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Interactive Videos As A Vocabulary Pre-Teaching Tool In Middle School Science

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INTERACTIVE VIDEOS AS A VOCABULARY

PRE-TEACHING TOOL IN MIDDLE SCHOOL SCIENCE

by

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CHAPTER ONE

Introduction

If you are a high school teacher, the parent of a teenager, or simply just a person walking down the street, there is no doubt that you have seen people of all ages – but especially young people – interacting with technology. From babies to centenarians, newly arrived immigrants to leading politicians, it's likely that each of these people interact with technology, probably on a daily basis. However, no group seems to have embraced technology more fully and exuberantly than the youngest, sometimes called Generation Z or iGen (Sanburn, 2015). In 2015, 73% of American teens aged 13 to 17 had access to a smartphone, 87% had access to a computer, and 92% reported that they went online daily (Pew Research Center, 2015). It should come as no surprise, then, that educators have also started incorporating technology into their classrooms, either by mandate or by choice, to keep Gen Z students engaged and to simultaneously take learning to new heights.

When I think back to my time as a student, I have some very vivid memories of technology – going to the school's singular computer lab to learn math facts with a leap frog game, purchasing floppy disks from the library, seeing my first Mac laptop (it was blue-green and curvy, with a built in handle) and wishing that *I* had broken my arm so I could have used it, or the screeching sound of the printer as the continuous form paper fed through it like a long white ribbon with perforated edges. Snapping back to 2017, it is clear that technology is so ubiquitous – no longer limited to one special room - and our interactions with it so profound, that it is only logical to integrate it into our classrooms. However, this is often easier said than done because of technology's rapidly evolving nature.

Although technology has certainly changed the way we live our lives and interact with each other, not every new technology can automatically be labeled as "good." This concept also applies to education, where we want to choose the best technology, putting it to work for us to make our lives and our students' learning better and easier.

As a middle school English as a Second Language (ESL) teacher, I am often pulled in a hundred different directions, trying to provide language development services to more than fifty students in grades five through eight across the content areas. Moreover, the students' language proficiencies vary greatly, ranging from students who arrived from Mexico just last week to those who have lived here their whole lives but struggle with the academic language required for success at the secondary level. *If only*, I thought, as I juggled textbooks and a laptop, darting from class to class, adapting materials on the fly, *I could clone myself so I could be in two places at once.* Thus began my quest to find a way to teach students effectively and interactively, without actually being there.

Of course, I had neither the desire nor the knowledge to create an ESL-teaching robot, but I knew that I could use my time more efficiently if I could help students create a solid foundation of background knowledge and vocabulary before they took part in classroom activities and projects that aimed to deepen their understanding of the concept. Instead of plucking drowning students from the water, I needed to give them a short introduction to the basic strokes before they dove in. In this case, the "basic stroke" was vocabulary. With an understanding of the vocabulary, students would be able to get more out of the instruction, making connections between new information and their background knowledge, and engaging with the material instead of struggling to understand what was happening around them.

I decided to begin utilizing virtual methods for pre-teaching vocabulary in an environment over which I had the most control – my classroom – with my largest group of students - fourteen 7th and 8th grade newcomers learning science. Despite being newcomers with limited English language skills, these students were not lacking in technology skills. Whether they had arrived yesterday or already had a year of English language instruction under their belts, these students interacted with technology in the classroom and in their free time on a daily basis. Since I knew that the students would be comfortable using technology, I felt comfortable using it as a tool for learning. My goal was to find out if a virtual method for vocabulary pre-teaching could be as effective as teacher-led vocabulary instruction. If it was, I could use this virtual method to help other students learn vocabulary, even if I wasn’t able to be in their classroom or study hall for in-person instruction.

Technology in Education

While the uses of technology are varied – if not endless – harnessing and teaching with technology for educational purposes is more complicated than simply providing every student with a device. One is unlikely to find many educators who believe pressing play on a video to build background or telling students to “Google it” as a research project will produce exemplary learning without additional scaffolding. However, when technology is implemented purposefully and judiciously, it can have positive impacts on student learning, motivation, and engagement (Harper & Milman, 2016). In our effort to find new and creative ways to meet the special challenges of educating English language learners (ELLs), technology may serve as an important tool.

This research aimed to investigate the effectiveness of interactive video, a technological tool, for pre-teaching science vocabulary to adolescent newcomer ELLs, as compared to teacher-led vocabulary instruction. In addition, it provided insight into the possible uses of interactive video for flipped learning vocabulary instruction in a middle school English as a Second Language (ESL) environment.

Vocabulary

Why focus on vocabulary? In addition to facilitating basic communication, vocabulary knowledge is essential for reading comprehension (Proctor, Carlo, August, & Snow, 2005; NICHD, 2000). While children learn most vocabulary indirectly through daily oral language, listening to books being read aloud and individual reading, some words must be taught directly, via explicit instruction of individual words and broader word-learning strategies (Reading Rockets, 2015).

This methodology, direct instruction, has been shown to be particularly effective for teaching vocabulary (NICHD, 2000). If teachers can simply instruct students directly in particular word meanings, why should we be interested in interactive videos? Interactive videos are not a method for teaching vocabulary but a means for delivering instruction in a flexible, engaging format. Just as Beck, McKeown, and Kucan (2013) chose to write a book about vocabulary instruction because "school vocabulary instruction tends to be dull," this study provides yet another option for meeting the needs of today's learners, and specifically today's diverse English language learners (p. 13). In 2012-13, there were 4.4 million English Language Learners in the United States, which constitutes 9.2% of the total student population (U.S. Department of Education, NCES, 2016). Unfortunately, however, ELLs as a group do not achieve at the same rate as the general student population; according to a longitudinal study by the U.S. Department of Education, ELLs in grade 8 scored lower than native English-speaking students and English proficient students in reading, mathematics, and science (U.S. Department of Education, NCES, 2012). Unsurprisingly, ELLs' graduation rates (62.6% in 2013-14) fall behind that of the general student population (82.3%) (U.S. Department of Education, OELA, 2016).

Videos in Education

Videos in education are not uncommon or revolutionary. A quick search of the internet will turn up thousands of videos, and there are several well-known websites, such as Khan Academy, TED-Ed, and YouTube EDU, dedicated to educational videos. However, most videos are not designed with ELLs, let alone newcomers, in mind and use vocabulary and syntax that may not be understood by viewers with limited English proficiency. While these videos may have outstanding content, it is unlikely that they have been designed to align with research-based principles of multimedia instruction, as documented by Kennedy, Deshler, and Lloyd's analysis of a Khan Academy video (2015).

Much of the emphasis on videos for learning has been through the flipped learning movement (Bergmann & Sams, 2014). Flipped learning is a teaching model in which students receive direct instruction outside of class so that class time can focus on application of the content (Bergmann & Sams, 2014). Research by Long, Logan, and Waugh (2016) and McLean et al. (2016) has shown positive learning outcomes for flipped video lessons in higher education. Videos have also been used successfully to teach vocabulary to younger children in the form of educational television (Silverman, 2013; Silverman & Hines, 2009), with adolescents in the form of podcasts and vodcasts (Lowman, 2014) and with adolescents with learning disabilities in the form of audio/video content acquisition podcasts (Kennedy, Deshler, & Lloyd, 2015).

However, little research has been undertaken to determine the effectiveness of videos as a vocabulary acquisition tool in the English as a Second Language classroom, either as part of a traditional or flipped learning environment. The research reported in this study measured the effectiveness of teacher-created interactive videos by comparing them to traditional teacher-led direct instruction of vocabulary as a pre-teaching tool in an ESL classroom. The effectiveness of each technique was determined by comparing pre- and post-test scores of science vocabulary from the experimental groups.

Summary

As the scope and prevalence of technology use in the classroom expands, so must we continue to pursue research that clarifies the best ways to utilize technology to improve learning outcomes. Innovative and creative approaches are required to meet the changing needs of our learners, but they must be research-based to ensure the best outcomes for those learners. The goal of this research was to determine the effectiveness of interactive videos as a vocabulary pre-teaching tool in comparison to teacher-led instruction; such information would provide another option for teaching vocabulary to ELLs in the content areas. In particular, this research focused on the pre-teaching of science vocabulary to adolescent newcomers, both in the classroom and in a flipped learning environment.

Chapter Preview

The next chapter, Literature Review, will discuss previous research related to interactive videos, and discuss gaps where new research and tools are needed. The subsequent chapter, Methods, will outline the methods, participants, and procedure used in the study. Following the methods will be the results in chapter four and, finally, conclusions in chapter five.

CHAPTER TWO

Review of the Literature

According to the Purdue University online learning webpage, "Technology has always been at the forefront of education…[and]…technology continues to push educational capabilities to new levels" (2016). While this belief may be widespread, educators know that such an idea must be supported by a foundation of research instead of merely assumed. Though the effectiveness of technology in the classroom may have produced mixed results thus far (Harper & Milman, 2016), this is by no means a reason to suspend the search for technology-based tools that improve learning outcomes. This study seeks to continue the quest for effective classroom tech tools by measuring the effectiveness of interactive videos by answering the following research question: Are interactive videos as effective as teacher-led vocabulary instruction for newcomer ELLs learning science, and can interactive videos be used effectively in a flipped learning environment for pre-teaching science vocabulary to newcomer English Language Learners? This chapter will examine previous research related to this study, including second language acquisition, vocabulary, multimedia learning, and videos in the classroom.

Second Language Acquisition

Second Language Acquisition (SLA) theories are at the heart of all research on English language learners (ELLs). SLA research involves not just what is happening in the "language" parts of the brain, but also other internal and external factors that influence language acquisition. Although not always mentioned, it is this combination of factors that influences the way that ELLs learn inside and outside the classroom.

One of the most well-known and concrete factor affecting SLA is age. While most studies support the existence of a critical period, before which native-like pronunciation (Patkowski, 1980) and grammaticality judgment (Johnson & Newport, 1989) is possible, all SLA studies do not agree on the exact age at which this critical period ends, with estimates ranging from nine to fifteen (Hummel, 2014). SLA research by Snow and Hoefnagel-Hohle (1978) has also demonstrated that older learners learn faster in the early stages of second language development than younger learners. However, the critical period hypothesis is just that – a hypothesis – and other research indicates that, although rare, it may be possible for older learners to achieve native-like pronunciation and/or grammar (Bongaerts, van Summeren, Planken, & Schils, 1997; Ioup, Boustagui, El Tigi, & Moselle, 1994).

While easily measurable, age is not the only factor that affects second language acquisition. Other, less easily measured factors, such as intelligence, language learning aptitude, attitude and motivation, personality, learning style and cognitive style and learning strategies may influence learners' second language acquisition. While any number of these factors may influence an individual's SLA experience, aptitude, and motivation have been found to be the most significant factors in certain situations (Hummel, 2014).

Skehan (1998) suggested that language learning aptitude consists of three abilities: phonetic coding, language analytic, and memory. Phonetic coding is the ability to produce and discriminate the phonemes, or sounds, of a language, and language analytic is the ability to infer rules about a language and make generalizations (Skehan, 1998). Memory is quite broad and can encompass sub-parts such as rote memory, which is tested by many aptitude tests, including the Modern Language Acquisition Test, developed by John Carroll and Stanley Sapon for the U.S. Army (Hummel, 2014) or phonological working memory, which has been found to positively influence second language vocabulary acquisition (Hu, 2003), grammar acquisition (French & O'Brien, 2008), oral fluency (O'Brien, Segalowitz, Freed & Collentine, 2007), and general proficiency (Hummel, 2009).

Motivation, as defined by Gardner (1985), consists of effort, the desire to learn the language and the attitudes toward learning the language. Motivation can be divided into several orientations, including intrinsic (internal) and extrinsic (external) or integrative (become part of the language community) and instrumental (to reach a goal) (Hummel, 2014). Finally, motivation can change over time; Dornyei and Otto (1998) formulated a motivational sequence, beginning with the preactional stage (generate motivation), then the actional stage (maintain motivation), and finally the postactional stage (evaluation). Put into practice, motivation has been shown to have positive effects on English achievement; in a meta-analysis of 75 studies, Masgoret and Gardner (2003) reached three important conclusions:

> First, the five classes of variables, attitudes toward the learning situation, integrativeness, motivation, integrative orientation, and instrumental orientation, are all positively related to achievement in a second language. Second, motivation is more highly related to second language achievement than either of the other four variables. Third, these findings are not moderated to any great degree by the

> availability of the language in the immediate environment or by the age of the learners. (p. 158)

Vocabulary

Importance for English Language Learners

If comprehension is essential for reading, then vocabulary is essential for comprehension. This is confirmed by the National Reading Panel report, which states that vocabulary knowledge correlates strongly with reading comprehension (NICHD, 2000). The same holds true for ELLs: vocabulary is crucial for English-language reading comprehension (Proctor, Carlo, August, & Snow, 2005). Therefore, vocabulary instruction is especially important for English language learners (August & Shanahan, 2006).

Moreover, the impact of vocabulary knowledge extends well beyond the scope of the ESL classroom. ELLs must learn to use and interpret specific vocabulary and language features in order to succeed in content area classes. New standards, such as the Common Core State Standards and the Next Generation Science Standards, increasingly require students to use more language as they learn math and science content (Hakuta & Santos, 2013).

Vocabulary and Second Language Acquisition

Just as a number of factors can influence an individual's second language acquisition, so too can a variety of factors influence an individual word's acquisition. These factors include pronounceability, length, grammatical category (ex. tense, number or gender), and morphological complexity (combination of meaningful elements within a word) (Hummel, 2014). Jiang (2004) divides vocabulary acquisition into two dimensions:

lexical entry (retention and automatization in the mental lexicon) and the content of the lexical entry (additional pronunciation, syntactic, and semantic knowledge). The semantic development of second language vocabulary often involves the "mapping" of the new word onto existing concepts or first language vocabulary (Jiang, 2004).

Facilitating Vocabulary Acquisition Among English Language Learners

Not just instruction – but quality instruction – is key to improving ELLs' literacy development. While much research has focused on the vocabulary development of monolingual English speakers (see NICHD, 2000), comparatively little has focused on the vocabulary development of ELLs (August, Carlo, Dressler, & Snow, 2005). August & colleagues' (2005) meta-analysis of research on vocabulary instruction for ELLs revealed that many of the same instructional strategies that have been effective for English-only learners (namely, providing definitions and contextual meaning, engaging students in active use and analysis of words, providing multiple exposures, and teaching word analysis) are also effective for English language learners. However, some strategies are especially applicable to or necessary for ELLs' vocabulary acquisition and deserve extra attention.

Word-learning strategies can be especially effective for students that may have limited access to English-rich environments outside of school. There are several word-learning strategies, including using prefixes, suffixes, and roots, using context clues, and using reference tools including dictionaries (Graves, August & Mancilla-Martinez, 2013). One word-learning strategy specific to ELLs is the use of cognates – words from two different languages that have a common root. Studies by Nagy, Garcia, Durgunoglu, and Hancin-Bhatt (1993) and Jimenez, Garcia, and Pearson (1996) have shown that knowledge and use of cognates had a positive correlation with students' reading comprehension in English. In Jimenez et al.'s (1996) qualitative study of bilingual readers of English, all eight successful readers explained how they used Spanish-English cognates even if they didn't identify the strategy by name. Nagy et al.'s (1993) quantitative study found that bilingual students' reading comprehension was highest when they were able to both identify a cognate in English and knew the word in Spanish. While this two-part process of utilizing cognates may come as no surprise, the study also revealed that students were able to identify less than half of the cognates that they reported knowing in both English and Spanish (Nagy et al., 1993). These findings suggest that students from Latinate language backgrounds would benefit not only from continued literacy instruction in their first language, but also from explicit instruction in the orthographic and morphological relationships between their first language and English so that they are better equipped to recognize cognates.

