Just because it's on an iPad it doesn't mean that it's not quality. Um, I've created it, it's the same as if I was standing up…"(T2)*

T1 talked about mathematics concepts being difficult for some students to grasp but the explicit, systematic instruction made the learning easier to understand.

> *"…video-based instruction breaks it down for them. It breaks it down into an easy way that they can understand it."*

T3 pointed out that the commercial mathematics program that the school uses was quite an explicit program, complete with detailed lesson plans and scripts for teachers. She did not find it difficult to apply this to CBVI:

> *"You can take what you need, but you can also make it better, whereas if you're direct teaching, it's a lot harder to change things up." (T3)*

**Pacing**

CBVI affected the pacing of lessons, with all teachers commenting that they *"got through our lessons quicker"(T3)* and that the lessons "*flowed a lot better"(T3)* when the video lessons were used, compared with regular live lessons. T3 clarified this:

> *"…a live lesson can take a whole forty-five minute lesson, whereas I find video-based instruction we can get through the lesson in, you know, 20, 25 minutes and that way it allows students that need to be extended, they can get into special projects, special extension work."*

T1 was amazed that CBVI *"… made the children more efficient in their time, completing their work"*. She used the word *"efficient"* in three separate comments about student learning and CBVI.

**Differentiation**

The use of video, allowing students to pause, or re-watch instruction as required was seen as an important benefit of CBVI in offering differentiated opportunities for students.

> *"Students were able to move at a different pace, uh so that actually helped those students that need a bit more help and those students who could move on at a quicker pace um get to more um in-depth sort of instruction."(T3)*

Students themselves enjoyed the freedom that this ability afforded:

> *"…this was the feedback that kept coming back to me from students, was just how much they enjoyed the videos, because they could work at their own pace – if they didn't understand something, they could go back, they didn't have to feel embarrassed about putting their hand up and admitting that they really didn't understand."(T3)*

**Special needs students**

T3 noticed that her three ADHD students remained focused on the CBVI lesson and were able to complete the task requirements.

> *"I found that this was a way they could focus, direct their attention to one thing, it stops them being distracted by things going on around them, um they can't get distracted by other students, and, you know, what other students are doing, so it just helps them to focus."(T3)*

She observed that her two students with socio-emotional needs also benefitted from the CBVI.

> *"The videos seem to give them that confidence to be able to work through things, as – again without having to put their hand up and admit they don't know something, uh for somebody that does have emotional needs, that can be a really positive thing."(T3)*

T2 remarked that her special needs students actually completed the CBVI lessons, which was unusual and an exciting achievement.

> *"…because they have headphones on, they're plugged in, they're engaged, and they're getting that guidance, I guess one-on-one, instead of one-to-twenty four."(T2)*

T1 pointed out that the chance to revisit the instruction and the ability for poor readers to hear the mathematics question read to them helped her low ability students.

> *"…it's verbally given to them, it's wonderful. They can hear it rather than, you know, having to understand the problem themselves by reading it"(T1).*

**Change of role**

Teachers noticed that using CBVI meant that their role changed to one of coach or mentor. They had more time and flexibility to assist individually as required, roam the room to monitor progress and leave behind the expectation to be in control at the front of the class.

> *"It gives me time, to help those that need more help, or differentiate"(T2).*
>
> *"I could go and pay attention to students that really needed help. It just frees you up."(T3).*
>
> *"I found that I could free up my time, you know, quickly finish what I'm doing. I'm very glad to say that I'm able to be more present" (T1).*

This theme of having the time to attend individual students to either provide remediation or extension support recurred throughout all interviews.

**Challenges**

The teachers acknowledged it took out-of-hours time to make the videos, however this wasn't a huge issue for the three teachers.

> *"Really, in comparison to the benefits that students get from them, and the benefits that we have as teachers in the classroom, it's definitely not a negative, the time it takes, 'cause really, it doesn't take that long"(T3).*

Technological constraints proved a greater challenge to the teachers – Internet connectivity and reliability.

> *"The platform that we have used to upload videos can be a bit glitchy, so while the videos themselves haven't been an issue, the, um, platform was."(T3)*
>
> *"Sometimes the technology doesn't work, or sometimes it doesn't save, there's always some problem that happens, with technology. And, sometimes when you upload it, it doesn't work."(T2)*

**Teacher wellbeing**

A substantial theme to emerge from the teacher interviews was one of teacher wellbeing. Using CBVI gave teachers the opportunity to have a mental break from the stress and pressure of the busy teaching day, while still providing a quality lesson for students. The issue of not having a break at recess or lunch times due to playground duty or extra-curricular expectations was raised.

> *"Yeah, it just gives me time to breathe a little bit, and yeah, I can take a bit more time for myself, not being so crazy after duty, like straight away, I can have a bit of time to breathe, and know that they're actually, they're still getting a quality lesson" (T2).*

Using CBVI was also impactful for teachers who had students with behavioural issues, not only to provide a mental break opportunity, but to also afford the chance to address behavioural incidents without the rest of the class listening.

> *"If there is a behaviour issue, I can do that while everyone else is still doing their work"(T2).*

Teachers commented that using CBVI reduced any behavioural management issues in the classroom, due to their high engagement with the technology. This resulted in the teachers being more relaxed and offered an opportunity for calm in the classroom.

> *"I have time to not worry about behaviour issues, or other things, because they're all on-task"(T2).*
>
> *"It's so nice, 'cause the class is like really quiet, and I'm that kind of teacher – I like a quiet classroom, like you know, I like them to be on task"(T1).*

Importantly, CBVI gave teachers the chance to attend to other requirements if needed, making effective use of their time during paid school hours. Teachers felt embarrassed discussing this, as if they would be in trouble for mentioning workload demands and the impact on their own wellbeing.

> *"I dunno if I'm allowed to say this, but it's so good – I feel like I can have time to, you know, possibly mark some other work that I need to mark, um, or you know, send correspondence to something uh important, you know, or even organise myself for the next lesson"(T1).*

The health and wellbeing theme continued into the physical demands of long teaching days and how CBVI assisted with this.

> *"I feel less tense, less stressed. They're able to go on with their task, I'm able to relax a bit too, because I'm not having to deliver the lesson live and – which would take way longer, and it's a bit more stressful, strain on my voice – you know, it's just sometimes, you just need that time"(T1).*

All teachers agreed that CBVI has a place in the primary school classroom in some capacity. They suggested direct instruction activities would be most applicable, such as some literacy and mathematics lessons, used in conjunction with a range of other pedagogical strategies.

> *"Not all the time, but it does have a place in the classroom. I've seen it work in my classroom"(T2).*
>
> *"Maybe not in every lesson, um but definitely in a maths lesson, I think."(T1)*
>
> *"The benefits to the students are phenomenal"(T3).*

A summary of the most common 100 words used by the teachers in their interview is included in Appendix 11.

## 4.3 Other observations

In order to better understand the data in more detail, individual data points were examined in attempts to identify explanations and anomalies. During this process it was noted that individual class results contributed to the overall significance result ($p=0.000$) for the mean improvement in scores for LL, although there were some confounding variables during the treatment that could have impacted these results.

For example, a significant LL result was from Lesson 3, Class 1, where the whole class demonstrated a significant improvement in their score ($p=0.003$). This teacher, T1, was on sick leave during the original scheduled time for the LL, and therefore this lesson was completed on her return to school four days later. The relief teacher covering in her absence was specifically asked not to teach any subtraction lessons during this time, which was adhered to. As previously noted, this LL took place at the same time of day as the previous schedule although the lesson and post-test took about 15 minutes longer than the video lessons. Confounding variables such as the time break between treatments, the longer time of the lesson, or students being happy to have their teacher back after some time away (so therefore potentially being eager to please with a concentrated effort) could have impacted their results. Class 1's average Academic Engaged Time from the behavioural observations for the LL treatment was the lowest of all three classes, 73.6% (see Figure 12) with students visibly disinterested and appearing close to sleep. This was in contrast to the video modes, where the behavioural engagement was 88.6% (TV) and 91.6% (SV), however they showed more academic growth during the LL.

**Figure 12** *Class 1 during the LL treatment.*

The class that completed Lesson 2 as a LL (Class 2), the females scored significantly lower than the males in the pre-test (p=0.022), but then increased their score to reduce this gender gap by the end of the lesson (p=0.763). In the interviews, the Class 2 teacher acknowledged that the females in her class were not strong mathematically, whereas her male students were quite competent and confident. These LL results were anomalous considering the apparent lack of behavioural engagement from students during the LL, particularly for two of the low-achieving females (Academic Engaged Time: Student 10: 41%, Student 56: 62%) who were chatting and playing hand games with each other rather than watching the teacher (see Figure 13). Teacher 2 had to constantly establish behavioural expectations with the class, using comments: *"Just watch [the board]", "pay attention", "Shhhhh, just watch first"* and *"Make sure you're all looking"*.

**Figure 13** *Class 2 females off-task during the LL treatment.*

Student 10 (a teacher-identified low achieving female) scored 0 on both her pre-and post-test during the TV, but 0 then 7 for the LL. Given her 41% engagement time in the LL, this marked improvement in scores is difficult to explain. The same student "strongly agreed" that both the TV and SV helped her with maths, yet she noted "neutral" for the LL. Similar results were for Student 56 (another teacher-identified low achieving female), who also scored 0 on the TV pre- and post-tests, but scored 0 then 6 for the LL tests. These results seem unusual compared to their other low results throughout the experiment, and would have impacted the LMM results for the LL mode. Teacher 2 confirmed that her class had mixed reactions towards CBVI, which was reflected in the student questionnaire as well. She believed her male students thought they were capable enough to complete the textbook without any additional teacher instruction and were frustrated by having to use the videos. Examination of the individual responses in Class 2 highlighted that, generally, the more competent students scoring 7 out of 8 or higher strongly disagreed that videos helped them to learn mathematics.

## 4.4 Summary

This chapter has detailed the results of the data collected from both quantitative and qualitative tools, including the LMM analysis. These results have been summarised in relation to the research questions as follows:

**Research Question 1: What effect does CBVI, compared to traditional face-to-face instruction, have on student learning, attitudes and behaviour?**

Students demonstrated a significant improvement in learning during the traditional face-to-face instruction (LL mode $p=0.000$) although this could be attributed to the confounding variable of additional time taken for both the LL and its post-test as compared to the other modes. The estimated mean for the post-test LL score was 6.399, compared to the TV post-test score of 5.957, meaning students achieved on average 0.442 of a mark higher (out of 8 marks) during the LL treatment. No significant difference in learning achievement was detected between the TV or SV modes of instruction. Students performed slightly higher when completing a LL, and the results of the questionnaire confirmed that 51% preferred a LL to a CBVI one. Behaviourally, students spent considerably more time academically engaged when completing a TV CBVI than LL, on average 90.8% (TV) versus 69.5% (LL). The student preference for LL, and the slightly higher academic performance during the LL treatment were interesting and unexpected results in this study, particularly given the juxtaposition between cognitive engagement and this mode recording the lowest behavioural engagement rates.

**Research Question 2: Does a change in video-creator voice (teacher or stranger) of the CBVI produce a change in student learning, attitudes and behaviour?**

No significant difference in learning achievement was detected between the TV ($p=0.514$) or SV video ($p=0.790$). Approximately 49% of students preferred hearing their teacher's voice on the video rather than a stranger. There were 52% who agreed that hearing the teacher's voice made them interested in completing the video, and 53% reported that the stranger's voice did not affect their work completion. The change in voice did appear to affect student's ability to stay focused on their work. Approximately 53% responded that the teacher's voice helped them to stay focused, compared to 24% for the stranger's voice. Students demonstrated slightly higher behavioural engagement with TV videos (90.8%) than SV (88.9%).

