Instructional Video Object-Based Learning in a Flipped Construction Management Classroom

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ABSTRACT

Traditional methods of teaching (i.e., didactic reading and lecture) remain the primary way instruction is delivered in construction management (CM) classrooms. This is true despite a growing body of literature promoting more contemporary, student-centered pedagogies that offer improvements over traditional teaching models. One of these is object-based learning (OBL), a student-centered approach that uses digital learning objects (LOs), such as videos, images, animations, mobile apps, and educational games, to facilitate deep and engaging learning experiences. One of the most common types of LO is instructional videos. Over the past quarter century, abundant research has been conducted in the field of computer science to advance the quality and reach of instructional video LOs. In contrast, a relatively small amount of research has been dedicated to understanding them in terms of their pedagogical efficacy. This is especially true for the field of CM. Very little empirical research currently exists at the intersection of CM and OBL.

This dissertation examines the ability of supplemental instructional videos (SIVs) — a specific type of instructional video that complements other forms of instruction, including in-person teaching, readings, and group work, to deliver a full learning experience — to improve both the performance and the quality of the learning experience for undergraduate CM students. The first chapter of the dissertation is introductory, providing information about the major themes of the dissertation including construction management education, OBL, SIVs, and flipped classrooms. The second chapter explores the foundational learning theories that support OBL in a flipped CM classroom. A theoretical framework is proposed that can be used by teachers to guide them as they tailor their own approach for using instructional videos. The third chapter presents an interdisciplinary synthesis of best practices for the design and development of SIVs. Using these best practices, I document the production process of SIVs for an undergraduate CM course called *Residential Construction Technologies*. The fourth and fifth chapters cover a study in which the SIVs I developed were used as teaching aids for pre-class readings in *Residential Construction Technologies*. Chapter Four centers on a repeated measures experiment that was

designed to evaluate the effectiveness of the SIVs at improving student performance. Chapter Five uses surveys and interviews to understand student perceptions of the SIVs. Overall, I found that the SIVs had little measurable effect on improving the student's grades. However, overwhelmingly, the students reported that they valued having the videos, and felt that they helped with their understanding of unfamiliar or complicated course topics. Chapter Six concludes the dissertation with a short synthesis of all chapters and summary of their major themes and findings.

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GENERAL AUDIENCE ABSTRACT

Increasingly, teacher-made instructional videos are being used as educational tools in university classrooms. Unfortunately, not much guidance is available to help teachers with this task, and many of the videos being produced today are both low quality and ineffective. This dissertation's purpose is to help teachers find an efficient way to produce effective and appealing instructional videos for their specific learning audiences. Although this work was executed in a construction management (CM) context, teachers in many fields can benefit from the research. The first major accomplishment of the dissertation is an educational framework that teachers can use to incorporate instructional videos in their own curriculums. Next, a collection of the current best-practice guidelines for the design and development of instructional videos was assembled and explained. Using the guidelines for ourselves, I produced twelve short videos on various construction topics to be used in an undergraduate CM course called *Residential Construction Technologies*. The videos were designed to accompany readings that the students were assigned to complete before coming to class. To understand if the videos were effective teaching aids, I conducted an experiment to measure whether the videos made a difference to the students' grades. Additionally, I asked the students with a survey and interviews to describe how they felt about the videos. Overall, I found that the videos had little impact in improving the student's scores. However, overwhelmingly, the students reported that they valued and appreciated having the videos and they felt that they helped with the reading topics.

DEDICATION

This dissertation is dedicated to my wife, Jessica and our daughters, Naomi, and Vivienne.

ACKNOWLEDGEMENTS

This dissertation is a result of the combined support of many dedicated and caring individuals. Foremost is my advisor, Dr. Andrew McCoy, for giving me the encouragement and space to pursue my interests. He exemplifies the professionalism, expertise, judgement, and ambition that I aspire to have. I extend enormous thanks to the members of my committee, Dr. Bradley Bowen, Dr. Josh Iorio, and Dr. Quinn Warnick. They dedicated many hours to helping me through the Ph.D. process. Their patience and attentiveness will not be forgotten. I would also like to thank Dr. Carolyn Shivers, my quantitative methods teacher. She went above and beyond to help me with the daunting task of statistical analysis on numerous occasions. Without her, this dissertation would have been a very different experience.

Finally, special thanks to my family, foremost, my incredible wife, Jessica. Without her love and support, this work would have never been possible. Nobody has shaped the way I think and work more than her. Also, to my daughters, Naomi and Vivienne, who were less helpful, but provided me with the motivation to rise early, focus, and work efficiently. Without their love and welcome distractions, these past few years wouldn't have been nearly as rewarding or fun.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF IMPORTANT TERMS

Cognitive Learning Theory is a learning theory in which knowledge results from the presentation and absorption of new information.

Constructivism is a learning theory asserting that learning is interpretive in which meaning is constructed rather than inherent.

Cognitive Load Theory is a learning theory that purports that working memory has a limited capacity.

Cognitive Theory of Multimedia Learning is a theory of how people learn from multimedia messages, specifically through words and pictures.

E-learning is the acquisition and use of knowledge distributed and facilitated primarily by electronic means.

Experiential Learning Theory: is a learning theory in which knowledge is a product of having experience.

Flipped Classroom is an instructional strategy where technology enables independent, engaging, and efficient, pre-class, and post-class learning activities to support active, mentored, and collaborative in-class learning experiences.

Learning Object is any digital resource that can be reused to support learning.

Object-Based Learning is a student-centered instructional approach that is based on the idea that people can learn from a digital learning object by exploring the object in its context.

Repeated Measures Experimental Design is an experimental method in which multiple measurements of a dependent variable are taken on single participants over two or more time periods.

Supplemental Instructional Videos are instructional videos that complement other forms of instruction, including in-person teaching, readings, and group work, to deliver a full learning experience.

LIST OF IMPORTANT ABBREVIATIONS

Cognitive Learning Theory	CLT
Construction Management	CM
Cognitive theory of multimedia learning	CTML
Experiential Learning Theory	ELT
Flipped Classroom	FC
Learning Object	LO
Learning Management System	LMS
Learning Style Theory	LST
Object-Based Learning	OBL
Object-Based Learning Model	OBLM
Repeated Measures Experimental Design	RMED
Research Question	RQ
Reusable Learning Object	RLO
Supplemental Instructional Video	SIV
Teaching Assistant	TA

PREFACE / ATTRIBUTION OF AUTHORS

This dissertation, which uses the manuscript format, consists of four self-contained chapters, bookended by an introduction and a conclusion. The four core chapters (i.e., Chapters 2,3,4, and 5) were written with publication in mind and are being prepared for publication in specific journals. The first and last chapters, the Introduction and Conclusion, will not be submitted for publication; rather they are intended only for this document. Consequently, some of the text and information between chapters inevitably repeats, sometimes verbatim, particularly between the dissertation-only introduction and conclusion chapters (1 and 6) and the others that were written for publication.

The outline below provides a brief summary of each chapter and specifies the contribution of each author. The summary also includes the target journal and the latest publication status.

Chapter 1: "Introduction"

- Summary of Contents: Overview, Background, Problem Statement, Research Questions.

Chapter 2: "Building a Theoretical Foundation for Object-Based Learning in Construction Management Education"

- Summary of Contents: Framework of foundational learning theories supporting object-based learning (OBL). Description of OBL, learning objects, and the flipped classroom.
- Contributing Authors: Andrew P. McCoy, Ph.D., Josh Iorio, Ph.D.
- Target Journal: *Review of Education Research (RER)*
- Status: Preparing for Publication

Chapter 3: "Developing Supplemental Instructional Videos for Traditional Construction Management Learning Materials"

- Summary of Contents: Description of the Cognitive Theory of Multimedia learning. Advantages and disadvantages of instructional videos. Description of supplemental instructional videos (SIVs). Current best practices for instructional video design and development. Production stages of SIVs. Recommendations for using SIVs in the classroom.
- Contributing Authors: Andrew P. McCoy Ph.D., Quinn Warnick, Ph.D.

- Target Journal: *Educational Technology Research and Development or Educational Media International*
- Status: Preparing for Publication

Chapter 4: "Evaluating the Effectiveness of Object-Based Learning in a Flipped Construction Management Classroom"

- Summary of Contents: Literature review on the effectiveness of SIVs in the construction management (CM) classroom. Execution and results of a repeated measures study on SIVs in the CM classroom.
- Contributing Authors: Andrew P. McCoy, Ph.D.
- Target Journal: *International Journal of Construction Education and Research*
- Status: Preparing for Publication

Chapter 5: "Assessing the Quality of Experience (QoE) of Object-Based Learning (OBL) in a Flipped Construction Management Classroom"

- Summary of Contents: Literature review on the perception that CM students have of SIVs in the construction management (CM) classroom. Results of a survey and interviews with CM Students about SIVs.
- Contributing Authors: Andrew P. McCoy, Ph.D., Bradley Bowen, Ed.D.
- Target Journal: *Educational Media International*
- Status: Preparing for Publication

Chapter 6: "Conclusion"

- Summary of Contents: Summary of Dissertation. Review and synthesis of general themes and findings of research questions and dissertation chapters. Reflection and moving forward.

CHAPTER 1

INTRODUCTION

Overview

As a relatively new admittee into higher education, the academic field of Construction Management (CM) is already establishing itself as a valuable addition to both academia and industry. However, despite the inaugural success of many university CM programs over the past few decades, future growth and progress are contingent upon the ability of teachers and instructional designers to meet the needs of CM learners. Unfortunately, similar to other closely-related academic fields, such as engineering education (Daramola, 2018), an accruing body of literature warns that the current, predominant instructional method in CM — traditional reading and lecturing — may be inadequate. If the standard teaching method is indeed insufficient, which teaching methods are more effective in construction education?

A review of recent literature on the topic of construction education indicates that providing an effective, transformative learning experience begins by thoughtfully examining and implementing a variety of foundational learning theories. The literature suggests that a blend of cognitive, constructivist, and experiential learning theories should inform the selected instructional approach. Further exploration of the literature reveals that one potential match to this learning theory criteria involves a new alternative pedagogy, object-based learning (OBL).

OBL is based on the idea that modularized digital learning resources, or learning objects (LOs), can be strategically deployed by teachers to provide highly efficient and focused learning opportunities. In 2021, LOs frequently take the form of carefully-produced instructional videos that can be used to enhance or supplement certain portions of the curriculum.

Scholarship posits that the OBL approach has the ability to overcome many of the challenges of traditional, reading and lecture-based teaching. In particular, OBL, in combination with other alternative pedagogies like flipped classrooms, can help teachers proportion the time spent on theoretical learning (i.e., “book learning”) to spare more in-class time for experiential learning opportunities. As will be discussed in detail shortly, OBL is currently supported by theory, but it still lacks sufficient, rigorous, evidence-based support, leaving many gaps and opportunities for future inquiry. One such gap encompasses an increasingly popular form of OBL called supplemental instructional videos (SIVs). SIVs are different from other subcategories of instructional videos because they are used to support and magnify other learning methods, mediums, and materials, but not substitute for them.

The research presented in this dissertation examines the effectiveness and impact of OBL, delivered as SIVs, in a CM context. A theoretical framework was established to underpin the pedagogical philosophy of OBL. An interdisciplinary literature review was conducted to synthesize a collection of the latest theory-based guidelines that could be used to inform the design and development of SIVs. Applying the guidelines, a batch of instructor-made SIVs was produced in preparation for an experiment designed to test the effectiveness of the SIVs as supplemental learning materials to augment pre-class readings in a CM course. The flipped classroom model — noted in the literature for being complementary with OBL and video-based learning — provided the class structure for the experiment. Surveys and interviews were used to ask students subjective questions about the impact of the SIV to help explain the findings from the experiment.

Background

The emergence of Construction Management (CM) within higher education half a century ago has served both academia and the construction industry well (Arditi et al., 2010). Before being admitted and legitimized by higher education in the mid-20th century, CM did not exist as an independent, formal degree (Arditi et al., 2010). In the 1960s and 1970s, the nascent CM discipline had been incorporated within the system of higher education but was represented by only a few small and scattered programs throughout the United States, often only as appendages to existing architecture or engineering programs (Chinowsky & Diekmann, 2004; Guggemos & Khattab, 2016). Nevertheless, in a relatively short period of time, CM proved successful, and by the early 1980s the number of independent, established programs surpassed 40 (Chinowsky & Diekmann, 2004). Today, the number of CM programs has risen to well over 100 accredited programs that collectively graduate thousands of students annually (Chinowsky & Diekmann 2004, Smith-Barrow, 2017).

The reason for the exponential growth of the CM academic field in a relatively short period of time can be ascribed primarily to economic necessity (Arditi et al., 2010). The economy required an increasingly sophisticated, college-educated construction workforce of professionals to help meet demand in the modern era (Chinowsky & Diekmann, 2004). Higher education institutions responded by providing resources and credentials to facilitate the growth of CM programs in higher education. Without these investments, the CM field might not have influenced the construction sector in the same manner (Arditi et al., 2010).

Problem Statement

Despite these university contributions, the emergence of CM as a formal degree in high education remains unfinished. This is particularly true in the domain of pedagogy. Broadly, higher education has been accused of being a complex bureaucratic network of legacy institutions (Willcox et al., 2016) that remain yoked to traditional teaching methods prioritizing the conveyance of theoretical knowledge to elevate cognitive-based learning (Behzadan & Kamat, 2013; Bernold, 2005; Friedrich et al., 2008). Correspondingly, CM departments that are newly embedded within the long-standing bureaucracy and traditional culture of higher education likewise tend to favor more traditional teaching methods (Lee, Salama, & Kim, 2016; McHenry et al., 2005). Much remains unknown about the way learners in the emerging field of CM should be educated (Holt et al., 2018; Puddicombe & Johnson, 2011). Additionally, a growing body of literature posits that predominant pedagogical approaches in CM — cognitive-based instruction emphasizing the conveyance of theory (i.e., traditional, didactic reading and lecture-based teaching) — are inadequate and need to be reconsidered (Bernold, 2005; Behzadan & Kamat, 2013; Deshpande & Salman, 2016; Friedrich et al., 2008; Holt et al., 2018; Hoxley & Rowsell, 2006; McGarr, 2009; Mukherjee et al., 2005; Rogers & Tingerthal, 2013; Rokooei & Goedert, 2015).

Central to the dilemma is the convergence of two competing learning priorities, theoretical learning and experiential learning, in the context of scarce class time and resources (Jensen et al., 2018). CM instructors must find the way to provide theoretical knowledge more efficiently, thereby allowing sufficient in-class time for active, student-centered, experiential learning opportunities (Fogarty, 2017; Rich et al., 2018).

Research Questions and Scope

Although this dissertation follows the manuscript format, in which each chapter is written to stand independently, all chapters are derived from and are unified by, a central research question: Are OBL solutions effective (i.e., answering the question: Does OBL, in the form of

SIVs, improve objective measures of student performance?) and impactful (i.e., answering the question: Does OBL, in the form of SIVs, improve the learning experience?) in a CM classroom?

Before these questions regarding student performance and the quality of experience could be answered, two precursory topics had to be examined: first, the foundational learning theories that support OBL, second, the best practices of SIV design and development. In the outline below, these broad topics have been distilled into exact research questions (RQs) to bring them within the scope and ability of research to address. Each of these RQs will comprise a single chapter of the dissertation and are ordered and organized linearly.

RQ1: In what ways do foundational learning theories inform or support the application of OBL in a flipped CM classroom? The investigation of this research question will the subject of Chapter 2: *Building a Theoretical Foundation for Object-based Learning in Construction Management Education*

RQ2: How does contemporary instructional design literature inform the design and development of SIVs for CM topics? The investigation of this research question will be the subject of Chapter 3: *Developing Supplemental Instructional Videos for Traditional Construction Management Learning Materials.*

RQ3: **Are SIVs an effective tool to support traditional learning materials in a flipped CM environment?** The investigation of this research question will be the subject of Chapter 4: *Instructional Video Object-based Learning in a Flipped Construction Management Classroom.*

RQ4: Do CM learners believe SIVs have a positive impact on the quality of their learning experience? The investigation of this research question will be the subject of Chapter 5: *The Quality of Experience of Object-based Learning in a Flipped Construction Management Classroom.*

Objectives and Purpose for the Dissertation

The primary objective of this dissertation is to identify a teaching approach that enhances learning for undergraduates in CM departments, and for learners throughout higher education more broadly. This overarching objective will be accomplished by deconstructing it into smaller, manageable objectives, or tasks, whose purposes are to answer the RQs and provide a greater understanding of:

1. The foundational learning theories that can be used to guide the selection of teaching approaches in CM education.
2. The current best practices for designing and developing instructional videos to supplement traditional teaching materials.
3. The capability of the OBL approach to improve learner performance in a flipped CM context.
4. The capability of the OBL approach to improve the learning experience in a flipped CM context.