Vocabulary experts Beck, McKeown, and Kucan (2013) support the use of cognates, but they also recognize its limitations. First, the use of cognates is only applicable to students whose first language has Latin roots. Second, cognates are only useful if the student knows the word in their first language (Beck, McKeown, & Kucan, 2013). Therefore, cognates may provide only limited utility to students with limited first language literacy. Instead, Beck, McKeown, and Kucan (2013), suggest focusing on root words, or word families, that have broader applicability in English and a higher frequency in students' Latinate first languages.

Recognizing and utilizing cognates has the potential to rapidly expand students' vocabulary, which is fortunate, because the vocabulary requirements for all students, including ELLs, are vast. Nagy and Anderson (1984) estimated the number of distinct words in printed school English to be 88,500. However, surface knowledge of a large pool of vocabulary words is not enough to ensure reading comprehension; readers must also have a depth of vocabulary knowledge, which includes understanding of "all word characteristics such as phonemic, graphemic, morphemic, syntactic, semantic, collocational, and phraseological properties" (Quian, 2002, p. 516). While this definition of depth seems more applicable to complex technical vocabulary (also named Tier 3 vocabulary by Beck, McKeown, & Kucan, 2013), it is important to ensure that ELLs have a full understanding of all words, even basic Tier 1 vocabulary (commonly spoken words, such as apple or green) especially if the words have multiple meanings or are not cognates (August, et al., 2005).

Providing clear and explicit word meanings as well as extended background information can also help ELLs form a deeper understanding of new vocabulary (Beck, McKeown, & Kucan, 2013). Word knowledge is not an "all-or-nothing proposition" but rather a continuum, so guiding students through the creation of new connections or helping them forge links to their existing schema increases their word knowledge (Beck, McKeown, & Kucan, 2013, p. 10). Instruction that aims to increase or employ background knowledge might focus on relationships to other concepts, register (degree of formality based on context), phonographic (sounds), orthographic (written conventions), morphologic (formation of words), and syntactic (structure, such as word order) components (Beck, McKeown, & Kucan, 2013). For example, an instructor might teach students to identify and decipher inflectional endings (morphology), such as manage, managing, managed or manager. Moreover, the instructor may help students make connections between the word, manager, and other synonyms such as supervisor, CEO, director, overseer, and foreman and help students identify the appropriate register for each word (ex. manager at a local pizza parlor, foreman at a factory and CEO of a corporation).

Another important tool in an ELL teacher's arsenal is visuals. The use of visuals to help ELLs learn vocabulary is supported by the dual coding theory. Indicated by its name, dual coding theorizes that cognition involves the activity of two subsystems, verbal (language in all its forms, including speech and writing) and nonverbal (sensory input, including visual [mental images], auditory [sounds], haptic [feel], and motor properties) (Paivio, 2006). Dual coding theory explains why abstract language, which relies on a web of verbal associations, can be more difficult to learn than concrete language, which utilizes both verbal associates and non-verbal images to construct meaning (Sadoski, 2005). However, the use of imagery, either self-created or instructor-provided, has been shown to be effective for the learning and retention of both abstract and concrete vocabulary words (Sadoski, 2005) and is frequently one of the top tips for teaching vocabulary to ELLs (see Swanson & Howerton, 2007; Colorin Colorado, 2015; Hogan, 2016). For example, learners may be able to learn the word *lemon* more quickly than *democracy* because lemon is a concrete noun while democracy is abstract. Learners may already have a mental image of a lemon in their heads, but if they don't, a photograph can easily be taken or a lemon brought into the class. Democracy, on the other hand, does not have a singular representative image and is more complex to explain verbally. However, educators might use visuals or kinesthetic learning to help students associate the abstract concept of democracy with concrete acts, such as the action of voting.

An important distinction in the realm of vocabulary acquisition is that of receptive and expressive language. In simplest terms, receptive language is used for comprehension while expressive language is used for expression. While these two facets of language work hand in hand, their development is not simultaneous; Barnett, Yarosz, Thomas, Jung, and Blanco (2007) have shown that gains in receptive language outpace those in expressive language among second language learners. Interestingly, Gibson, Oller, Jarmulowicz, and Ethington (2011) observed an even larger receptive-expressive gap in ELLs' first language, despite different levels of exposure to English. The potential for differences in ELLs' expressive and receptive vocabulary necessitates multiple measures in any study of ELLs' vocabulary. For example, multiple choice comprehension questions only require readers to use receptive vocabulary, so an additional task such as written or verbal responses or a translation task might be added to measure expressive vocabulary as well.

It is clear that acquiring vocabulary is both essential and challenging for English language learners. However, second language learners are not starting from square one; instead, they can build their second language vocabulary around the frame of existing linguistic knowledge in their first language. Teachers can assist in this process by utilizing both the target language and students' first language (L1). Lugo-Neris, Jackson, and Goldstein (2010), found that bridging (providing input in the students' L1) led to significant improvement in both receptive and expressive vocabulary; however, students with weak first language skills showed significantly less growth than those with strong language skills. These results support the word association model, which operates under the assumption that "dual language learners gain access to concepts in the L2 through their L1 lexicon" (Lugo-Neris, Jackson, & Goldstein, 2010, p. 315).

English Language Learners and Science Vocabulary

The relationship between academic vocabulary knowledge and general achievement is well-documented, and science is no exception (Dobbs, 2004). Moreover, the alignment between national science standards and vocabulary used on associated standardized tests means that students with extensive science vocabularies are more likely to score well on these tests (Nutta, Bautista & Butler, 2011).

What, then, should educators do to facilitate students' science vocabulary acquisition? A National Science Teachers Association publication recommends focusing not just on science-specific vocabulary, also called Tier 3 vocabulary, but also putting equal emphasis on general academic words, also called Tier 2 vocabulary (Rosebery & Warren, 2008). Another general vocabulary acquisition strategy, teaching students to identify and use cognates, is especially important in science, and specifically in life science, because of its many words with Latin roots (Nutta, Bautista, & Butler, 2011). Finally, Nutta, Bautista, and Butler (2011), encourage teachers to engage students in inquiry-based activities so that they can form personal connections with the concepts underlying the terminology.

Using Multimedia in Theory and in Practice

Cognitive Theory of Multimedia Learning

The cognitive theory of multimedia learning attempts to apply the principles of learning to the design of multimedia materials, with multimedia being any material presented in more than one format (for example, text and pictures or text, pictures, and spoken words). The theory is based on three underlying assumptions: dual channels – that there are two channels, visual and auditory, for processing material and that material can be converted and transferred between the two channels; limited capacity – that each channel has a limited processing capacity of approximately five to seven pieces or groups of information; and finally active processing – that learners must actively engage with material by paying attention, organizing new information, and integrating it with existing knowledge (as opposed to the passive approach of receiving, filing, and retrieving information). According to the theory of multimedia learning, information from multimedia is processed simultaneously in both the visual and auditory channel. First, pictures/words enter the sensory memory very briefly before a limited number of images/words are selected to enter the working memory where they are manipulated and converted into verbal/pictorial models, or representations. Finally, these two models are integrated to make a single representation which is connected to prior knowledge in order to enter the long-term memory (Mayer, 2009).

Mayer (2009) divides the application of the cognitive theory of multimedia learning into three areas: the reduction of extraneous cognitive processing, the selection of essential material for processing, and the organization and integration of material during cognitive processing. Mayer (2009) outlines five principles for reducing extraneous processing: 1) the coherence principle, which states that unnecessary words, pictures, sounds, music, and symbols should be removed from multimedia; 2) the signaling principle, which contends that essential material should be highlighted, or signaled; 3) the redundancy principle, which asserts that printed subtitles or captions should be removed; 4) the spatial contiguity principle, which avers that words and pictures should be in close proximity to each other; and, finally, 5) the temporal contiguity principle, which maintains that images and narration should be presented simultaneously. For example, note the differences between Figure 2.1 and Figure 2.2 below. While informative, Figure 2.1 includes extraneous words, pictures, and symbols; Figure 2.2 includes only the most essential information and highlights the essential material, adhering to both the coherence and signaling principles.

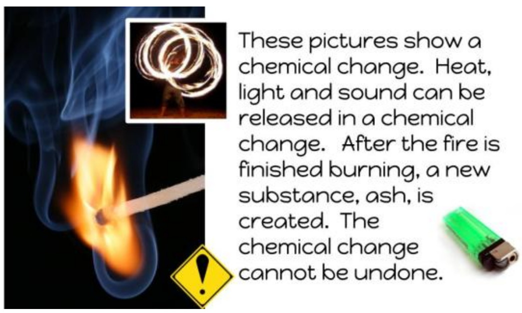

Figure 2.1 *Extraneous Information*

Figure 2.2 *Essential Information*

While Mayer, one of the leading researchers on the cognitive theory of multimedia learning, has written the book on the topic, both literally and figuratively, by authoring or co-authoring more than four dozen studies, independent studies also reinforce the tenets underlying Mayer's theory of multimedia learning. For example, in a study on eye-tracking, Wiley and Sanchez (2006) found that readers with a low working memory capacity were especially vulnerable to seductive details (interesting but irrelevant illustrations) in a scientific text, spending more time looking at the seductive details than high working memory readers. The number of correct answers supplied by low working memory readers who read the text with seductive images was significantly lower than number of correct answers supplied by low working memory readers who read a non-illustrated text, thus supporting Mayer's coherence principle. The signaling principle is independently supported by Naumann, Richter, Flender, Christmann, and Groeben (2007) who found that navigational aids and rhetorical signals helped low-skill readers gain, focus, and integrate knowledge from a hypertext (a text that allows user-directed navigation between sections via clickable links) better than traditional linear text or a hypertext without signals. For high-skill readers, however, there was no significant difference in outcomes between the two types of text or the amount of signaling (Naumann et al., 2007). While the negative effects of split attention due to simultaneous graphics and printed text are supported by several studies, including Kalyuga, Chandler, and Sweller (1999), Moreno & Mayer (2002), and Mayer, Hesier, and Lonn (2001), the redundancy effect also has its limitations. Samur (2012), for example, found that on-screen text of new foreign language vocabulary helped students learn better than graphics and audio alone. Support for the spatial contiguity principle is provided by Kester, Kirschner, and van Merrienboer's (2005) study of split-source and integrated presentation formats among Dutch high school physics students. In the study, participants that viewed the integrated presentation (diagrams with spatially contiguous explanatory text) performed significantly better on transfer test problems than participants who had viewed the split-source presentation (diagrams with spatially disconnected explanatory text) (Kester, Kirschner, & van Merrienboer, 2007). Moreover, in a 50-study meta-analysis, Ginns (2006) concluded that "increasing either the spatial or temporal contiguity of related elements of information can lead to substantial learning gains" (p. 511).

To manage essential processing, or help learners select the most pertinent information for processing, Mayer (2009) outlines three principles: segmenting, whereby information should be divided into user-paced segments; pre-training, whereby names and characteristics of important concepts should be pre-taught; and modality, whereby pictures and narration are more effective than pictures and printed words. For example, a training video that includes user-paced modules (ex. click to continue, the option to review previous segments, etc.) would align to the segmenting principle while a continuously played video would not. This same training video could align with the pre-training principle by introducing the learning objectives and explaining important or difficult concepts at the beginning.

The concept of interactive videos fits neatly into Mayer's segmenting principle, which is also supported by Cheon, Crooks, and Chung (2014), who found that segmentation via active pauses (embedded questions) led to significantly better recall and transfer test results than passive pauses (without questions) among undergraduate participants. For example, in the study, the active pause group had a mean score of 7.08 for the written text and 8.04 for the spoken text, as compared to the passive pause group, who had mean scores of 5.09 and 5.29, respectively (Cheon, Crooks, & Chung, 2014). The results for the recall test (5.12 active written and 6.24 active spoken, compared to 3.36 passive written and 4.21 passive spoken) and the transfer test (4.76 active written and 5.17 active spoken, compared to 3.00 passive written and 2.92 passive spoken) followed a similar pattern (Cheon, Crooks & Chung, 2014). While Mayer's pre-training principle aligns with current educational practices (ex. pre-teaching vocabulary before a unit), research on the type (supportive or procedural) of information that should be pre-taught is mixed. Kester, Kirschner, and van Merrienboer (2004), found that presenting procedural information before practice and supportive information during practice led to the best learning, while a previous study by Kester, Kirschner, van Merrienboer, and Baumer

(2001) found just the opposite – that supportive information presented before practice and procedural information presented during practice produced the best results. However, as the authors explain, these mixed results might be due to the cognitive load of the tasks; if working memory capacity was not exceeded, the "superiority of one of the formats over the others is not to be expected" (Kester, Kirschner, & van Merrienboer, 2004, p. 248). Since cognitive load cannot always be reliably predicted, perhaps the most useful conclusion from research on pre-training is that supportive or procedural information should be presented piece-by-piece in order to maximize the working memory capacity available for learning (Kester, Kirschner, & van Merrienboer, 2006). Support for the modality principle, on the other hand, is less divisive. In a meta-analysis of 43 studies, Ginns (2005) found that instructional materials with graphics and spoken text were more effective than materials with graphics and printed text.

Finally, to assist learners' generative processing, or organization and integration of new material, Mayer (2009) offers three principles: multimedia, which states that words should be accompanied by pictures for improved learning; personalization, which affirms that a conversational presentation style leads to better outcomes than a formal presentation style; and voice, which maintains that people learn better from a human voice as opposed to a machine-synthesized voice.

Mayer's multimedia principle is independently supported by Moreno and Valdez (2007) who found that students who watched a video of a teaching technique being demonstrated performed better on an immediate transfer test and a delayed recall test than those who read a text about the technique. However, there was no effect on the delayed transfer test. The application of the multimedia principle suggests that the students who watched the video performed better than those who read the text because the video was able to demonstrate, in an authentic way, the complexities and subtleties of the teaching technique that text alone was unable to convey. Regarding personalization, Mayer's principle is supported by Kartal's (2010) study of Turkish-speaking undergraduates, which found that students receiving personalized informal instructional materials performed significantly better on retention and transfer tasks than students who received neutral-formal materials. Personalization in Kartal's (2010) study included informal language and comments directed at the user, but classroom teachers might take personalization a step further by using familiar names and places or appealing to students' hobbies and interests to improve students' learning.

Other Factors Impacting Video Instruction for English Language Learners

In addition to the eleven design principles that are included in Mayer's (2009) cognitive theory of multimedia learning, other factors such as learner preferences, access to glosses, and screen size can affect students' learning from multimedia.

In a study of English language learners, Yang and Wu (2015) found that students who were able to set their own preferences for an e-learning system acquired and retained more vocabulary than their choice-less peers. However, the researchers also found that higher-proficiency students employed their preferred vocabulary learning strategy consistently while low-proficiency students did not choose their preferred strategy but "tended to use what they perceived to be the easiest strategy" (Yang & Wu, 2015 p. 319). Thus, the degree to which multimedia materials adhere to individual learner preferences may affect subsequent learning.

In a context specific to second language learners, access to glosses (translations) may also affect multimedia learning. In a study of undergraduate Spanish second language learners' reading comprehension, Abraham (2007) found that access to verbal and pictorial glosses significantly improved participants' scores on a vocabulary and summary test. Recalling Mayer's (2009) cognitive theory of multimedia learning, one might hypothesize that bilingual glosses reduce the functional cognitive load of the text and free up more working memory for the integration of new information.