**Research Question 3: How do teachers perceive that different aspects of CBVI influenced classroom activity and their practice?**

The three teachers were positive in their review of using CBVI in their classrooms. These interviews confirmed the student perception and behavioural engagement data and provided additional insights into the use of CBVI to benefit classroom management (both behaviour and academic) and aid teacher wellbeing. Themes such as the creations of explicit, sequenced instructional design, efficient pacing of CBVI lessons, the self-pacing ability for students, and change of role of the teacher emerged as benefits of CBVI in the classroom. The positive impact on teacher wellbeing was an additional theme to originate from the interviews.

# Chapter 5: Discussion and Conclusion

## 5.1 Discussion

The goal of this study was two-fold. First, the study aimed to discover what, if any, differences the mode of delivery of lessons made when using CBVI in a holistic sense, according to cognitive, affective and behavioural impact. A secondary objective was to examine the impact teacher-created video lessons had on the actual teachers themselves, and whether this mode of content delivery was beneficial to include in their 'toolbox' of pedagogical strategies to use in their classroom. The findings challenged some previous results outlined in the literature review, confirmed others, and uncovered perspectives previously unconsidered. The main findings of this study are interpreted and discussed in this chapter. These findings are arranged according to the conceptual dimensions around which the study was framed, namely, student cognition, student affective perceptions, student behaviour, and impact on teachers.

### 5.1.1 Interpretations of cognitive findings

The LMM results found that students had a significant improvement in their learning score during the LL mode ($p=0.000$), yet the improvements in the SV and TV video modes were not significant. This was a surprising result in some respects, with previous experiences and literature indicating that the self-pacing nature of video instruction to allow students to revisit concepts and clarify their understandings in their own time (Chandra, 2007; Odhabi & Nicks-McCaleb, 2009) would result in a more noticeable improvement in learning. Additionally, despite the high behavioural observation scores (AET) for the video lessons, confirming that students were highly engaged while using mobile technologies (Pegrum et al., 2013; Tay, 2016), this did not result in a significant cognitive improvement for the CBVI treatments.

According to the LMM results, the significant improvement for the LL mode was almost one mark ($M=0.978$) out of 8, compared with the slight TV improvement of $M=0.157$ of a mark, and the slight SV decrease of $M=0.063$ of a mark. This could be explained by the longer duration of the LL, which took approximately 15 minutes longer for all classes. The additional time and much slower pace of the live lesson provided time for students to be positively affected by the spacing effect (Sweller et al., 2019), where their working memory had time to rest and recover, thus enabling a higher performance on the post-test than the CBVI lessons. The issue of timing and its possible impact on the results from this study is addressed in the limitation section. The possibility that there was limited improvement in results due to the tests being too easy, as indicated by the high pre-test scores, is also discussed in the limitation section. This indicated students were already able to complete the work.

Overall, however, the mean post-test score for students (M=6.158) was higher than the pre-test score (M=5.805), indicating that some learning took place in this study, albeit minor. It was anticipated that there would be greater growth across all treatment modes, as the lesson scripts were carefully designed in order to optimise cognitive load for students (Sweller et al., 2019) and incorporate Multimedia Learning Theory (Mayer, 2008). Comparing between lessons, the LMM identified a significantly lower mean score for Lesson 3 indicating that this lesson was more difficult than Lesson 1 and Lesson 2. The most likely explanation for this is because it introduced a new subtraction strategy (bridging), whereas the previous lessons used known strategies (jump and split). Lesson 3, being new knowledge, would have required a higher cognitive load and been dependent on mastery of previous strategies. The difference in lesson difficulties demonstrates the challenges of designing different treatments and measures that are sensitively calibrated to one another.

The LMM included eight significant fixed effects, however some of these related specifically to groups of students within a class, therefore the sample size was small, making interpretation difficult. Generally, females showed a significant improvement over the duration of the study ($p=0.004$), however this included all modes. The mean score for males was significantly higher than females ($p=0.032$) indicating that the Year 3 boys were collectively stronger mathematically than the girls. Regardless of the treatment mode, females scored significantly higher in the post-test of Lesson 1 ($p=0.043$), indicating they were focused and engaged at the start of the study. As mentioned in the Results section, including the LikertRating data in the LMM improved the model fit, however it was difficult to draw firm conclusions about the relationship between LikertRatings and performance due to the uneven distributions across the five-point scale and the small sample size.

Other potentially impacting factors could have affected the cognitive results. The anomaly of the high post-test scores of two low-achieving female students in Class 2 during the LL, as well as the interruption to Class 1's treatment schedule due to their teacher being on sick leave, may have influenced results. The timing of the LL for Class 1 being completed the following week may have become a confounding variable. When taken as a whole, the cognitive results based on the LMM analysis were somewhat inconclusive.

### 5.1.2 Interpretation of student affective engagement

The results for student attitude contained a degree of disparity. Overall, students indicated they preferred LL to CBVI, which was confirmed at the conclusion of the actual lessons as well as from the post-experiment questionnaire. Differentiated videos, catering more appropriately to learning needs, could possibly have resulted in more positive student attitudes towards CBVI. Teacher 2 reflected that her high-achieving males were reluctant to use the videos due to their confidence with the content, which was confirmed by their poor Likert ratings of CBVI.

Other considerations could have affected the student responses in their questionnaire. For example, students may have preferred that the LL took longer, and they may have been able to benefit from a spacing effect (Sweller, 2019), by effectively being allowed to "do nothing" while waiting for other students to catch up. With the CBVI, students were required to be on-task and working for a larger proportion of the lesson. It could have been this work pressure expectation compared with the more relaxed LL that students were reflecting on when indicating their affective preferences, rather than the mode of instruction per se. Perhaps navigating the technical requirements of loading, viewing and interacting with the CBVI lessons may have caused additional stress that then impacted their attitudes. Students may also have felt disconnected from their teacher's attention, even though they were in the room with them. These are all areas of possible influence that require future investigation.

The final student questionnaire showed that with the CBVI, when asked specifically whether they preferred the teacher voice to the stranger voice, around half of the students (49%) agreed/ strongly agreed, 42% were neutral, and 9% disagreed /strongly disagreed. Despite preferring the teacher voice, the post-test SV Likert rating indicated students did not feel they were not affected by the SV (53% agreed/ strongly agreed, 31% were neutral) in terms of being able to complete their work. These results showed that the voice used on the CBVI was not a major issue or concern for students. Interestingly, students showed a slight decrease in their learning scores (M=0.063 of a mark out of 8) comparing the pre- and post-test results after the SV treatment, although this was not significant. The rapport of the teacher is an important consideration. Students preferred their teacher rather than a stranger and achieved better academically on average (even though this was not significantly higher). The lesson scripts were designed with rapport-building strategies such as having clear instructions, inclusion of rhetoric questions and praise (Chatham-Carpenter, 2017). Teachers were encouraged to use vocal variety rather than a monotone (Hackman & Walker, 1990). These strategies were also used in the SV video. Students improved in their learning slightly more when hearing their teacher's voice on the video, but decreased slightly in their learning with the stranger, despite identical scripts. Further research would be needed to see if this affect was significant with larger sample sizes and longer duration of treatment. Student interviews could also be used to clarify whether it was just a preference or whether it helped their anxiety levels to hear and know it was their teacher's voice, and this positively affected them. This accords with the Higher Education rapport building strategies research by Kim and Thayne (2015) and its impact on video instruction.

Approximately 69% of students agreed that they liked having the control of the video to pause, re-watch, or adjust the volume as needed. These affordance benefits of using video align with Special Education findings about CBVI (Plavnick et al., 2013; Rayner et al., 2009) and highlight that students like having autonomy with their learning.

It is unclear whether the student questionnaire questions were interpreted correctly or whether the comprehension was confused, potentially because students were filling in the questionnaire without much thought, for instance so that they could go out for playtime. It was unexpected that they preferred the LL to the CBVI, considering the lessons all used the same scripts and the drawn out nature of the LL meant that it was quite a tedious lesson. Also plausible is that the students' attitudes could have been impacted by their own teacher's attitude towards CBVI. Class 3 responded most favourably about using CBVI and their teacher was the most enthusiastic about the pedagogical approach. This supports research about self-efficacy with technology, and the internal barriers of a teacher that can impact on their students (Bower, 2017; Minshew & Anderson, 2015; Penuel, 2006). Overall, however, 40% of students agreed that the videos helped them learn maths, 31% were neutral and 29% disagreed. Future research could use student interviews to better understand the reasons for student perceptions, for instance, disagreement because students already knew the work.

### 5.1.3 Interpretations of student behavioural engagement

The difference in Academic Engaged Time (AET) between the videos and the normal LL was marked. The use of headphones reduced distractions and assisted students to remain focused on the screen and the required task. Although only five students per class were officially observed, this was the norm for the remainder of the class as well. This impressive engagement level mirrored the research by Tay (2016), and Pegrum et al. (2013). Students seemed eager to use their iPads for CBVI and were highly engaged behaviourally when using the videos (TV 90.8%, SV 88.9%). It was in some respects surprising that this enthusiasm was not reflected in their questionnaire, however it could be because they found the topic uninteresting.

The high behavioural observation scores correlated with teacher observations of increased on-task behaviour of students, high engagement with the video and improved work completion as noted in the teacher interviews. The positive comments from the teachers about the reduced behaviour management issues and the class being calm and completing their work efficiently when using CBVI provides additional evidence for the viability of this method in the classroom. This challenged Johnson's (2017) findings on the negative impact on student behaviour while using mobile devices.

During the live lessons, teachers had to continually remind students of the behavioural expectations, whereas the researcher did not observe this during the video lessons. The instructions were clearly stated on the video and students had the ability to pause and rewind to gain clarification if needed. In the interviews, the teachers noted the difference this high student behavioural engagement made to their own wellbeing, in terms of less vocal strain and voice use, and feeling calmer due to students being more independent and on-task. This reflects the Special Education literature about the implications and benefits for the teacher of CBVI (Rayner et al., 2009; Weng et al., 2014).

### 5.1.4 Teacher perception of using CBVI

Two major themes emerged from the teacher interviews about using CBVI in the classroom: 1) the benefits for the students and 2) the benefits for the teacher. The three teachers were positive about the use of teacher-created CBVI in their classroom and identified advantages for students such as focused, increased engagement, being able to provide differentiated content to groups or individuals and using a method of instruction that could be accessed and used by a diverse range of learners. By using CBVI, students were given the autonomy to self-pace their own learning with the security of the teacher present in the classroom to be able to ask for clarification or additional help if needed. An additional theme of using CBVI as a tool to assist teachers became evident throughout all three interviews. Teacher-created CBVI changed the way the teachers could use their time within the classroom and allowed them to morph their role into one of a coach. It facilitated the ability to: address any student concerns individually (including behavioural problems from break times), provide additional one-on-one teaching time while the class was occupied, minimise behavioural problems due to increased student engagement therefore modifying the classroom dynamics and environment, personalise learning content, reduce interruptions to lessons and provide detailed, well-planned direct instruction for challenging content.

It was beneficial to interview the teachers about their perceptions, not only of the impact of the CBVI in the classroom, but their reactions to creating explicit, systematic instruction. They were proud of their instructions, with all of them commenting about the benefit of clear, sequential teaching as noted by Stockard et al. (2018) and Hattie (2009). The teachers were positive about the use of CBVI in the classroom. The researcher had to explicitly prompt them at the end of the questions about any challenges or concerns they had, because the feedback appeared too favourable. Even then, the challenges were about technicalities of the video sharing and accessing - external barriers that are commonly mentioned in the educational technology literature (Bower, 2017; Minshew & Anderson, 2015) – rather than issues with the means of instruction.