References

Arditi, D., Asce, M., & Polat, G. (2010). “Graduate Education in Construction Management.” Journal of Professional Issues in Engineering Education and Practice, https://ascelibrary.org/doi/pdf/10.1061/%28ASCE%29EI.1943-5541.0000014

Barth, M., & Burandt, S. (2013). Adding the “e-” to Learning for Sustainable Development: Challenges and Innovation. Sustainability, 5(6), 2609–2622. https://doi.org/10.3390/su5062609

Behzadan, A. H., & Kamat, V. R. (2013). Enabling discovery-based learning in construction using telepresent augmented reality. Automation in Construction, 33, 3–10. https://ascelibrary-org.ezproxy.lib.vt.edu/doi/abs/10.1061/40704%282003%2938

Bernold, L. E. (2005). Paradigm Shift in Construction Education is Vital for the Future of Our Profession. Journal of Construction Engineering and Management, 131(5), 533–539. https://doi.org/10.1061/(ASCE)0733-9364(2005)131:5(533)

Chinowsky, P. S., & Diekmann, J. E. (2004). Construction Engineering Management Educators: History and Deteriorating Community. Journal of Construction Engineering and Management, 130(5), 751–758. https://doi.org/10.1061/(ASCE)0733-9364(2004)130:5(751)

Fogarty, J. (2017). Assessment of Flipped Classroom in Upper-Level Engineering Course. 2017 ASEE Annual Conference & Exposition Proceedings, 27635. https://doi.org/10.18260/1-2--27635

Friedrich, K. A., Sellers, S. L., & Burstyn, J. N. (2008). 9: Thawing the Chilly Climate: Inclusive Teaching Resources for Science, Technology, Engineering, and Math. To Improve the Academy, 26(1), 133–141. https://doi.org/10.1002/j.2334-4822.2008.tb00505.x

Guggemos, A. A., & Khattab, M. (2016). The Future of Construction Education: Partnering with Industry. Construction Research Congress 2016, 120–129. https://doi.org/10.1061/9780784479827.013

Holt, E. A., Chasek, C., Shaurette, M., & Cox, R. (2018). The Learning Styles of Undergraduate Students in CM Bachelor’s Degree Programs in the U.S. International Journal of Construction Education and Research, 14(1), 4–21. https://doi.org/10.1080/15578771.2017.1342718

Jensen, J. L., Holt, E. A., Sowards, J. B., Heath Ogden, T., & West, R. E. (2018). Investigating Strategies for Pre-Class Content Learning in a Flipped Classroom. Journal of Science Education and Technology, 27(6), 523–535. https://doi.org/10.1007/s10956-018-9740-6

Ke, F. (2013). Online interaction arrangements on quality of online interactions performed by diverse learners across disciplines. The Internet and Higher Education, https://doi.org/10.1016/j.iheduc.2012.07.003

Lee, J. H., McCullouch, B. G., & Chang, L.-M. (2008). Macrolevel and Microlevel Frameworks of Experiential Learning Theory in Construction Engineering Education. Journal of Professional Issues in Engineering Education and Practice, 134(2), 158–164. https://doi.org/10.1061/(ASCE)1052-3928(2008)134:2(158)

Lee, N., Salama, T., & Kim, S. J. (2016). Using the Flipped Classroom Model to Improve Construction Engineering and Management Education. 2016 ASEE Annual Conference & Exposition Proceedings, 27168. https://doi.org/10.18260/p.27168

McHenry, A. L., Depew, D. R., Dyrenfurth, M. J., Dunlap, D. D., Keating, D. A., Stanford, T. G., Deloatch, G. (2005). Constructivism: The Learning Theory That Supports Competency Development of Engineers For Engineering Practice and Technology Leadership Through Graduate Education. 7. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.564.7691&rep=rep1&type=pdf quired-course-competencies-in-mechanical-engineering

Puddicombe, M. S., & Johnson, B. (2011). Research and Theory Building in Construction Management. International Journal of Construction Education and Research, 7(2), 126–142. https://doi.org/10.1080/15578771.2011.557142

Rich, B. M., Kretschmer, D., Goldmann, C., Hettling, L., Brandt, A., & Woll, R. (2018). Praxis-Oriented Teaching of Project Management Skills for STEM Students in Higher Education. 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), 829–834. https://doi.org/10.1109/TALE.2018.8615345

Smith-Barrow, D. (2017). Majoring in Construction Gets More Popular. US News & World Report. Retrieved March 1, 2020, from https://www.usnews.com/education/best-colleges/articles/2017-08-10/weigh-a-college-degree-in-construction-management

Willcox, Karen E; Sarma, Sanjay; Lippel, Philip (2016). “Online Education: A Catalyst for Higher Education Reforms. Online Education Policy Initiative.” Massachusetts Institute

of Technology: Online Education Policy Initiative,
https://dspace.mit.edu/bitstream/handle/1721.1/103912/MIT%20Online%20Education%20Policy%20Initiative%20April%202016_0.pdf?sequence=1

CHAPTER 2

BUILDING A THEORETICAL FOUNDATION FOR OBJECT-BASED LEARNING IN CONSTRUCTION MANAGEMENT EDUCATION

Andrew F. Barnes

Target Journal: Review of Educational Research

Abstract:

As a relatively new admittee into higher education, Construction Management (CM) is confirming itself as a valuable addition to both academia and industry. However, increasingly, scholars warn that the traditional, reading and lecture-based method of teaching in CM is inadequate in a technologically, economically, and pedagogically shifting college environment. A literature review on the topic of construction education indicates that providing learners with a transformative learning experience requires a framework blending cognitive, constructivist, and experiential learning theories. Further exploration of the literature reveals that one match to this framework criteria is a new alternative pedagogy, object-based learning (OBL). Recent scholarship asserts that OBL, in combination with other pedagogies, e.g., flipped classrooms (FCs), has the ability to alleviate many of the challenges associated with traditional models of teaching. The application of OBL to CM education is currently supported in theory, but it still lacks sufficient evidence-based support, leaving gaps and opportunities for future inquiry.

Keywords: construction management, construction education, object-based learning, learning objects, flipped classroom

Introduction

The emergence of Construction Management (CM) within higher education half a century ago has served both academia and the construction industry well (Arditi et al., 2010). Before being admitted and legitimized by higher education in the mid-20th century, CM did not exist as an independent, formal degree (Arditi et al., 2010). In the 1960s and 1970s, the nascent CM discipline had been incorporated within the system of higher education but was represented by only a few small and scattered programs throughout the United States, often only as appendages to existing architecture or engineering programs (Chinowsky & Diekmann, 2004; Guggemos & Khattab, 2016). Nevertheless, in a relatively short period of time, CM proved successful and by the early 1980s the number of independent, established programs surpassed 40 (Chinowsky & Diekmann, 2004). Today, the number of CM programs has risen to well over 100 accredited programs that graduate thousands of students annually (Chinowsky & Diekmann 2004, Smith-Barrow, 2017).

The reason for the exponential growth of the CM academic field in a relatively short period of time can be accurately ascribed to economic necessity (Arditi et al., 2010). The economy required an increasingly sophisticated, college-educated construction workforce of professionals to help meet demand in the modern era (Chinowsky & Diekmann, 2004). Higher education institutions responded by providing resources and credentials to sponsor the growth of CM programs in higher education. Without these investments, the CM field might not have influenced the construction sector in the same manner (Arditi et al., 2010).

Despite these university contributions, the emergence of CM as a formal degree in higher education remains unfinished. This is particularly true in the domain of pedagogy. Broadly, higher education has been accused of being a complex bureaucratic network of legacy institutions (Willcox et al., 2016) that remain yoked to traditional teaching methods prioritizing the conveyance of theoretical knowledge to elevate cognitive-based learning (Behzadan & Kamat, 2013; Bernold, 2005; Friedrich et al., 2008). Correspondingly, CM departments that are newly embedded within the long-standing bureaucracy and traditional culture of higher education likewise tend to favor more traditional teaching methods (Lee, Salama, & Kim, 2016; McHenry et al., 2005). Much remains unknown about the way learners in the emerging field of CM should be educated (Holt et al., 2018; Puddicombe & Johnson, 2011). Additionally, a growing body of literature posits that predominant pedagogical approaches in CM — cognitive-based instruction emphasizing the conveyance of theory (i.e., traditional, didactic reading and lecture-based teaching) — are inadequate and need to be reconsidered (Bernold, 2005; Behzadan & Kamat, 2013; Deshpande & Salman, 2016; Friedrich et al., 2008; Holt et al., 2018; Hoxley & Rowsell, 2006; McGarr, 2009; Mukherjee et al., 2005; Rogers & Tingerthal, 2013; Rokooei & Goedert, 2015).

In addition to the forces of bureaucracy and institutional culture that keep higher education tethered to traditional teaching approaches, in recent years finance is likewise proving itself to have considerable influence on teaching. Human educators are expensive and getting more expensive with time, even though they already account for the greatest cost in higher education (Neuman, 2017). Meanwhile, over the past two decades, state and local financial support for higher education has been in precipitous decline (Neuman, 2017; Picciano et al., 2010). Reactively, publicly funded research universities have prioritized hiring professors with a strong record of winning grant money over those with a reputation for good teaching (Picciano et al., 2010). By necessity, these conditions transfer large portions of the teaching responsibilities to the unproven academic echelon of graduate students and teaching assistants (Picciano et al., 2010). This all points to the increasingly urgent need for pedagogical innovations that can alleviate instructors of some of their teaching responsibilities while maintaining a high level of quality in a cost-sensitive environment.

Evidence suggests that the academic field of CM is distinct from others (Puddicombe & Johnson, 2011) and that CM learners tend to respond positively to an instructional design that is tailored specifically for CM subject matter (Jensen & Fischer, 2006). With the standard, traditional teaching approach considered inadequate for CM learners and other construction-related fields, the ensuing question is: which teaching methods are capable of delivering effective and transformative learning experience to construction learners (Daramola, 2018)?

Transformative learning "shape[s] people and re-orientate their minds" though "providing ...individual[s] the opportunity to acquire experience, question some assumptions during the learning and reflect on them at the later stage" (Daramola, 2018, p. 2). Delivering a transformative learning experience to a specific audience begins by tailoring a theoretical framework that can be used to inform the selection of a teaching approach (Daramola, 2018; Fellows & Liu, 2015). A review of the literature reveals that one method frequently used to build effective theoretical frameworks involves extracting and assembling elements from a variety of foundational learning theories, rather than only one. This combination-of-theories method has been used frequently in previous education literature (Baruque & Melo, 2004; Bishop & Verleger, 2013a; Daramola, 2018; Klassen, 2006; Lam et al., 2016; Marzano et al., 2001; McWhirter & Shealy, 2018; Ozdamli & Asiksoy, 2016; Ritzhaupt, 2010; Tennyson & Rasch,

1988) as a way for practitioners to avoid the limitations of a more-restrictive, single-theory approach.

Building from recent work in engineering education by Daramola (2018), this paper proposes a new framework for CM based on the combined theories of cognitive learning theory (CLT), experiential learning theory (ELT), and constructivism. The first half of the paper analyzes and describes the contributions of each of the theoretical framework's constituent theories (i.e., CLT, ELT, constructivism) for a CM context. The second half outlines one way the proposed theoretical framework may be operationalized through a combination of emerging and innovative teaching methods: object-based learning and a flipped classroom.

Looking to Engineering Education: Combining CLT, ELT, and Constructivism

Scholars in fields adjacent to CM, namely engineering education, have pointed out the deficiencies of traditional teaching approaches (Fogarty, 2017; McHenry et al., 2005; Prince, 2004) and are currently working to find better alternatives through blended theoretical models. Daramola (2018) proposed the combination of both cognitive learning theory (CLT) and experiential learning theory (ELT) to deliver transformative learning in engineering education, as shown in Figure 2.1.

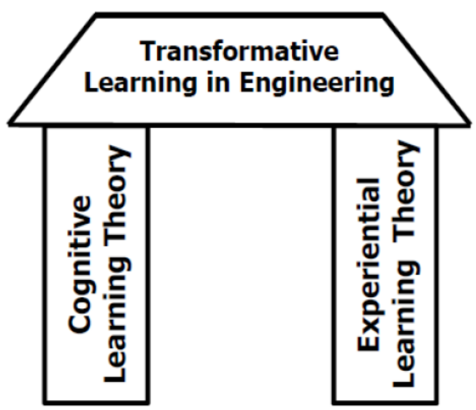

Figure 2.1 Cognitive Learning Theory (CLT) and Experiential Learning Theory (ELT) proposed as the "the two strong pillars of the transformative learning in engineering education and training" by Daramola (2018, p. 2).

For CM, however, Daramola's framework is incomplete. Recent literature has touted constructivism, a modern variation of classical cognitivism, as a critical element of learning in

CM (e.g., Graham & Thomas, 2008; Hartmann et al., 2010; Hedden et al., 2017; McWhirter & Shealy, 2018). For instance, Hartmann et al., writes that "CM [is] a discipline that requires students to solve sociotechnical problems by collaboratively engaging in a social process of knowledge production and sense-making. That is in line with the constructivist view of learning..." (2010 p. 255). Hence, in this paper, Daramola's framework has been adapted to include elements of constructivism in alignment with this recent trend of constructivism in CM academic literature as shown in Figure 2.2.

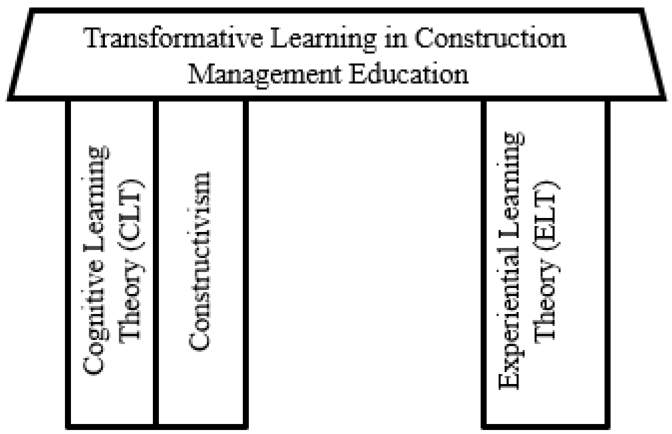

Figure 2.2 Cognitive Learning Theory (CLT), Constructivism, and Experiential Learning Theory (ELT) acting in unified interdependence to sustain the transformative learning experience in CM education. (Adapted from Daramola, 2018)

Cognitive Learning Theory

The CLT model, founded on the theory of cognitivism, is a broad theory that is defined by its divergence from behaviorism — the idea that learning is primarily motivated by external stimuli (Perry, 1999). Thus, in contrast with behaviorist theory, CLT emphasizes the intrinsic motivations (Perry, 1999) and internal mental processes (i.e., receiving, organizing, storing, and retrieving information) that are necessary for acquiring knowledge (Ertmer & Newby, 1993). At its core, CLT asserts that knowledge is the result of being presented with new information and then absorbing it (McHenry et al., 2005). The cerebral focus of CLT serves learners by helping them navigate the complexities of thinking, diagnosing, communicating, conceptualizing, and information processing (Snelbecker, 1974). Hence, in a classroom in which CLT is applied, as learners are presented with new concepts, ideas, and theories, and the scientific processes by which they are generated, they start to develop the intellectual skills that guide information gathering, theory-building, and problem-solving.

For CM learners, cognitive skills (e.g., critical thinking and problem-solving) promoted by CLT help foster the intellectual dexterity that is required to solve real-world problems. Construction workforce professionals are routinely exposed to a wide array of unprecedented challenges. Resolution to these challenges depends, in part, on a construction professional's mental abilities to collect and process available information in order to produce theory-based solutions and then apply them (Pears et al., 2012). For example, figuring out how to stage a large and complex commercial construction project in a densely populated urban environment surrounded by other commercial, residential, and civil infrastructure is a problem many CM students will eventually face. Intellectual competency developed through cognitive training prepares them for assignments like this.

Historically, cognitivism in the construction classroom has taken the form of traditional, teacher-centered instruction (i.e., lecture-based teaching), in which a teacher spends considerable class time disseminating theory to learners (McHenry et al., 2005). Lecture-based teaching, however, is not synonymous with cognitive-based learning. Lecture-based teaching is merely one highly-criticized delivery method rooted in cognitivism. Increasingly, lecture-based teaching is being branded as ineffective, as well as time intensive, garnering calls for reform away from the method (Baruque & Melo, 2004; Behzadan & Kamat, 2013; Deshpande & Salman, 2016; Friedrich et al., 2008; Stewart et al., 2009). Regardless of criticisms against lecturing, evidence demonstrates unambiguously that cognitive-based learning remains an important part of the learning experience (Douglas, 2011; Mayer, 2014; Research and Teaching, 2018) to help learners develop higher-order thinking skills (Bincy & Raja, 2015). Thus, CLT's documented effectiveness does not exonerate the lecture-based teaching method, but it does help to explain its modern resilience despite so many emerging pedagogical alternatives (McHenry et al., 2005).

Constructivism

Since its conceptualization about a century ago (Liu & Chen, 2010) constructivism has emerged as the predominant pedagogical rival to the traditional learning approach, i.e. lecture and text-book learning (Klassen, 2006). Building on the foundation of classical cognitivism, constructivism is a branch of student-centered cognitivism (McHenry et al., 2005; Stewart et al., 2009; Swan, 2005; Tangdhanakanond et al., 2006) that accounts for both individual context and existing knowledge in the learning process (Ertmer & Newby, 1993; McHenry et al., 2005). To provide a definition, constructivism is

> a poststructuralist psychological theory...that construes learning as an interpretive, recursive, nonlinear building process by active learners interacting with their surround[ings] — the physical and social world. It is a psychological theory of learning that describes how structures, language, activity, and meaning-making come about, rather than one that simply characterizes the structures and stages of thought, or one that isolates behaviors learned through reinforcement (Fosnot, 2005, p. 34).

As with cognitivism, constructivist learning remains a mental activity, but rather than learners absorbing information by the "passive transfer of facts" (Ertmer & Newby, 1993 p. 62), new knowledge aggregates with, and enhances, an individual's existing knowledge (Tempelman & Pilot, 2011). In essence, learners create meaning for themselves rather than attempting to extract it from outside sources (Fosnot, 2005). Hence, according to constructivism, learning can be described as the perennial adjustment of a learner's existing mental framework to accommodate new deposits of knowledge and experiences (Lohani et al., 2011; McHenry et al., 2005).