Finally, Kim and Kim (2016) found that larger screen size had a positive effect on English as a foreign language learners' acquisition and retention of vocabulary. While the availability of ideally sized technology may be beyond teachers' control, the results of Kim and Kim's (2016) research provided a recommended minimum screen size of 600 x 800 pixels (approximately 15.9 cm x 21.2 cm), which is met by most tablets, netbooks and laptops.

Videos as a Vocabulary Learning Tool

Videos in Elementary Education

In today's wealth of technology, videos are among the most familiar and frequently used. In a survey of 130 secondary teachers, Hobbs (2006) found that 60% used videos as a teaching tool frequently or often. While videos can be employed for any number of non-optimal uses, including as a reward, to control student behavior, to give the teacher a break or as an attentional hook (Hobbs, 2006), research has also shown that videos can be used optimally to improve student learning.

Professionally-produced video clips from well-known sources such as National Geographic or educational television series like *Arthur* and *Sesame Street* are among the most easily accessible multimedia resources. Using video clips about habitats, Silverman and Hines (2009) found that vocabulary instruction enhanced with video multimedia had a positive effect on ELLs' vocabulary knowledge as compared with non-enhanced instruction. In fact, the multimedia-enhanced intervention closed the gap in target word knowledge between ELL and non-ELL students but did not negatively affect non-ELLs. Moreover, the positive effects of the multimedia intervention on ELLs' vocabulary knowledge were demonstrated in both a researcher-created assessment and a general assessment of vocabulary knowledge, the Peabody Picture Vocabulary Test (Silverman & Hines, 2009).

A more traditional, and perhaps more popular, tool among educators is the storybook, and the 21st century version of the storybook may be the digital storybook. In a study of five-year-old second language learners, Verhallen and Bus (2010) found statistically significant gains in L2 Dutch learners' expressive vocabulary after reading a digital storybook with videos as compared to a storybook with static illustrations. Another study by Verhallen, Bus, and de Jong (2006) on a similar cohort indicated that the positive effects of multimedia-enhanced storybooks were cumulative. While enhanced digital storybooks may hold promise for improving students' vocabulary acquisition, a similar genre, educational television programming, was found to be no more effective than traditional teacher-led read-alouds (Silverman, 2013).

In a more comprehensive attempt to incorporate multimedia into reading instruction, Chambers, Cheung, Madden, Slavin, and Gifford (2006) found mixed results. Analyzing the effects of embedded multimedia within the *Success for All* reading program at ten elementary schools, the authors found significant improvements in the Word Attack score of students using the multimedia-enhanced program. The Word Attack test required students to decode nonsense words (ex. *phan* or *pid*). Disappointingly, there was no significant difference in scores between the control and experimental groups in the other three areas tested; however, when the content of the multimedia clips (letter sounds and blending) is considered, it is logical that Word Attack, which requires these two skills, was more greatly affected than the other areas of study (Chambers et al., 2006).

Videos in Secondary & Higher Education

In secondary school settings, storybooks – either digital or physical – are not the tool of choice for researchers and teachers. Instead, researchers have focused on podcasts, vodcasts, and interactive videos.

Building on work by Putman and Kingsley (2009), which found statistically significant growth in science vocabulary for students with access to vocabulary podcasts, Lowman (2014) compared the effectiveness of podcasts with vodcasts, audio files enhanced with visuals. In addition to students' general preference for visuals to assist with vocabulary learning, the students watching vodcasts showed statistically significant gains in expressive and receptive vocabulary (Lowman, 2014).

Similar to vodcasts, Kennedy, Deshler, and Lloyd (2015) pioneered the use of content acquisition podcasts (CAPs), a multimedia-based vignette that utilizes audio and images paired with explicit instruction methodology and the keyword mnemonic strategy to teach vocabulary and concepts for the content areas. For example, an instructor teaching the term *fungi* might use the keyword mnemonic strategy to associate *fungi* with the words *fun guy* and show a picture of a happy mushroom. CAPs differed from previous research on vodcasts or other multimedia in that they adhered to Mayer's (2009)

Instructional Design Principles. The strong theoretical foundation of the CAPs proved to make a difference: students utilizing CAPs made statistically significant gains in vocabulary knowledge as compared to those using multimedia without a specific theoretical design; this pattern held true for both students with learning disabilities and general education students (Kennedy, Deshler, & Lloyd, 2015).

Another type of video vignette, this time interactive, also holds promise for teaching content-area vocabulary. Interactive video vignettes differ from traditional video vignettes because they incorporate questions that require students to make predictions and analyze real-world examples (Laws, Willis, Jackson, Koenig, & Teese, 2015). Laws et al.'s (2015) interactive video vignette about projectile motion includes multiple choice questions, question feedback, and clickable graphing superimposed on a video of a ball in motion. By comparing pre- and post-tests, Laws and colleagues found that students made statistically significant gains learning physics concepts after viewing the vignettes (2015). However, the gains only applied to two out of four vignettes that the researchers tested.

Taken as a whole, the concept of video to improve learning holds promise. One interesting and perhaps influential difference between the elementary-level studies reviewed in this section and secondary-level studies is the degree of personalization. Whereas the elementary-level studies utilized pre-made, professionally-produced videos, the secondary-level studies were all tailor-made by the researcher. It is possible that such personalization may have had an effect on the results.

Flipped Learning

Like teachers and students, flipped learning and videos are a natural fit. According to flipped learning pioneers, Jonathan Bergmann and Aaron Sams (2014), flipped learning can be defined as:

> a pedagogical approach in which direct instruction moves away from the group learning space to the individual learning space, and the resulting group space is transforming into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter. (p. 20)

If educators hope to teach students basic concepts before class, then the virtual instruction used to deliver this information must prove effective.

Based on the body of research available, flipped learning appears to have been most studied within higher education. In a qualitative study of students' perceptions of videos for flipped learning, Long, Logan, and Waugh (2016) report positive attitudes and a general suggestion to keep videos short and engaging. In another study, McLean, Attardi, Faden, and Goldszmidt (2016) found less self-reported multitasking in flipped classrooms as compared to traditional lecture-based formats.

In quantitative studies of flipped learning in higher education, studies have also yielded positive results. Mason, Shuman, and Cook (2013), found that engineering students in a flipped learning course performed as well or better than their peers in a traditional course on quiz and exam questions. In addition, the flipped learning format allowed the instructor to cover more material than in the traditional format, and students in the flipped learning group reported spending significantly fewer hours studying as compared to their peers (Mason et al, 2013). Similarly, nursing students in a flipped learning environment demonstrated higher achievement than their traditionally-taught peers, but the flipped learning students were less satisfied with the course (Missildine, Fountain, Summers, & Gosselin, 2013).

The research on flipped learning in the secondary setting has also produced similar results. Bhagat, Chang, and Chang (2016) compared student achievement and motivation in a traditional lecture-based math classroom and a flipped learning environment. Despite being taught by the same teacher, students in the flipped learning group demonstrated a statistically significant learning achievement and were more highly satisfied and positive than their traditionally-taught peers. When student data was disaggregated for general achievement, low-achieving students benefitted more than mid- and high-achieving peers; the authors suggest this difference is due to the student-centered nature of flipped learning (Bhagat, Chang, & Chang, 2016).

Research Gap

In this age of technology, research on technology in the classroom is slowly gaining ground, but there are still many areas left unexplored. Video clips and digital storybooks have been used successfully to teach vocabulary to elementary aged-language learners (Silverman & Hines, 2009; Verhallen & Bus, 2010), but the use of these technologies has not been studied among older learners. While studies using podcasts and vodcasts to help students learn vocabulary have been undertaken among middle (Putman & Kingsley, 2009; Lowman, 2014) and high school students (Kennedy, Deshler, & Lloyd, 2015), these studies have focused on native English-speaking regular education students and native English-speaking special education students, respectively. Although similar technologies may be useful for English language learners, they have yet to be studied. Finally, flipped learning, which has generally been met with success in higher education (Mason, Shuman, & Cook, 2013; Missildine, Fountain, Summers, & Gosselin, 2013) and secondary education (Bhagat, Chang, & Chang, 2016), has been sparsely researched among middle school students. This research on interactive videos begins to fill some of these gaps by integrating a new technology, both in the classroom and as part of flipped learning environment, among middle school students with low levels of English language proficiency. Finally, this research draws upon previous research in second language acquisition, strategies for teaching vocabulary to English language learners, and the cognitive theory of multimedia learning to create an ideal environment for pre-teaching science vocabulary to ELLs. More specifically, both the interactive videos and teacher-led instruction utilize vocabulary instruction best-practices for ELLs, such as phonological elements (pronunciation and syllabification), morphological and syntactic elements (endings such as -ed, and –ing verb endings or –ation to change a verb to a noun), first language translation, including cognates, and visuals. Moreover, all of the interactive videos align with Mayer's (2009) principles of multimedia cognitive theory. For example, the videos include only the most important words and pictures, are segmented (the video is punctuated by pauses for questions) and allow learners to progress at their own pace (by replaying any segment of the video).

While the body of research on vocabulary acquisition among English language learners is vast, as are the choices for technology-use in the classroom, the intersection between the two is as tangled as ever. There are more than 10 million subscribers to YouTube EDU, but how many videos meet the unique cultural, linguistic, and cognitive needs of ELLs? This research will provide research-based guidelines for creating interactive videos to help ELLs acquire vocabulary as well as providing qualitative data about the effectiveness of interactive videos implemented in the classroom as compared to teacher-led vocabulary instruction.

Summary

This chapter provided an overview of the research related to interactive videos as a classroom tool and their relationship to the research question: Are interactive videos as effective as teacher-led vocabulary instruction for newcomer ELLs learning science? While vocabulary is an important aspect of literacy for all learners, it is especially important for English language learners, and there are certain strategies and considerations, including cognates, visuals, depth and breadth, and receptive and expressive vocabulary, that must be considered when teaching and assessing ELLs. In addition to pedagogical influences, qualities of multimedia, such as redundancy, annotations, glosses, and detail may affect students' learning from videos. Finally, a small body of research on videos in a variety of multimedia environments has paved the way for this research on interactive videos.

Chapter Preview

The next chapter will describe, in detail, the methodology, participants, data collection tools, and procedure used in the study of interactive videos as a vocabulary pre-teaching tool. Following the methodology will be results and implications.

CHAPTER THREE

Methodology

Being classroom-based action research, the goal of this study was to provide practical, applicable information for classroom teachers as they choose or create interactive videos for vocabulary instruction and to provide data about the effectiveness of interactive videos as compared to teacher-led instruction to pre-teach science vocabulary by answering the research question, “Are interactive videos as effective as teacher-led instruction and are they effective in a flipped learning environment?” In order to achieve such results, any conclusions must be based on a carefully crafted research design and systematically archived data. Consequently, this chapter aims to provide a detailed recollection of the methodology, participants, design, and creation of each treatment group, data collection, and procedure.

This study of interactive videos as a vocabulary instruction tool used an action research methodology with an experimental design. Action research is a type of inquiry that is designed and implemented by a teacher to better understand and improve student learning. Action research is known by many different names but often follows the same cyclical sequence – identification of a problem, research or investigation, collection and analysis of data, and synthesis of the results for application or further study in the classroom (Mackey & Gass, 2016). In this case, the teacher-researcher conducted the study in her classroom by creating a control group (direct vocabulary instruction taught by the teacher-researcher) and an experimental group (receiving instruction via interactive video). Such methodology is appropriate because it takes place in the same situation that the technique will likely be used by other teachers – a secondary content classroom.

Participants

The participants included fifteen 7th and 8th grade students, aged twelve to fourteen, classified as "newcomers" (began U.S. schooling zero to eighteen calendar months ago) and/or had proficiency levels of 1.0 – 2.7, as measured by the ACCESS or W-APT assessment (WIDA, 2014; WIDA, 2015). The ACCESS assessment is an annual test while W-APT is a screener but both are aligned to WIDA's English Language Development Standards and measure students' English language proficiency in the four domains of language (speaking, reading, writing, and listening). All of the students spoke Spanish, though thirteen of the students also spoke or understood an indigenous language (nine spoke Mixteco, three Purepecha, one Nahuatl and one Qan'jobal). Thirteen of the students were from Mexico, one was from Guatemala, and one was from Honduras. Seven of the students tested at a 4th grade level of Spanish-language reading comprehension, as measured by the Diagnostic Online Reading Assessment (DORA) (Let's Go Learn, 2016); one students read at the 5th grade level, four at a 2nd grade level, and three at a 1st grade level. Looking at a more complete picture of the students' Spanish language proficiency skills, which included reading comprehension, word recognition, spelling and oral vocabulary as determined by the DORA (Let's Go Learn, 2016), four of the students tested at a 3rd grade level, five at a 4th grade level and six at a 5th grade level. The students were part of a sheltered newcomer science class taught by an ELL teacher. The class followed the curriculum of the mainstream science class, though it utilized a variety of instructional methods (ex. visuals and hands-on activities) and languages (English & Spanish) to meet the specialized needs of the learners.

Setting

The study took place at a rural middle school in the Midwest. The middle school consisted of grades five through eight with 363 total students, of which 116 were ELLs (32% of the student population). Most ELLs were provided services through inclusion, such as EL support in the classroom or co-teaching; however, newcomer ELLs were enrolled in a special program, in which half the day was pull-out language and content instruction taught by ELL teachers and half the day was spent in mainstream classes with English-speaking peers. The pull-out portion of the program consisted of two periods of English instruction, one period of bilingual science instruction, and one period of bilingual social studies instruction. The pull-out EL instruction took place in a small classroom with an interactive whiteboard and a class set of Chromebooks; the classroom set-up and technology in the EL classroom was similar to that of the mainstream classrooms.

Interactive Videos

Video Interface

What do Instagram, Snapfish, Photobucket, and Flickr have in common? They’re photo-sharing apps. Dell, HP, Apple, and Acer? Computer brands. Facebook, LinkedIn, Twitter, and Google Plus+? Social networking sites. What do tech consumers have? Options.

Unsurprisingly, there are several interfaces for creating interactive videos, each with different options and limitations (see Figure 3.1)**.** Of the five chosen for analysis in this study, four were created and marketed for educational use. Despite being named on several educational technology blogs and lists and promoting educational uses on its own website, Hakyap's monthly fee of $500 makes it a service more suited for the corporate sector than the K-12 public educational sphere.

Three of the other interfaces – EdPuzzle, Playposit, and Vialogue – offered similar tools and options. All three allowed users to upload a pre-made video from sharing sites such as YouTube or upload a teacher-created video and then provided an embeddable link for viewing once the interactive video had been created. In terms of editing tools, EdPuzzle offered the most features, allowing users to trim the video and add text, graphic, or audio overlays. Playposit, on the other hand, only offered a cutting tool, and Vialogue had no such editing tools. EdPuzzle, Playposit, and Vialogue also shared similarities among their question-creation options. Playposit offered the most question types, including multiple choice, fill in the blank, check boxes, open ended, polls, and questions with embedded pictures. However, three of these options were only offered through the upgraded subscription with a price tag of $96 per year. EdPuzzle offered four types of questions, and Vialogue offered three. Vialogue was unique from the other two interfaces because it included a discussion/comment-based question and showed all the questions and the video simultaneously, whereas EdPuzzle and Playposit segmented the video by pausing it for each question. EdPuzzle and Playposit also gave the option for immediate question feedback, and manual and automatic question scoring while Vialogue did not. In both programs, the open ended questions could be scored manually by the teacher while the other questions were score automatically. Only EdPuzzle allowed the teacher to monitor the students' viewing time. Finally, both EdPuzzle and Playposit prevented viewers from skipping forward in the video or leaving questions unanswered. Due to the different layout of Vialogue mentioned earlier, this was not an issue for the Vialogue interface.