Issues around teacher wellbeing and health that emerged from the interviews were unexpected, and is an area that deserves further exploration and research. If using CBVI can be designed to produce learning results from students that are similar to a usual LL, then this method of instruction could afford teachers small amounts of time to regroup and regain their own mental health during the school day.

## 5.2 Implications for Practice

This study highlights a number of implications for the regular primary school classroom. Teacher-created CBVI needs to be pitched appropriately for the learning needs of students in order to promote learning gains. Teachers would have a more appropriate idea of the learning needs of their own class. Further gains may consequently be achieved by creating differentiated videos that catered for the range of learning needs found in their classroom.

Potentially strong benefits of CBVI, identified by the teachers, include effective pacing of the CBVI lessons and the ability for students to control the pace of their learning. Students concurred, strongly indicating that they liked the ability to pause the video, re-watch parts that were unclear, and manipulate the volume. This promoted independence in students and less reliance on adult assistance, particularly for students with additional needs or socio-emotional issues. Teachers also identified that CBVI gave them the ability to choose what to do with their time, whether that be to provide individual guidance, or have time to complete other tasks. It enabled them to change into a coach role, while being reassured that their students were completing a quality lesson. This has important implications for regular primary school teachers who have a variety of learning needs and special needs integrated in their classes. Specific video creation has the potential to aid instructional differentiation and assist teachers by providing opportunities to cater for a range of learning needs.

Improved behaviour management is another important implication resulting from this study. The on-task behaviour while completing the CBVI was impressive and has the potential to be used in the primary school classroom to complete instructional lessons efficiently and quietly. The use of headphones reduced outside distractions for students, which has implications for regular primary teachers struggling with ASD or other easily distracted students. CBVI could be a way of providing a calm, controlled environment for learning even for a short time.

Results from this study indicated that the teacher's voice is more conducive to rapport building with students, and preferred by students, but not necessarily for advancing cognitive gains. The implication is that it would be of more benefit to create their own videos for their class in terms of improving the rapport that students experience, and teachers would therefore have to be confident with the technical components of video making and sharing. This would also necessitate creating the video in personal time.

Finally, an implication for teachers is that using CBVI as a pedagogical approach could possibly afford both physical and mental health benefits. It provides a strategy to enable voice rest and avoid vocal strain. CBVI can create time for teachers to take a mental break from the busy demands of a class, particularly after transitions between activities and locations, at no expense to student learning.

## 5.3 Limitations and Future Research

The results of this study raised some key questions regarding factors that could have influenced student achievement and issues that could be addressed in future studies. These questions include:

1) Would student achievement and perception results for CBVI change if the lessons were academically differentiated?
2) Did the longer lesson time for the LL influence the post-test results?
3) Would an independent commercialised standardised pre/post-test have shown different learning growth for students?
4) Would a longer time frame and a larger sample size for the study affect test results?
5) How does CBVI impact teacher wellbeing?

Each of these will be discussed in turn below.

**1) Content differentiation in lessons**

Due to the restricted scope and time frame of this project, the lessons created were not academically differentiated for students. Further research is necessary to discover whether student learning (and attitudes) would change if the lessons were differentiated to suit leaning needs. The pre-test results, scored out of a possible 8 marks, were high (*M=5.8, Std. Error 0.28, df 55.71, lower 95: 5.24, upper 95: 6.36)* which meant that if students were already scoring highly in the pre-test, there was limited ability to demonstrate learning growth in the post-test. This will be further discussed in point 3. If the work were too easy for many of the students, as demonstrated by a high pre-test score, perhaps this affected their attitude towards the mode of delivery of the lesson. Their attitudinal results may be attributed to the fact that they had to listen to, and complete, content they already knew. Further investigation is needed to discover whether their attitude towards CBVI would change if they felt that the content was more useful to them.

As this study did not have the scope to allow differentiated lessons to be created to cater for remediation, core and extension learners, from a Cognitive Load Theory (CLT) perspective, perhaps the working memory of low achieving students was overloaded (as seen by the low results on both pre- and post-testing - see Appendix 9), whereas the capable students had already achieved well on the pre-test, and therefore learning growth was not effectively captured because the post-test was also out of only 8 marks.

There are a number of other possible explanations as to why students did not show a greater improvement in their post-test results, which could be investigated in future studies. Over-confidence could have constrained the level of increase in post-test results, with students generally not moving to a higher score of 8 out of 8. Or, students may have understood the concept quite readily at pre- and post-testing, but did not score full marks due to careless mistakes (which can be hard for students to self-correct in a short time frame). Alternatively, students may have rushed the post-test in order to be released for recess or lunch (discussed further in point 2). The testing effect (familiarity with the testing instrument – due to the same pre- and post-test used) and regression effect (the tendency for very high pre-test scores to become lower in the post-test) could also have impacted the learning achievement of students in this study (Johnson, 2017). If this study was replicated, then it would be advisable to specify the duration of lessons and also include a specific time allocation for the post-test to be completed in order to minimise these concerns and avoid time becoming a confounding variable. A more comprehensive study that acknowledged prior knowledge levels of students, which is a key criteria in Cognitive Load Theory (Sweller, 2019) not just by pre-testing, but by delivering differentiated content lessons is recommended.

**2) Lesson length variations**

Time was a factor that potentially influenced results in this study. The CBVI lessons took less time than the LL to complete, whereas all the LL treatments took extra time (approximately 15 minutes for each lesson). Due to the naturalistic setting of this study, it was not possible for the researcher to control for duration of lesson, as the teacher was ultimately directing this without intervention from the researcher. During the study, all the teachers completed the full script of the LL. This was achievable because the LL's were scheduled at the start of the 1½-hour morning teaching block, so a longer duration was possible. This meant that the post-test was completed under less time pressure than other lessons that had a strict 45-minute time frame.

Contrastingly, due to the Year 3 timetable schedule, some of the CBVI lessons were only allocated a 45-minutes duration, before the recess break. This meant that the CBVI post-tests were completed hastily, as the bell had gone for break times and students wanted to go outside to play. The teachers required students to complete the tests before going, but it was obvious from classroom observations that students were rushing the test and anxious to leave, rather than completing the post-test in a calm, focused test environment. It would be interesting to see whether the results for the treatment modes changed if the duration of the lessons was constant. In hindsight, the time spent on the pre-test completion, the lesson completion, and the post-test completion should have been clearly stipulated and these timings adhered to for all lessons. Future investigations would ideally aim to control and standardise lesson durations.

**3) Choice of Pre/Post-testing instrument**

The school advised the researcher to use the pre- and post-testing material that was included as part of the school's commercial mathematics program, so that this study would not impact the scope and sequence of Mathematics for Year 3. After investigation and consultation with the Year 3 teachers, it was trusted that these pre and post-tests would be suitable for participants. In hindsight, students' scored quite highly on the pre-tests (see point 1), which indicated many already knew the mathematical content. Thus, limited growth could be seen with this study as they had already scored quite well on the pre-test. The ability level of students prior to conducting a study is difficult for the researcher to know in advance, beyond the advice of the participating teachers. A commercial standardised test perhaps would have more evenly distributed student ability and highlighted growth more discernably and would be recommended to be a consideration for future studies.

**4) Longer study duration and larger sample size**

Due to the limited nature of this project, only three mathematics lessons were covered. This meant that there was only a small amount of time for significant effects to be detected. Measuring the mathematical growth of students for an entire unit of lessons, or a much longer time frame, may have meant that the impact of CBVI on achievement was more easily distinguished. Additionally, a larger sample size could provide opportunities to compare and clarify findings, particularly for the behavioural observations. The small sample size (5 students per class) is acknowledged as a limitation for this aspect of the study.

**5) Teacher wellbeing**

Examination of teacher wellbeing issues, in terms of how CBVI could positively impact workload demands, teacher mental health and voice preservation emerged as a pertinent result from the teacher interview data. This was an unforseen dimension to the study that is worthy of further investigation in future studies.

## 5.4 Concluding comments

Teacher-created CBVI has been a somewhat overlooked pedagogical approach in the regular primary school classroom. With the omnipresence of technologies, particularly mobile technologies, in classrooms, teachers have ready access to simple video creation apps and have devices capable for student viewing. CBVI allows the teacher to design and make specific, explicit instruction tailored to their own students' needs. It affords teachers the opportunity to be present during the video delivery, thus enabling students to have live instructional interaction if needed, but simultaneously granting the teacher the ability to support individual students as required. Explicit instruction through the mode of video aims to optimise the cognitive load of students and maximise the process of schema creation for long-term retention. The use of headphones aims to reduce distractions for students and maintain student attention, particular with the self-pacing and control that video fosters.

The results of this study were unexpected, with the LL recording a significant result for student learning growth. When the estimated means for post-test scores were compared however, they were close for all modes (LL: 6.399, SV: 6.096 & TV: 5.957), with a maximum difference of 0.442 of a mark. Replication or further research is needed to determine whether the outlined influencing factors of a longer lesson time for LL, or rushing the post-test completion in the video modes had any confounding effect in this study. Conducting student interviews would help to better understand the reasons for student preferences and performance.

The impact and benefits of using CBVI as a strategy in the primary school classroom were clearly visible during this study. Students were highly engaged behaviourally when accessing the videos and teachers noted the benefits and consequences of this: that they had the ability to address individual concerns with students, prepare other lessons, address administration matters or just regroup after playground duty. Teachers were also proud of the detailed, considered, sequential lessons they had made for their students. These considerations positively affected the teachers' wellbeing and exposed a previously unconsidered area of research that deserves further investigation. Student engagement was noticeably higher during video lessons than the live lessons. In combination, the results from this study indicate that teacher-created CBVI deserves consideration for inclusion in the teacher’s toolbox, and also warrants further research to better understand how to best design and implement this pedagogical approach.

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# Appendices

## Appendix 1. Ethics approval letter

Human Sciences Ethics Subcommittee
Macquarie University, North Ryde
NSW 2109, Australia

MACQUARIE
University

01/05/2019

Dear Associate Professor Bower,

**Reference No: 5201952748520**
**Project ID: 5274**
**Title: Computer-Based Video Instruction for Mathematics in the Primary School Classroom**

Thank you for submitting the above application for ethical review. The Human Sciences Subcommittee has considered your application.

I am pleased to advise that ethical approval has been granted for this project to be conducted by Associate Professor Matthew Bower, and other personnel: Mrs Jodie Torrington.

This research meets the requirements set out in the National Statement on Ethical Conduct in Human Research 2007, (updated July 2018).

**Standard Conditions of Approval:**

1. Continuing compliance with the requirements of the National Statement, available from the following website: https://nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2007-updated-2018.
2. This approval is valid for five (5) years, subject to the submisson of annual reports. Please submit your reports on the anniversary of the approval for this protocol. You will be sent an automatic reminder email one week from the due date to remind you of your reporting responsibilities.
3. All adverse events, including unforeseen events, which might affect the continued ethical acceptability of the project, must be reported to the subcommittee within 72 hours.
4. All proposed changes to the project and associated documents must be submitted to the subcommittee for review and approval before implementation. Changes can be made via the Human Research Ethics Management System.

The HREC Terms of Reference and Standard Operating Procedures are available from the Research Services website: https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics.

It is the responsibility of the Chief Investigator to retain a copy of all documentation related to this project and to forward a copy of this approval letter to all personnel listed on the project.