The constructivist model's emphasis on additive and adaptive learning aptly match the needs of CM learners who are in, or preparing to join, the modern CM workforce (Jones, 2018). For example, the constructivist model trains CM learners to keep up with advancements in technology of the modern construction industry (McHenry et al., 2005). This technology comes in the various forms of devices, equipment, systems, processes, policies, human networks, and infrastructure (Pearson & Ollis, 2006). Constructivist learning theory caters to learners in this shifting technological environment by helping them develop the mental framework necessary to embrace change with openness and agility. Constructivism also prepares CM learners for constant variation between projects. No matter how similar two construction projects are in design, they are never exactly alike. Each project is unique in location, materials, time, environmental conditions, labor, or all of the above. Thus, CM professionals are constantly needing to adapt to project variability by relying on a learning framework that accounts for their previous knowledge and experience.

Despite the effective record of both cognitivism and constructivism, these cognitive-based learning models alone are not without their shortcomings (Jonassen, 1991). In CM education, cognitive-exclusive instruction is insufficient because, logically, CM is not an exclusively cognitive activity. CM is highly applied. Many CM professionals depend on their past experiences for guidance in handling current problems. Thus, increasingly, research advocates for the inclusion of experiential learning as part of an effective instructional design for construction fields (Daramola, 2018; Lee et al., 2008; Pedro et al., 2016; Quinn et al., 2019).

Experiential Learning Theory

ELT is a learning model that complements cognitive learning models (Kolb, 1984; Kolb, Boyatzis, & Mainemelis, 2014; Kolb & Kolb, 2009) by helping learners personalize, internalize, and retain information that can be retrieved for productive application in real settings (Lee et al., 2008). David A. Kolb, the originator of ELT, defined learning "as the process whereby knowledge is created through the transformation of experience" (Kolb, 1984, p. 38). ELT emphasizes the role of direct, personal experiences in the learning process, which means having unmediated, personal exposure to an event that can afterward be translated into knowledge (Kolb, et al., 2014).

The key to understanding the ELT model is distinguishing a direct learning experience from a conveyed learning experience (Kolb & Kolb, 2013). Direct learning experiences are always personal and probably more meaningful experiences, while conveyed learning experiences, delivered by cognitive-based pedagogies, come by learning from other people's experiences. To illustrate with an example of this difference, directly experiencing a movie means watching it in person, while a conveyed experience would be reading about the movie from a critic's review. Or, in a construction context, hearing about the erection of a tower crane is quite different than experiencing the event firsthand.

Lee et al. (2008) wrote "the construction industry may be considered one of the experience-oriented enterprises where [learners] need experience associated with the general knowledge" (p. 160). ELT serves CM learners by providing an experience-based, professional context where they can draw knowledge, examine the theory, reflect, and, most importantly, develop a professional identity. By the ELT model, instead of leaving college having only learned something, CM learners will have become something (Lohani et al., 2011). This professional “becoming” happens in college through experiential classroom time and internships that emphasizes praxis (i.e., practicing theory), using technology, setting goals, solving problems, and making decisions (Kolb, 1984; Kolb & Kolb, 2013), which are all important skills for a competent CM professional to master.

Finding a Pedagogical Solution for the CLT/ELT/Constructivist Framework

While the CLT/ELT/constructivist framework as presented in Figure 2.2 above offers solutions to many of the persistent issues with traditional teaching methods, it poses a new challenge for any practitioners who may attempt to apply the theoretical framework (Jensen et al., 2018). Central to the dilemma is the convergence of two competing learning priorities, theoretical learning and experiential learning, in the context of scarce class time and resources (Jensen et al., 2018). CM instructors must find a way to provide theoretical knowledge more efficiently while maintaining an acceptable level of quality, thereby allowing sufficient in-class time for active, student-centered, experiential learning opportunities (Fogarty, 2017; Rich et al., 2018). The remainder of this paper discusses the possible application of this theoretical framework in Figure 2.2 through one pedagogical solution: object-based learning (OBL) in a flipped classroom (FC) environment. As illustrated in Figure 2.3 below, the combination of foundational learning theories (i.e., cognitive, constructivist, and experiential) synergistically supports OBL in a flipped classroom (FC) environment to facilitate a transformative learning experience for construction learners.

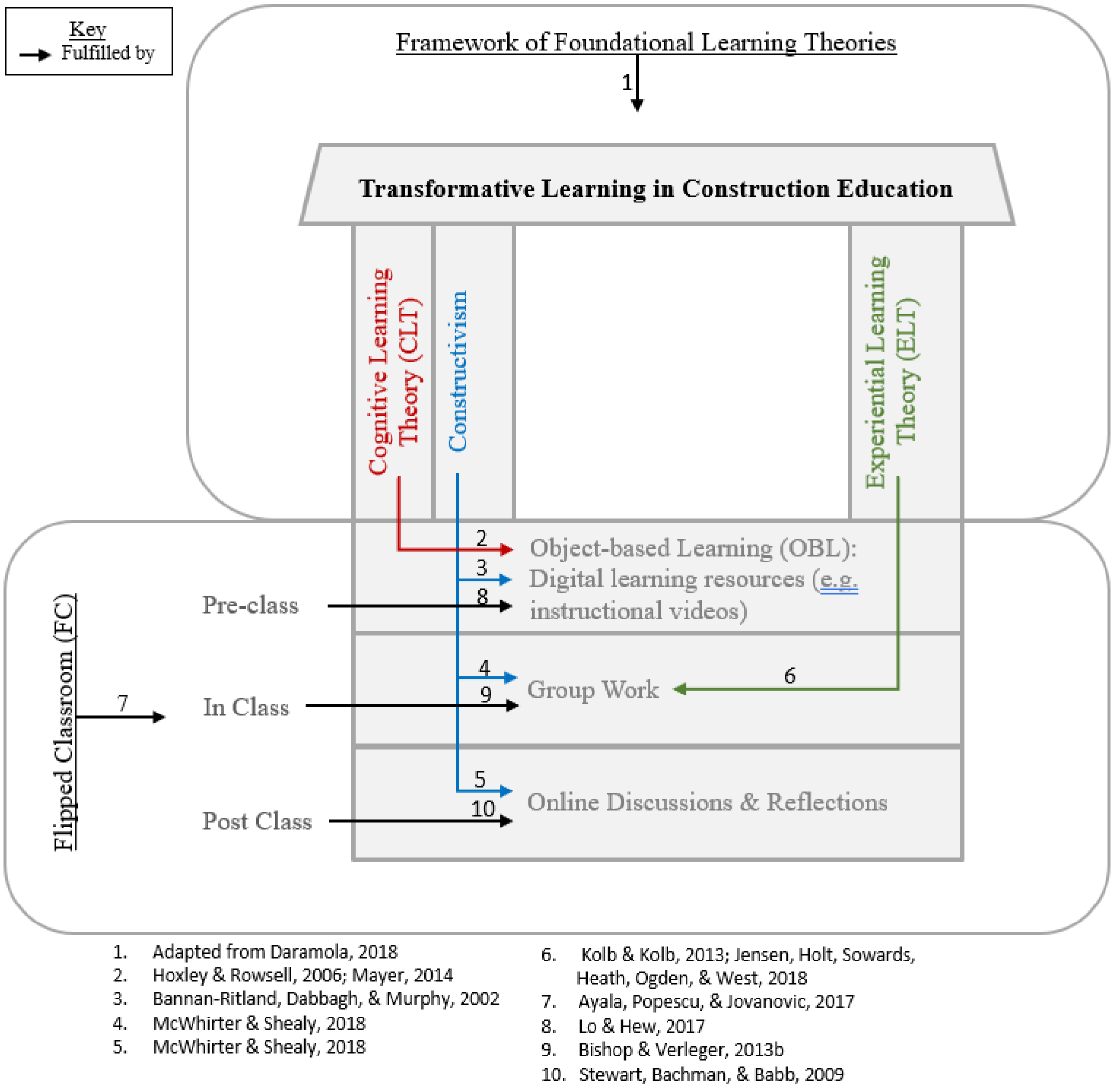

Figure 2.3 An educational framework outlining how OBL in a FC is supported by foundational learning theories (i.e., cognitive, constructivist, and experiential) to provide transformative learning opportunities for CM students.

Object-Based Learning

The opportunities presented by the modern e-learning environment, coupled with the deficiencies of the traditional teaching approach, have cultivated the development of new digital pedagogies (i.e., technology-enabled teaching approaches). One of these, that had been forecasted to help usher in meaningful reforms in higher education generally (S3 Working Group, The Masie Center, e-Learning Consortium, 2002; Wiley, 2002), and CM specifically (Lee et al., 2003) is object-based learning (OBL). OBL, from its origins as physical artifacts in museums (Chatterjee & Hannan, 2016), is “an instructional strategy that is based on the idea that people can learn from an object by exploring the object in its context” (Lee et al., 2003 pg. 1). It is part of the growing family of alternative, student-centered teaching approaches which include problem-based learning, outcome-based education, inquiry-based learning, game-based learning, project-based learning, flipped classrooms, blended learning, workshop teaching, and competency-based learning, to name a few.

OBL has many strengths, ranging from improving the accessibility of educational materials to content customization (Griffith, 2003). It has been widely applied in e-learning (Kiaw et al., 2016) and is recognized across many academic fields in most institutions of higher education (Griffith, 2003). The OBL method has even been employed in some large commercial and private organizations (e.g., Cisco) as part of their corporate training programs (Hoe & Woods, 2010). Possibly the greatest feature of OBL is its versatility and compatibility with other pedagogies to “make instructional resources more efficient and promote learners’ intrinsic motivation for learning” (Hoe & Woods, 2010 p. 640).

While an authoritative, universally-accepted definition of OBL has not yet received widespread adoption, OBL can be described as an active, student-centered teaching approach (Rockenbach, 2011) that engages learners by “decomposing existing course material” (Goh et al., 2014 p. 1) into manageable, modularized portions of instruction that are delivered as either digital (Wiley, 2002) or, less commonly, as physical (Chatterjee, 2011) artifacts called learning objects (LOs).

Learning Objects

Central to OBL are learning objects (LOs), instructional tools that experts hypothesize to become powerful enough that, under the proper conditions, “teaching and learning as we know them are certain to be revolutionized” (Wiley, 2002, pg. 20). Some examples of these LOs include animations, videos, simulations, educational games, multimedia texts, electronic text, web sites, images, movies, or mobile apps that can be used for educational purposes (McGreal, 2004). Recognizing the potential of LOs, the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) believed it was important to build the legitimacy of LOs by authoring a formal definition. Their definition states that a LO is “any entity—digital or non-digital—that may be used for learning, education, or training” (IEEE, 2002 pg. 3).

Although the IEEE’s definition helped legitimize the new instructional tool and “facilitate the widespread adoption of the learning objects approach” the intentionally broad nature of the definition diluted its usefulness (Wiley, 2002, p. 4). In essence, by the IEEE definition, essentially all nouns, real, abstract, or virtual, can reasonably be considered LOs. For example, a historical event, like the Civil War, or a historical figure, like Abraham Lincoln, could be considered a LO (Wiley, 2002). As an improvement to the IEEE definition, David Wiley, editor for the Agency for Instructional Technology and Association for Educational Communication and Technology proposed a more exact definition which is “any digital resource that can be reused to support learning” (Wiley, 2002, p. 6). By Wiley’s definition, only LOs that are digital in nature, and thus accessible via the internet (Ritzhaupt, 2010), are considered true LOs. Without discounting the effectiveness of physical, non-digital LOs (Chatterjee, 2011), this research uses Wiley’s definition, as previously done in other publications, that narrows LOs to only those that are digital in nature (Atif et al., 2003).

Notably and productively, throughout his work, Wiley (2002) repeatedly emphasizes online instructional videos as tangible examples of LOs. Additionally, the FIPSE/LAAP definition seconds this pattern by directly naming “on-line...video” directly inside its definition of LO (Chitwood et al., 2000, p. 14). By providing concrete, straight-forward definitions and guidance, these authoritative sources have helped practitioners ground OBL theory in real classrooms and coordinate OBL solutions with other pedagogical interventions, like flipped classrooms (FCs), and others.

OBL and the CM Learning Theory Framework

Though somewhat obscure presently, the OBL approach shows considerable promise and is a close match to the established theoretical framework in Figure 2.2. As discussed, the literature indicates that an effective pedagogical framework in CM should combine the mental fitness emphasized by CLT, the adaptive competence emphasized by constructivism, and the experiential context emphasized by ELT. Furthermore, for any proposed pedagogical alternative to work, it must take into account the educational and technological conditions of the learning environment. OBL fulfills these criteria in a variety of ways.

Briefly, regarding CLT, scholarship indicates that OBL can "provide learning support at a cognitive level" to improve learner engagement, reduce distraction, and mind-wandering (Willcox et al., 2016, p. IX). In accordance with constructivist theory, OBL facilitates an additive learning experience in which learners are presented with discrete, organized bundles of information and are then expected to link them into a coherent, unified idea (Adams et al., 2010; Atif et al., 2003; Wiley, 2002). Also, as promoted by constructivist theory (McHenry et al., 2005), the e-learning technology itself helps to improve the quality of learning (Ruiz et al., 2006; Willcox et al., 2016) by allowing learners greater flexibility and control to direct their own learning experiences according to their own style and pace. OBL supports ELT by providing learners first-hand exposure (Kolb et al., 2014) to events and artifacts that stimulate learning. And it enables instructors to spend more of their time customizing learning experiences through increased interactions with their students (Christensen 2017; Willcox et al., 2016).

The meager literature that exists to date at the intersection of both OBL and CM education seems to indicate that CM learners are well-positioned to benefit from the OBL approach. One research team hypothesized that "the object-based learning method can offer many advantages to training in the construction industry, especially teaching construction activities that consist of various construction methods, equipment, materials, and costs" (Lee et al., 2003, pg. 2). Despite literature like this promoting OBL in theory, the approach currently lacks adequate, rigorous, evidence-based support (Kay, 2007; Lau & Woods, 2009; Lockyer et al., 2009). Furthermore, what scanty empirical evidence that has been collected on OBL generally is too thinly spread across various, unrelated disciplines (e.g., statistics, biology, general education) making it difficult to apply specifically to CM education, creating a gap and opportunity for future research (Hoxley & Rowsell, 2006; Wiley, 2008).

The Flipped Classroom: A Supporting Context for Object-Based Learning

Like many other fields, over the past decade the flipped classroom (FC) strategy has gained momentum in CM education as instructors search for ways to create an in-class learning environment that is more conducive to active and experiential learning (Burgett, 2014; Lee, Lee, & Kovel, 2016; Lee, Salama, & Kim, 2016; Rogers & Tingerthal, 2013). Although many variations and interpretations of FC literature share common themes, to date, a single, formal definition of the FC has yet to achieve widespread adoption (Abeysekera & Dawson, 2015).

Recognizing this, Abeyskera and Dawson (2015) gathered "lowest-common denominator" characteristics from the literature that could be used to help guide the construction of a universal definition (p. 6). These are: 1) active, student-centered, peer learning, 2) the rearrangement of conventional pre-class, in-class, and post-class activities so that most information transmission happens outside of class time, and 3) the use of supplemental technology, especially video for pre-class instruction (Abeysekera & Dawson, 2015). Scholarship has further clarified that a FC is not merely synonymous with e-learning, distance, online or computer-aided learning, a substitution of a human instructor with technology, or a student doing homework or studying independently (Ozdamli & Asiksoy, 2016).

Thus, to provide a definition of the FC for the CLT/ELT/Constructivist framework in Figure 2.2, I drew upon the current descriptions and characteristics of the FC from literature (Abeysekera & Dawson, 2015), and borrowed heavily from the definition of "flipped learning" (Yarbro et al., 2014) and other definitions (Ayala et al., 2017; Bishop & Verleger, 2013b; Bowen et al., 2012; Jensen et al., 2018; Kelly et al., 2009; Kozma, 1991; Lo & Hew, 2017; Sever et al., 2013). In this research the FC is defined as a student-centered instructional approach in which technology enables independent, engaging, and efficient, pre-class and post-class learning activities that allow teachers to engage learners in active, mentored, collaborative in-class learning experiences that can be used to build knowledge. Figure 2.4 illustrates a simple, adapted model of a FC that conforms with this definition.