The Vignette Studio, a project funded by the National Science Foundation was highly customizable, even allowing users to create a branched video (where viewers can be directed to different segments of the video depending on their answer to a question). However, the customizable nature of the interface also made it more complicated to work with, requiring a downloadable Java application and a 44-page manual. Experience with computer coding may have made the Vignette Studio interface less time consuming, but since such background is not common among educators, the Vignette Studio interface was not selected for this study.

Instead, the interface EdPuzzle was selected for this study, due to its user-friendly features and education-friendly price (free). While interactive videos are probably here to stay, just like their unimodal forerunner the regular video, the interfaces on which to create them will likely change even before this paper is published; therefore, it is not the specific interface that is crucial to this study but the concept and capabilities of interactive video learning in general.

Table 3.1: *Comparison of Interactive Video Platforms*

	EdPuzzle	Hapyak	Playposit	Vialogue	Vignette Studio
Unlimited free storage	✓	✓*	up to 50 MB	✓	n/a
Video source					n/a
URL (ex. YouTube)	✓	✓	✓	✓	
Direct upload	✓	✓		✓	
Indirect upload (via Google Drive or video hosting site)			✓		
Editing tools					
Video trimming	✓		✓		
Audio overlay/slide	✓				✓
Text overlay/slide	✓	✓			✓
Graphic overlay/slide	✓	✓			✓
Type of questions					
Multiple choice	✓	✓	✓	✓	✓
Fill in the blank	✓		✓**		
Check boxes		✓	✓**	✓	✓
Open ended	✓		✓		
With picture	✓		✓		✓
Poll			✓**		
Discussion/comment board				✓	
Question feedback	✓	✓	✓		✓
Tracking					
Manual scoring	✓		✓		
Automatic scoring	✓	✓	✓		✓
Viewing time	✓	✓			
Viewing experience					
Skip back only (not forward)	✓		✓		✓
Required questions	✓		✓		✓
Sharing					n/a
Downloadable					
Link or embed	✓	✓	✓	✓	

* unlimited videos and core analytics with subscription ($500/month)
** available with subscription ($96/year)

Research-Based Instructional Design Principles

To create the highest quality learning experience possible, each of the videos adhered to Mayer's (2008, 2009) Twelve Instructional Design Principles. See Figure 3.2 for an example of the checklist used to evaluate each video and evidence of adherence from a sample interactive video that can be viewed at http://bit.ly/2nSULXS.

Video Segmentation

Each interactive video followed the same pattern: (A) introduction of the unit and target words, (B) instruction of each word, and (C) final review. Part A included a simple introduction to the unit and words, such as "This unit is about earthquakes. In this video, we will talk about five words that will help us learn about earthquakes. The words are earthquake, P-wave…" Part B was made of several subparts that were repeated for each word, including: (i) translation of the word into Spanish, (ii) direct instruction of the word meaning in English and Spanish, (iii) pronunciation and segmentation/morphemes of the word in English, (iv) examples, and (v) word derivations, if possible (ex. atom and atomic). The final review, Part C, was a comprehensive review of all the target words in the video.

Table 3.2: *Instructional Design Principle Checklist*

Instructional Design Principles (Mayer, 2009)	**Met?**	**Evidence from sample interactive video**
Coherence – extraneous words, graphics and sounds are excluded	✓	Only the most essential information is included.
Signaling – essential information/main ideas are emphasized/highlighted; may include outlines, headings, vocal emphasis or pointer words	✓	The target words are listed in the introduction; each target word segment follows the same pattern; slides have headings and are color coded.
Redundancy – subtitles are excluded, leaving only graphics and audio; only carefully selected words/phrases are included	✓	The video contains only carefully selected text.
Spatial Congruity – corresponding text and images are in close proximity	✓	Text and images are presented in close proximity
Temporal Congruity – corresponding narration and images are presented simultaneously	✓	Images and narration are presented simultaneously.
Segmenting - information is presented in small units, preferably user-paced	✓	Video length is 13:49; the video is divided into 6 segments with an average length of 2:18
Pretraining – names and characteristics of main concepts are pre-taught	✓	Students have been taught how to find and use the features of an interactive video through modeling and individual practice.
Modality – includes audio (narration) and graphics and excludes text (subtitles)	✓	Images and an audio track are included; subtitles are not.
Multimedia – includes graphics and narration (instead of narration alone)	✓	Graphics, including illustrations, photos and videos are included.
Personalization – narration is conversational in style (versus formal)	✓	The narration uses informal and simple language.
Voice – presentation is narrated by human voice with a standard accent	✓	The video is narrated by a familiar voice (the viewers' teacher).

Selection of Target Words

In an attempt to keep the videos close to ten minutes in length while still providing a comprehensive explanation of each word, four to six words were selected for each video. The target words were generally technical science vocabulary drawn from the "Key Words" section of the students' textbook. Words were selected based on their importance to the unit as well as their ability to being represented by images, animations, or videos. Of the 25 words listed in Figure 3.3, nineteen were nouns, two were verbs, and four were adjectives.

Nouns	**Verbs**
substance	dissolve
physical change	rust
chemical change	
product	
subscript	**Adjectives**
reactant	saturated
coefficient	unsaturated
solute	strong
solvent	weak
acid	
base	
pH scale	
litmus paper	
hydrogen ion	
hydroxide ion	
reference point	
speed	
velocity	
motion	

Figure 3.3: *Target Vocabulary*

Time Burden

A total of eight interactive videos were created specifically for this study (one for the pilot, one for the demonstration, four for Experiment 1, and two for Experiment 2). The time burden for video creation ranged from 80 minutes to 210 minutes, with 134 minutes as an average.

Interactive Video Statistics

Looking only at the six videos created for the experimental phase of the study, the average length was twelve minutes. Once student-initiated rewinds and pauses, processing, and response time for questions and question feedback were accounted for, the viewing time ranged from 20 to 35 minutes. The number of questions per video ranged from thirteen to 22 with nineteen as the average. Multiple choice questions were most frequently used, followed by open ended questions, as shown in Figure 3.4. Figure 3.4 depicts the correlation between the number of questions and the video length. Interestingly, the time and number of questions had an inverse relationship, with the time generally decreasing as the number of questions increased.

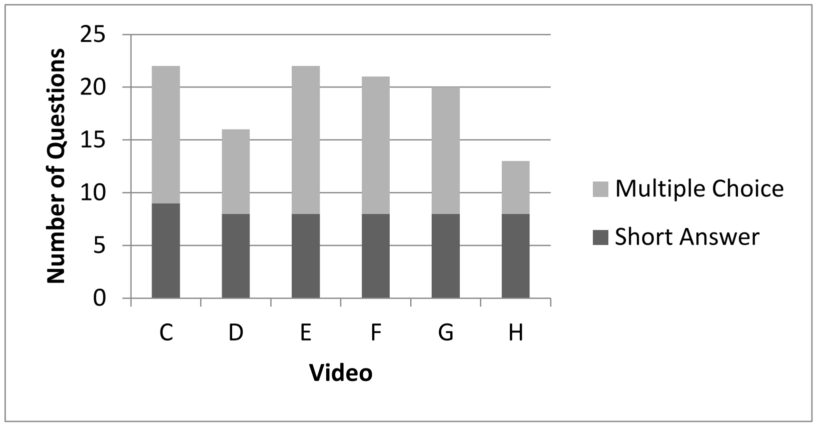

Figure 3.4: *Type of Questions*

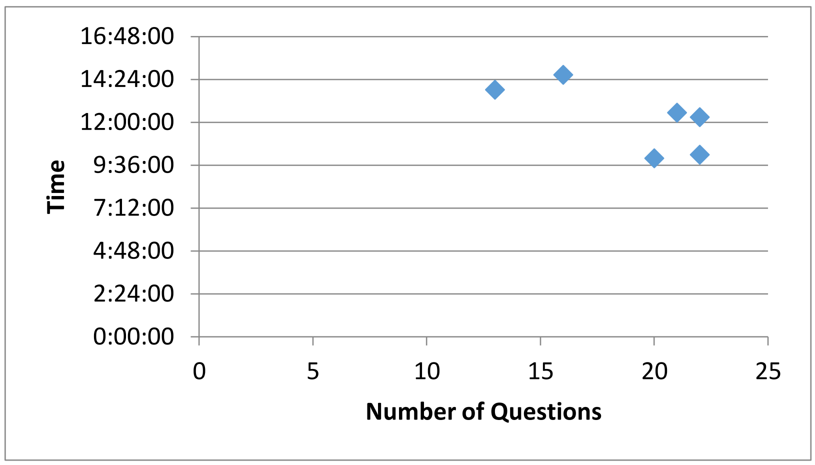

Figure 3.5: *Time vs. Number of Questions*

Hardware & Accessories for Viewing Videos

To view the interactive videos, the participants used 11.6-inch Lenovo N22 Chromebooks. The devices were not equipped with mice so the participants navigated using the 4.1 x 2.4-inch touchpad. Headphones of no particular type or brand were supplied for the audio component. The participants were required to navigate to the researcher's website to view the interactive video. Prior to the pilot, the researcher demonstrated the navigation sequence to the participants and supervised their practice. The navigation sequence was similar to that used in other classes and for other tasks in the ESL classroom. It included the following steps:

1) Power on the device
2) Log onto the device using username (ex. sallystudent@sallysschool.k12.st.us) and password
3) Click on Google Chrome icon
4) Click on the “Newcomer Science” button saved on the Bookmarks Bar

Teacher-Facilitated Direct Instruction

The teacher-facilitated portion of the experiment utilized direct instruction. Direct instruction is a method of teaching where the instructor explicitly explains the skill or concept being taught. Generally, during explicit instruction, the teacher stands in front of the class and presents information. Direct instruction is teacher-centered, as opposed to student-centered instructional methods, such as group projects, inquiries or laboratories, debates or discussion, or brainstorming. The teacher-led direct instruction in this experiment was used for pre-teaching vocabulary. In order to introduce students to new vocabulary words, and perhaps even new concepts, the teacher followed a systematic explanation of the vocabulary terms. The systematic explanation of the terms included a translation of the word in Spanish, a student-friendly definition and examples of the term within science or in other content areas, if applicable. The teacher’s direct instruction followed the same slideshow presentation that was used in the interactive video; this also included the same questions that checked understanding and reviewed the vocabulary.

Students used small whiteboards and markers to share their individual responses with the teachers and receive feedback.

Similarities to Interactive Video

The teacher-facilitated direct instruction and interactive video were similar in many ways. First, the goal of both groups was to become proficient with the selected target words. To achieve this, both groups followed the same instructional pattern – introduction, instruction of each word, and review. Similarly, the direct instruction followed the same subparts for direct instruction of the word – translation, student-friendly definition, pronunciation and segmentation, examples, and derivations. In addition, teacher-facilitated direct instruction was approximately the same length as the corresponding interactive video and used the same images and questions.

Differences from Interactive Video

The most basic difference between the experimental interactive video and the control group was the manner of instructional delivery. The interactive video was controlled by the participant, whereas the teacher-led instruction was controlled by the teacher. While the questions used in the video and the teacher-led instruction were the same, it does not mean that student-initiated questions were prohibited or ignored. Like normal classroom instruction, the flow of the lesson was sometimes impacted by student questions or needs.

Classroom Environment and Tools

Though all the participants are in the same class, the environment and tools for each group were slightly different. The teacher-led group had access to an interactive whiteboard and the instruction took place in a traditional classroom space with desks clustered in small groups of three. The interactive video group had access to

Chromebooks and headphones, and their instruction took place in a small room connected to the main ESL classroom. This room was equipped with a large rectangular table and chairs for each student.

Data Collection

In an effort to provide the most comprehensive information, this study included both quantitative and qualitative research components.

Quantitative Data

Generally, quantitative research manipulates a variable in order to determine the relationships between those variables by comparing pre-treatment and post-treatment data (Mackey & Gass, 2016). In this study, the variable was the type of vocabulary instruction; the interactive video was the experimental variable while the teacher-led vocabulary instruction was the controlled variable. Quantitative data was obtained by comparing the results of the pre-treatment test to the results of the post-treatment test. Both tests measured participants' expressive and receptive vocabulary knowledge.

Qualitative Data

Qualitative research, on the other hand, relies on descriptive data, such as observations, interviews, or journals (Mackey & Gass, 2016). In this study, qualitative data took the form of a student survey which utilized a Likert scale to gather self-reported data about students' learning, students' like/dislike of the lesson format, and the ease of use of the video.

Receptive Vocabulary

The participants' receptive vocabulary was tested before and after the treatment with a multiple choice test. One question was included for each target word, and each question included four potential answers with one correct answer. One point was awarded for each correct answer and no partial credit was given. Whenever possible, the questions were application questions that required participants to apply their knowledge of the target word, as shown in Appendices B and C. To avoid habituation, the order of questions and answers in the pre-tests and post-tests were changed, and participants were not told the correct answers or their scores until the study was completed.

Expressive Vocabulary

The participants' expressive vocabulary was also tested before and after the treatment with a translation test. To complete the test, participants were required to translate each target word from Spanish to English, as shown in Appendices B and C. One point was awarded for each correct answer, including spelling, and half credit was awarded for spelling that resembled the correct answer but was not exact. Like the receptive vocabulary test, the order of the questions was changed to avoid habituation.

Student Survey

After students of both groups completed the treatment, they answered a short, online questionnaire about their experience (Appendix A) For simplicity and understanding, the questionnaire utilized a 3-point Likert scale (disagree, no opinion, agree) and questions were in both English and Spanish. For ease of use, the questionnaire was linked at the end of the video or available from the teacher's webpage. The questionnaire sought to elicit qualitative data regarding the students' feelings about their learning and engagement in the lesson, as well their feelings about the length and speed of the video or teacher's lesson.

Procedure

Modeling and Practice

Participants were provided with an opportunity for modeling and practice before they worked with the interactive video independently. A sample video, following the same segmentation outlined above, was created and modeled by the teacher. The video also included a link to the survey, which the teacher completed in front of the class. After the participants watched the teacher navigate the video and survey and think aloud about the answers, they had an opportunity to try it on their own. The teacher circulated throughout the room to answer questions as needed. To access the practice video, the students had to navigate to the video by powering on the device, logging in, opening Google Chrome, and clicking on the appropriate bookmarked webpage. This was the same procedure the students used when participating in the treatment.

Experiment 1: Interactive Videos as a Vocabulary Pre-Teaching Tool

Before any treatments were administered, all participants completed a pencil-and-paper pre-test (Appendix B) that measured their productive and receptive knowledge of the target words. The pre-test was completed either immediately before the treatment or during the previous day's lesson.

To begin the treatment, the participants were assigned to groups, which had been randomly assigned by the researcher before the participants began the pre-test. To begin the treatment, participants in the experimental group retrieved their computers and accessories and moved to their assigned location, a small room adjacent to the main classroom, to watch the interactive video. The participants in the experimental group were supervised by a paraprofessional or high school student aide who was available to assist students with technology troubleshooting and ensure that the participants worked independently. When students were finished, they were instructed to enter to the main classroom, return their device, and work quietly on their independent study book. The teacher-researcher also had a line of sight into the room where students working on the interactive video were seated.