Should you have any queries regarding your project, please contact the Faculty Ethics Officer.

The Human Sciences Subcommittee wishes you every success in your research.

Yours sincerely,

Dr Naomi Sweller

Chair, Human Sciences Ethics Subcommittee

*The Faculty Ethics Subcommittees at Macquarie University operate in accordance with the National Statement on Ethical Conduct in Human Research 2007, (updated July 2018), [Section 5.2.22].*

## Appendix 2. Cognitive Load Theory principles

Cognitive Load Theory is summarised by five overarching principles:

1) *Long-term memory and the information store principle.* [Information for human cognition is stored in long-term memory.]
2) *Schema theory and the borrowing and reorganizing principle.* [Humans create schema to organise information. Through listening or reading, we can borrow schemas from others although these can be reorganized according to our individual long-term memory, resulting in changes being made.]
3) *Problem solving and the randomness as genesis principle.* [This is used when new knowledge is needed but unavailable in our own or others long-term memories. Humans problem solve using a random cause and effect process, creating new knowledge.]
4) *Working memory and the narrow limits of change principle.* [Working memory is limited in both capacity and duration in order to allow the problem solving space, where new information is processed and reorganized, to be manageable.]
5) *Long-term working memory and the environmental organising and linking principle.* [Working memory is only limited when handling new information. It is able to incorporate extensive amounts of retrieved information from long-term memory, which reduces the strain on working memory.] (Wong et al., 2012)

Identified cognitive load effects that inform the effective design of instruction are:

- *Goal-Free Effect* - No specified end goal is provided to the learner, rather the focus is on solutions.
- *Worked Example Effect* - Full solutions to problems are provided to learners to aid knowledge construction.
- *Completion Problem Effect* - Learners complete partially solved problems using their worked example knowledge.
- *Split-Attention Effect* - Learners have to integrate two sources of information (e.g. diagram and solution) and this is best achieved when both sources are integrated and therefore presented together.

- *Redundancy Effect* - Reducing the effort of processing two sources of information that may be actually providing the same information.
- *Variability Effect* - Varying the complexity of the intrinsic cognitive load to encourage learners to develop more general knowledge.
- *Modality Effect* - Working Memory is able to process both auditory and visual information and is even more effective when both auditory and visual information is presented simultaneously (Sweller et al., 2019).

Sweller's latest research (2019) added additional effects, included as a result of ongoing research studies that could have direct relevance to video instruction creation and use. These are:

- *Transient Effect* [If many elements need to be processed together in working memory (element interactivity), this information should be presented in a permanent form (eg. text) or given in smaller chunks.]
- *Expertise Reversal and Element Interactivity Effect* [Instructional procedures should change depending on level of expertise. The needs of novel and expert learners differ.]
- *Working Memory Depletion Effect (or the Spacing Effect)* [Working memory fatigues with use and recovers after rest.]

## Appendix 3. Participant Information and Consent Form

Department of Educational Studies
Faculty of Human Sciences
MACQUARIE UNIVERSITY NSW 2109

Phone: +61 (02) 9850 8626
Fax: +61 (02) 9850 8674
Email: matt.bower@mq.edu.au

**Participant Information and Consent Form**

**Research Project Title:** *The Impact of Teacher-Created Personalised Video Instruction.*

**Chief Investigator:** Associate Professor Matt Bower

Dear Parent/Caregiver,

Your child is invited to participate in a study of Teacher-Created Video Instruction for Mathematics in the Primary School Classroom. The purpose of the study is to investigate the effect that teacher-created computer-based video instruction using iPads in mathematics lessons has on learning, behaviour and attitudes in the primary school. This study aims to provide evidence to formalise the work that Mrs Jodie Torrington (former Year 3 teacher) has been doing previously at the college (2016-2018) regarding custom-made, teacher-created video instruction.

This study is being conducted by Mrs Jodie Torrington to meet the requirements for the degree of Master of Research under the supervision of Associate Professor Matt Bower, Department of Educational Studies, Faculty of Human Sciences, Macquarie University, Tel: +61 2 9850 8626, Email: matt.bower@mq.edu.au.

If you decide to allow your child to participate, they will complete four 45-minute mathematics lessons with their class, as part of their regular weekly mathematics program. Students will be required to: complete testing of their subtraction strategies, both before and after all lessons; complete two normal lessons with their class teacher and two using teacher-created video instruction and; complete a brief questionnaire regarding their attitudes and feelings about all lessons. Students will not be required to undertake any additional lessons other than those they would normally take for the topic being studied (subtraction).

Video cameras will be set up to record 10 randomly selected students from each Year 3 class for the four lessons. The researcher will use a checklist to observe the behaviour of the selected students over a 15 minute time period per lesson. Behaviours such as whether students are focused on the video, completing set work, and interacting with the screen (pressing pause as required, re-watching sections) will be noted. Video recording enables the observations to be conducted at a later time and will not be used for any other purpose. You can choose below whether or not you are willing for your child to participate in this aspect of the study.

Photographs may also be taken during these lessons, and you can choose below whether or not you are willing to have any photos of your child made available in publications, presentations and on websites.

This study is considered 'low-risk research', where the only foreseeable risk is one of discomfort. The mathematical content is based on the Year 3 prescribed textbook and the class teacher will be present throughout the study. Year 3 students are familiar with using iPads, including accessing teacher-created video instruction.

Any information or personal details gathered in the course of the study are confidential, except as required by law. No individual will be identified in any publication of the results. The chief investigator and Mrs Torrington will be the only ones with access to the data. Collected physical data (consent forms, information, topic tests and questionnaires) will be secured in a locked cabinet only accessible to the research team. Digital data (video observation recordings) will be stored on password protected computers and servers, only accessible to the research team. Data will be kept for five years before being destroyed. Parents will be presented with a summarised poster of results that outlines the study findings in November. Parents will also be able to access the final thesis on request from either the Headmaster or the Chief Investigator.
***Participation in this study is entirely voluntary: your child is not obliged to participate and if you decide to allow your child to participate, you are free to withdraw them at any time without having to give a reason and without consequence. Not taking part in this study will not affect your child's marks or access to their usual education.***

**Please complete the following form and arrange for it to be returned to the school office or your child's teacher:**

| | | |
|---|---|---|
| I have read and understand the information above and any questions I have asked have been answered to my satisfaction. I have discussed participation in the project with my child and they are willing to take part. I understand that the lessons will be video recorded for analysis purposes, but that my child's name or any identifying information will not be used in the final thesis. I know that my child can stop participating in the research at any time without affecting their education. I have been given a copy of this form to keep. | ☐Yes | ☐No |
| I am willing for my child to participate in this study. | ☐Yes | ☐No |
| I am willing to have my child's image appear in photographs relating to this study, such as in publications, presentations or websites. | ☐Yes | ☐No |
| I am willing for my child to be selected for behavioural observations during each lesson. I understand the lessons will be recorded, and that only the researchers will have access to | ☐Yes | ☐No |

these recordings, and that they will only use these recordings to code children's behaviour.

Parent's/Caregiver's Name:_______________________________________
(Block letters)

Parent's/Caregiver's Signature:______________ Date:_________________

Participating child's name: _____________Age: _________

Participating child's teacher: ________________________

Investigator's Name: Matt Bower
(Block letters)

Investigator's Signature: Date: 11/6/19

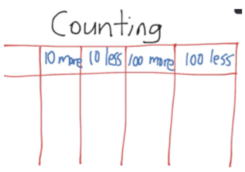
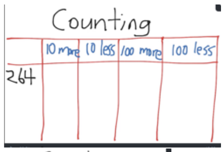
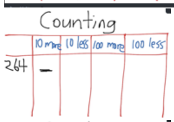
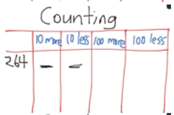
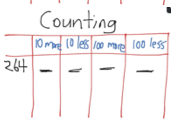
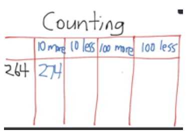
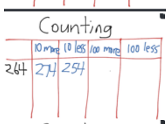
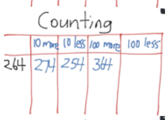
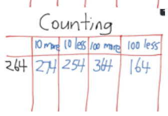
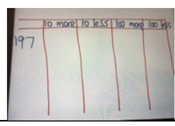
The ethical aspects of this study have been approved by the Macquarie University Human Research Ethics Committee. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Director, Research Ethics & Integrity (telephone (02) 9850 7854; email ethics@mq.edu.au). Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

**(PARTICIPANT'S COPY)**

## Appendix 4. Lesson Scripts

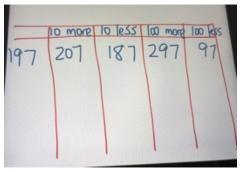
**<u>Lesson 1 CBVI script (Unit 6.2 in the Year 3 Stepping Stones program)</u>**

*Outcomes: MA2-5NA, MA2-1WM. Use strategies (jump and split) to subtract two- and three-digit numbers (without bridging).*

| ***Script*** | ***Shown on screen (or on whiteboard if live lesson)*** |
|---|---|
| Hi!<br>Before we get started on our Origo textbook today, we're going to have some practice counting from given numbers.<br>So, I would like you to look at this table that I have already drawn, and I would like *you* to draw this table in your little grid book. You need to rule the lines – you need 5 columns, and you need to write the same headings that I've written. Press pause and rule yourself this table. |  |
| OK, now that you've ruled the columns, the first number is going to be 264. So write that over on this very first column *(write 264 on screen in first column)*.<br>I want you to fill in the answers – What's ten more than 264? Write it in *this* column *(underline in the column)* |  |
| What's ten less? (If I took away a ten?) Write it in *this* column *(underline in the column)*. |  |
| What's 100 more than 264? Write the answer *there (underline in the column)*. |  |
| And what's 100 less than 264? Write the answer *there (underline in the column)*. |  |
| Press pause, and do that now. |  |
| OK, so you should have written in the answers – let's see if you're on the right track.<br>10 more is 2**7**4 *(write this in the column)*. Give yourself a little tick if you got that. | |
| 10 less is 2**5**4 *(write this in the column)*. Tick. | |
| 100 more – it's not **2**64, it's going to be… **3**64 *(write this in the column)*. |  |
| And what's 100 less than the first number? It's **1**64 *(write this in the column)*.<br>Press pause and give yourself a tick if you got that. |  |
| OK, the next number you're going to write in your book is **197** *(write this in the column)*. Write the number, press pause, then fill in the answers. |  |
| OK, so you would have got: 197 – what's 10 more? Yes, that's right: 2**0**7 *(write this in the column)*. I was trying to trick you a bit there. |  |
| What's 10 less than 197? Remember, we're going from the *starting* number.<br>It's 1**8**7 *(write this in the column)*. Give yourself a tick if you got that. |  |

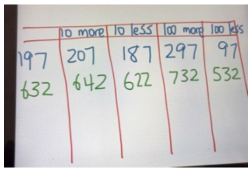
What's 100 more? **2**97 *(write this in the column)*.

And 100 less is..? Just 97 *(write this in the column)*. I hope that you're on the right track with this counting.




The next number is **632.** Write that number in your column. Work out: 10 more, 10 less, 100 more and 100 less. Press pause and do this.

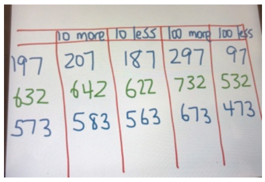
OK – **632** *(write this in the column like above)*.
10 more is 6**4**2 *(write this in the column)*. 10 less is 6**2**2 *(write this in the column)*. 100 more is **7**32- the other numbers don't change because we're only talking about the hundreds place *(write this in the column)*. 100 less – **5**32 *(write this in the column)*. Tick your answers – I hope you're going well.