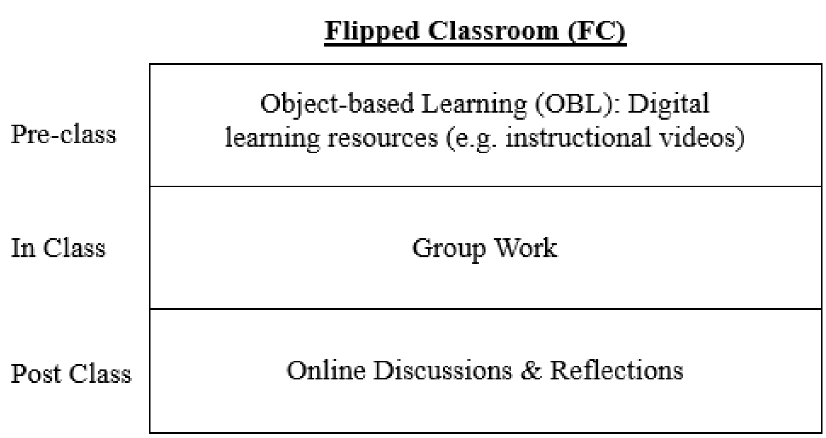

Figure 2.4 Simple, proposed model of a FC using OBL (Adapted from Lo & Hew, 2017)

When combined, OBL and FC are interdependent. FCs rely on e-pedagogies like OBL for outsourcing in-class lectures to pre-class activities (Abeysekera & Dawson, 2015). Reciprocally, OBL depends on supporting contexts, like FCs, for propagation (McGreal, 2004). Combined with OBL, the FC completes the cognitive learning theory (CLT), constructivist, and experiential learning theory (ELT) framework (Figure 2.2). Regarding CLT, according to Bloom's Revised Taxonomy (2001) the FC serves learners by reserving higher levels of cognitive learning (i.e., application, analysis, synthesis, evaluation) for in-class time (Gilboy et al., 2015) while they are being mentored in an active and collaborative environment (Brame, 2013). Regarding constructivism, "constructivism believes learning is a social activity" (McWhirter & Shealy, 2018, p.3) making the active and collaborative group work of the in-class activities of the FC highly consonant. Furthermore, because constructivist learning theory is based on the idea that learners create meaning for themselves through authentic work tasks (Fosnot, 2005), pre-class preparation for in-class group work converts into a meaningful activity as well. Regarding ELT, which is founded upon the view that learning comes by doing, the FC conforms definitionally to this foundational theory by allocating nearly all of in-class time for active, experiential learning (Lo & Hew, 2017).

Conclusion

In the pedagogically (Behzadan & Kamat, 2013), economically (Neuman, 2017), and technologically (Bond et al., 2020) shifting college environment, the traditional, reading and lecture-based instructional method is insufficient to deliver a transformative learning experience for construction management (CM) learners. Following a review of the literature, I proposed a theoretical framework in Figure 2.3 adapted from one used in engineering education (Figure 2.2) (Daramola, 2018). This adapted framework is composed of a variety of foundational learning theories including cognitive learning theory (CLT), constructivism, and experiential learning theory (ELT). These theories were used to inform the selection of a new learner-centered teaching approach — object-based learning (OBL) applied in a flipped classroom (FC) environment, a pedagogical combination theoretically powerful enough to deliver an effective, transformative learning experience to CM learners.

Recommendations & Future Work

As the learning environment continues to shift away from traditional teaching approaches, well-researched alternatives will be in greater demand. OBL and FC are in need of more supporting evidence, calling for greater efforts in empirical testing in both highly controlled research settings and in real classrooms (Abeysekera & Dawson, 2015; Lockyer et al., 2009). Researchers, instructional designers, and educational practitioners planning to conduct research on OBL in a FC environment should be careful to follow the most current definitions, descriptions, specifications, and guidelines for terms and constructs that have widespread adoption (e.g., LOs). They should provide clear and specific working definitions of less-developed definitions (e.g., FCs). Special consideration should be given to the selection, creation, and application of LOs, particularly for self-made instructional videos, which are rapidly growing in popularity as educational tools (Brame, 2016).

Above all, despite whatever educational challenges arise, as mindful teachers continue searching for better ways to serve their learners, alternative pedagogical interventions like OBL, FCs, and others can provide new options for delivering an education that is transformative for students.

References

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. Higher Education Research & Development, 34(1), 1–14. https://doi.org/10.1080/07294360.2014.934336

Acedo, M. (2019). 10 Pros And Cons Of A Flipped Classroom. TeachThought.com. https://www.teachthought.com/learning/10-pros-cons-flipped-classroom/

Adams, J., Kaczmarczyk, S., Picton, P., & Demian, P. (2010). Problem solving and creativity in engineering: conclusions of a three year project involving reusable learning objects and robots. Engineering Education, 5(2), 4–17. https://doi.org/10.11120/ened.2010.05020004

Ahmed, V., Pathmeswaran, R., & Aouad, G. (2007). A Generic Framework for the Development of Standardised Learning Objects within the Discipline of Construction Management. Journal for Education in the Built Environment, 2(2), 115–135. https://doi.org/10.11120/jebe.2007.02020115

Andreatta-da-Costa, L. (2016). Using Learning Objects to Teach Structural Engineering. International Journal of Online Engineering (IJOE), 12(04), 14. https://doi.org/10.3991/ijoe.v12i04.5014

Arditi, D., Asce, M., & Polat, G. (2010). "Graduate Education in Construction Management." Journal of Professional Issues in Engineering Education and Practice, https://ascelibrary.org/doi/pdf/10.1061/%28ASCE%29EI.1943-5541.0000014

Atif, Y., Benlamri, R., & Berri, J. (2003). Learning Objects Based Framework for Self-Adaptive Learning. Education and Information Technologies, 8(4), 345–368. https://doi.org/10.1023/B:EAIT.0000008676.64018.af

Ayala, O., Popescu, O., & Jovanovic, V. (2017). Flipped Classroom as Blended Learning in a Fluid Mechanics Course in Engineering Technology. 2017 ASEE Annual Conference & Exposition Proceedings, 28367. https://doi.org/10.18260/1-2--28367

Barth, M., & Burandt, S. (2013). Adding the "e-" to Learning for Sustainable Development: Challenges and Innovation. Sustainability, 5(6), 2609–2622. https://doi.org/10.3390/su5062609

Baruque, L.B. & Melo, R.N. (2004). Learning Theory and Instruction Design Using Learning Objects. Journal of Educational Multimedia and Hypermedia, 13(4), 343-370. Norfolk, VA: Association for the Advancement of Computing in Education (AACE). Retrieved June 17, 2019 from https://www.learntechlib.org/primary/p/7432/.

Behzadan, A. H., & Kamat, V. R. (2013). Enabling discovery-based learning in construction using telepresent augmented reality. Automation in Construction, 33, 3–10. https://ascelibrary-org.ezproxy.lib.vt.edu/doi/abs/10.1061/40704%282003%2938

Bergmann, J., & Sams, A. (2012). Flip your classroom: Reach every student in every class every day. International society for technology in education.

Bergmann, J., & Sams, A. (2014) The Flipped Classroom. CSE Volume 17 Number 3. https://wp0.vanderbilt.edu/cft/guides-sub-pages/flipping-the-classroom/

Bernold, L. E. (2005). Paradigm Shift in Construction Education is Vital for the Future of Our Profession. Journal of Construction Engineering and Management, 131(5), 533–539. https://doi.org/10.1061/(ASCE)0733-9364(2005)131:5(533)

Bincy, M. & Raja, B. (2015). Does higher-order thinking impinge on learner-centric digital approach? I-Manager's Journal on School Educational Technology, 11(2), 17. https://doi.org/10.26634/jsch.11.2.3702

Bishop, J., & Verleger, M. (2013a). Testing the flipped classroom with model-eliciting activities and video lectures in a mid-level undergraduate engineering course. 2013 IEEE Frontiers in Education Conference (FIE), 161–163. https://doi.org/10.1109/FIE.2013.6684807

Bishop, J., & Verleger, M. (2013b). The Flipped Classroom: A Survey of the Research. 18. https://www.asee.org/public/conferences/20/papers/6219/view

Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. International Journal of Educational Technology in Higher Education, 17(1), 2. https://doi.org/10.1186/s41239-019-0176-8

Brame, C. J. (2013). Flipping the Classroom. Retrieved July 1, 2019, from Vanderbilt University website: https://wp0.vanderbilt.edu/cft/guides-sub-pages/flipping-the-classroom/

Brame, C. J. (2016). Effective Educational Videos: Principles and Guidelines for Maximizing Student Learning from Video Content. CBE—Life Sciences Education, 15(4), es6. https://doi.org/10.1187/cbe.16-03-0125

Brewer, R., & Movahedazarhouligh, S. (2018). Successful stories and conflicts: A literature review on the effectiveness of flipped learning in higher education. Journal of Computer Assisted Learning, 34(4), 409–416. https://doi.org/10.1111/jcal.12250

Burgett, J. M. (2014). Can "Flipping the Classroom" Improve the Educational Experience in Construction Management Courses: A Case Study in Teaching HVAC Psychrometrics. 8. http://ascpro0.ascweb.org/archives/cd/2014/paper/CEUE127002014.pdf

Chatterjee, H. J. (2011). Object-Based learning in higher education: The pedagogical power of museums.

Chatterjee, H. J., & Hannan, L. (2016). Engaging the Senses: Object-Based Learning in Higher Education. Routledge. https://books.google.com/books?id=E7K1CwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q=experiential&f=false

Chinowsky, P. S., & Diekmann, J. E. (2004). Construction Engineering Management Educators: History and Deteriorating Community. Journal of Construction Engineering and Management, 130(5), 751–758. https://doi.org/10.1061/(ASCE)0733-9364(2004)130:5(751)

Chitwood, K., May, C., Bunnow, D., & Langan, T. (2000). Battle stories from the field: Wisconsin online resource center learning objects project. In D. A. Wiley (1), The Instructional Use of Learning Objects: Online Version. Retrieved June 2, 2020 from the World Wide Web: http://reusability.org/read/chapters/chitwood.doc

Christensen, Clayton M. (2017). "Disrupting class : how disruptive innovation will change the way the world learns." New York: McGraw-Hill, 38-39.

Daramola, M. O. (2018). Enhancement of Transformative Learning in Large Classes of Learners in Engineering Education. IOP Conference Series: Materials Science and Engineering, 413, 012026. https://doi.org/10.1088/1757-899X/413/1/012026

Deshpande, A., & Salman, B. (2016). Think-Pair-Share: Application of an Active Learning Technique in Engineering and Construction Management Classes. 7. http://ascpro.ascweb.org/chair/paper/CEUE149002016.pdf

Douglas, E. P. (2011). Student Construction of Knowledge in an Active Learning Classroom Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. https://peer.asee.org/18479

Elliott, J. W., Perkins, M., & Thevenin, M. K. (2018). Measuring Undergraduate Students' Construction Education Domain Self-Efficacy, Motivation, and Planned Behavior: Validation of a Concise Survey Instrument. International Journal of Construction Education and Research, 14(4), 235–256. https://doi.org/10.1080/15578771.2017.1316802

Ertmer, P. A., & Newby, T. J. (1993). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. Performance improvement quarterly, 6(4), 50-72.

Farrow, C. B., Liu, J., & Tatum, M. C. (2011). Curriculum Delivery and Assessment for Net Generation Construction Students. International Journal of Construction Education and Research, 7(2), 109–125. https://doi.org/10.1080/15578771.2011.575440

Fellows, R. F. Liu, L. (2015). Research Methods for Construction Fourth Edition. Oxford: John Wiley & Sons, Ltd. https://doi-org.ezproxy.lib.vt.edu/10.1002/j.2168-9830.2005.tb00829.x

Fogarty, J. (2017). Assessment of Flipped Classroom in Upper-Level Engineering Course. 2017 ASEE Annual Conference & Exposition Proceedings, 27635. https://doi.org/10.18260/1-2--27635

Fosnot, C. T. (2005). Constructivism: Theory, perspectives, and practice (2nd ed). New York: Teachers College Press. http://faculty.arts.ubc.ca/emeyers/LIBR535/readings/Fosnot&Perry_2005.pdf

Friedrich, K. A., Sellers, S. L., & Burstyn, J. N. (2008). 9: Thawing the Chilly Climate: Inclusive Teaching Resources for Science, Technology, Engineering, and Math. To Improve the Academy, 26(1), 133–141. https://doi.org/10.1002/j.2334-4822.2008.tb00505.x

Gilboy, M. B., Heinerichs, S., & Pazzaglia, G. (2015). Enhancing Student Engagement Using the Flipped Classroom. Journal of Nutrition Education and Behavior, 47(1), 109–114. https://doi.org/10.1016/j.jneb.2014.08.008

Goh, O. S., Ghani, M. K. Abd., Kumar, Y. J., Choo, Y.-H., & Muda, A. K. (2014). Massive Open Online Course (MOOC) with Learning Objects and Intelligent Agent Technologies. 2014 International Conference on IT Convergence and Security (ICITCS), 1–4. https://doi.org/10.1109/ICITCS.2014.7021786

Gonzalez, M. J., Montero, E., de Heredia, A. B., & Martinez, D. (2010). Integrating digital video resources in teaching e-learning engineering courses. IEEE EDUCON 2010 Conference, 1789–1793. https://doi.org/10.1109/EDUCON.2010.5492420

Graham, B., & Thomas, K. (2008). Building Knowledge – Developing a Grounded Theory of Knowledge Management for Construction. 6(2), 8.

Griffith, R. (2003). Learning objects in higher education. Academic Advanced Distributed Learning Co-Lab publication, University of Wisconsin (April 2003). http://www.academiccolab.org/resources/webct_learningobjects.pdf.

Guggemos, A. A., & Khattab, M. (2016). The Future of Construction Education: Partnering with Industry. Construction Research Congress 2016, 120–129. https://doi.org/10.1061/9780784479827.013

Gunderson, D. E., & Moore, J. D. (2008). Group Learning Pedagogy and Group Selection. International Journal of Construction Education and Research, 4(1), 34–45. https://doi.org/10.1080/15578770801943893

Hamdan, N., McKnight, P., McKnight, K., Arfstrom, K., (2013). A Review of Flipped Learning. 21. https://flippedlearning.org/wp-content/uploads/2016/07/LitReview_FlippedLearning.pdf

Hartmann, A., Dorée, A., & Martin, L. (2010). A Constructivist Approach for Teaching Research Methodology in Construction Management. International Journal of Construction Education and Research, 6(4), 253–270. https://doi.org/10.1080/15578771.2010.527181

Hedden, M., Worthy, R., Akins, E., Slinger-Friedman, V., & Paul, R. (2017). Teaching Sustainability Using an Active Learning Constructivist Approach: Discipline-Specific Case Studies in Higher Education. Sustainability, 9(8), 1320. https://doi.org/10.3390/su9081320

Holt, E. A., Chasek, C., Shaurette, M., & Cox, R. (2018). The Learning Styles of Undergraduate Students in CM Bachelor's Degree Programs in the U.S. International Journal of Construction Education and Research, 14(1), 4–21. https://doi.org/10.1080/15578771.2017.1342718

Hoxley, M., & Rowsell, R. (2006). Using Video in the Construction Technology Classroom: Encouraging Active Learning. Architectural Engineering and Design Management, 2(1–2), 115–122. https://doi.org/10.1080/17452007.2006.9684609

Jensen, W., & Fischer, B. (2006). Student Perspectives on the Qualities/Behaviors of Faculty That Contribute Most Significantly to Student Learning. International Journal of Construction Education and Research, 2(2), 67–73. https://doi.org/10.1080/15578770600775850

Jensen, J. L., Holt, E. A., Sowards, J. B., Heath Ogden, T., & West, R. E. (2018). Investigating Strategies for Pre-Class Content Learning in a Flipped Classroom. Journal of Science Education and Technology, 27(6), 523–535. https://doi.org/10.1007/s10956-018-9740-6

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? Educational Technology Research and Development, 39(3), 5–14. https://doi.org/10.1007/BF02296434

Jones, K. (2018). How Technology Is Reshaping the Construction Industry. Retrieved June 27, 2019, from ConstructConnect.com website: https://www.constructconnect.com/blog/construction-technology/technology-reshaping-construction-industry/

Kay, R. (2007). A Systematic Evaluation of Learning Objects for Secondary School Students. Journal of Educational Technology Systems, 35(4), 411–448. https://doi.org/10.2190/M770-J104-V701-8N45

Ke, F. (2013). Online interaction arrangements on quality of online interactions performed by diverse learners across disciplines. The Internet and Higher Education, https://doi.org/10.1016/j.iheduc.2012.07.003

Kiaw, L. W. Y., Hoe, L. S., Ling, L. S., & Chew, L. M. (2016). Designing an object-based lesson model based on a proposed cloud e-learning framework. Kidmore End: Academic Conferences International Limited. Retrieved from http://login.ezproxy.lib.vt.edu/login?url=https://search.proquest.com/docview/1860069987?accountid=14826

Klassen, S. (2006). A Theoretical Framework for Contextual Science Teaching. Interchange, 37(1–2), 31–62. https://doi.org/10.1007/s10780-006-8399-8

Kolb, D. A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Englewood Cliffs, NJ: Prentice Hall. http://academic.regis.edu/ed205/Kolb.pdf

Kolb, A. Y., & Kolb, D. A. (2009). Experiential Learning Theory: A Dynamic, Holistic Approach to Management Learning, Education and Development. In The SAGE Handbook of Management Learning, Education and Development (pp. 42–68). https://doi.org/10.4135/9780857021038.n3

Kolb, A. Y., & Kolb, D. A. (2013). A Comprehensive Guide to the Theory, Psychometrics, Research on Validity and Educational Applications. 234.

Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2014). Experiential Learning Theory: Previous Research and New Directions. In R. J. Sternberg & L. Zhang (Eds.), Perspectives on Thinking, Learning, and Cognitive Styles (0 ed., pp. 227–248). Routledge. https://doi.org/10.4324/9781410605986-9

Lam, E. W. M., Chan, A. P. C., Chan, D. W. M., & Oladinrin, T. O. (2016). Analysis of the Effectiveness of Instructional Strategies for Construction Management Students. Journal of Professional Issues in Engineering Education and Practice, 142(3), 04016001. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000276

Lau, S.H., Woods, P. C. (2009). Understanding learner acceptance of learning objects: The roles of learning object characteristics and individual differences. British Journal of Educational Technology, 40(6), 1059–1075. https://doi.org/10.1111/j.1467-8535.2008.00893.x

Lee, N., Lee, L. W., & Kovel, J. (2016). An Experimental Study of Instructional Pedagogies to Teach Math-Related Content Knowledge in Construction Management Education. International Journal of Construction Education and Research, 12(4), 255–269. https://doi.org/10.1080/15578771.2016.1141440

Lee, J. H., McCullouch, B. G., & Chang, L.-M. (2003). Object-Based Learning Method in Engineering. Towards a Vision for Information Technology in Civil Engineering, 1–17. https://doi.org/10.1061/40704(2003)38

Lee, J. H., McCullouch, B. G., & Chang, L.-M. (2008). Macrolevel and Microlevel Frameworks of Experiential Learning Theory in Construction Engineering Education. Journal of Professional Issues in Engineering Education and Practice, 134(2), 158–164. https://doi.org/10.1061/(ASCE)1052-3928(2008)134:2(158)

Lee, N., Salama, T., & Kim, S. J. (2016). Using the Flipped Classroom Model to Improve Construction Engineering and Management Education. 2016 ASEE Annual Conference & Exposition Proceedings, 27168. https://doi.org/10.18260/p.27168

Liu, C. C., & Chen, I. J. (2010). Evolution Of Constructivism. Contemporary Issues in Education Research (CIER), 3(4), 63. https://doi.org/10.19030/cier.v3i4.199

Lo, C, & Hew, K. (2017). A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. Research and Practice in Technology Enhanced Learning, 12(1), 4. https://doi.org/10.1186/s41039-016-0044-2

Lockyer, L., Bennett, S., Agostinho, S., & Harper, B. (2009). Handbook of Research on Learning Design and Learning Objects: Issues, Applications, and Technologies. https://doi.org/10.4018/978-1-59904-861-1

Lohani, V. K., Wolfe, M. L., & Wildman, T. (2011). Reformulating General Engineering and Biological Systems Engineering Programs at Virginia Tech. 30.

Long, T., Cummins, J., & Waugh, M. (2017). Use of the flipped classroom instructional model in higher education: Instructors' perspectives. Journal of Computing in Higher Education, 29(2), 179–200. https://doi.org/10.1007/s12528-016-9119-8

Maghiar, M., Sturges, D., Maurer, T., & Jackson, M. (2015). Exploration of Student Perceptions, Behaviors and Academic Performance in Construction Management Classes. International Journal of Construction Education and Research, 11(4), 241–256. https://doi.org/10.1080/15578771.2015.1009960

Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). Classroom instruction that works: Research-based strategies for increasing student achievement. Alexandria, VA: ASCD https://eric.ed.gov/?id=ED450096

Mayer, R. E. (2014). Cambridge handbooks in psychology. The Cambridge handbook of multimedia learning (2nd ed.). New York, NY, US: Cambridge University Press. http://dx.doi.org/10.1017/CBO9781139547369

McGarr, O. (2009). A review of podcasting in higher education: Its influence on the traditional lecture. Australasian Journal of Educational Technology, 25(3). https://doi.org/10.14742/ajet.1136

McGreal, R. (2004). Learning objects: A practical definition. https://auspace.athabascau.ca/handle/2149/227

McHenry, A. L., Depew, D. R., Dyrenfurth, M. J., Dunlap, D. D., Keating, D. A., Stanford, T. G., Deloatch, G. (2005). Constructivism: The Learning Theory That Supports Competency Development of Engineers For Engineering Practice and Technology Leadership Through Graduate Education. 7. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.564.7691&rep=rep1&type=pdf quired-course-competencies-in-mechanical-engineering

McWhirter, N., & Shealy, T. (2018). Case-based flipped classroom approach to teach sustainable infrastructure and decision-making. International Journal of Construction Education and Research, 1–21. https://doi.org/10.1080/15578771.2018.1487892

Milman, N. B. (2015). Distance Education. In International Encyclopedia of the Social & Behavioral Sciences (pp. 567–570). https://doi.org/10.1016/B978-0-08-097086-8.92001-4

Moore, J. L., Dickson-Deane, C., & Galyen, K. (2011). e-Learning, online learning, and distance learning environments: Are they the same? The Internet and Higher Education, 14(2), 129–135. https://doi.org/10.1016/j.iheduc.2010.10.001

Mukherjee, A., Rojas, E. M., & Winn, W. D. (2005). Understanding Cognitive and Metacognitive Processes in Construction Management: The System Dynamics Perspective. Construction Research Congress 2005, 1–9. https://doi.org/10.1061/40754(183)46

Neuman, R. W. (2017). Charting the Future of US Higher Education: A Look at the Spellings Report Ten Years Later. Association of American Colleges & Universities. Association of American Colleges & Universities, https://www.aacu.org/liberaleducation/2017/winter/neuman.

Ozdamli, F., & Asiksoy, G. (2016). Flipped Classroom Approach. World Journal on Educational Technology, 8(2), 98. https://doi.org/10.18844/wjet.v8i2.640

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning Styles: Concepts and Evidence. Psychological Science in the Public Interest, 9(3), 105–119. https://doi.org/10.1111/j.1539-6053.2009.01038.x

Pears, A., Thota, N., Kinnunen, P., & Berglund, A. (2012). Harnessing theory in the service of engineering education research. 2012 Frontiers in Education Conference Proceedings, 1–5. https://doi.org/10.1109/FIE.2012.6462292

Pearson, G., & Ollis, D. (2006). What Is Technological Literacy And Why Does It Matter? 8. https://peer.asee.org/what-is-technological-literacy-and-why-does-it-matter.pdf

Pedro, A., Le, Q. T., & Park, C. S. (2016). Framework for Integrating Safety into Construction Methods Education through Interactive Virtual Reality. Journal of Professional Issues in Engineering Education and Practice, 142(2), 04015011. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000261

Perry, W. G. (1999). Forms of ethical and intellectual development in the college years: A scheme. San Francisco: Jossey-Bass.

Picciano, A. G., Seaman, J., & Allen, I. E. (2010). Educational Transformation through Online Learning: To Be or Not to Be. Online Learning. The Official Journal of Online Learning, https://doi.org/10.24059/olj.v14i4.147.

Prince, M. (2004). Does Active Learning Work? A Review of the Research. Journal of Engineering Education, 93(3), 223–231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x

Puddicombe, M. S., & Johnson, B. (2011). Research and Theory Building in Construction Management. International Journal of Construction Education and Research, 7(2), 126–142. https://doi.org/10.1080/15578771.2011.557142

Quinn, D., Cioffi, E., Hill, S., Kor, M., & Longford, A.-C. (2019). Implementing work-integrated learning in online construction management courses, Journal of University Teaching & Learning Practice, 16(1), 2019. Available at: https://ro.uow.edu.au/jutlp/vol16/iss1

Research and Teaching: Observable Features of Active Science Education Practices. (2018). Journal of College Science Teaching, 047(06). https://doi.org/10.2505/4/jcst18_047_06_83

Rich, B. M., Kretschmer, D., Goldmann, C., Hettling, L., Brandt, A., & Woll, R. (2018). Praxis-Oriented Teaching of Project Management Skills for STEM Students in Higher Education. 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), 829–834. https://doi.org/10.1109/TALE.2018.8615345

Ritzhaupt, A. D., (2010). Learning Object Systems and Strategy: A Description and Discussion. Interdisciplinary Journal of E-Skills and Lifelong Learning, 6, 217–238. https://doi.org/10.28945/1306

Rockenbach, B. (2011). Archives, Undergraduates, and Inquiry-Based Learning: Case Studies from Yale University Library. The American Archivist, 74(1), 297–311. https://doi.org/10.17723/aarc.74.1.mml4871x2365j265

Rogers, T., & Tingerthal, J. (2013). Blended learning and ‘Flipping’ The Construction Management Classroom for Improved Teaching and Learning. In Proceedings of the 49th ASC Annual International Conference, San Luis Obispo, California. http://ascpro0.ascweb.org/archives/cd/2013/paper/CEUE40002013.pdf

Rokooei, S., & Goedert, J. (2015). Lessons Learned from a Simulation Project in Construction Education. 2015 ASEE Annual Conference and Exposition Proceedings, 26.1083.1-26.1083.11. https://doi.org/10.18260/p.24420

Ruiz, J. G., Mintzer, M. J., & Leipzig, R. M. (2006). “The Impact of E-Learning in Medical Education.” Academic Medicine, https://doi.org/10.1097/00001888-200603000-00002

S3 Working Group, The Masie Center, e-Learning Consortium (2002). Making Sense of Learning Specifications & Standards: A Decision Maker’s Guide to their Adoption. http://www.academiccolab.org/resources/S3Guide.pdf

Shafaat, A., & Marbouti, F. (2014). A New Model for Offering Construction Education on MOOC Platforms. Construction Research Congress 2014, 399–408. https://doi.org/10.1061/9780784413517.041

Hoe, S. L., & Woods, P. C. (2010). Developing object-based learning environment to promote learners’ motivation for learning digital systems. Computer Applications in Engineering Education, 18(4), 640–650. https://doi.org/10.1002/cae.20268

Smith-Barrow, D. (2017). Majoring in Construction Gets More Popular. US News & World Report. Retrieved March 1, 2020, from https://www.usnews.com/education/best-colleges/articles/2017-08-10/weigh-a-college-degree-in-construction-management

Snelbecker, G. E. (1974). Learning theory, instructional theory, and psychoeducational design. New York, NY, US: McGraw-Hill. https://psycnet.apa.org/record/1974-21717-000

Stewart, C., Bachman, C., & Babb, S. (2009). Replacing Professor Monologues with Online Dialogues: A Constructivist Approach to Online Course Template Design. 5(3), 11. https://pdfs.semanticscholar.org/0ba4/af1cf7df42fb6809bdd333818a38e36a095b.pdf

Sunindijo, R. Y. (2016). Teaching First-year Construction Management Students: Lessons Learned from Student Satisfaction Surveys. International Journal of Construction

Education and Research, 12(4), 243–254. https://doi.org/10.1080/15578771.2015.1121937

Tangdhanakanond, K., Pitiyanuwat, S., & Archwamety, T. (2006). Assessment of achievement and personal qualities under constructionist learning environment. Education, 126(3), 495+. Retrieved from https://link.gale.com/apps/doc/A145681741/AONE?u=viva_vpi&sid=AONE&xid=d04ee2bf

Tawfik, A. A., & Lilly, C. (2015). Using a Flipped Classroom Approach to Support Problem-Based Learning. Technology, Knowledge and Learning, 20(3), 299–315. https://doi.org/10.1007/s10758-015-9262-8

Tempelman, E., & Pilot, A. (2011). Strengthening the link between theory and practice in teaching design engineering: An empirical study on a new approach. International Journal of Technology and Design Education, 21(3), 261–275. https://doi.org/10.1007/s10798-010-9118-4

Tennyson, R. D., & Rasch, M. (1988). Linking cognitive learning theory to instructional prescriptions. Instructional Science, 17(4), 369–385. https://doi.org/10.1007/BF00056222

U.S. Department of Education. (2006). "A Test of Leadership: Charting the Future of U.S. Higher Education. Washington, D.C., 2006." (2006). US Department of Education, https://www2.ed.gov/about/bdscomm/list/hiedfuture/reports.html

Uzunboylu, H., & Karagozlu, D. (2015). Flipped classroom: A review of recent literature. World Journal on Educational Technology, 7(2), 142. https://doi.org/10.18844/wjet.v7i2.46

Walvoord, B. E., & Anderson, V. J. (1998). Effective grading: A tool for learning and assessment in college. John Wiley & Sons.

Wang, Y. (2014). Technology and Products Supporting E-learning by Knowledge Management - A Review. International Journal of Emerging Technologies in Learning (IJET), 9(4), 56. https://doi.org/10.3991/ijet.v9i4.3625

Wentling, T. L., Waight, C., Gallaher, J., Fleur, J. L., Wang, C., & Kanfer, A. (2000). e-learning - A Review of Literature. 73. https://pdfs.semanticscholar.org/5443/6f2ce08a83fb5f14f523e79b65b8a2c2f708.pdf

Wiley, D., (2002). The instructional use of learning objects (1st ed). Bloomington, Ind: Agency for Instructional Technology: Association for Educational Communications &

Technology.
https://members.aect.org/publications/InstructionalUseofLearningObjects.pdf

Wiley, D. A. (2008). The learning objects literature. Handbook of research for educational communications and technology: A project of the association for educational communications and technology, 345-353.

Willcox, Karen E; Sarma, Sanjay; Lippel, Philip (2016). "Online Education: A Catalyst for Higher Education Reforms. Online Education Policy Initiative." Massachusetts Institute of Technology: Online Education Policy Initiative, https://dspace.mit.edu/bitstream/handle/1721.1/103912/MIT%20Online%20Education%20Policy%20Initiative%20April%202016_0.pdf?sequence=1

Yarbro, J., Arfstrom, K. M., McKnight, K., & McKnight, P. (2014). Extension of a review of flipped learning. Flipped Learning Network/Pearson/George Mason University.

Zhai, X., Gu, J., Liu, H., Liang, J. C., & Tsai, C. C. (2017). An experiential learning perspective on students' satisfaction model in a flipped classroom context. Journal of Educational Technology & Society, 20(1), 198-210. https://www.jstor.org/stable/10.2307/jeductechsoci.20.1.198

CHAPTER 3

DEVELOPING SUPPLEMENTAL INSTRUCTIONAL VIDEOS FOR TRADITIONAL CONSTRUCTION MANAGEMENT LEARNING MATERIALS.

Andrew F. Barnes

Target Journal: Educational Technology Research and Development or Educational Media International

Abstract

Technological advancements and lower production costs since the mid-1990s have dramatically improved the opportunities teachers have to tailor self-made instructional videos for their learners. Unfortunately, video production technology has outpaced the development of practical theory, causing instructional videos to consistently fall short of their pedagogical potential. Responding to these shortcomings, scholars from various backgrounds have started publishing best-practice guidelines to help practitioners as they develop instructional videos for their respective fields. This article contributes to this ongoing effort by synthesizing theory-based, best-practice guidelines for a specific subcategory of educational videos called supplemental instructional videos (SIVs). SIVs are different from other subcategories of instructional videos because they are used to support and magnify other learning methods, mediums, and materials, not substitute for them. Bringing best-practice guidelines immediately into application, they were used to inform the production of SIVs for a real undergraduate course that was held in the Building Construction Department of a major public university during the Spring 2020 semester. The process and strategies used to apply the SIV guidelines were documented during the course for future researchers and practitioners to learn and build from.

Keywords: Supplemental Instructional Videos, Cognitive Theory of Multimedia Learning, Construction Management, Building Construction, Higher Education

Introduction

For at least three decades, construction management (CM) departments were trying to incorporate instructional videos into the classroom (Borzage & Reynolds, 1994). Throughout the 1980s and 1990s, CM teachers were eager to test the technology in their classrooms, however, even after years of being available, the cost and skill required to produce quality instructional videos remained prohibitively high (Borzage & Reynolds, 1994; Matthewson, 1988). To illustrate the magnitude of this barrier, one estimate in 1994 placed the per-minute cost of professionally produced instructional videos in CM between $800 and $1,000 (Borzage & Reynolds, 1994). This meant that even the most inexpensive techniques of the era made the cost for creating an entire instructional video in the thousands of dollars (Epstein, 1990; Senior & Miura, 1996).

Owing to the technological boom at the turn of the millennium, high-quality videos can be designed and developed internally, at minimal cost, with user-friendly options in both video editing software (e.g., TechSmith Camtasia, Adobe Presenter, iMovie) and video hosting platforms (e.g., YouTube, ScreenCast, Vimeo) (Hernández-Ramos, 2007; Ozdamli & Asiksoy, 2016). As a result, higher education is quickly embracing this low-cost opportunity to capture teachings with high-production-quality instructional videos (Hernández-Ramos, 2007). Unfortunately, the creation and use of instructional videos is happening despite teachers having "little or no knowledge of the design techniques that actually improve learning" (Allison, 2015, p. 19). Many instructional videos being produced at this time amount to little more than recorded lectures. Consequently, research has documented that learners often complain that these video lectures are low-production-quality, confusing, boring, irrelevant, and lengthy (Guy & Marquis, 2016; Lo & Hew, 2017). Noting this problem, researchers across fields are beginning to investigate the advantages and disadvantages of using instructional videos in higher education and the current best practices in their design and development that make them effective (Allison, 2015).

This paper presents a study in which a batch of supplemental instructional videos was produced as teaching aides for pre-class reading materials in a flipped undergraduate CM course. The design and development of the videos was guided by the underlying theories of multimedia learning and based upon an interdisciplinary synthesis of best practices. The steps of the pre-production, production, and post-production processes are described in detail.

Cognitive Theory of Multimedia Learning

Contemporary research shows that teaching with video enhances learning (Brame, 2016). Noting this effect, scholars have attempted to explain what makes using videos different from traditional, didactic, reading and lecture-based teaching methods. The current, prevailing theory is known as the cognitive theory of multimedia learning (CTML) (Brame, 2016, Kulgemeyer, 2018). According to Richard Mayer (2005), the originator of the theory, CTML is a view

> of how people learn from words and pictures based on the idea that people possess separate channels for processing verbal and visual material (dual-channel assumption), each channel can process only a small amount of material at a time (limited capacity assumption), and meaningful learning involves engaging in appropriate cognitive processing during learning (active processing assumption (p. 47).