Participants in the control group followed a similar procedure: they were assigned to their group, received the treatment and then began work on their independent book study until all the students in the experimental group were finished. The control group received its treatment (direct instruction) from the EL teacher in the EL classroom. The direct instruction was guided by a slideshow (the same used for the interactive video) that was projected on a whiteboard, and the students used small whiteboards with markers to write their responses to questions in the lesson.

All participants completed the pencil-and-paper post-test (Appendix C) during class time on the day following the treatment. The post-test measured the participants' expressive and receptive knowledge of the target words taught in the treatment.

The experiment was repeated approximately every two weeks over an eight-week span for a total of four experiment cycles. If a student was absent during any part of the experiment cycle (pre-test, treatment, or post-test), he/she continued to take part in the treatment but his/her scores for that cycle were excluded from the data analysis.

Experiment 2: Interactive Videos for Flipped Learning

After four treatment cycles had passed and the student-participants were familiar with interactive videos, the experiment moved into phase two, flipped learning. This experiment also began with a pencil-and-paper pre-test of participants' receptive and expressive knowledge of the target words but was followed by the treatment which took place outside of the classroom. All students were part of one group which was assigned to watch the interactive video outside of class as homework. Even though many of the students did not have access to the internet in their homes, they were able, in theory, to complete the assignment during their 40-minute study hall which took place every day. A pencil-and-paper post-test was then administered two days following the pre-test, which allowed the participants 48 hours to complete the assigned interactive video. The students were required to take the post-test, regardless of whether they had completed the assigned interactive video or not.

Ethics

Several steps were undertaken to ensure the safety, anonymity, and education of the participants. First, the study was approved by the school district, and parents of the participants were informed about the details of the study and provided their consent (Appendix D). Participant data was recorded with numbers, not names, and only the researcher handled the data. Data was stored on password-protected, school-owned equipment and was destroyed within 90 days of the completion of the study.

Due to the nature of the study, it was possible that one group of students did not learn the vocabulary as effectively as the other. However, this inequality was mitigated by the high-quality general instruction that followed for all students. The general instruction included activities such as lecture, labs, group work, review, and assessment. Each experimental portion, including pre-test, video and post-test, required approximately only 20 minutes of instructional time, which was only a small portion (approximately 5%) of the comprehensive unit, consisting of approximately 400 minutes of instruction.

Pilot

Before the experimentation phase began, a pilot study was conducted. In line with the aforementioned methodology, all students completed a paper-and-pencil pre-test of expressive and receptive vocabulary, were divided into two groups for treatment (teacher-led instruction and interactive video instruction), and then completed a paper-and-pencil post-test of expressive and receptive vocabulary. The results of the pre-tests were not shared with participants until after the experiment had been completed.

The pilot served two purposes: first to familiarize the participants with the interactive video technology, and, second, to provide feedback to the researcher about the general procedure and format of the data collection instruments. The pilot was beneficial for all participants because they were able to watch modeled use of the interactive video and, later, were able to practice using the video technology with supervision and assistance from the instructor. After the modeling and practice, half of the participants viewed the interactive video independently while the other half received the same content but from an instructor in a whole-group classroom setting.

The pilot also provided valuable feedback to the researcher about the procedure and the data collection instruments. First, the pilot provided general guidance about the amount of time required for each phase of the experiment: approximately ten minutes for the pre-test, 20-30 minutes for the teacher-led instruction or interactive video, and ten minutes for the post-test. Information about the time required to complete each phase was important because the interactive video did not permit skipping. Therefore, if sufficient class time was not provided and participants failed to complete the entire video before logging off their device, they would have to start from the beginning of the video (0:00 minutes) when they began again.

In addition, the researcher noted two areas in which the interactive video required improvement. First, many students neglected to complete the student survey after finishing the interactive video. To resolve this problem, a link to the survey was provided at the end of the video along with a verbal reminder and a visual reminder (a slide that said, “Don’t forget to take the survey”). Second, participants in the interactive video group were generally less confident using the new vocabulary terms in class than participants from the teacher-led group. The researcher hypothesized that this difference may have been caused by the lack of direct feedback provided to the interactive video group. To easily and quickly remedy this imbalance, the researcher decided to provide both verbal and visual answers within the review section (for example, circling and explaining the correct answers on the slide; see Figure 3.6) as opposed to solely relying on the participant to notice correct and incorrect answers indicated by arrows, scores and red and green coloring within the interactive video questions (See Figure 3.7).

Finally, the pilot revealed an error in the data collection instrument measuring expressive vocabulary. Instead of measuring expressive English vocabulary, the instrument was inadvertently measuring expressive Spanish vocabulary by asking participants to translate words from English and write them in Spanish. This error was corrected and, thereafter, participants viewed a word in Spanish and were asked to write the English translation.

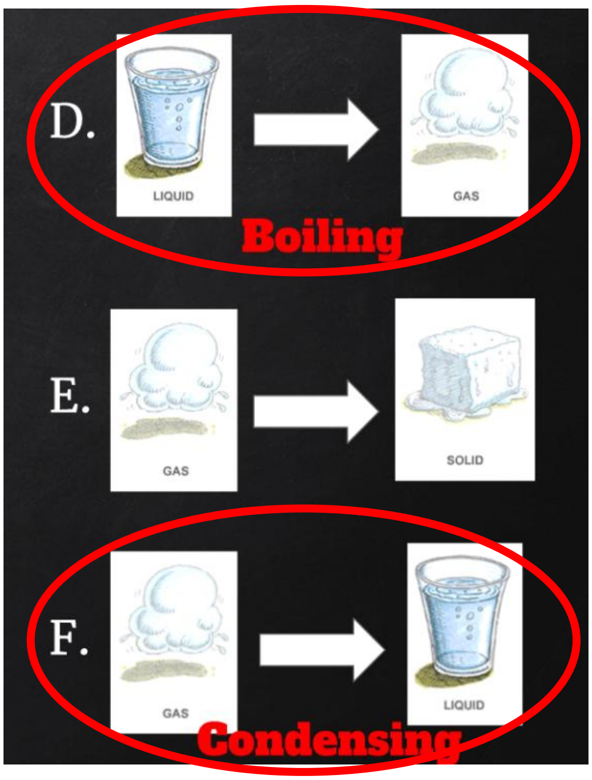

Figure 3.6: *Additional Feedback*

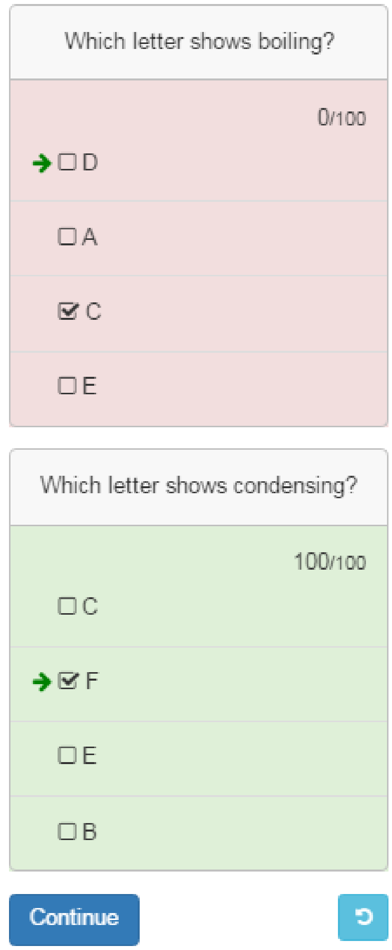

Figure 3.7: *Interactive Video Feedback*

Summary

This chapter outlined the participants, data collection tools, and procedures used to complete the experiment. It also provided details about the research paradigm chosen for the study and the experimental and control group treatments, including the video interface, design principles, segmentation, statistics, and hardware. The teacher-led direct instruction was then compared to and contrasted with the interactive video treatment. The purpose of this study has been to examine the effectiveness of interactive videos as a tool for pre-teaching science vocabulary to adolescent English language learners by answering the following research question: Are interactive videos as effective as teacher-led vocabulary instruction for newcomer ELLs learning science, and can interactive videos be used effectively in a flipped learning environment for pre-teaching science vocabulary to newcomer English Language Learners?

Chapter Preview

The next two chapters will discuss the results and conclusions, respectively. Chapter four, Results, will include analysis of both quantitative and qualitative data collected in the experiments. Finally, chapter five, Conclusions, will discuss the major findings of the study and their implications.

CHAPTER FOUR

Results

This study, which compared the effectiveness of interactive videos to teacher-led instruction for pre-teaching science vocabulary, took place in a pull-out ESL science class for 7th and 8th grade newcomers in the second semester of 2017. The first phase of the experiment, which compared teacher-led instruction to interactive video instruction, was conducted over eight weeks, with a new group of vocabulary words being introduced approximately every two weeks. The second phase of the experiment, which utilized interactive videos as a flipped learning tool, was conducted over a four-week span, with a new group of vocabulary words being introduced approximately every two weeks. In addition, both phases included a short student survey that explored ease of use, satisfaction with the mode of instructional delivery and the students' perceived learning. The results of vocabulary pre-tests and post-tests, as well as the student survey, contributed to the understanding of the research question: Are interactive videos as effective as teacher-led vocabulary instruction for newcomer ELLs learning science, and can interactive videos be used effectively in a flipped learning environment for pre-teaching science vocabulary to newcomer English Language Learners?

Teacher-led Instruction

The teacher-led instruction to pre-teach science vocabulary utilized the same content and framework (a slideshow) as the interactive video. The major difference, then, between the two types of instruction was the delivery method. The video was digital and engaged students in questions that required them to apply their learning and provided general feedback about the correct and incorrect answers to some questions. The teacher-led instruction, on the other hand, engaged students in the same application questions but was face-to-face and provided participants with personalized feedback to all questions. The nature of the teacher-led instruction also enabled the instructor to gauge student understanding and re-teach difficult concepts, while students were able to ask questions or express confusion about the topic.

Expressive Vocabulary

There were four vocabulary pre-teaching modules that utilized teacher-led instructional delivery. In each of these modules, participants demonstrated overall growth in expressive vocabulary knowledge; such growth was calculated by comparing the participants' average pre-test scores to the participants' average post-test scores. Average growth ranged from 27% to 55%, as shown in Table 4.1.

Table 4.1: *Participants' Average Scores for Expressive Vocabulary with Teacher-led Instruction*

	Average Pre-test Score	Average Post-test Score	Average Score Change
Module C	44%	73%	+29%
Module D	16%	43%	+27%
Module E	22%	75%	+53%
Module F	18%	73%	+55%

Averages, while helpful for painting an overall picture, can obscure individual outcomes. In this case, however, the change in average score rested on a solid foundation of overall individual improvement. In all four modules, which totaled 29 instances of participation, only one participant demonstrated zero growth, and no participants showed negative growth, as depicted in Table 4.2.

Table 4.2: *Participant Growth in Expressive Vocabulary with Teacher-led Instruction*

	Total # of Participants	# of Participants with Positive Growth	# of Participants with Negative Growth	# of Participants with No Growth
Module C	7	7	0	0
Module D	7	6	0	1
Module E	8	8	0	0
Module F	7	7	0	0
Total	**29**	**28**	**0**	**1**

Receptive Vocabulary

The same four modules that utilized teacher-led vocabulary instruction were also measured for participants' receptive vocabulary growth, which was calculated by comparing the participants' average pre-test scores to the participants' average post-test scores. All modules showed positive change, ranging from 18% improvement to 54% improvement in participants' average score of receptive vocabulary knowledge, as demonstrated in Table 4.3

Table 4.3: *Participants' Average Scores for Receptive Vocabulary with Teacher-led Instruction*

	Average Pre-test Score	Average Post-test Score	Average Score Change
Module C	26%	63%	+37%
Module D	21%	39%	+18%
Module E	25%	53%	+28%
Module F	32%	86%	+54%

Looking at individual growth within each module, overall receptive vocabulary growth was positive but not to the same extent as expressive vocabulary growth. In the 29 total measurements from all four modules, there were four instances of zero growth and three instances of negative growth in receptive vocabulary, as exhibited in Table 4.4.

Table 4.4: *Participant Growth in Receptive Vocabulary with Teacher-led Instruction*

	Total # of Participants	# of Participants with Positive Growth	# of Participants with Negative Growth	# of Participants with No Growth
Module C	7	6	0	1
Module D	7	4	2	1
Module E	8	5	1	2
Module F	7	7	0	0
Total	**29**	**22**	**3**	**4**

Interactive Video Instruction

The interactive video differed only from the teacher-led instruction in the delivery method. The interactive video was pre-made and recorded with the voice of the teacher speaking in a style similar to that of normal classroom instruction. Both delivery methods included the same questions, but the interactive video was only able to provide general explanations about the correct and incorrect answers and left the final synthesis up to the participant.

Expressive Vocabulary

Similar to the teacher-led instruction, there were four modules that utilized an interactive video delivery method. In each of these modules, participants demonstrated overall growth in expressive vocabulary knowledge as calculated by comparing the participants' average pre-test scores to the participants' average post-test scores. Average growth ranged from 14% to 63%, as shown in Table 4.5.

Table 4.5: *Participants' Average Scores for Expressive Vocabulary with Interactive Video Instruction*

	Average Pre-test Score	Average Post-test Score	Average Score Change
Module C	42%	68%	+27%
Module D	30%	45%	+14%
Module E	25%	45%	+20%
Module F	15%	77%	+63%

Individual growth in expressive vocabulary was also generally, though not exclusively, positive. Of the 26 instances of participation, 19 students demonstrated positive growth while six showed zero growth and one showed negative growth, as depicted in Table 4.6.

Table 4.6: *Participant Growth in Expressive Vocabulary with Interactive Video Instruction*

	Total # of Participants	# of Participants with Positive Growth	# of Participants with Negative Growth	# of Participants with No Growth
Module C	6	4	0	2
Module D	7	4	1	2
Module E	7	5	0	2
Module F	6	6	0	0
Total	**26**	**19**	**1**	**6**

Overall, expressive vocabulary learning from an interactive video format showed more variation in scores than its teacher-led counterpart, with average score improvements for interactive video instruction ranging from 14% to 63% (a difference of 49%) and individual negative or zero growth results accounting for seven of 26 total scores (27%), as compared to teacher-led instructional scores ranging from 27% to 55% (a difference of 28%) and individual negative or zero growth results accounted for one of 29 total scores (3%).

Receptive Vocabulary

Again utilizing the same four vocabulary pre-teaching modules, pre- and post-tests measured change in participants' receptive vocabulary knowledge. In this case, the average change in participants' receptive vocabulary knowledge ranged from -11% to +46% change, as depicted in Table 4.7. The negative average change in receptive vocabulary with the interactive video method is the only instance of overall negative change in the study.

Table 4.7: *Participants' Average Scores for Receptive Vocabulary with Interactive Video Instruction*

	Average Pre-test Score	Average Post-test Score	Average Score Change
Module C	50%	63%	+13%
Module D	29%	50%	+21%
Module E	43%	32%	-11%
Module F	38%	83%	+46%

Individual change within each module was reflective of the overall averages. In this case, thirteen of the 26 instances of participation yielded positive change, while seven showed zero change and six demonstrated negative change, as shown in Table 4.8.

Table 4.8: *Participant Growth in Receptive Vocabulary with Interactive Video Instruction*

	Total # of Participants	# of Participants with Positive Growth	# of Participants with Negative Growth	# of Participants with No Growth
Module C	6	3	2	1
Module D	7	3	0	4
Module E	7	2	3	2
Module F	6	5	1	0
Total	**26**	**13**	**6**	**7**

Similar to expressive vocabulary, the change in receptive vocabulary learning, as measured by pre- and post-tests, showed wider-ranging differences between modules and among participants for digitally delivered instruction than for teacher-led instruction. Average score changes for receptive vocabulary with interactive videos ranged from -11% to 46% (a difference of 57%), as compared to teacher-led instruction, in which average score changes ranged from 18% to 54% (a difference of 36%). Similarly, individual negative or zero growth scores accounted for thirteen of 26 total interactive video scores (50%) but only seven of 29 total teacher-led scores (24%).