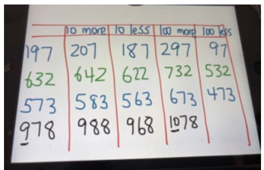

The next number is **573** *(write this in the column)*. Press pause and do the answers yourself first before you check.

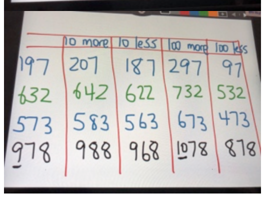
OK – **573:** 10 more is...5**8**3 *(write this in the column)*. 10 less is... 5**6**3 *(write this in the column)*. 100 more? **6**73. 100 less? **4**73. Good. How are you going? I want to see beautiful neat work in your grid book. I want to see that you can do this with no fuss and no problems whatsoever.

The last one is **978** *(write this in the column)*. Write that in your column, press pause, and do the answers.



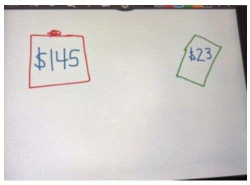

**978** *(write this in the column)*. 10 more? 9**8**8. 10 less? 9**6**8 *(write this in the column)*. 100 more? Mmmm, here's a trick! That's right – one thousand and seventy eight (1078). See it's a 9 there *(underline the 9 in the start column)*, yet it looks like a 10 there *(underline the 10 in the 100 more column)*?
100 less? **8**78 *(write this in the column)*.



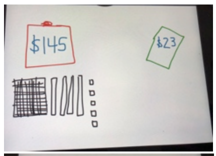

This lesson is all about *subtraction*, or *take-away*. When we subtract a number, we find out the *difference* – the *difference* between the original number and the number you subtracted. What's the missing piece of the puzzle?
Let's say I had $145 in my wallet and I wanted to buy a game for $23. How much money will I have left in my wallet? What will the *difference* be? What would you do to work this out?

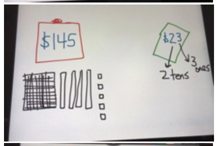
There are two main ways we want you to practice to work this out.
The first way is the *place value* way.
If I have $145 *(write this on screen)* - here is what $145 looks like in blocks *(draw in blocks)* and I buy a game for $23 *(write this on screen)* – that's 2 tens and 3 ones *(write this on screen).* Here's the tens here *(circle the 4 in $145)*, so you take away 2 tens, so it's going to be $125 *(write this on screen and also cross off 2 tens from block drawing),* and then you take away 3 of the ones *(circle the 5 in $145 and also cross off 3 of the ones blocks)*. What's the answer going to be? What are you *left* with? **$122**
That's the *place value* way, where you look at the different *places* of the numbers. Press pause and write the place value way in your book.

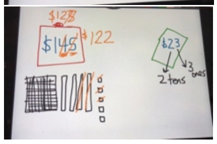



Or, you could rule yourself a *number line* and work it out that way. *(Draw a number line on screen)*
Choose a spot – remember we are subtracting (or taking away), so you need

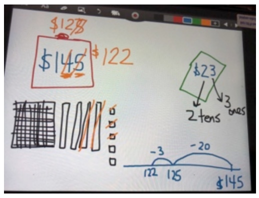
to start on the right-hand side. Draw a starting little line and call it $145. We're taking away the cost of the game I buy, which is $23. Firstly, I take away 20 *(draw the jump on the number line)* – what you I land on? That's right – 125. Then take away 3 *(draw the jump on the number line)*- 122. Remember you have to tell us what you jumped back, so that we can work out what you've done in your grid book. Instead of jumping back 3, you could jump back in ones (1-2-3) *(draw the jumps on the number line)*, and instead of jumping back the 20, you could jump back two lots of 10 *(draw the jumps on the number line)*, if that makes it easier for you. That's fine. Does it give you the same answer? Yes, it will give you the same answer. It doesn't matter whether you jump one whole big jump of 20, or jump back two lots of ten – two lots of ten (10, 10 *(draw the jumps on the number line)*): is that still 20? Yes. You do it the way you feel happiest with, as long as you get the right answer.



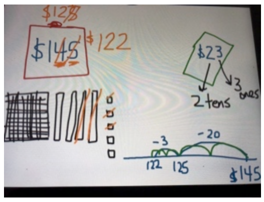




You can see both ways have given us the answer $122 (remember to put the dollar sign – we're talking dollars in this problem, so you need the dollar sign). Press pause and write the number line way in your book.



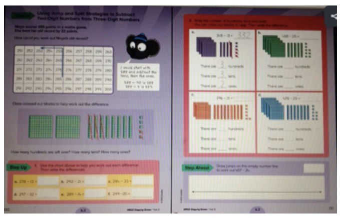

Now you need to open your Origo book to 6.2 on page 130.

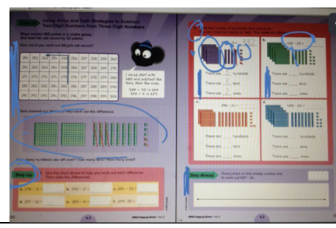
They are showing you at the start that you can either count *back* on the number chart *(circle)* or you can cross of the blocks *(circle)*. That's the *place value* way that we did before, crossing off some tens *(circle)*, crossing off some ones *(circle)*. It doesn't really matter what strategy you choose – place value or number line – as long as you are careful and don't rush. You don't want to make silly mistakes!




Start at the Step Up *(circle)*. Use the chart above *(circle)* if you need it, or just do the place value way in your head. Complete those, then go to number 2 *(circle)*. They show the actual blocks for you, cross off the number that's being taken away, and then write the answer. Underneath, they have written the answer – there are 3 hundreds left *(circle)*, there are 3 tens left *(circle)* and there are 2 ones left *(circle)*. So, do the take-away *(circle)*, cross out the blocks *(circle)*, and then write the answer – what's left *(circle)*? There's just one number line questions for the step ahead *(circle)*.

Good luck – don't rush. Make sure you are careful with your subtraction. When you have finished 6.2, then you can go straight on to Studyladder while you wait for everyone to finish.





| | |
|---|---|
| *After the class has finished the Origo page:*<br><br>Close the iPads. Hand out the post-test to complete silently.<br><br>Bring the class down to the floor with their book and a pencil to mark. Project 6.2 answers so that they can self-mark. Ask students to reflect on how well they used each strategy. Which strategy did they prefer? Why? | |

**<u>Lesson 2 CBVI script (Unit 6.3 in the Year 3 Stepping Stones program)</u>**

*Outcomes: MA2-5NA, MA2-1WM. Use strategies (jump and split) to subtract three-digit numbers (without bridging).*

<table>
<tr><th>Script</th><th>Shown on screen (or on whiteboard if live lesson)</th></tr>
<tr><td>
Hi!<br>
We're going to do some counting practice again in your grid book. This time, I just want you to draw three columns – just like mine. Press pause and rule that now.<br><br>
The first number is 312. I want you to write the number that is 100 less in this column (underline), and write the number that is 200 less than 312 (the original starting number) in this column (underline). Press pause and do that now.<br><br>
Did you get: 100 less (212)(write in column), 200 less (112) (write in column)? Give your self little ticks – make sure they're neat little ticks!<br><br>
I'm going to write the next four starting numbers. 534, 826, 295 and 694 (write in column). Press pause and work out the answers.<br><br>
Let's check you got them correct (write answers in correct columns).<br>
534: 100 less is 434, 200 less is 334.<br>
826: 100 less is 726, 200 less is 626.<br>
295: 100 less is 195, 200 less is just 95 – you've taken away all the hundreds.<br>
694: 100 less is 594, 200 less is 494.<br>
How did you go with those? Are there lots of ticks because you got them right? I hope so!<br><br>
Now I want you to practice both of the strategies that we used yesterday to subtract numbers and find the difference (what's left at the end – the answer). In your grid book, I want you to rule two columns and write the headings just like mine (Place Value, Number Line). Press pause and do that now.<br><br>
Jordan has $279 and he wants to buy a new bike that costs $152. How much money will Jordan have left if he buys the bike?<br>
I'm going to show you the blocks – there's 2 hundreds (circle), 7 tens (circle) and 9 ones (circle) – so that's 279 – the amount of money Jordan has (erase the circling).
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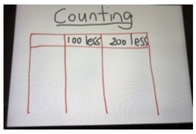
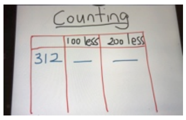
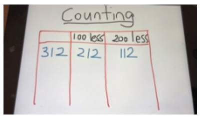
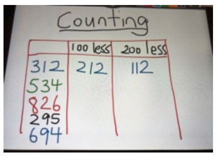
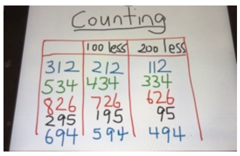
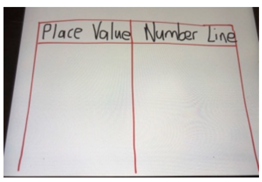






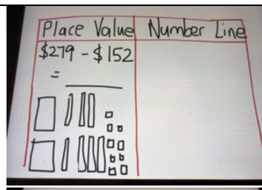


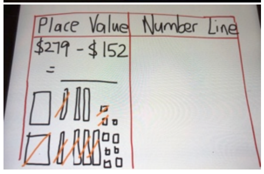




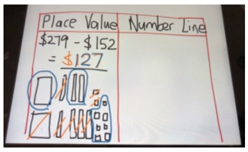
</td></tr>
</table>

Firstly let's do the place value way:
The bike costs $152, so I'm going to cross off 1 of the hundreds *(cross off 1)*, 50 – so that's *5 tens* *(cross off 5)* and 2 ones *(cross off 2)*. Let's do this just with the numbers: $279 – cross off 1 hundred, 5 tens, and 2 ones – do we have enough in each place to take away? Yes. What are we left with? $127
Press pause and write this in your book.

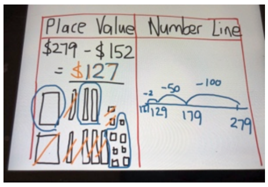



Do you remember the other strategy? Yes, the number line.
Rule a number line *(draw number line)* – you can press pause and do this. Draw a little stripe and call it 279. That's the amount Jordan started with *before* he spent anything. First, jump back 100 *(draw)*. Remember you need to label what you have jumped back. Where do we land? 179. Write this on. Then jump back the 50 *(draw)*. You can do it in one big jump, or 5 lots of 10 – that still equals 50. Where do we land? 129.

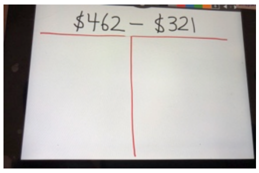



Lastly, jump back the ones – we have to jump back 2 ones *(draw)*. What is the number that we land on? 127. Just do a last check – have you taken away the hundreds (yes), the tens (yes) and the ones (yes). Have I forgotten anything? It's really good to ask yourself this before just rushing on to the next question. You need to make sure you're careful and correct when you're doing subtraction.

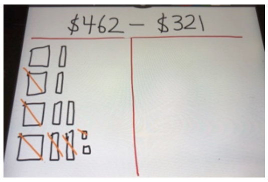



The next question is this: I had $462 and I paid $321 for a holiday. How much money do I have left?
I want you to do this in your book *both* ways: the place value way (you can look at the blocks to help) and also the number line way. Press pause and work it out.