Stated simply, CTML is the idea that "people learn more deeply from words and pictures than from words alone" (Mayer, 2005, p. 31). CTML is founded upon cognitive load theory and a variety of other forerunning cognitive science theories — i.e., Paivio's (1986) dual-coding theory, Baddeley's (1998) theory of working memory, and Wittrock's (1989) generative-learning theory (Mayer & Moreno, 2003) — to explain how multimedia improves learning efficiency by avoiding a condition known as cognitive overload (She et al., 2009). Cognitive overload is a situation in which the cognitive demands of a learning task exceed the learner's ability to process and store new information (Mayer & Moreno, 2003), a frustrating and discouraging situation that many learners have experienced. Hence, cognitive load theory asserts that for new information to be stored in the long-term memory, it must first pass through the working memory, which has limited processing capacity and has the ability to overload (Kulgemeyer, 2018; Sweller, 1999).

Central to understanding CTML, and its underlying theories, is the dual-channel assumption, which makes the case that the human body has the ability to receive information through multiple channels, chief among them the auditory and visual channels (Mayer & Moreno, 2000). Thus, according to Mayer's CTML, video would be more effective at transferring information through the limited working memory because it utilizes multiple channels (i.e., auditory and visual) concurrently, allowing learners to focus more cognitive energy towards decoding and internalizing information rather than unlocking it from less-effective, single-channel, traditional mediums such as readings (Hoxley & Rowsell, 2006; Mayer, 2005; Mayer & Moreno, 2003).

The Benefits of Using Instructional Videos

Beyond the potential institutional benefits of reducing cost (Ruth, 2012), saving instructional time (Pai, 2014), and increasing accessibility (Bonk, 2008), scholars across fields have documented the learning benefits that result from using instructional videos. In 2013, Sever, Oguz-Unver, and Yurumezoglu published a review of previous studies on video teaching. From their research, they uncovered two key benefits of learning from video.

First, Sever et al. (2013) stated that video prompts both concentration and motivation in students throughout their learning experience. One popular theory that helps explain why video stimulates concentration and motivation in learners is Kearsley & Shneiderman's (1998) *Engagement Theory: A Framework for Technology-based Teaching and Learning*. This theory emphasizes the abilities of technology, namely video, to connect students with each other, to new ideas, and to meaningful tasks when they otherwise would not be able to. It asserts that learner engagement is a product of three components: relating (the exchange of ideas), creating (application of ideas), and donating ("making a useful contribution while learning" in an "authentic learning context [which] increases student motivation and satisfaction") (p. 20). Modern instructional videos, distributed via online hosting platforms, provides the opportunity for all three of these components to be fulfilled.

The second benefit listed by Sever et al. (2013) is that instructional videos possess a unique ability to help learners understand and internalize complicated or abstract concepts. This benefit is further explained by Elizabeth Choe (2017), whose work focuses on highlighting the best-practices from instructional video case studies across disciplines. Choe found that when videos are effectively produced, they have special instructional capabilities, unique from other teaching methods and instruments. For instance, from her research, Choe (2017) determined that SIVs are capable of "transcend[ing] space and time to make concepts clearer or more interesting" (p. 4), showcasing inaccessible events and processes, and "provid[ing] visual metaphors that make abstract concepts tangible" (p 9). Hence, through the "amplified realism" (Koumi, 2015, p. 9) that video can provide, learners have the ability to view impossible-to-see, real-life phenomenon in action. To provide an example of this in a CM context, video can demonstrate the microscopic, imperceptibly-slow, chemical process of hydration that bonds cement to stone aggregate to yield concrete — a feat impossible with other traditional, single-channel mediums.

Other advantages of using instructional videos from the literature include: improving student attention, achievement, and attitude (Allison, 2015; Choudhury, 2011), preventing cognitive overload (Hew et al., 2018), improving the ease of learning (Sumbawat, 2016), and accommodating the preferences of a younger, college-age audience (Pai, 2014). Furthermore, with instructional videos, learners are able to watch and rewatch course material at their convenience, in their environment, on their devices, at their own pace (Ahmed et al., 2007; Lee et al., 2003; Lee et al., 2016; Sumbawat & Munoto 2015; Swan, 2005), and even take any corresponding assessments in tandem (Hew et al., 2018; Moradi et al., 2016).

Instructional videos may introduce some limitations or disadvantages as well. Allison (2015) concluded that using instructional videos may adversely impact accessibility for older or economically disadvantaged populations. Furthermore, McGarr (2009) stated that instructional videos may have the adverse consequence of distracting from primary learning sources and even "add to the passivity of students and may ultimately encourage less engagement" (p. 17). Finally, producing quality instructional videos can be a time-consuming process for busy teachers (Kulgemeyer, 2018), a task that should not be overlooked. Fortunately, technological, and pedagogical solutions are being developed to address these potential shortcomings. They will be discussed below.

Current Best Practices for the Design and Development of Instructional Videos

Instructional videos are not intrinsically superior or inferior to in-person instruction, rather, the success of an instructional video depends on its correct design, development, and application (Brame, 2016; Muller, 2008). To stress this point, Richard Mayer (2005), in his explanation of CTML, warned that "simply adding pictures to words does not guarantee an improvement in learning — that is, all multimedia presentations are not equally effective" (p. 31). Hence, the effectiveness of video as a learning medium is conditional, depending in large measure upon its conformity with best-practice guidelines.

Because the success of instructional videos relies on using the proper production techniques, it is imperative that scholars provide correct and contemporary guidelines to those interested in creating their own videos (Giannakos et al., 2014). Table 3.1 is a contribution to this effort, merging best-practices across a variety of applied disciplines, including: biology (Brame, 2016; Jensen et al., 2018), engineering (Bristow et al., 2014; Moradi et al., 2016), education (Allison, 2015; Kay, 2014; Kulgemeyer, 2018; Lo & Hew, 2017; Mayer & Moreno, 200), STEM fields (Choe, 2017), library science (Majekodunmi & Murnaghan, 2012), construction management (Hurtado et al., 2014; Nasir & Bargstädt, 2017), computer science (Espino et al., 2013; Van der Meij & Van der Meij, 2013), and medicine (Forbes, 2016; Prime et al., 2017), and business and marketing (Krämer & Böhrs, 2016), among many others (Choe, 2017). By no means is Table 3.1 intended to be an exhaustive collection of all scholarship commenting on the subject of SIV production, rather it is a curated collection of guidelines focused on supporting researchers, instructional designers, and educational practitioners as they tailor content for their specific audiences. For this reason, content creators should note that because the set of guidelines presented in Table 3.1 was generated from a wide variety of disciplines, the principles and techniques presented are broadly applicable as demonstrated by their shared points of overlap (Ahmed et al., 2007)

Table 3.1 Best practices to optimize student learning from supplemental instructional videos.

Guideline	**Rationale**	**Supporting Sources**
Short	Videos should be made as short as necessary to convey the message. Because sources vary somewhat defining what this means, it makes sense to recommend an upper limit. Ideally, most instructional videos should not exceed 15 minutes. (Some recommend that the length should not exceed one and a half minutes per grade level of the learning audience. Others say that between 1-4 minutes is ideal. Much of the current literature seems to agree that between five and ten minutes is the target duration of an instructional video, stating, specifically that	Allison, 2015; Bergmann & Sams, 2014; Bonk, 2008; Brame, 2016; Bristow et al., 2014; Choe, 2017; Espino et al., 2013; Guo et al., 2014; Hew et al., 2018; Hornung, 2014; Krämer & Böhrs, 2016; Kulgemeyer, 2018; Lo & Hew, 2017; Moradi et al., 2016; Nasir & Bargstädt, 2017; Prime et al., 2017; Van der Meij & Van der Meij, 2013

	six minutes has been cited as the ideal length.)	
Scripted	A carefully-written script is essential for a clear message. Impromptu monolog can be detrimental to the delivery, quality, and effectiveness of the instruction.	Krämer & Böhrs, 2016; Rubin et al., 2015
Segmented	Instead of introducing multiple topics in a single video, multiple videos should be used to cover single topics.	Allison, 2015; Brame, 2016; Choe, 2017; Hew et al., 2018; Kulgemeyer, 2018
High-quality	Video, audio, graphics, and animations should be neat, smooth, sufficiently loud, and visually and auditorily clear so learners are not distracted or confused by jarring media.	Allison, 2015; Choe, 2017; Espino et al., 2013; Forbes, 2016; Kulgemeyer, 2018; Mayer & Moreno, 2003; Moradi et al., 2016; Nasir & Bargstädt, 2017
Self-made	As often as possible, instructional videos should be created by the teacher. Custom-made videos do better to connect learners with both their teacher and lesson material, in addition to augmenting the relevance of the content.	Bergmann & Sams, 2014; Brame, 2016; Bristow et al., 2014; Espino et al., 2013; Guo et al., 2014; Hurtado et al., 2014; Moradi et al., 2016; Pai, 2014
Engaging	Instructional videos should include abundant visual and auditory stimuli such as hand gestures, vocal inflection, facial expressions, sound effects, complex backgrounds, changing color and contrasts, and motion graphics. It can also be effective to appropriately elicit emotion, for example, using humor.	Allison, 2015; Nasir & Bargstädt, 2017; Brame, 2016; Choe, 2017; Espino et al., 2013; Hew et al., 2018; Jensen et al., 2018; Kay, 2014; Kulgemeyer, 2018; Moradi et al., 2016; Guo et al., 2014; Rubin et al., 2015

Clear	All audio and visual content should be deliberate and have a clear purpose. Only necessary sounds and visuals should be used (e.g., avoid meaningless background music). The content of the instructional video should be expressed in the most efficient and easy-to-understand way possible. Remove any visual clutter. Use effective combinations of narration, written text, and imagery (e.g., written, on-screen text should not be coupled with visuals. Narration and visuals are a better combination).	Choe, 2017; Espino et al., 2013; Hurtado et al., 2014; Kay, 2014; Kulgemeyer, 2018; Mayer & Moreno, 2003; Moradi et al., 2016; Nasir & Bargstädt, 2017; Van der Meij & Van der Meij, 2013
Personalized	Narration should use personalized, polite, conversational language and avoid third-person references (e.g., say “you” and “I” instead of “him”, “her”, or “the learner”). Topics should not use too much difficult terminology or jargon.	Allison, 2015; Brame, 2016; Bristow et al., 2014; Espino et al., 2013; Lo & Hew, 2017; Majekodunmi & Murnaghan, 2012
Active	Instructional videos should incorporate guiding questions, interactive questions, or other interactive digital elements that are coordinated with other assignments.	Brame, 2016; Majekodunmi & Murnaghan, 2012; Moradi et al., 2016; Van der Meij & Van der Meij, 2013
Connecting	Instructional videos should address the learning topic directly in a way that is relevant to the learner.	Choe, 2017; Forbes, 2016; Kulgemeyer, 2018; Majekodunmi & Murnaghan, 2012; Nasir & Bargstädt, 2017; Van der Meij & Van der Meij, 2013

Paced	Instructional videos should have an effective and reasonable pace that is fast enough to retain the learners' attention, but slow enough so learners are not overloaded and lost.	Mayer & Moreno, 2003; Guo et al., 2014; Kay, 2014; Lo & Hew, 2017; Nasir & Bargstädt, 2017; Van der Meij & Van der Meij, 2013

Developing Supplemental Instructional Videos for Traditional Learning Materials in Construction Management Courses.

During the spring semester of 2020, the theory-based guidelines outlined in Table 3.1 were incorporated into a second-year, undergraduate CM course called Residential Construction Technologies, offered at a large, public university located in the Mid-Atlantic region of the United States. This course was ideal for the research because it applied a flipped classroom (FC) teaching approach noted in the literature for being conducive to using video (Abeysekera & Dawson, 2015). The FC reverses the traditional model of in-class learning and at-home assignments (Roehl et al., 2013). Homework becomes teacher-guided classwork, frequently done in groups, and theory-based instruction is conducted outside of the physical classroom, often as readings, online learning modules, or instructional videos (Brewer & Movahedazarhouligh, 2018).

Supplemental Instructional Videos

The type of videos produced for the course were supplemental instructional videos (SIVs). According to Kay (2014), four subcategories of instructional videos are commonly used in higher education. These include lecture-based, enhanced, supplementary, and worked examples. Lecture-based videos are simply a recorded lecture. Enhanced videos are an embellishment of another medium. They are frequently used to upgrade or enrich a lecture. Supplementary videos, in contrast with enhanced videos, complement another teaching medium. They reinforce the main messages of the instruction by providing emphasis, focus, or clarity. Worked examples are video explanations of procedural problems. They are frequently used to help with math and other calculation-based instruction. While the lecture-based category is the most common form of instructional video used in higher education currently, supplementary is recommended due to its ability to provide “significantly more educational value” (McGarr, 2009 p. 317). Speaking specifically of SIVs, McGarr (2009) claimed that

> as well as providing revision and summary material, supplementary material can also be in the form of additional material which may broaden or deepen the student’s understanding. This type of use can facilitate higher cognitive learning outcomes since the provision of supplementary material can provide students with alternative perspectives on content previously delivered or enable further and deeper exploration of topics (p. 317).

Hence, rather than videos merely substituting for an in-person lecture (i.e., lecture-based instruction) or embellishing existing learning materials (i.e., enhanced videos), SIVs complement other forms of instruction, including in-person teaching, readings, and group work, to deliver a full learning experience.

The main job of the SIVs in the course was to introduce unfamiliar and complex construction topics in an accessible way, in order to make subsequent assignments (i.e., readings, group work, reflections, and classroom discussions) more effective and meaningful for learners. Notably, the videos in this course were designed to supplement the pre-class readings, rather than the in-class lecture. In alignment with FC theory, the main reason to do this is to provide help where it is likely to be most needed, but often least available — at home, where reading for class traditionally happens (Bergmann & Sams, 2012). Also, it is advisable to use SIVs to help with readings because, increasingly, college-age learners (i.e., Millennials and Generation Z) are expressing dissatisfaction with reading as a method for learning, in favor of multimedia-based alternatives. Recent research by the Harris Poll, a global market research firm, on behalf of Pearson Education, shows that video is quickly overtaking reading as the instructional medium of choice for upcoming college generations (Pearson Education, 2018). This trend appears to be true broadly, for learners across all fields of study, as well for CM learners specifically (Bernold, 2005; Hoxley & Rowsell, 2006).

The research procedures in the study follow similar scholarship in other applied disciplines (Gonzalez et al., 2010; Hurtado et al., 2014; Majekodunmi & Murnaghan, 2012; Moradi et al., 2016) in which the development of instructional videos was informed by an established set of guidelines through the video production process. The remainder of this paper is dedicated to reporting the approach used to apply the guidelines in Table 3.1 to the course.

The Course

The course, Residential Construction Technologies, trained students to critically evaluate and compare competing construction materials, methods, building systems, and products. Each week, for twelve weeks, the 46 learners enrolled in the course were asked to first complete readings about a specific, industry-standard construction technology termed *the conventional technology*. The conventional technologies covered a wide range of construction topics: foundations, wall framing, floor framing, roof framing, the mechanical system, the electrical system, the plumbing system, windows, roofing, insulation, exterior wall finishes, and finished flooring. After learning about the conventional technology, learners were assigned readings covering more advanced alternatives, called *the conventional-plus technologies*.

SIVs were developed and provided by the instructor to help learners understand the readings that covered the conventional-plus technologies, which were expected to be unfamiliar for students. The SIVs were developed following the production guidelines found in Table 3.1. Once both technologies (i.e., conventional and conventional-plus) had been introduced, learners were asked to do additional research in groups and complete a report comparing the two technologies using an established set of criteria. The criteria included cost, time/schedule, production/delivery, quality, safety, and sustainability. In their report, each group was asked to provide a final recommendation to adopt the conventional-plus technology or use the conventional technology.

To provide an example of one week of this course outline, in week seven, the conventional technology was a standard traditional storage tank water heater, a widely-used model found in millions of homes across the United States (Ryan et al., 2010). Learners were provided literature describing this water heater model in detail. Then learners were assigned readings covering the conventional-plus technology, a condensing storage water heater, purportedly superior to the traditional model in a number of ways, but primarily in the domain of energy efficiency (Lunt, 2009). Condensing storage water heaters also cost substantially more and have far less market presence. To help learners more fully understand the function and features of the technologically-advanced condensing storage water heater in comparison with its conventional counterpart, the traditional storage tank water heater, a four-minute SIV was produced to accompany the reading, as represented in Figure 3.1 below. This process was repeated for all twelve topics covered in the semester.

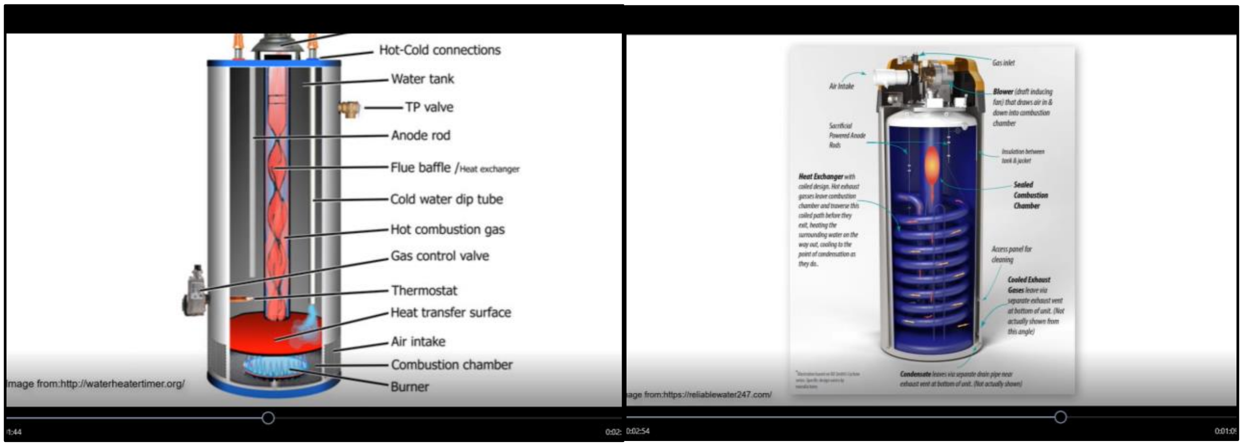

Figure 3.1 Supplemental instructional video comparing traditional storage tank water heaters (left) with its technologically advanced alternative, condensing storage water heaters (right).