Teacher-led vs. Interactive Video Instruction

Experiment 1, the bulk of the study, focused on the comparison between teacher-led vocabulary pre-teaching and independent vocabulary learning via interactive video.

Since the same content, framework and questions were used for both delivery methods, comparisons between the two can easily be drawn. For both teacher-led instruction and interactive video instruction, participants made greater gains in expressive vocabulary than receptive vocabulary, as displayed in Figure 4.9. This finding is contrary to previous research by Barnett, Yarosz, Thomas, Jung, and Blanco (2007) which found that receptive vocabulary learning eclipses expressive vocabulary learning in ELLs.

Table 4.9: *Average Change in Vocabulary Score for Teacher-led and Interactive Video Instruction*

	Teacher-led Instruction		Interactive Video Instruction	
	Expressive	Receptive	Expressive	Receptive
Module C	29%	37%	27%	13%
Module D	27%	18%	14%	21%
Module E	53%	28%	20%	-11%
Module F	55%	54%	63%	46%
Average	**41%**	**34%**	**31%**	**17%**

In this study, participants receiving teacher-led instruction demonstrated greater gains in both expressive and receptive vocabulary learning than participants receiving interactive video instruction; the average expressive vocabulary increase in the teacher-led group was 41% compared to 31% in the video group. The same is true of receptive vocabulary knowledge; there was a 34% increase for the teacher-led group versus a 17% average gain for the interactive video group.

Flipped Learning

After completing four modules of vocabulary pre-teaching within normal class time, participants were asked to watch two interactive videos during their study hall that pre-taught science vocabulary. Like the first phase of the experiment, the second "flipped learning" phase utilized the same type of slideshow, narration, and question feedback as the interactive videos watched during class time. Similarly, pre- and post-tests were administered, respectively, before and after the flipped learning viewing window. The flipped learning videos were assigned as homework but were not graded, and participants were aware of the formative nature of the assignment. All participants took the pre- and post-test, regardless of whether or not they had finished watching the assigned video; however, the data from the "incomplete" participants (less than 50% of the video completed) has been disaggregated from the general data.

Expressive Vocabulary

Data from two modules of vocabulary pre-teaching was gathered in the experiment. As shown in Table 4.10, the average improvement in expressive vocabulary scores for Module G was 38% and 27% for Module

Table 4.10: *Participants' Average Scores for Expressive Vocabulary with Flipped Learning*

	Average Pre-test Score	Average Post-test Score	Average Score Change
Module G	5%	43%	+38%
Module H	23%	50%	+27%
Incomplete (G)	N/A	N/A	N/A
Incomplete (H)	19%	31%	+13%

H. All participants completed the video for Module G, and the incomplete participants in Module H had an average improvement of 13%.

Individually, the majority of participants' scores in both Module G and Module H showed positive change in expressive vocabulary, as shown in Table 4.11. In the first flipped learning module, fourteen out of fifteen students scored higher on the post-test than they did on the pre-test; only one student out of fifteen showed negative change for Module G. In Module H, two participants did not complete the interactive video; one watched 0% of the video, while the other watched 40%. Of the thirteen completed participants, twelve scored higher on the post-test than on the pre-test, and one participant's score decreased between the two tests. Both incomplete participants showed positive change in their expressive vocabulary, though this change (13% or 0.5 point) was half that of the average change for completed participants (27%).

Table 4.11: *Participant Growth in Expressive Vocabulary with Flipped Learning*

	Total # of Participants	# of Participants with Positive Growth	# of Participants with Negative Growth	# of Participants with No Growth
Module G	15	14	1	0
Module H	13	12	1	0
Incomplete (G)	N/A	N/A	N/A	N/A
Incomplete (H)	2	2	0	0

Receptive Vocabulary

The change in receptive vocabulary knowledge follows the same general trend as expressive vocabulary in phase one of the experiment and the research by Barnett, Yarosz, Thomas, Jung, and Blanco (2007). As Table 4.12 illustrates, receptive vocabulary scores increased from 50% to 75% in Module G, an improvement of 25%, and similarly increased from 29% to 46% in Module H, an improvement of 17%. On the other hand, the scores of the incomplete participants in the second module decreased by an average of 25%.

Table 4.12: *Participants' Average Scores for Receptive Vocabulary with Flipped Learning*

	Average Pre-test Score	Average Post-test Score	Average Score Change
Module G	50%	75%	+25%
Module H	29%	46%	+17%
Incomplete (G)	N/A	N/A	N/A
Incomplete (H)	38%	13%	-25%

Table 4.13: *Participant Growth in Receptive Vocabulary with Flipped Learning*

	Total # of Participants	# of Participants with Positive Growth	# of Participants with Negative Growth	# of Participants with No Growth
Module G	15	8	3	4
Module H	13	9	2	2
Incomplete (G)	N/A	N/A	N/A	N/A
Incomplete (H)	2	0	2	0

The individual scores of participants' receptive vocabulary knowledge showed more variation than that participants' expressive vocabulary knowledge. In the first module, for example, nearly half (47%) of individual participants (7 of 15) had zero or negative growth of receptive vocabulary (see Table 4.13) as compared to only 7% of individual participants (1 of 15) for expressive vocabulary. The same is true of Module

H, where 31% of individual participants (4 of 13) had zero or negative receptive vocabulary growth (see Table 4.13) while 8% of individuals (1 of 13) had zero or negative expressive vocabulary growth. Both individuals who did not complete the flipped learning assignment showed negative growth in receptive vocabulary.

Interactive Videos Inside & Outside the Classroom

The design of the study also allowed for comparison between interactive video lessons completed during class time and interactive videos completed outside of class (also called flipped learning). Apart from the vocabulary words in each module, the interactive videos created for use during class time utilized the same format as those which were assigned outside of normal class time.

Table 4.14: *Participants' Average Scores for Expressive & Receptive Vocabulary with Interactive Videos Completed Inside & Outside of Class*

	Average Expressive Vocabulary Score Change	Average Receptive Vocabulary Score Change	Average Total Score Change
In-class videos (Modules C-F)	+31%	+17%	+24%
Out-of-class videos (Modules G-H)*	+33%	+21%	+27%

*Averages do not include scores of participants who did not complete the interactive video module.

Though the average total scores for interactive videos viewed in both contexts were fairly similar, flipped learning modules (those completed outside of class) held a slight, three-point advantage over interactive videos completed during class time.

Vocabulary Growth & English Language Proficiency

Another factor to consider when looking at data about vocabulary growth is the participant's English language proficiency. Since both the teacher-led instruction and the interactive video pre-teaching were primarily in English, a student's overall English language proficiency may have affected how much the student was able to learn from the lesson, despite being teacher-led or video-based.

English language proficiency level can be determined in a number of ways; for the purposes of this study, participant data was divided into language proficiency groups by standardized test scores (in this case, WIDA ACCESS or W-APT).

Expressive Vocabulary

Overall, the middle proficiency group (WIDA 1.6-2.1) had the greatest gains in expressive vocabulary overall (41%), as shown in Table 4.15. When broken down by mode of delivery, the middle proficiency group (WIDA 1.6-2.1) saw its greatest gains in expressive vocabulary from the interactive video (42%), though these gains were nearly equal to the growth from teacher-led instruction (40%). The low proficiency group (WIDA 1.0-1.5) made the greatest leaps in expressive vocabulary from the teacher-led instruction (47%) with smaller but still positive growth from the interactive video (17%). The high proficiency group (WIDA 2.1-2.7) gained equally (26%) from both types of instruction.

Table 4.15: *Average vocabulary growth by participants' English language proficiency level*

WIDA proficiency level (# of participants)	**IV Exp**	**TL Exp**	**IV Rec**	**TL Rec**	**Exp**	**Rec**	**IV**	**TL**
1.0-1.5 (6 participants)	17%	47%	22%	35%	32%	29%	19%	41%
1.6-2.1 (8 participants)	42%	40%	-1%	37%	41%	18%	21%	39%
2.1-2.7 (2 participants)	26%	26%	17%	25%	26%	21%	21%	26%

Receptive Vocabulary

In the area of receptive vocabulary, the low proficiency group (WIDA 1.0-1.5) had an average growth of 29%, the highest of the three proficiency groups. The low proficiency group also outperformed the other proficiency groups in receptive vocabulary growth from the interactive video (22%) while the middle proficiency group barely outperformed the low proficiency group in the teacher-led delivery with gains of 37% and 35%, respectively.

Teacher-led vs. Interactive Video Instruction

In general, all proficiency groups saw the greatest combined vocabulary gains from the teacher-led instruction as compared to interactive video instruction. For two out of the three proficiency groups, the average increase in vocabulary knowledge from the interactive video treatment were approximately half that of the teacher-led instruction (low proficiency, 41% teacher-led [TL] to 19% interactive video [IV]; middle proficiency, 39% TL to 21% IV).

Vocabulary Growth & Spanish Language Proficiency

While the majority of the both the teacher-led instruction and the interactive video instruction were in English, a few critical pieces, including the word itself and the definition, were in Spanish. In addition, some answers were explained briefly in Spanish and many visuals were used in both types of instruction to help participants of all language proficiencies learn the vocabulary. It is possible, then, that participants' background knowledge and general Spanish language proficiency may have impacted how much they learned from the lesson.

Table 4.16: *Average vocabulary growth by participants' Spanish language levels*

DORA Spanish language level (# of participants)	**IV Exp**	**TL Exp**	**IV Rec**	**TL Rec**	**Exp**	**Rec**	**IV**	**TL**
3rd grade (4 participants)	15%	37%	4%	15%	26%	10%	10%	26%
4th grade (5 participants)	32%	42%	20%	41%	37%	31%	26%	42%
5th grade (6 participants)	38%	43%	7%	42%	41%	25%	22%	43%

Expressive Vocabulary

In the area of expressive English language vocabulary, the group with highest level Spanish language skills (5th grade), showed the greatest improvement (41%), as depicted in Table 4.16. Disaggregating the expressive vocabulary data by delivery model, all three groups of Spanish language skill levels showed similar gains from teacher-led instruction (3rd grade, 37%; 4th grade, 42%; 5th grade, 43%). For the interactive video instructional delivery, however, participants with stronger Spanish language skills showed greater expressive vocabulary gains (32% and 38% for 4th & 5th grade, respectively) than those with weaker Spanish language skills (15% for 3rd grade).

Receptive Vocabulary

Growth in receptive English-language science vocabulary followed a similar pattern to that of expressive vocabulary. In the area of receptive vocabulary in general, groups with higher level Spanish language skills showed two to three times more growth than the lower level Spanish language group (31% and 25% growth for 4th & 5th grade, respectively, as compared to 10% growth for the 3rd grade group). All groups demonstrated greater receptive vocabulary growth from teacher-led instruction as opposed to interactive video instruction. Interestingly, however, the middle Spanish language group (4th grade) outpaced both the high group and the low group in receptive vocabulary gains from interactive videos (20% vs. 7% and 4%, respectively).

Teacher-led vs. Interactive Video Instruction

Similar to the data grouping based on English language proficiency, participants of all Spanish language levels showed greater gains from teacher-led instruction than from interactive video instruction. Participants with 3rd grade level Spanish language skills showed a 26% improvement in vocabulary from teacher-led instruction as opposed to a 10% jump from interactive video instruction; both the 4th and 5th grade level groups followed a similar pattern: 26% average improvement from interactive video instruction, compared to 42% average improvement for teacher-led instruction for the 4th grade group, and 22% to 43% for the 5th grade group.

Vocabulary Growth & General Language Proficiency

Unsurprisingly, both English and Spanish language proficiency can affect students' growth in target language vocabulary. When divided into four groups (low English/low Spanish, high English/low Spanish, high Spanish/low English, and high Spanish/high English), the differences between these groups and the effect that language proficiency may have on target vocabulary become more apparent. Figure 4.17 shows the average increase in vocabulary scores for each proficiency group (numbers in large font) as well as score differences between these groups (indicated by arrows and numbers in small font). Generally, the "vertical" difference (low vs. high Spanish language proficiency) was greater than the "horizontal difference (low vs. high English language proficiency), indicating that Spanish language proficiency may have had a greater impact on vocabulary learning than English language proficiency. This fact may not be shocking, however, considering previous research that has demonstrated the positive impact of learners' first language knowledge on the acquisition of a second language (Nagy, Garcia, Durgunoglu, & Hancin-Bhatt, 1993; Jimenez, Garcia, & Pearson, 1996; Jiang, 2004; Lugo-Neris, Jackson, & Goldstein, 2010).

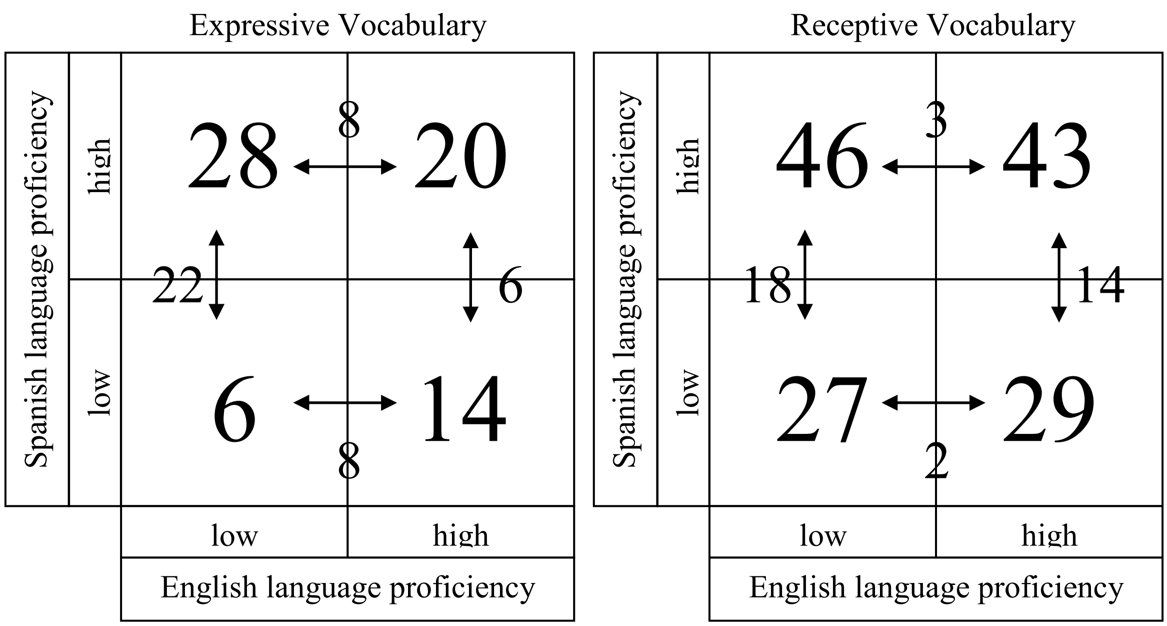

Figure 4.17: *English & Spanish Language Proficiency & Vocabulary Growth*

Student Survey

After each module, participants were asked to fill out a three to four question survey about their satisfaction with the instruction, their perceived learning and, if applicable, the technological ease of use. Response choices were based on a simple three-point Likert scale, and all questions and answers were provided in Spanish, the participants' primary language.