Using the blocks, you should have crossed off 3 hundreds *(cross)*, 2 tens *(cross)* and 1 one *(cross)* because that's what we're taking away from the big number. When I write it, it should look like this: $462 - $321 = _____.
$462: cross out the 4 hundreds, there's only 1 left *(cross)*, cross off the tens, now there's only 4 left because I took 2 away *(cross)*, and finally cross off the ones (I took away 1), so there should be 1 left *(cross)*. What number if left? $141
Did you write that in your book?

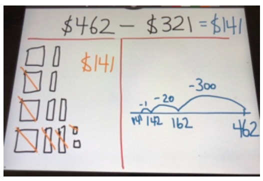


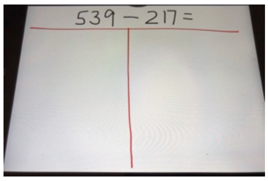
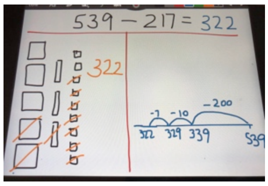
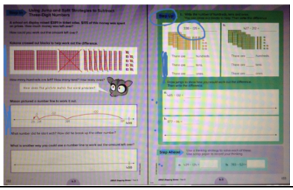

OK – the number line way. You should have your line, marked 462 *(draw)*. Then jump back 300 (or 3 lots of 100) *(draw)*. Where did you land? 162. Jump back 2 tens (either 20, or 2 jumps of 10) *(draw)*. Where did you land? 142. Then jump back 1 *(draw)*. The final answer? 141. Remember the dollar sign. $141.
Did you get that? Did you get the same answer for both strategies?




I want you to work out the answer to this question both ways as well.
If I had 539 books in my bookshelf, but I gave 217 to charity, how many books would I still have left?
Press pause and work out the answer both ways in your grid book.

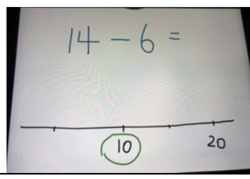
Here's the answer for you to check. Using the blocks, you should have crossed off 2 hundreds *(cross)*, 1 ten *(cross)* and 7 ones *(cross)* because that's what we're taking away from the big number.
When I write it, it should look like this: 539 - 217 = _____.
539: cross out the 2 hundreds, there's 3 left *(cross)*, cross off the 1 ten, now there's 2 left *(cross)*, and finally cross off the 7 ones, so there should be 2 left



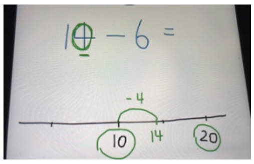
| | |
|---|---|
| *(cross)*. What number if left? 322.<br>Did you write that in your book?<br><br>OK – the place value way. You should have your line, marked 539 *(draw)*. Then jump back 200 (or 2 lots of 100) *(draw)*. Where did you land? 339. Jump back 1 ten *(draw)*. Where did you land? 329. Then jump back 7 *(draw)*. The final answer? 322.<br>Did you get that? Did you get the same answer for both strategies?<br><br>Now open your Origo book to 6.3, page 132. They have blocks to help you – you can cross off the hundreds, tens and ones just like I showed you. They have number lines as well – just like we've practiced. Have a look at the first page, then start at the Step Up *(circle)*. Work it out, write your answer, and then also write the answer underneath, like yesterday *(circle)*.<br>There are 2 number line questions to work out *(circle)*. Then there's the step ahead question.<br><br>When you have finished, go onto your maths on Studyladder while you wait for everyone to finish. Good luck! | <br><br><br><br> |
| *After the class has finished the Origo page:*<br><br>Close the iPads. Hand out the post-test to complete silently.<br><br>Bring the class down to the floor with their book and a pencil to mark. Project 6.3 answers so that they can self-mark. Ask students to reflect on how well they used each strategy. Which strategy did they prefer? Why? | |

## Lesson 3 CBVI script (Unit 6.4 in the Year 3 Stepping Stones program)

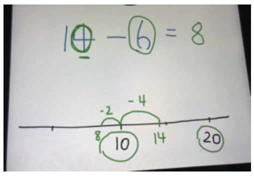
*Outcomes: MA2-5NA, MA2-1WM. Use strategies (jump and split) to subtract one-digit numbers from three-digit numbers (with bridging).*

| ***Script*** | ***Shown on screen (or on whiteboard if live lesson)*** |
|---|---|
| Hi!<br>Today we're doing subtraction with bridging. So, what I want you to do in your grid book, is write this heading here *(arrow to text on screen)*. Write it up the top of the page, nice and neatly, underlining it as well. Press pause and do that.<br><br>OK, what we mean by 'bridging', is when you go through one of the 'ten' numbers *(circle the 10 on the number line)*. It makes it easier to try and subtract numbers.<br>For example, look at this one: 14 take-away 6. I want you to press pause, and write that right underneath your heading. Nice and neatly, not taking up too much space. Press pause and do that. | <u>Subtraction with bridging</u><br><br> |

OK, so, I'm just going to show you what we mean by 'bridging'. On this number line, you've got 10 here *(circle)*, 20 here *(circle)*, so the one in the middle must be…15 *(circle)*. But we want the number 14. So it's going to be just before 15 on the number line *(draw a stripe)*. Now our problem is **14 take away 6**. How much do I take-away just to get back to the 10 *(draw a 0 over the 4 in the ones column, also jump back on number line from 14 to 10)*? When I land on the 10? That's right, I'd just be taking-away 4 *(write -4 above the jump)*.

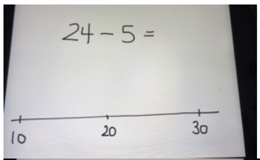



But I want to take-away **6** *(circle the 6 in the equation)*. We've *already* taken-away 4, how many more do I need to take-away? That's right – I need to take-away 2 more *(draw the jump, label it -2)*.
10 take-away 2 more…where would I land? **8** *(write it on number line)*. So the answer is **8** *(write this on the equation)*.

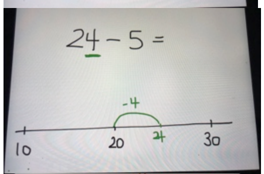



So what we're trying to do, is get *back* to the ten *(circle)*, and then take-away as many as we need to after that. Press pause and write the answer in your book.

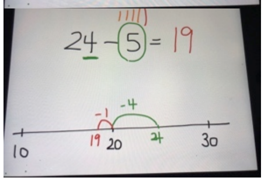
Right, in your book, I want you to write 24 take-away 5.
What do we need to take-away just to get back to 20 *(underline the 4 in the ones column)*?
24 – here's 24 on the number line *(draw a stripe)*. How many do I take-away to get back to just 20 *(draw a jump)*?
That's right – I take-away 4 *(write -4 above jump)*.



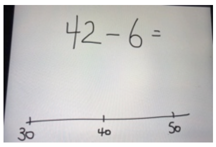

But – I need to take away *more than 4* *(circle the 5)*. I need to take away **5**. So how many is left? *(Draw tally marks above the 5)* 1-2-3-4-**5.** I've got…*1 more* to take-away.
So, if I just take-away 1, where would I land? *(draw a single jump from the 20 on the number line – label it -1)*.
20 take-away 1? **19.** *(write 19 on number line)*



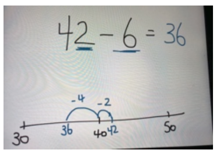

So, it's breaking the number up, so that you use the 'ten' number *(circle the 20 on the number line)*. That makes it quite easy to do. So, I want you to write the answer: **19** *(write on equation)*.




Next one: write that in your book underneath. 42 take away 6. Press pause and write that.
I want you to have a go on your own. You can have a look at this number line, and have a think about what you need to take-away to get back to 40 *(underline the 2 in the ones column)*. And then think about how many are still left to take-away *(underline the 6)*.
Work it out. Press pause. Write your answer.

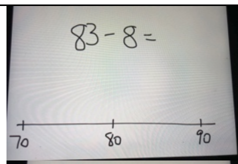


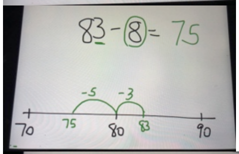

OK, so 42 would be about here *(draw a stripe on the number line)*. I'd take-away **2**, to get back to 40 *(draw the jump, label -2)*, but I need to take-away **6**. I've taken-away 2, so there's **4** left to take-away *(draw the jump, label -4)*. What's 40 take-away 4? 36 *(write on number line and on equation)*. Did you get that?

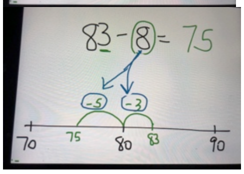



Next one: 83 take away 8. Press pause and write this in your book.
Work it out.

**83** *(draw on number line)*. How many do I need to take-away just to get back to 80 *(jump to 80)*? That's right: it's 3 *(label -3 on jump)*. But I need to take-away **8** *(circle the 8)*. So I've got *another* 5 to take-away *(jump and label on number* *line)*. Did you get the answer **75**? *(Write on number line and on equation)*.



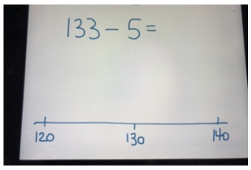



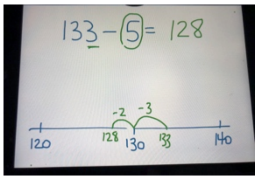




See how we're just splitting this *(circle the two jumps)*, we're splitting this subtraction *(circle the 8, draw an arrow to the 2 parts below: the 3 and the 5 on the number line)*, so that it's easier, through the ten *(circle the 80)*.

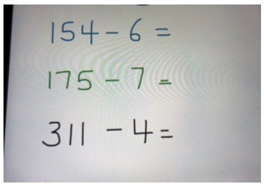
This is way I do my subtraction – I find it quite easy.
133 take-away 5. Press pause, write this in your book, work out the answer, and then write the answer.

**133** *(draw/write on number line)*.
How many do I need to take-away just to get back to 130? *(jump back on number line)* That's right: **3** *(label jump)*.
How many do I need to take-away altogether? *(circle the 5)*. **5**
So, I've got another **2** to go *(draw jump and label)*. 3 there, 2 there, that's 5 altogether *(underline labels)*.
So what's the answer? 128 *(write on number line and on equation)*.
Did you get that?



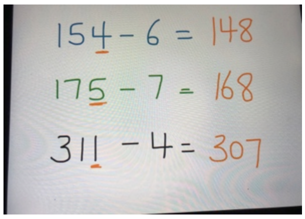

Here are three for you to write down in your book, and work out. Press pause and work them out.




OK, for *answers*:
You should have taken-away the **4**, to get back to 150 *(underline the 4)*, then taken-away another **2**. So the answer is **148** *(write answer on equation)*.

The next one – you should have taken the **5** away *(underline the 5)*, to get to 170. Then you need to take **2** more away. So it's **168** *(write answer on equation)*.

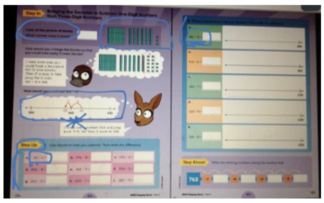
And the last one – take-away the **1** *(underline the 1 one)* to get to 310, then you need to take **3** more away. So that leaves you with **307** *(write answer on equation)*.




Now it's time to open your Origo book to unit 6.4, on page 134. Look at this picture *(circle the words)*, what number does it show? *(circle the blocks)*. Write it in the white box. That should be fairly straightforward for you to do.
Now, we've been practicing the number line version *(circle the number line example next to the kangaroo)*.