Stages of Supplemental Instructional Video Production

Preproduction

Preproduction involved preparing standard tools and procedures to help the development process remain as consistent as possible across all twelve SIVs created for the course. The video editing software chosen to develop the SIVs was TechSmith Camtasia 2018, a widely-recognized, user-friendly, and relatively low-cost option that provides many professional-grade capabilities. A standard video introduction and outroduction (i.e., intro/outro) was formulated and saved as a TechSmith Project file (.tscproj) template to be used for all videos. The introduction and outroduction involved finding engaging “bump” music and developing an attractive animated sequence introducing the course and SIV topic (e.g., condensing storage water heaters). The outroduction mimicked the introduction, only it was shorter. The music was procured from the YouTube Audio Library, a vast collection of free music made available specifically to support video production. All music used for the template was taken from the attribution-free portion of the music library.

The SIV production for this course was intentionally minimalist. No professional studio or equipment was used. Camtasia, Microsoft Office, and a laptop computer were the extent of the software and equipment required to produce all SIVs for the course. None of the SIVs required the use of external video recording equipment or photography. Hence, no cameras, lighting equipment, or external microphones were necessary. Nearly all images, graphics, animations, music, and sounds effects used during production came from free, license-free, and attribution-free sources (i.e., Pixabay.com, Google, YouTube Audio Library, FreeSounds.org). The others were given attribution inside of the video and were used in compliance with the four-factor test for fair use under the Copyright Act of 1976 (Adler, 2016). Instructor narration was recorded using the laptop microphone in a quiet room. Screen recording was facilitated by Camtasia and Microsoft PowerPoint.

The final step of the preproduction process involved authoring a carefully-worded script for the narration. Because the SIVs were designed to supplement the reading assignments, rather than the classroom lecture, developing the script for each SIV was straightforward. The main points of the readings were highlighted, notes were taken, and any confusing points or unresolved questions left by the text were researched and answered. The main summary points were then written into a script, using basic, personalized language, that could be recorded during the production process.

Production

For this animated SIV series, which did not include traditional filming with cameras, the production process centered on collecting, developing, and combining the discrete digital elements that made up both the audio track (e.g., narration, music, and sound effects) and visual tracks (e.g., video, photographs, captions, and animations) to be used in the Camtasia projects.

Recording and editing the narration was the first step for each SIV. After the narration was recorded in Microsoft PowerPoint, the raw audio file had to be edited to remove any misspoken words, unwanted sounds (e.g., coughs, bumping the table), and outtakes. Additional audio effects were added to the narration track to increase the volume, level the sound, and, if necessary, reduce any persistent background noise (i.e., room noise).

With the narration complete, the visual tracks were then developed to support the narration. License-free stock videos, images, and graphics were used liberally from a variety of sources (e.g., Pixabay, Google, Archive.org). Also, Camtasia’s embedded library of animated icons and objects were used to support the development of the visual tracks. Screen-recordings were also used on occasion.

After the visual elements were built, preset animations and behaviors (e.g., fly-in images, bouncing words, rotating photos) were applied to them to improve visual engagement. Sound effects (e.g., pops, swooshes, and dings) were used sparingly to emphasize some of the animated visuals. Occasionally, transition effects (e.g., fading and fading to black) were used between scenes, but less frequently. Other visual effects like blurring, fading, highlighting, and zooming in and out were appropriately applied to the visual elements throughout the SIVs as well. Figure 3.2 below provides a visual sample of the various digital elements and SIV sections that comprise one of the Camtasia project files created for the course.

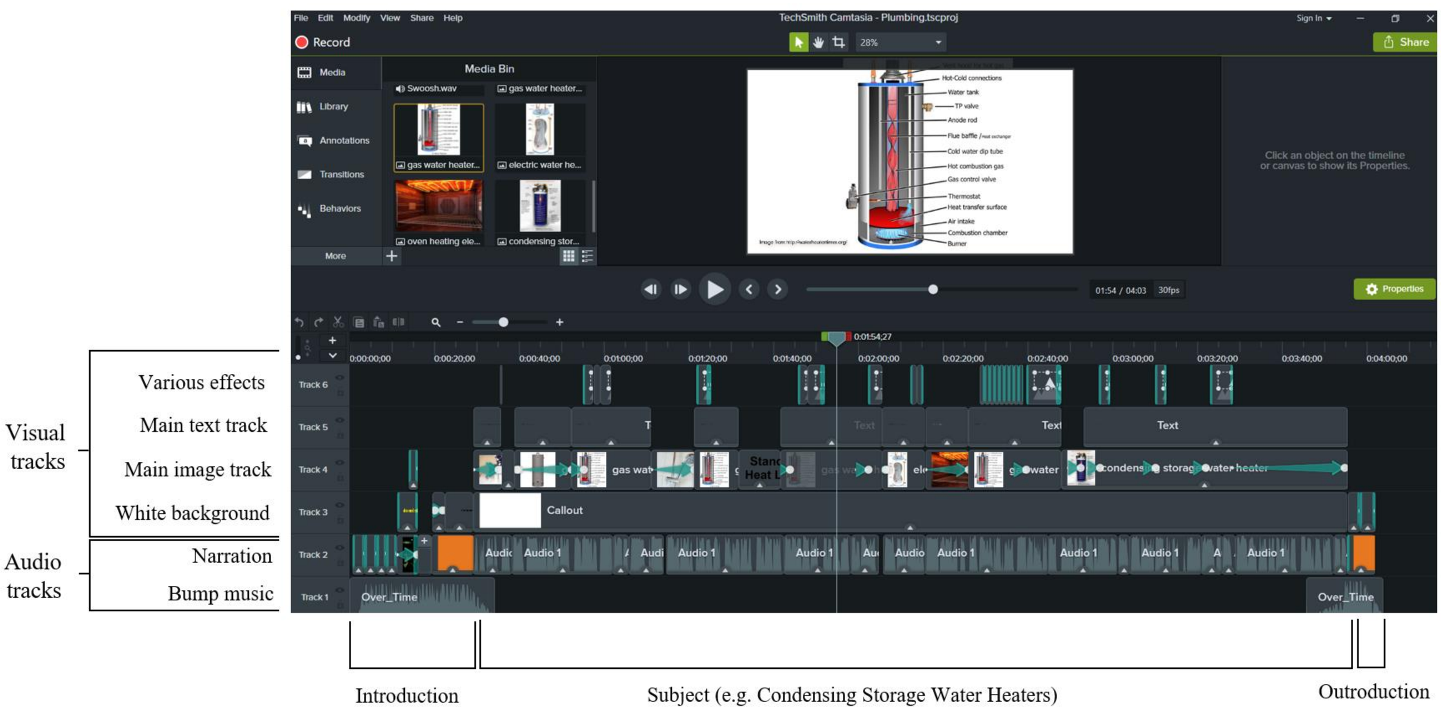

Figure 3.2 Screenshot of the in-progress Camtasia project for the condensing storage water heaters SIV.

Post-production

Post-production of the SIVs began with rendering each Camtasia project into a video file (i.e., .mp4) in preparation for final review. Once the video file was generated, the draft was given a close review by all members of the development team for any missed errors that needed to be addressed. If any errors were discovered in the draft file, the Camtasia project was revised and re-rendered. This process was repeated until no errors were found and all production team members approved.

Following the rendering and revision process, dissemination of the final draft was the last step to deliver the SIVs to the learners. The university learning management system (LMS), Canvas, was used as the video hosting platform. The reason for using Canvas instead of more public options (e.g., YouTube) was to allow the videos to be joined with other educational tasks, like quizzes, that could be directly linked to the grade book.

Time Commitment

Following the semi-experimental production of the first few SIVs in the research course, an effort was made to document the time required to produce the remaining SIVs. Table 3.2 outlines the time expended during each step in the production sequence of the final seven SIVs in the course. This table does not include the time spent on researching the assigned readings, building the Camtasia project file template, production team discussions or revisions, or launching the video on Canvas LMS. For production events in which the time expense was difficult to calculate precisely (e.g., writing and editing the script would sometimes require additional research halfway through the task, causing it to be scattered over various days), they were estimated to the closest minute, five minutes, or, in some cases, fifteen minutes.

Table 3.2 Recorded time for various production stages of seven SIVs created for the course.

	Preproduction	Production			Post-production			
	Write & edit script	Audio recording & editing	Production of visual layers	Render	Initial review, edit, revision	Re-render	Total production time	Length of final video
Video 1	90	45	120	7	15	7	284	2.73
Video 2	120	45	60	8	15	10	258	4.05
Video 3	60	30	90	4	15	4	203	2.13
Video 4	60	30	90	6	15	5	206	2.03
Video 5	90	45	90	10	5	0	240	3.13
Video 6	90	25	90	10	5	0	220	2.46
Video 7	90	30	90	9	5	0	224	2.59
Total	600	250	630	54	75	26	1635	19.12
Average	85.71	35.71	90.00	7.71	10.71	3.71	233.57	2.73

All times in minutes.

Course Administration

An important aim of this research report is to promote a positive change in the quality and efficiency of the multimedia content that is being developed for college courses. One way this change can happen is for professors to enlist the help of their teaching assistants (TAs). For example, under the direction of professors, and guided by the theoretical best practices like those found in Table 3.1, TAs could be the primary technicians who create customized batches of SIVs that can support traditional readings and lectures. Then, in a drafting process, professors will review the initial video rendering, request revisions, and eventually give their approval of the final versions of each SIV. This format is ideal because it will concurrently familiarize TAs with the course subject matter while sparing the professor's time from the technical tediousness of creating SIV content. Some other benefits of this structure include:

- Training for TAs in video-editing software and course subject matter, building their knowledge, and improving their resumes and portfolios with meaningful contributions.
- Making educational materials more accessible and distributable by modularizing them digitally.
- Building a digital content warehouse of SIVs that can be easily recycled by professors and departments for use in future courses.

Additional Considerations

As with any new undertaking, the level of expertise of the SIV production team should be considered when setting expectations or when comparing product-based or experience-based outcomes. For the research presented above, the technician who produced the SIVs has years of experience in every stage of the instructional video production process (e.g., planning and authoring messages, writing and narrating scripts, and working with video editing software). Hence, those with little or no experience producing instructional videos will likely have different experiences from the ones documented in this paper as they make their initial attempts to create SIVs. To this end, I feel compelled to offer a word of encouragement by reminding readers that not long ago Microsoft PowerPoint undoubtedly seemed overwhelmingly complex in comparison with transparencies and overhead projectors. Keep in mind that, in the cycles of technological development (Rogers, 2010), instructional video hardware and software is still relatively new and likely to continue improving with time. I expect that in the coming years video production will be even more intuitive than it is now and those previously excluded from adopting the medium because of computer and user interface challenges will feel more comfortable with it.

Conclusion

Over the past few decades, easily-accessible, low-cost video editing software has been developed that enable professors to produce high-quality educational resources. Instructional videos can now be developed that approximate the quality of traditional, in-person instruction. However, despite the new software's robust functionality and intuitive interface, reports of poorly executed multimedia content ensued, demonstrating that producing college-level instructional videos required more than exceptional technology. Hence a new barrier emerged — the professoriate needed better guidance with the new video editing technology. Responding to this barrier, multimedia scholars and experts throughout higher education began publishing a wave of best-practice recommendations to help with instructional video design and development.

This paper is one outgrowth of that effort, cataloging current best practices used across fields specifically for supplemental instructional videos (SIVs) — a subcategory of instructional video that has been touted in the literature for its effectiveness. This paper also contributed by documenting the application of the best-practice guidelines for an undergraduate CM course. The research offered many new insights ranging from recommendations for a production sequence to reporting the time expense of each stage of SIV development. Possibly the most important contribution of the research is its confirmation that the best-practice theories promoted by the literature, and curated in this paper are practical, deployable, and realistic. The strategies and procedures used to apply the guiding theories have been documented and are ready for reference. Finally, the execution of the research also revealed important knowledge gaps and additional opportunities for inquiry.

Recommendations for Future Work

As revealed by research from The Harris Poll on behalf of Pearson Education (2018), instructional video is quickly becoming the preferred learning medium for upcoming generations. Researchers can be responsive to this growing trend in a few helpful ways. First, more primary research is needed for expanding and improving the best-practice theory that teachers and instructional designers should use when designing and developing instructional videos. Also, part of the primary research should include a more comprehensive time expenditure for these prescriptions. It is important to know how much time it requires professors and their TAs to follow the production guidelines. Second, in the constantly shifting pedagogical and technological college environment, existing sets of best-practice guidelines must be routinely checked for relevance and updated. Third, this paper focused on reviewing and applying theory specifically for SIVs. More research is needed on the other mentioned subcategories of instructional videos (i.e., lecture-based, enhanced, and worked examples) to identify points of commonality and departure. Finally, although the efforts documented in this paper are an important first step to improving instructional videos that are used in classrooms, equally as important is knowing how learners respond to instructional videos in real and controlled settings. Thus, more empirical research is needed to find out the extent to which instructional videos have an effect on student performance and the quality of their learning experience.

References

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. Higher Education Research & Development, 34(1), 1–14. https://doi.org/10.1080/07294360.2014.934336

Adler, A. (2016). Fair use and the future of art. NYUL Rev., 91, 559.

Ahmed, V., Pathmeswaran, R., & Aouad, G. (2007). A Generic Framework for the Development of Standardised Learning Objects within the Discipline of Construction Management. Journal for Education in the Built Environment, 2(2), 115–135. https://doi.org/10.11120/jebe.2007.02020115

Allison, C. (2015). The use of instructional videos in K-12 classrooms: A mixed-method study. https://knowledge.library.iup.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=1146&context=etd

Baddeley, A. (1998). Human memory. Boston: Allyn & Bacon.

Bernold, L. E. (2005). Paradigm Shift in Construction Education is Vital for the Future of Our Profession. Journal of Construction Engineering and Management, 131(5), 533–539. https://doi.org/10.1061/(ASCE)0733-9364(2005)131:5(533)

Bergmann, J., & Sams, A. (2012). Flip your classroom: Reach every student in every class every day. International society for technology in education.

Bergmann, J., & Sams, A. (2014) The Flipped Classroom. CSE Volume 17 Number 3. https://wp0.vanderbilt.edu/cft/guides-sub-pages/flipping-the-classroom/

Bonk, C. J. (2008, March). YouTube anchors and enders: The use of shared online video content as a macrocontext for learning. Paper presented at the American Educational Research Association (AERA) 2008 Annual Meeting, New York, NY.

Borzage, M., & Reynolds, W. M. (1994). An Analysis of the Effectiveness of VideoTape Topics for the Use in Construction Management Education. 10.

Brame, C. J. (2016). Effective Educational Videos: Principles and Guidelines for Maximizing Student Learning from Video Content. CBE—Life Sciences Education, 15(4), es6. https://doi.org/10.1187/cbe.16-03-0125

Brewer, R., & Movahedazarhouligh, S. (2018). Successful stories and conflicts: A literature review on the effectiveness of flipped learning in higher education. Journal of Computer Assisted Learning, 34(4), 409–416. https://doi.org/10.1111/jcal.12250

Bristow, E. C., Bruhl, J. C., & Klosky, J. L. (2014). Effect of Supplemental Instructional Videos on Student Performance in Engineering Mechanics Class. 11.

Choe, E. (2017). Optimizing Video for Learning: A Case Study-Based Primer of Informal, Educational, Digital Video Best Practices. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2909769

Choudhury, I. (2011). The Effect of Watching Video Clips on Student Performance in a Construction Science Course at an Undergraduate Level on Student Performance in a Construction Science Course at an Undergraduate Level. 8. https://www.asee.org/public/conferences/1/papers/50/view

Epstein, M. (1990). Animation in the classroom: A low-cost, educationally effective approach. 3.

Espino, J. M., Artal, C. G., & Garcia-Sanchez, S. (2013). Low-cost, High-value Process for Creating Instructional Videos. 9.

Forbes, H., Oprescu, F. I., Downer, T., Phillips, N. M., McTier, L., Lord, B., ... & Simbag, V. (2016). Use of videos to support teaching and learning of clinical skills in nursing education: A review. Nurse education today, 42, 53-56.