Teacher-led Instruction

The data from the Student Survey in Table 4.18 indicates that the participants had a generally favorable view of the teacher-led instruction. Ninety-six percent of the responses indicated that the participant liked the teacher's lesson and learned some or many new words. Only one respondent to the statement "I _______ the teacher's lesson" chose "no opinion"; similarly only one respondent to the statement "I learned _______ new words from the teacher's lesson" chose "no opinion". Eighty-nine percent of

Table 4.18: *Participant Responses to Survey*

		Teacher-led Instruction (27 responses total)			**Interactive Video Instruction (27 responses total)**			Flipped Learning (23 responses total)		
		Positive	Negative	Neutral	**Positive**	**Negative**	**Neutral**	Positive	Negative	Neutral
Satisfaction with instruction (like/dislike)	%	96	0	4	**96**	**4**	**0**	70	17	13
	#	26	0	1	**26**	**1**	**0**	16	4	3
Number of new words learned (many/few)	%	96	4	0	**96**	**4**	**0**	78	9	13
	#	26	1	0	**26**	**1**	**0**	18	2	3
Comparison to other type of instruction (like less/like more)	%	89	4	7	**70**	**22**	**7**	-	-	-
	#	24	1	2	**19**	**6**	**2**	-	-	-
Ease of use (easy/difficult)	%	-	-	-	**78**	**7**	**15**	52	0	48
	#	-	-	-	**21**	**2**	**4**	12	0	11
Readiness to use the new words (ready/not ready)	%	-	-	-	**-**	**-**	**-**	30	17	52
	#	-	-	-	**-**	**-**	**-**	7	4	12

respondents selected the statement "I liked the teacher's lesson better than watching a video about the new words" while 4% (one respondent) preferred the video and 7% (two respondents) had no opinion.

Interactive Video Instruction

The participants' satisfaction with the interactive video instruction and perceived learning are almost identical to the results of the teacher-led instruction, as illustrated in Table 4.18. Ninety-six percent of the responses indicated that the participant liked the video and learned some or many new words. Only one respondent disliked watching the video and learned few or no new words. Despite the high levels of satisfaction and perceived learning, 22% of responses (6 of 27) reported that they would prefer a teacher's lesson to a video lesson and 7% (2 of 27) had no opinion about the matter.

Flipped Learning

The results for Phase 2, flipped learning, were not as overwhelmingly positive as those of Phase 1. Seventy percent of respondents (16 of 32) expressed satisfaction with lesson while 17% chose "dislike" and 13% had no opinion. A slightly higher number, 78% (18 of 23) thought that they had learned some or many new words, 9% thought they had learned none or a few new words, and 13% had no opinion. Despite the general confidence in having learned new words, only 30% (7 of 23) answered that they were "ready to use the new words in class" while 17% reported that they were not ready and 52% had no opinion.

Summary

This chapter presented the data which had been collected to answer the research question: Are interactive videos as effective as teacher-led vocabulary instruction for newcomer ELLs learning science, and can interactive videos be used effectively in a flipped learning environment for pre-teaching science vocabulary to newcomer English Language Learners? The results revealed that, generally, participants made greater gains in expressive vocabulary than receptive vocabulary, there was a positive correlation between Spanish language proficiency and English language vocabulary gains, and teacher-led vocabulary pre-teaching was more effective than interactive video instruction.

Chapter Preview

The final chapter, Conclusions, will address the major findings, limitations, and implications of the study. It will draw connections to previous research and provide suggestions for future research.

CHAPTER FIVE

Conclusions

This study endeavored to compare the efficacy of teacher-led vocabulary pre-teaching to vocabulary pre-teaching facilitated by an interactive video for newcomer middle school ELLs. Data about participants' expressive and receptive vocabulary knowledge was gathered before and after four modules in which half the participants were taught vocabulary by a teacher, and the other half worked independently to watch an interactive video. After this phase, all participants watched two interactive video modules outside of class time to test the technology's efficacy as a tool for flipped learning.

Major Conclusions

The foremost conclusion of this study was that interactive video instruction is not as effective as teacher-led vocabulary instruction for pre-teaching science vocabulary to newcomer English language learners. Participants in teacher-led vocabulary lessons improved by an average of 38% compared to a 24% increase for participants who watched interactive videos about the same topic. That said, both treatments resulted in improved vocabulary knowledge for participants. While interactive video lessons cannot be said to be *equally* as effective as teacher-led vocabulary lessons, they also cannot be labeled as ineffective, either. Interactive video lessons for pre-teaching vocabulary are less effective than teacher-led lessons but, in all likelihood, are more effective than no vocabulary pre-teaching at all.

A second conclusion that might be drawn from the results of this study is that teacher-led and interactive video vocabulary pre-teaching leads to greater gains in expressive vocabulary than receptive vocabulary. However, this conclusion runs contrary to previous research on the topic by Barnett, Yarosz, Thomas, Jung, and Blanco (2007), who concluded that receptive vocabulary develops faster than expressive vocabulary. In this study, the data that supports this conclusion (an average increase of 36% in expressive vocabulary versus 26% increase in receptive vocabulary) may be misleading because of the way that the vocabulary pre-test and post-test were designed and scored. To complete the expressive vocabulary task, participants were required to read a vocabulary word in Spanish and then write its English translation. Participants were awarded full credit for correctly spelled answers and half credit for answers that closely resembled the correct answer but were misspelled or ordered incorrectly (for example, for the word *cambio fisico*, the answer “physical change” would receive full credit while “change physical” would receive half credit). Since there were no choices, word bank or other clues about what a correct answer might be, it was unlikely that participants who had never been exposed to the English vocabulary word would guess the answer correctly or guess closely enough to receive half credit. For the receptive vocabulary questions, however, multiple choice questions were used, meaning that even participants who had never been exposed to the English vocabulary word had a 25% chance of guessing the answer correctly. Therefore, the “luck” factor of multiple choice questions may have contributed to the smaller gains that participants made in the area of receptive vocabulary. One piece of data from this study that may support this hypothesis is the 25% decrease in receptive vocabulary scores of the two participants who did not complete the flipped learning module. Instead of “losing” knowledge, it may be possible that these participants guessed better on the pre-test than the post-test.

The correlation between Spanish language skills and gains in English language vocabulary led to another conclusion: participants with high Spanish language skills and low English language skills generally made greater vocabulary gains than participants with any other combination of English-Spanish language skills. This conclusion, of course, applies only to average *gains* and does not necessarily mean that high Spanish/low English participants outscored either the high English/low Spanish or high English/high Spanish group. Results showing a positive influence from strong first language literacy skills, however, are not unique to this study; Lugo-Neris, Jackson, and Goldstein (2010) found that students with strong first language skills showed greater gains than those with weak skills, and research by Jiang (2004) suggested that second language learners rely on first language semantic knowledge.

The results of the student survey, while generally positive overall, lead to the conclusion that the students preferred teacher-led instruction to digital instruction (either during class time or out of class as flipped learning). Interestingly, the participant reaction to in-class interactive videos was more positive than their reaction to out-of-class interactive videos (flipped learning). One possible reason might be that the students would have preferred to use their time during study hall to play games or talk with friends rather than to do homework for science class. Regardless of the reason for the students’ lower satisfaction with flipped learning, it is in line with previous research on flipped learning that also showed lower levels of student satisfaction (Missildine, Fountain, Summers, & Gosselin, 2013).

A final conclusion that can be drawn from this study is that interactive videos used outside the classroom (for flipped learning) are equally effective to those used during regular classroom instruction. While it has already been established that interactive videos are not as effective as teacher-led vocabulary instruction, the instructional time saved by pre-teaching vocabulary words outside of class (flipped learning) might counterbalance the fact that interactive videos are not as effective as face-to-face instruction.

Implications

Interactive videos, while not equally as effective as teacher-led instruction, still have potential for use in ESL classrooms. If both time and staffing allow, face-to-face vocabulary pre-teaching is ideal; however, this is not the situation in many ESL contexts. If contact time between an ESL teacher and his/her students is limited, the teacher might consider creating interactive videos to introduce students to key vocabulary before the topic is covered in class; doing so could save precious instructional time and allow teachers to cover more content, as was found in previous research on flipped learning by Mason, Shuman, and Cook (2013). Additionally, pre-teaching vocabulary outside of class might allow instructors to devote more class time to activities that are less easily replaced by digital media, such as simulations and labs, problem solving, teamwork, and higher level thinking. Moreover, interactive videos might be used to pre-teach vocabulary in situations where an ESL teacher has no face-to-face time with students. The ESL teacher could make the video and allow the content teacher to work it into the class schedule as it fits, such as during stations, small group work, or after assessments.

One possible obstacle to creating interactive videos to pre-teach vocabulary is the time required to do so. With an average creation time of 134 minutes, the interactive videos in this study required a serious time commitment. However, once the video is made it can be reused again and again without any updates. Plus, with EdPuzzle and many other interactive video creators, most questions are self-grading, which saves time on the back end of the teaching process.

Limitations

This study, while a first step in the investigation of interactive videos as a teaching tool, also has its limitations. First, the study had a limited number of participants. The same study with a larger sample size might yield different results. In addition, the study only included data from a limited period of time (eight weeks for experiment one and four weeks for experiment two). Had data been collected over several more months or even an entire school year anomalous data (positive or negative) might have had a smaller impact. In addition, the scope of the study was limited to vocabulary pre-teaching only. Participant knowledge was tested immediately before and after the pre-teaching, but no follow-up test measured participants' vocabulary knowledge at the end of the unit or even weeks later. Such data could add important information about the long-lasting effects of vocabulary pre-teaching for English language learners. Finally, the homogeneous nature of the participant pool limited the impact of the study. Using participants of different ages, first language backgrounds, levels of English proficiency and levels of first language literacy might all yield different results.

Future Research

There are many possibilities for future research involving interactive videos in the classroom and as part of a flipped learning environment. The efficacy of interactive videos might be compared to other technology, such as traditional, passive videos or other new-tech platforms made for one-to-one learning, like Nearpod. The possibilities for using interactive videos are nearly limitless as well; this study focused only on pre-teaching vocabulary, but future research might use interactive videos for activating prior knowledge, building background, reviewing, re-teaching, or enrichment. The study of interactive videos as a teaching tool might also be expanded to other groups of students, such as special education students, students with limited or interrupted formal education, or simply for mainstream classrooms. In addition, any research on flipped learning in the middle school setting would be welcome. In this age of ubiquitous technology and expanding one-to-one classrooms, teachers must be able to use technology in strategic and research-based ways.

Summary

This chapter outlined the major conclusions of this study: interactive videos are not as effective as teacher-led vocabulary pre-teaching, participant gains in expressive vocabulary knowledge may have been incidentally greater than receptive vocabulary gains because of the study’s design, the correlation between high first language skills and vocabulary gains was stronger than the correlation between second language skills and vocabulary gains, the participants were generally positive about all types of learning but preferred teacher-led instruction, and, finally, interactive videos as a flipped learning tool are equally effective as interactive videos used as a part of regular classroom instruction.

This chapter also enumerated the study's limitations, including a small sample size and homogenous participant pool, and suggested many possibilities for future research.

REFERENCES

Abraham, L. B. (2007). Second-language reading comprehension and vocabulary learning with multimedia. *Hispania, 90*(1), 98-108.

August, D., & Shanahan, T. (2006). *Executive summary. Developing literacy in second language learners: Report of the national literacy panel on language-minority children and youth.* Mahwah, NJ: Lawrence Erlbaum Associates.

August, D., Carlo, M., Dressler, C., & Snow, C. (2005). The critical role of vocabulary development for English language learners. *Learning Disabilities Research & Practice, 20*(1), 50-57. doi:10.1111/j.1540-5826.2005.00120.x

Barnett, W. S., Yarosz, D. J., Thomas, J., Jung, K., & Blanco, D. (2007). Two-way and monolingual English immersion in preschool education: An experimental comparison. *Early Childhood Research Quarterly, 22*(3), 277-293. doi:10.1016/j.ecresq.2007.03.003

Beck, I. L., McKeown, M. G., & Kucan, L. (2013). *Bringing words to life: Robust vocabulary instruction* (2nd ed.). New York, NY: The Guilford Press.

Bergmann, J., & Sams, A. (2014). Flipped learning: Gateway to student engagement. *Learning & Leading with Technology*, 18-23.

Bhagat, K. K., Chang, C., & Chang, C. (2016). The impact of the flipped classroom on mathematics concept learning in high school. *Educational Technology & Society, 19*(3), 134-142.

Bongaerts, T., van Summeren, C., Planken, B., & Schils, E. (1997). Age and ultimate attainment in the pronunciation of a foreign language. *Studies in Second Language Acquisition, 19*(4), 447-465. doi:10.1017/S0272263197004026

Chambers, B., Cheung, A. C. K., Madden, N. A., Slavin, R. E., & Gifford, R. (2006). Achievement effects of embedded multimedia in a Success for All reading program. *Journal of Educational Psychology, 98*(1), 232-237. doi:10.1037/0022-0663.98.1.232

Cheon, J., Crooks, S., & Chung, S. (2014). Does segmenting principle counteract modality principle in instructional animation?: Segmenting principle and modality principle. *British Journal of Educational Technology, 45*(1), 56-64. doi:10.1111/bjet.12021

Colorin Colorado. (2015). Vocabulary development. Retrieved from http://www.colorincolorado.org/article/vocabulary-development

Dobbs, F. (2004). *Essential elements of effective science instruction for English learners* (2nd ed.). Los Angeles, CA: California Science Project.

Dornyei, Z., & Otto, I. (1998). Motivation in action: A process model of L2 motivation. *Working Papers in Applied Linguistics*, *4*, 43-69.

French, L. M., & O'Brien, I. (2008). Phonological memory and children's second language grammar learning. *Applied Psycholinguistics, 29*(3), 463-487. doi:10.1017/S0142716408080211

Gardner, R.C. (1985). *Social psychology and second language learning: The roles of attitudes and motivation.* London: Edward Arnold.

Gibson, T., Oller, D. K., Jarmulowicz, L., & Ethington, C. (2012). The receptive-expressive gap in the vocabulary of young second-language learners: Robustness and possible mechanisms. *Bilingualism: Language and Cognition, 15*(1), 102-116. doi:10.4324/9781410612038

Ginns, P. (2005). Meta-analysis of the modality effect. *Learning and Instruction, 15*(4), 313-331. doi:10.1016/j.learninstruc.2005.07.001

Ginns, P. (2006). Integrating information: A meta-analysis of the spatial contiguity and temporal contiguity effects. *Learning and Instruction, 16*(6), 511-525. doi:10.1016/j.learninstruc.2006.10.001

Hakuta, K., Santos, M., & Fang, Z. (2013). Challenges and opportunities for language learning in the context of the CCSS and the NGSS. *Journal of Adolescent & Adult Literacy, 56*(6), 451-454. doi:10.1002/JAAL.164

Harper, B., & Milman, N. (2016). One-to-one technology in K–12 classrooms: A review of the literature from 2004 through 2014. *Journal of Research on Technology in Education, 48*(2), 129-142. doi:10.1080/15391523.2016.1146564

Hobbs, R. (2006). Non-optimal uses of video in the classroom. *Learning, Media & Technology, 31*(1), 35-50. doi:10.1080/17439880500515457

Hogan, E. (2016). Supporting vocabulary acquisition for English language learners. Retrieved from http://www.readwritethink.org/professional-development/strategy-guides/supporting-vocabulary-acquisition-english-30104.html

Hu, C. (2003). Phonological memory, phonological awareness, and foreign language word learning. *Language Learning, 53*(3), 429-462

Hummel, K. M. (2009). Aptitude, phonological memory, and second language proficiency in nonnovice adult learners. *Applied Psycholinguistics, 30*(2), 225-249. doi:10.1017/S0142716409090109

Hummel, K. M. (2014). *Introducing second language acquisition: Perspectives and practices* (1st ed.). Chichester, West Sussex: John Wiley & Sons.