Start with the Step Up *(circle these words)* and use the number line way that we just practiced in your grid book. So for this one *(circle 1a)* 151 – 4, take away 1 to get back to 150. Then what do you still need to take-away? So you're bridging the tens.

On the second page *(circle number 2)*, they have number line for you to use. Show your working out, your jumps, on the number line. Remember to write your answer as well *(underline where the answer should be written)*.
Then, challenge yourself with the Step Ahead *(circle these words)*. Write in your answer after you work out each step *(underline the answer space)*, so that you keep working out the new subtraction.



When you have finished, go onto your maths on Studyladder while you wait for everyone to finish. Good luck!

| | |
|---|---|
| | |
| *After the class has finished the Origo page:*<br><br>Close the iPads. Hand out the post-test to complete silently.<br><br>Bring the class down to the floor with their book and a pencil to mark. Project 6.4 answers so that they can self-mark. Ask students to reflect on how well they used the bridging strategy. Did they find it easy? Challenging? | |

## Appendix 5. Pre- and Post-tests

**Pre- and post-test for Lesson 1**

*Concept: Subtracting two-digit numbers from three-digits using the jump and split strategy.*

| **Name:** | **Class:** |
|---|---|

1. 378-10=

2. 392-30=

3. 384-20=

4. 389-20=

5. 534-21=

6. Jane has $257 in savings. If she buys a book that costs $25, how much money will she have left?

7. Tim has $168 in savings. If he buys toys for $46, how much money will he have left?

8. Draw jumps on this empty number line to show 322-56

**Pre- and post-test for Lesson 2**
*Concept: Subtracting three-digit numbers from three-digits using the jump and split strategy.*

| **Name:** | **Class:** |
|---|---|

1. 456-100=
2. 823-300=
3. 324-200=
4. 947-400=
5. 644-211=
6. Milla has $268 in savings. She buys a bike for $126. How much money does she have left?
7. Addison has $569 in savings. She wants to buy a model car for $234. How much does she have left?
8. 323-141=

**Pre-and post-test for Lesson 3**
*Concept: Bridging the decade with one-digit numbers*

| **Name:** | **Class:** |
|---|---|

1. 432-5=
2. 275-8=
3. 141-4=
4. 823-6=
5. 153-25=
6. $315-34=
7. 136-18 =
8. 506-24=

## Appendix 6. Behavioural Observation Checklist

### *Quantitative observation protocol for student participants*

*Purpose:*

*-To collect quantifiable data for analysis of student behavioural engagement*

This checklist is based on the Academic Engaged Time Code of the Systematic Screening for Behavior Disorders (AET-SSBD) (Volpe et al., 2015), which is a standardised quantitative observational protocol designed to measure the amount of time a student is engaged in academic material during independent seatwork in the primary school classroom.

The total amount of time a student demonstrates engaged behaviour will be recorded using a stopwatch. This value is divided by the total observation time, which is 15 minutes per student, and multiplied by 100 to determine the academic engaged time.

Observation time: 15 minutes

| | |
|---|---|
| Engaged behaviour during CBVI | -focusing on the screen<br>-completing work in book as required<br>-remaining in seat<br>-not talking to others<br>-talking to others about the learning task |
| Disengaged behaviour during CBVI | -looking around the room rather than keeping attention on the screen<br>-leaving seat<br>-calling out<br>-talking to others about unrelated topics |
| Total engaged time: | Raw score % |

## Appendix 7. Student Questionnaire

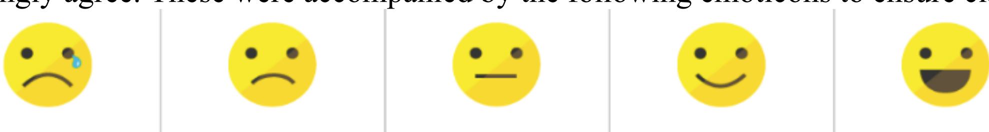
*Quantitative questionnaire – student participant*

*Purpose:*

- *To determine the effects of the treatments used had on student affective engagement*
- *To collect quantifiable data for analysis.*

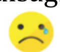
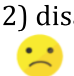
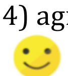
Students completed this questionnaire cumulatively, by answering two questions after each treatment, and the remaining six questions at the conclusion of the final treatment. The two questions included with each treatment post-test related to students' immediate perceptions and the final six questions compared between the treatment approaches.

The questionnaire measured self-evaluated affective engagement using a Likert 5-point rating scale with the anchor: strongly disagree, disagree, neutral, agree, and strongly agree. These were accompanied by the following emoticons to ensure clarity:



Including two questions in the post-test of each lesson enabled affective engagement data to be collected immediately following the treatment, which was an important consideration for Year 3 students who may easily forget their perceptions, and allowed affective engagement comparisons of means between treatments.

## Questions for inclusion after each treatment

| # | Stem | Scale/ Anchors |
|---|---|---|
| **Questions to be included in the post-test after the TEACHER VOICE video:** | | |
| 1 | **I feel that my teacher's voice on the video made me interested in completing the video.** | 1) strongly disagree  ; 2) disagree  ; 3) neutral  ; 4) agree  ; 5) strongly |
| 2 | **I feel that hearing my teacher's voice helped me to stay focused on my work to complete it.** | |
| **Questions to be included in the post-test after the STRANGER VOICE video:** | | |
| 3 | **I felt the stranger's voice on the video did not affect me completing my work.** | |

| | | |
|---|---|---|
| **4** | **I feel that hearing the stranger's voice helped me to stay focused on my work to complete it.** | agree  . |
| **Questions to be included in the post-test after the LIVE LESSON with the teacher:** | | |
| **5** | **I liked when my teacher taught me maths without the video.** | |
| **6** | **I feel like completing my work when my teacher teaches me without a video.** | |
| **Questions to be included in the post-test at the conclusion of the experiment:** | | |
| **7** | **I prefer hearing my teacher's voice on the video rather than a stranger.** | |
| **8** | **I prefer my teacher doing a normal lesson for maths, with no video.** | |
| **9** | **I like using videos to learn maths.** | |
| **10** | **I like that I can control the video – I can pause the video, watch it again if I don't understand and change the volume if I need to.** | |
| **11** | **I feel that using videos helps me to learn my maths.** | |
| **12** | **I feel like my teacher is talking just to me when I listen to the videos.** | |

## Appendix 8. Teacher Interview Questions

*Qualitative questions for semi-structured interview – teacher participant*

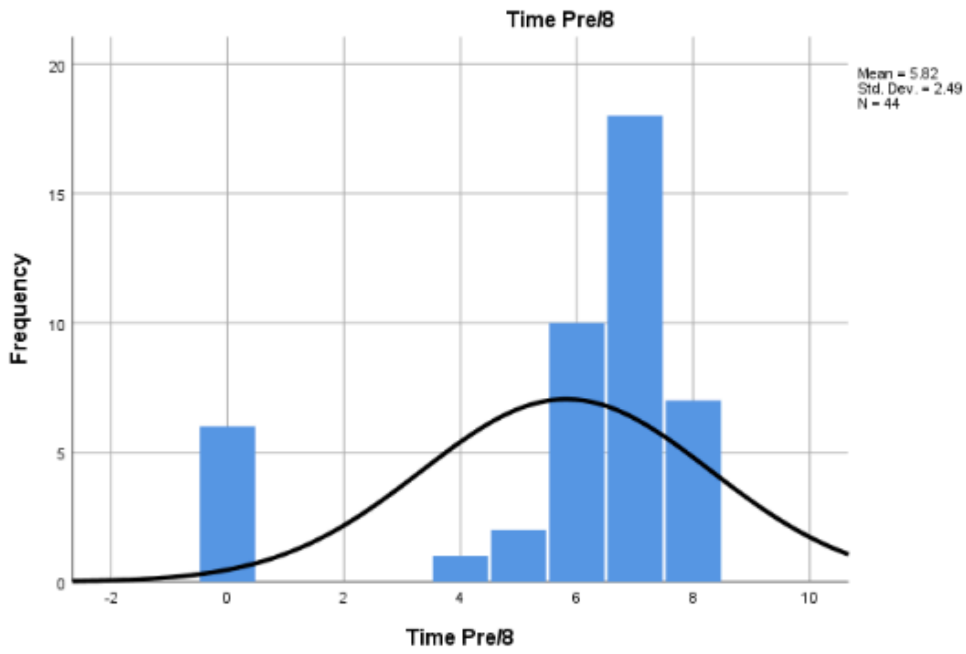
*Purpose: To gather qualitative data about the CBVI experience, the video making and the perception of CBVI and its use in a primary classroom setting.*

The three teachers participating in the treatment experiment were interviewed separately after the conclusion of the final treatment. This was an opportunity to collect more in-depth, personalised opinions and feedback about the impact of CBVI in the classroom.

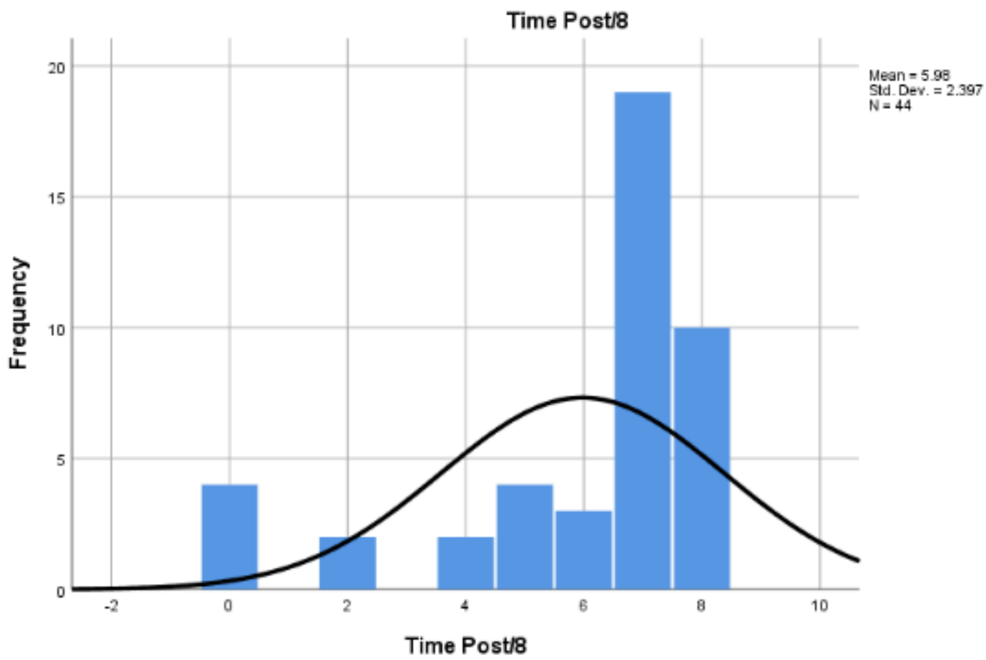
| | |
|---|---|
| 1 | What effect do you think the CBVI had on the mathematics lessons? |
| 2 | Did you think the students were successfully engaged using CBVI? Why/why not? |
| 3 | Do you think it makes a difference to student engagement whether the teacher or a stranger makes the video? |
| 4 | Do you feel students were enthusiastic about using CBVI for mathematics lessons? Why/ why not? |
| 5 | Can you please tell me about any special needs of students in your class? How well did you feel this approach (CBVI) catered to these students, and in what ways? |
| 6 | Did you feel that using CBVI in the classroom benefitted you? In what ways? |
| 7 | Do you feel CBVI has a place in the primary school classroom? |

## Appendix 9. Descriptive statistics: Pre- and Post-test results for the treatments

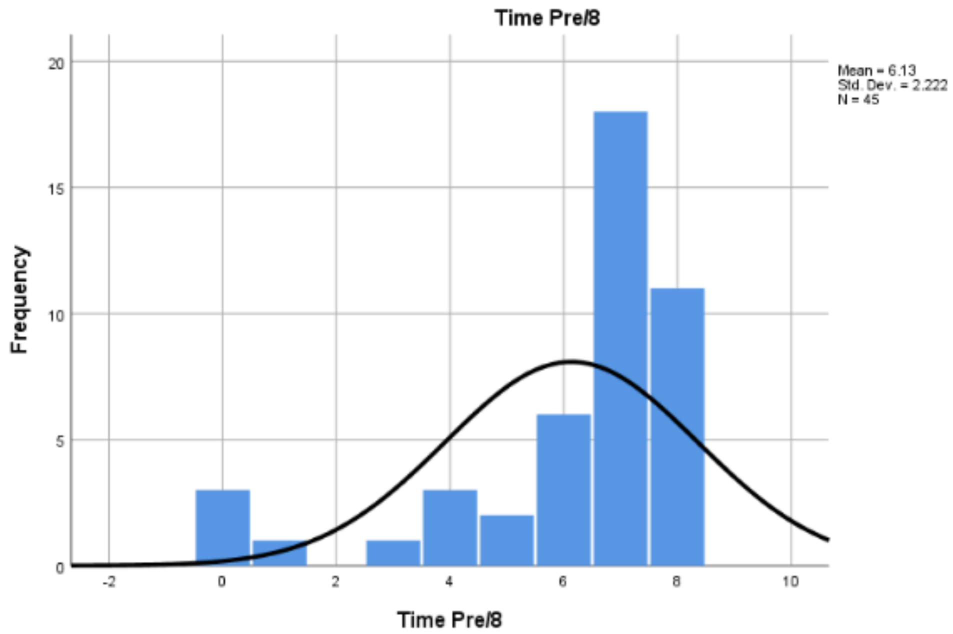
TV Pre-test results



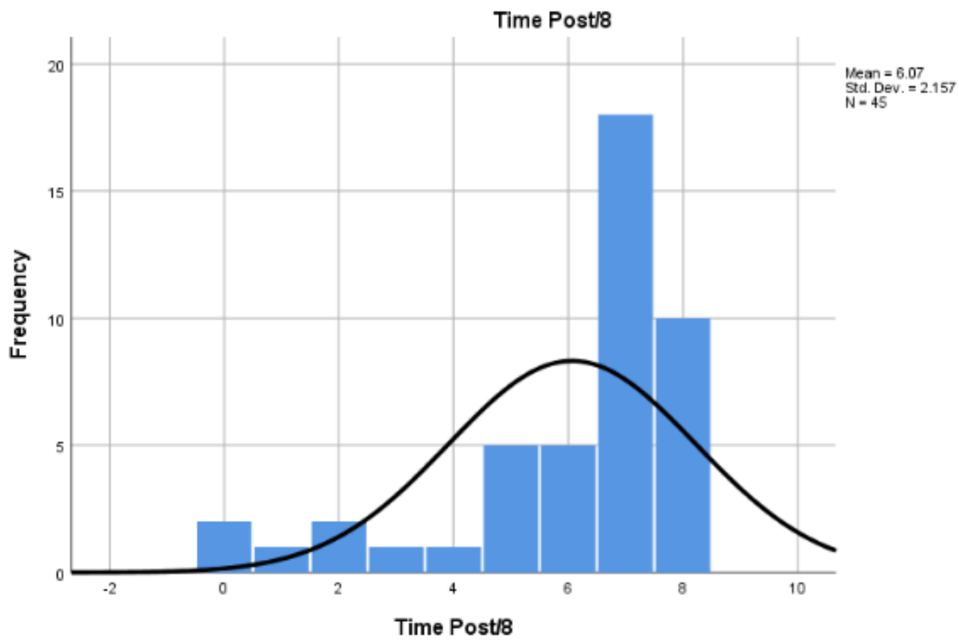

TV Post-test results



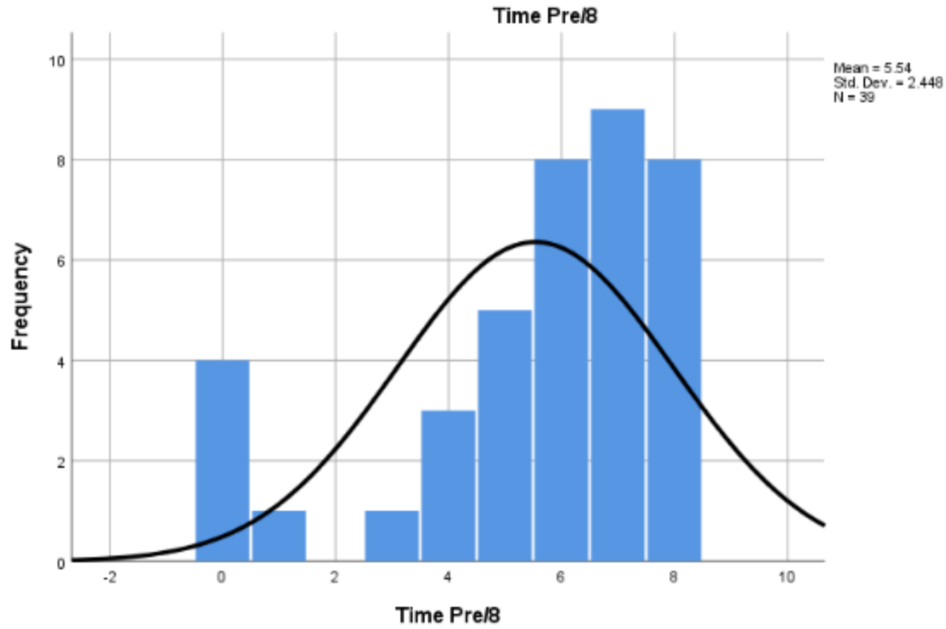
SV Pre- test results



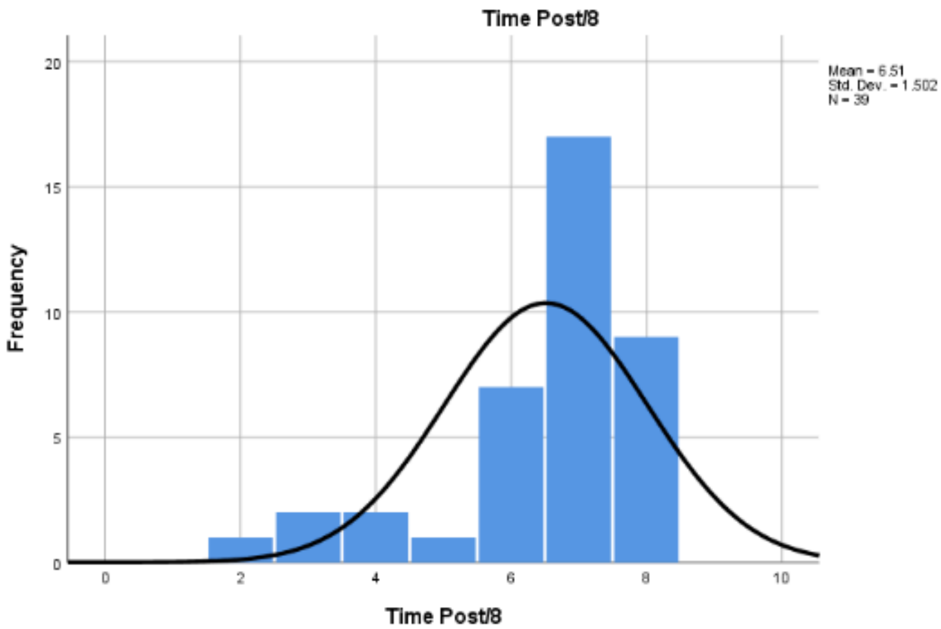

SV Post-test results



LL Pre-test results




LL Post-test results



## Appendix 10. LMM results: Fixed Effects table

**Model Dimension**[a]

| | | Subject Variables |
|---|---|---|
| Fixed Effects | Intercept | |
| | Gender | |
| | Time | |
| | Mode | |
| | Lesson | |
| | Gender * Time | |
| | Gender * Mode | |
| | Gender * Lesson | |
| | Time * Mode | |
| | Time * Lesson | |
| | Mode * Lesson | |
| | Gender * Time * Mode | |
| | Gender * Time * Lesson | |
| | Gender * Mode * Lesson | |
| | Time * Mode * Lesson | |
| | Gender * Time * Mode * Lesson | |
| | LikertRating | |
| | Gender * LikertRating | |
| | Mode * LikertRating | |
| | LikertRating * Lesson | |
| | Gender * Mode * LikertRating | |
| | Gender * LikertRating * Lesson | |
| | Mode * LikertRating * Lesson | |
| | Gender * Mode * LikertRating * Lesson | |
| Random Effects | Intercept[b] | ID * Class |
| Residual | | |
| Total | | |

a. Dependent Variable: Score.

b. As of version 11.5, the syntax rules for the RANDOM subcommand have changed. Your command syntax may yield results that differ from those produced by prior versions. If you are using version 11 syntax, please consult the current syntax reference guide for more information.

## Fixed Effects

### Type III Tests of Fixed Effects[a]

| Source | Numerator df | Denominator df | F | Sig. |
|---|---|---|---|---|
| Intercept | 1 | 36.221 | 753.857 | .000 |
| Gender | 1 | 40.203 | 3.595 | .065 |
| Time | 1 | 132.471 | 6.288 | .013 |
| Mode | 2 | 130.969 | 1.905 | .153 |
| Lesson | 2 | 160.608 | 28.491 | .000 |
| Gender * Time | 1 | 132.471 | 1.370 | .244 |
| Gender * Mode | 2 | 165.476 | 4.336 | .015 |
| Gender * Lesson | 2 | 164.953 | 1.266 | .285 |
| Time * Mode | 2 | 132.471 | 4.933 | .009 |
| Time * Lesson | 2 | 132.471 | .047 | .954 |
| Mode * Lesson | 4 | 73.001 | .999 | .414 |
| Gender * Time * Mode | 2 | 132.471 | 1.257 | .288 |
| Gender * Time * Lesson | 2 | 132.471 | .053 | .948 |
| Gender * Mode * Lesson | 4 | 83.591 | 2.086 | .090 |
| Time * Mode * Lesson | 4 | 132.471 | .383 | .820 |
| Gender * Time * Mode * Lesson | 4 | 132.471 | 1.054 | .382 |
| LikertRating | 4 | 160.984 | 2.742 | .030 |
| Gender * LikertRating | 4 | 159.687 | 2.088 | .085 |
| Mode * LikertRating | 8 | 135.399 | 2.570 | .012 |
| LikertRating * Lesson | 8 | 161.973 | 5.282 | .000 |

### Type III Tests of Fixed Effects[a]

| Source | Numerator df | Denominator df | F | Sig. |
|---|---|---|---|---|
| Gender * Mode * LikertRating | 3 | 169.055 | .739 | .530 |
| Gender * LikertRating * Lesson | 4 | 164.997 | .365 | .833 |
| Mode * LikertRating * Lesson | 7 | 172.206 | 1.939 | .066 |
| Gender * Mode * LikertRating * Lesson | 2 | 172.406 | 3.407 | .035 |

a. Dependent Variable: Score.

## Appendix 11. 100 most common words from teacher interviews