Ioup, G., Boustagui, E., El Tigi, M., & Moselle, M. (1994). Reexamining the critical period hypothesis: A case study of successful adult SLA in a naturalistic environment. *Studies in Second Language Acquisition, 16*(1), 73.

Jiang, N. (2004). Semantic transfer and development in adult L2 vocabulary acquisition. In P. Bogaards & B. Laufer (Eds.), *Vocabulary in a second language* (pp. 101-126). Philadelphia: John Benjamins.

Jimenez, R., Garcia, G., & Pearson, P. D. (1996). The reading strategies of bilingual Latina/o students who are successful English readers: Opportunities and obstacles. *Reading Research Quarterly, 31*(1), 90-112.

Johnson, J. S., & Newport, E. L. (1989). Critical period effects on second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology*, *21*, 60-99.

Kalyuga, S., Chandler, P., & Sweller, J. (1999). Managing split-attention and redundancy in multimedia instruction. *Applied Cognitive Psychology, 13*(4), 351-371. doi:AID-ACP589>3.0.CO;2-6

Kartal, G. (2010). Does language matter in multimedia learning? Personalization principle revisited. *Journal of Educational Psychology, 102*(3), 615-624. doi:10.1037/a0019345

Kennedy, M., Deshler, D., & Lloyd, J. (2015). Effects of multimedia vocabulary instruction on adolescents with learning disabilities. *Journal of Learning Disabilities, 48*(1), 22-38. doi:10.1177/0022219413487406

Kester, L., Kirschner, P. A., & van Merriënboer, J. J. G. (2004). Timing of information presentation in learning statistics. *Instructional Science, 32*(3), 233-252. doi:TRUC.0000024191.27560.e3

Kester, L., Kirschner, P. A., & van Merriënboer, J. J. G. (2005). The management of cognitive load during complex cognitive skill acquisition by means of computer-simulated problem solving. *The British Journal of Educational Psychology, 75*, 71-85. doi:10.1348/000709904X19254

Kester, L., Kirschner, P., van Merriënboer, J. J. G., & Bäumer, A. (2001). Just-in-time information presentation and the acquisition of complex cognitive skills. *Computers in Human Behavior, 17,* 373-391.

Kester, L., Kirschner, P.A., & Van Merriënboer, J. J. G. (2006). Just-in-time information presentation: Improving learning a troubleshooting skill. *Contemporary Educational Psychology, 31*, 167-185.

Kim, D., & Kim, D. (2012). Effect of screen size on multimedia vocabulary learning: Multimedia learning and screen size. *British Journal of Educational Technology, 43*(1), 62-70. doi:10.1111/j.1467-8535.2010.01145.x

Laws, P., Willis, M., Jackson, D., Koenig, K., & Teese, R. (2015). Using research-based interactive video vignettes to enhance out-of-class learning in introductory physics. *American Association of Physics Teachers, 53*, 114-117. doi:10.1119/1.4905816

Lenhart, A. (2015). *Teens, social media & technology overview 2015.* Washington, DC: Pew Research Center.

Let's Go Learn. (2016). Diagnostic Online Reading Assessment [Assessment instrument]. Kensington, CA: Let's Go Learn.

Lock, R., Swanson, E., & Howerton, D. (2007). Influence vocabulary acquisition for English language learners. *Intervention in School and Clinic, 42*(5), 290-294. doi:10.1177/10534512070420050501

Long, T., Logan, J., & Waugh, M. (2016). Students' perceptions of the value of using videos as a pre-class learning experience in the flipped classroom. *Association for Educational Communications & Technology*, 60, 245-252. doi:10.1007/s11528-016-0045-4

Lowman, J. (2014). Exploring the use of podcasts and vodcasts: Multimedia tools for word learning. *Computers in the Schools, 31*(4), 251-270. doi:10.1080/07380569.2014.967622

Mackey, A. & Gass, S. M. *Second language research: Methodology and design*. New York: Routledge.

Masgoret, A.-M., & Gardner, R. C. (2003). Attitudes, motivation, and second language learning: A Meta–Analysis of studies conducted by Gardner and associates. *Language Learning, 53*(1), 123-163. doi:10.1111/1467-9922.00212

Mason, G. S., Shuman, T. R., & Cook, K. E. (2013). Comparing the effectiveness of an inverted classroom to a traditional classroom in an upper-division engineering course. *IEEE Transactions on Education, 56*(4), 430-435. doi:10.1109/TE.2013.2249066

Mayer, R. E. (2008). Applying the science of learning: Evidence-based principles for the design of multimedia instruction. *American Psychologist*, 760-769.

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). New York, NY: Cambridge University Press.

Mayer, R. E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. *Journal of Educational Psychology, 93*(1), 187-198. doi:10.1037/0022-0663.93.1.187

McLean, S., Attardi, S. M., Faden, L., & Goldszmidt, M. (2016). Flipped classrooms and student learning: Not just surface gains. *Advances in Physiology Education, 40*(1), 47.

Missildine, K., Fountain, R., Summers, L., & Gosselin, K. (2013). Flipping the classroom to improve student performance and satisfaction. *Journal of Nursing Education, 52*(10), 597-599. doi:10.3928/01484834-20130919-0300084-0

Moreno, R., & Mayer, R. E. (2002). Verbal redundancy in multimedia learning: When reading helps listening. *Journal of Educational Psychology, 94*(1), 156-163. doi:10.1037//0022-0663.94.1.156

Moreno, R., & Valdez, A. (2007). Immediate and delayed effects of using a classroom case exemplar in teacher education: The role of presentation format. *Journal of Educational Psychology, 99*(1), 194-206. doi:10.1037/0022-0663.99.1.194

Nagy, W., & Anderson, R. (1994). How many words are there in printed school English? *Reading Research Quarterly, 19*(3), 304-330.

Nagy, W., Garcia, G. E., Durgunoglu, A., & Hancin-Bhatt, B. (1990). Spanish-English bilingual students' use of cognates in English reading. *Journal of Literacy Research, 25*(3), 241-259. doi:10.1080/10862969009547816

National Institute of Child Health and Human Development. (2000). *Report of the National Reading Panel. Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction* (NIH Publication No. 00-4760). Washington, DC: U.S. Government Printing Office.

Naumann, J., Richter, T., Flender, J., Christmann, U., & Groeben, N. (2007). Signaling in expository hypertexts compensates for deficits in reading skill. *Journal of Educational Psychology, 99*(4), 791-807. doi:10.1037/0022-0663.99.4.791

Nutta, J. W., Bautista, N. U., & Bulter, M. B. (2011). *Teaching science to English language learners.* New York, NY: Routledge.

O'Brien, I., Segalowitz, N., Freed, B., & Collentine, J. (2007). Phonological memory predicts second language oral fluency gains in adults. *Studies in Second Language Acquisition, 29*(4), 557-581. doi:10.1017/S027226310707043X

Paivio, A. (2006). “Dual coding theory and education.” Pathways to Literacy Achievement for High Poverty Children, Ann Arbor, MI, 29 Sept 2006.

Patkowski, M. S. (1980). *The sensitive period for the acquisition of syntax in a secondary language* (Doctoral dissertation). Retrieved from Proquest Dissertations Publishing.

Proctor, C. P., Carlo, M., August, D., & Snow, C. (2005). Native Spanish-speaking children reading in English. *Journal of Educational Psychology, 97*(2), 246-256. doi:10.1037/0022-0663.97.2.246

Purdue University. (2016). The evolution of technology in the classroom. Retrieved from http://online.purdue.edu/ldt/learning-design-technology/resources/evolution-technology-classroom

Putman, S. M., & Kingsley, T. (2009). The atoms family: Using podcasts to enhance the development of science vocabulary. *The Reading Teacher, 63*(2), 100-108. doi:10.1598/RT.63.2.1

Qian, D. D. (2002). Investigating the relationship between vocabulary knowledge and academic reading performance: An assessment perspective. *Language Learning, 52*(3), 513-536. doi:10.1111/1467-9922.00193

Reading Rockets. (2015). *Vocabulary: An introduction.* Retrieved from http://www.readingrockets.org/article/vocabulary-introduction

Rosebery, A. S. & Warren, B. (Eds.). (2008). *Teaching science to English language learners: Building on students' strengths*. Arlington, VA: National Science Teachers Association Press.

Sadoski, M. (2005). A dual coding view of vocabulary learning. *Reading & Writing Quarterly, 21*(3), 221-238. doi:10.1080/10573560590949359

Samur, Y. (2012). Redundancy effect on retention of vocabulary words using multimedia presentation. *British Journal of Educational Technology, 43*(6), E166-E170. doi:10.1111/j.1467-8535.2012.01320.x

Sanburn, J. (2015). Here's what MTV is calling the generation after millennials. Retrieved from http://time.com/4130679/millennials-mtv-generation/

Sanchez, C. A., & Wiley, J. (2006). An examination of the seductive details effect in terms of working memory capacity. *Memory & Cognition, 34*(2), 344-355. doi:10.3758/BF03193412

Silverman, R. (2013). Investigating video as a means to promote vocabulary for at-risk children. *Contemporary Educational Psychology, 23*, 170-179.

Silverman, R., & Hines, S. (2009). The effects of multimedia-enhanced instruction on the vocabulary of English-language learners and non-English-language learners in pre-kindergarten through second grade. *Journal of Educational Psychology, 101*(2), 305-314. doi:10.1037/a0014217

Snow, C. E., & Hoefnagel-Höhle, M. (1978). The critical period for language acquisition: Evidence from second language learning. *Child Development, 49*(4), 1114-1128. doi:10.1111/j.1467-8624.1978.tb04080.x

U.S. Department of Education, Office of English Language Acquisition. (2016). *National- and state-level high school graduation rates of English learners.*

U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics. (2012). *Reading, mathematics, and science achievement of language-minority students in grade 8.* (NCES Publication No. 2012-028).

U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics. (2016). *The condition of education 2016* (NCES Publication No. 2016-144).

Verhallen, Maria J. A. J, & Bus, A. G. (2010). Low-income immigrant pupils learning vocabulary through digital picture storybooks. *Journal of Educational Psychology, 102*(1), 54-61. doi:10.1037/a0017133

Verhallen, Maria J. A. J, Bus, A. G., & de Jong, M. T. (2006). The promise of multimedia stories for kindergarten children at risk. *Journal of Educational Psychology, 98*(2), 410-419. doi:10.1037/0022-0663.98.2.410

WIDA. (2014). WIDA-ACCESS Placement Test [Assessment instrument]. Washington, DC: Center for Applied Linguistics.

WIDA. (2015). ACCESS for ELLs 2.0 [Assessment instrument]. Washington, DC: Center for Applied Linguistics.

Yang, F. O., & Wu, W. V. (2015). Using mixed-modality learning strategies via e-learning for second language vocabulary acquisition. *Journal of Educational Technology & Society, 18*(3), 309.

APPENDIX A:

Student Survey Questions

Survey Version 1 (control group, treatment #1)

	1	2	0
I _______ the teacher's lesson.	Disliked	Liked	No opinion
I learned _______ new words from the teacher's lesson.	no/few	Some/many	No opinion
I liked the teacher's lesson _________ than watching a video about the new words.	Less	More	No opinion

Survey Version 2 (experimental group, treatment #1)

	1	2	0
I _______ watching the video.	Disliked	Liked	No opinion
I learned _______ new words from the video.	no/few	Some/many	No opinion
I liked the video _________ than class activities led by the teacher.	Less	More	No opinion
The video was ________ to use.	Difficult	Easy	No opinion

Survey Version 3 (for all students, treatment #2)

	1	2	0
I _______ watching the video.	Disliked	Liked	No opinion
I learned _______ new words from the video.	no/few	Some/many	No opinion
I am _______ to use the new words in class.	Not ready	Ready	No opinion
The video was ________ to use.	Difficult	Easy	No opinion

APPENDIX B:

Sample Pre-test

A – Chemical Equations

Directions: Translate the words from Spanish to English.
Instrucciones: Traducir las palabras del Español al Inglés.

1. producto ________________________

2. súbindice _________________________

3. reactivo _____________________________

4. coeficiente _____________________________

Name: ___________________________

A – Chemical Equations

Directions: Circle the letter of the best answer.
Instrucciones: Encierra la letra de la mejor respuesta.

________ 1. The substances in the box are the
Las sustancias en la caja son los/las

a. products
b. reactants
c. coefficients
d. subscripts

$$\boxed{Fe_3O_4 + H_2} \rightarrow Fe + H_2O$$

________ 2. The substances in the box are the
Las sustancias en la caja son los/las

a. products
b. reactants
c. coefficients
d. subscripts

$$Fe_3O_4 + H_2 \rightarrow \boxed{Fe + H_2O}$$

________ 3. What is the coefficient?
¿Que es el coeficiente?

a. N
b. H
c. 2
d. 3

$$N_2 + 3H_2$$

________ 4. What is the subscript?
¿Que es el súbindice?

a. N
b. H
c. 2
d. 3

$$N_2 + 3H_2$$

APPENDIX C:

Sample Post-test

Name: ___________________________

B – Motion

Directions: Translate the words from Spanish to English.
Instrucciones: Traducir las palabras del Español al Inglés.

1. velocidad _________________________

2. punto de referencia __________________________

3. rapidez______________________________

4. movimiento ______________________________

Name: ___________________________

B – Motion

Directions: Circle the letter of the best answer.
Instrucciones: Encierra la letra de la mejor respuesta.

________ 1. Which answer is a velocity?
¿Qué respuesta es una velocidad?
a. 12 cm/s
b. 12 cm/s north
c. 12
d. 12 g/mL

________ 2. If an object's distance from another object is changing, the object is...
Si la distancia de un objeto de otro objeto está cambiando, el objeto es ...
a. a point
b. a meter
c. with velocity
d. in motion

________ 3. The formula for speed is...
La fórmula para la velocidad es ...
a. distance ÷ velocity
b. distance ÷ time
c. time ÷ distance
d. velocity ÷ time

________ 4. In this picture, the car is in motion. What is the reference point?
En esta imagen, el coche está en movimiento. ¿Cuál es el punto de referencia?
a. tree
b. man
c. car
d. air


fig. 1


fig. 2

APPENDIX D:

Consent Letter

December 1st, 2016

Dear Parents:

I am studying at Hamline University. To get my master's degree, I need to do research in our classroom. I want to use videos to help teach Science vocabulary. Hamline University has given permission for this research. Our school, Arcadia Middle School, has given permission for this research. I also need your permission.

During class in December, January, February and March we will watch specially-made Science videos and talk about Science vocabulary. I will also give the students a Science vocabulary test before and after our lessons to see what they have learned. I will report the students' test scores, but I will not use any names. No one will know who is part of the research.

The research about using videos to teach Science words will be published in a book and online. If you do not want to be in the research, that is okay. If you want to leave the research later, that is okay. You just need to tell me.

If you have questions, contact me at XXX-XXX-XXXX. You can also contact my Hamline Professor, XXXXXX at XXXXX@hamline.edu.

If your child has permission to participate in my study about the use of interactive vocabulary videos, please sign both letters. Return one to me and keep one.

Signature____________________________ Date_____________________________