Giannakos, M., Chorianopoulos, K., Ronchetti, M., Szegedi, P., & Teasley, S. (2014). Video-Based Learning and Open Online Courses. International Journal of Emerging Technologies in Learning (IJET), 9(1), 4. https://doi.org/10.3991/ijet.v9i1.3354

Gonzalez, M. J., Montero, E., de Heredia, A. B., & Martinez, D. (2010). Integrating digital video resources in teaching e-learning engineering courses. IEEE EDUCON 2010 Conference, 1789–1793. https://doi.org/10.1109/EDUCON.2010.5492420

Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement: An empirical study of MOOC videos. Proceedings of the First ACM Conference on Learning @ Scale Conference - L@S ’14, 41–50. https://doi.org/10.1145/2556325.2566239

Guy, R., & Marquis, G. (2016). The flipped classroom: A comparison of student performance using instructional videos and podcasts versus the lecture-based model of instruction. Issues in Informing Science and Information Technology, 13, 1-13. http://www.informingscience.org/Publications/3461

Hernández-Ramos, P. (2007). Aim, shoot, ready! Future teachers learn to “do” video. British Journal of Educational Technology, 38(1), 33–41. https://doi.org/10.1111/j.1467-8535.2006.00600.x

Hew, K. F., Qiao, C., & Tang, Y. (2018). Understanding Student Engagement in Large-Scale Open Online Courses: A Machine Learning Facilitated Analysis of Student's Reflections in 18 Highly Rated MOOCs. The International Review of Research in Open and Distributed Learning, 19(3). https://doi.org/10.19173/irrodl.v19i3.3596

Hornung, Y. (2014, May 2). The Optimal Length For Video Marketing Content. The Next Web. https://thenextweb.com/socialmedia/2014/05/02/optimal-length-video-marketing-content-short-possible/

Hoxley, M., & Rowsell, R. (2006). Using Video in the Construction Technology Classroom: Encouraging Active Learning. Architectural Engineering and Design Management, 2(1–2), 115–122. https://doi.org/10.1080/17452007.2006.9684609

Hurtado, K. C., Kashiwagi, D. T., & Sullivan, K. T. (2014). An Assessment Tool for Using Videos and Rich Media in Construction Management Curriculum—A Case Study. 11.

Jensen, J. L., Holt, E. A., Sowards, J. B., Heath Ogden, T., & West, R. E. (2018). Investigating Strategies for Pre-Class Content Learning in a Flipped Classroom. Journal of Science Education and Technology, 27(6), 523–535. https://doi.org/10.1007/s10956-018-9740-6

Kay, R. H. (2014). Developing a Framework for Creating Effective Instructional Video Podcasts. 9(1), 10. https://pdfs.semanticscholar.org/9bcc/94d61ae0c25e2924569222cda1b5f23b8f50.pdf

Kearsley, G., & Shneiderman, B. (1998). Engagement theory: A framework for technology-based teaching and learning. Educational technology, 38(5), 20-23.

Koumi, J. (2015). Learning outcomes afforded by self-assessed, segmented video–print combinations. Cogent Education, 2(1), 1045218. https://doi.org/10.1080/2331186X.2015.1045218

Krämer, A., & Böhrs, S. (2016). How Do Consumers Evaluate Explainer Videos? An Empirical Study on the Effectiveness and Efficiency of Different Explainer Video Formats. Journal of Education and Learning, 6(1), 254. https://doi.org/10.5539/jel.v6n1p254

Kulgemeyer, C. (2018). A Framework of Effective Science Explanation Videos Informed by Criteria for Instructional Explanations. Research in Science Education. https://doi.org/10.1007/s11165-018-9787-7

Lee, A., Zhu, H., & Middleton, J. (2016). Effectiveness of Flipped Classroom for Mechanics of Materials. 2016 ASEE Annual Conference & Exposition Proceedings, 26907. https://doi.org/10.18260/p.26907

Lee, J. H., McCullouch, B. G., & Chang, L.-M. (2003). Object-Based Learning Method in Engineering. Towards a Vision for Information Technology in Civil Engineering, 1–17. https://doi.org/10.1061/40704(2003)38

Lo, C, & Hew, K. (2017). A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. Research and Practice in Technology Enhanced Learning, 12(1), 4. https://doi.org/10.1186/s41039-016-0044-2

Lunt, J. (2009). Condensing Storage Water Heaters.The Journal of Light Construction (7). 1-8. https://www.luntmarymor.com/sites/default/files/condensing-water-heaters-article.pdf

Majekodunmi, N., & Murnaghan, K. (2012). "In Our Own Words": Creating Videos as Teaching and Learning Tools. Partnership: The Canadian Journal of Library and Information Practice and Research, 7(2). https://doi.org/10.21083/partnership.v7i2.2007

Matthewson, C. (1988). "Camcorders" - A Hi Tech Aid to Construction Education. 11.

Mayer, R. E., & Moreno, R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. Educational Psychologist, 38(1), 43–52. https://doi.org/10.1207/S15326985EP3801_6

Mayer, R. E. (2005). Cognitive theory of multimedia learning. The Cambridge handbook of multimedia learning, 3148.

McGarr, O. (2009). A review of podcasting in higher education: Its influence on the traditional lecture. Australasian Journal of Educational Technology, 25(3). https://doi.org/10.14742/ajet.1136

Moradi, M., Liu, L., & Luchies, C. (2016). Identifying Important Aspects in Developing Interactive Instructional Videos. 8.

Moreno, R., & Mayer, R. E. (2000). A learner-centered approach to multimedia explanations: Deriving instructional design principles from cognitive theory. Interactive multimedia electronic journal of computer-enhanced learning, 2(2), 12-20.Muller, D. A. (2008). Designing effective multimedia for physics education. University of Sydney Australia 2008. Retrieved from: http://www.physics.usyd.edu.au/super/theses/PhD(Muller).pdf

Muller, D. A. (2008). Designing effective multimedia for physics education. University of Sydney Australia 2008. Retrieved from http://www.physics.usyd.edu.au/super/theses/PhD(Muller).pdf

Nasir, A. R., & Bargstädt, H.-J. (2017). An Approach to Develop Video Tutorials for Construction Tasks. *Procedia Engineering*, *196*, 1088–1097. https://doi.org/10.1016/j.proeng.2017.08.066

Ozdamli, F., & Asiksoy, G. (2016). Flipped Classroom Approach. World Journal on Educational Technology, 8(2), 98. https://doi.org/10.18844/wjet.v8i2.640

Pai, A. (2014). Case Study: A Picture Worth a Thousand Words? Making a Case for Video Case Studies. Journal of College Science Teaching, 043(04). https://doi.org/10.2505/4/jcst14_043_04_63

Paivio, A. (1986). Mental representations: A dual coding approach. Oxford, England: Oxford University Press.

Pearson Education, New Research Finds YouTube, Video Drives Generation Z Learning Preference. (2018). Retrieved February 22, 2020, from https://www.pearson.com/content/dam/one-dot-com/one-dot-com/global/Files/news/news-annoucements/2018/The-Next-Generation-of-Learners_final.pdf

Prime, M., Bhatti, Y., & Harris, M. (2017). Frugal and Reverse Innovations in Surgery. In A. Park & R. Price (Eds.), *Global Surgery* (pp. 193–206). Springer International Publishing. https://doi.org/10.1007/978-3-319-49482-1_11"

Roehl, A., Reddy, S. L., & Shannon, G. J. (2013). The Flipped Classroom: An Opportunity To Engage Millennial Students Through Active Learning Strategies. Journal of Family & Consumer Sciences, 105(2), 44–49. https://doi.org/10.14307/JFCS105.2.12

Rogers, E. M. (2010). Diffusion of innovations. Simon and Schuster.

Rubin, S., Berthouzoz, F., Mysore, G. J., & Agrawala, M. (2015). Capture-Time Feedback for Recording Scripted Narration. Proceedings of the 28th Annual ACM Symposium on User Interface Software & Technology - UIST '15, 191–199. https://doi.org/10.1145/2807442.2807464

Ruth, S. (2012). Can MOOC's and Existing E-Learning Efficiency Paradigms Help Reduce College Costs? SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2086689

Ryan, D., Long, R., Lauf, D., Ledbetter, M., & Reeves, A. (2010). ENERGY STAR water heater market profile. Efficiency Sells, US Department of Energy.

Senior, B. A., & Miura, A. S. (1996). Developing an Educational Interactive Multimedia Application for Construction Estimating. 9.

Sever, S., Oguz-Unver, A., & Yurumezoglu, K. (2013). The effective presentation of inquiry-based classroom experiments using teaching strategies that employ video and demonstration methods. Australasian Journal of Educational Technology, 29(3). https://doi.org/10.14742/ajet.229

She, J.-H., Wu, C., Wang, H., & Chen, S. (2009). Design of an e-learning system for technical Chinese courses using cognitive theory of multimedia learning. Electronics and Communications in Japan, 92(8), 1–10. https://doi.org/10.1002/ecj.10204

Sumbawat, M. S., & Munoto, M. (2015). The Development of Instructional Video to Illustrate How Teaching in a Real Learning Environment. In 2015 International Conference on Innovation in Engineering and Vocational Education. Atlantis Press.

Swan, K. (2005). A constructivist model for thinking about learning online. In J. Bourne & J. C. Moore (Eds), Elements of Quality Online Education: Engaging Communities. Needham, MA: Sloan-C. https://pdfs.semanticscholar.org/30a9/85a3d9e1cb72c7cd6eadddc1e959b30c76d4.pdf

Sweller, J. (1999). Instructional design in technical areas. Camberwell. Victoria: ACER Press.

Van der Meij, H., & Van der Meij, J. (2013). Eight guidelines for the design of instructional videos for software training. Technical communication, 60(3), 205-228. http://www.ingentaconnect.com/content/stc/tc/2013/00000060/00000003/art00004

Wittrock, M. C. (1989). Generative processes of comprehension. Educational Psychologist, 24, 345–376.

CHAPTER 4

INSTRUCTIONAL VIDEO OBJECT-BASED LEARNING IN A FLIPPED CONSTRUCTION MANAGEMENT CLASSROOM

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Abstract

Instructional videos are quickly becoming a permanent fixture of modern higher education. However, little empirical research has been conducted testing the effectiveness of instructional videos for improving student performance. The meager literature published to date makes this particularly true in the field of construction management (CM). In the spring semester of 2020, 46 learners in a CM course participated in a research study aimed at understanding the ability of supplemental instructional videos (SIVs) to improve student understanding of pre-class readings in a flipped classroom. The SIVs were designed and developed based on an interdisciplinary synthesis of best practices and delivered online as supplemental learning materials in a repeated-measures crossover experiment. Results from the experiment indicated that supplemental instructional videos had little measured effect on student performance, regardless of age, year in school, gender, final class grade, or complexity of the learning topic. A closer examination of the negative results suggest that practitioners should not expect large or significant changes in their learners' performance from supplemental, instructional video interventions. Outside of the SIV treatment, the research discovered that the abrupt shift to exclusively online class in response to the COVID-19 pandemic was associated with a significant increase in student performance.

Keywords: Construction Management, Object-Based Learning, Supplemental Instructional Videos, Flipped Classrooms, COVID-19

Background and Introduction

Object-Based learning (OBL) is an active, student-centered teaching approach (Rockenbach, 2011) that breaks down course subject matter (Goh et al., 2014) into small, modularized portions of instruction that can be delivered digitally (Wiley, 2002). As defined by some of the pioneering construction education scholars of the pedagogy, OBL is “based on the idea that people can learn from an object by exploring the object in its context” (Lee et al., 2003 pg. 1). Fundamental to the OBL approach are learning objects (LOs) — “digital resource[s] that can be reused to support learning” and are openly distributable online via the internet (Wiley, 2002, p. 6). Some examples of LOs that conform to this definition include various multimedia content such as digital text, graphics, photographs, animations, and, most notably in recent years, instructional videos (Chitwood et al., 2000; Wiley, 2008).

The conceptualization of modern LOs is attributable to H. Wayne Hodgins, who has been called the “father” of LOs or “Mr. Metadata” for his contribution to the field of computer science (IEEE Computer Society, 2020). Foreseeing a future defined by internet-based learning, Hodgins envisioned placing the “control of content...into the hands of every individual...where everyone in need of a given skill or knowledge can be connected directly with those who have it… to have potentially billions of authors and publishers...” (Hodgins, 2002, p. 81). Hodgins also claimed that the “most significant promise [of LOs would be] to increase and improve the effectiveness of learning and human performance” (Hodgins, 2002, 76).

Hodgins’s work has empowered companies like YouTube, possibly the largest repository of video-based multimedia content on the planet, to largely fulfill the first half of his vision — putting the control of content within reach of everyone, connecting people, and empowering “billions of authors" (Hodgins, 2002, p. 81). Following the concurrent, sudden breakout of both online learning and low-cost, high-quality video editing software, instructional videos have also become a defining feature in the landscape of modern education (Brame, 2016). To illustrate the extent to which Hodgins's vision has materialized, YouTube EDU, a sub-site of YouTube devoted exclusively to publishing instructional videos, was chartered in 2009 (Arrington, 2009) and currently makes available more than 700,000 instructional videos produced by a variety of both well-known (i.e., PBS, TEDEd, and Khan Academy) and lesser-known authors (Teachers YouTube, n.d.).

Although the reach and momentum of instructional videos is extensive, because of Hogdin’s sustained emphasis on developing the technical side of LOs, research in this field has been disproportionately focused on the computer science of LOs rather than their pedagogy, leaving many open questions about the educational efficacy of LOs and OBL (Wiley, 2008).

Fundamental questions regarding the pedagogical quality of instructional videos remain unanswered. Chief among them: Do instructional videos live up to their "most significant promise […] to increase and improve the effectiveness of learning and human performance." (Hodgins, 2002, p. 76)? If so, for who, in which ways, and to what extent?

As a result of these lingering questions, this study aims to explore the impact of instructional videos for undergraduate students, focusing on a flipped classroom (FC) construction management (CM) course. In the field of CM, few studies have been published that directly evaluate the effectiveness of instructional videos. Those that are available are too dissimilar in scope and methods to aggregate and generalize to the overall population of undergraduate CM learners (Burgett, 2014; Choudhury, 2011; Hurtado et al., 2014; Lee, Salama, and Kim, 2016). The scant research that has been published on the effectiveness of instructional videos for CM education report mostly positive results (Choudhury, 2011; Hurtado et al., 2014; Lee, Salama, and Kim, 2016). However, no previous research could be found that evaluated the ability of instructional videos to supplement traditional, pre-class learning materials (in contrast with lecture) in a FC setting. Considering McGarr's (2009) claim that "[supplementary video] material can facilitate higher cognitive learning outcomes [by] providing students with alternative perspectives on content previously delivered or enable further and deeper exploration of topics" (p. 317), this works focuses on the effectiveness of SIVs, determined by the improvement between pretest to posttest scores, rather than other types of instructional videos. This paper contributes to the literature by reporting the outcome of an explanatory, quasi-experimental research study measuring the effectiveness of SIVs for traditional, pre-class learning materials in an authentic, CM FC. It also provides insight on the student performance differences between in-person instruction and exclusively online learning. Unexpectedly, exactly halfway through the research study (after week 6 of 12), the COVID-19 pandemic suddenly forced all in-person classes to move online. Hence, a *COVID-19* research question (RQ4) and variable were created to examine any changes between the two periods of different instructional delivery methods (i.e., six weeks of in-person vs. six weeks of online instruction).

Literature Review

Prevailing pedagogical theory suggests that instructional videos should have the ability to improve undergraduate CM learner achievement (Lee et al., 2003). The literature predicts that instructional videos will be most effective and conducive to learning in two situations: first, to demonstrate a technique, and second, when learners need visuals to gain a true appreciation of the subject matter (Meisel, 1998). Both situations apply to CM education (Hoxley & Rowsell, 2006) due to the applied nature and complexity of the field. These two situations imply that instructional videos should be particularly helpful when integrated as visual supplements to existing CM curricula. Additionally, because the medium of video remains effective regardless of the level of complexity of the content (Liu & Hatipkarasulu, 2014), this supplementation may be uniquely effective with more difficult or technical topics. Other theory suggests that the visual elements of instructional videos may have a greater impact with less-experienced learners who are unfamiliar with learning topics and find readings or other traditional mediums challenging (Nasir & Bargstädt, 2017).

While this theory provides guidance on the deployment of instructional videos, limited research has empirically evaluated the effectiveness of instructional videos directly, and specifically in a construction education context. Choudhury (2011) tested the effectiveness of instructional videos on undergraduate CM students in an environmental control systems course. Learners enrolled in the summer 2009 course did not have any instructional videos while learners in the 2010 course were “shown video clips related to the course” (p. 5). He found that using instructional videos to supplement classroom lecture had a statistically significant positive effect on learners’ test scores across years. A notable weakness of this work is that the paper provides little-to-no information about the characteristics of the “video clips” (p. 2) themselves. Details about content, length, quality, selection and development criteria, and the process for applying the videos in the lectures, are all left out.

Burgett (2014) used the flipped classroom (FC) approach to test the effectiveness of video lectures in a CM course on Heating, Ventilation and Air Condition (HVAC). The course was divided into two sections, providing the first section of 23 learners with a traditional teaching experience in which in-person lectures were given during class time. The second class section, comprising 18 learners, was given recorded video lectures to be watched before class on the course website. The research study concluded that the results on the final exam for both class sections were nearly identical. In this study, students reported that they did not appreciate the recorded lectures. They were reluctant to watch them and felt that they were a “poor choice” for teaching difficult concepts (Burgett, 2014, p. 6). Burgett (2014) thus concluded that instructional videos are better suited for introducing basics of complex subject matter like HVAC systems.

Similar to Burgett (2014), Lee, Salama, and Kim (2016) studied the effectiveness of instructional videos on separate sections of a FC that used various self-developed, multimedia-based tools including instructional videos. Two sections of an upper level estimating course in a CM department served as the treatment group and two served as the control group for the research. The pretest and posttest scores revealed that the FC, which utilized instructor-developed, lecture-based instructional videos, produced greater positive changes in performance. Notably, the researchers emphasized their belief that success in a FC is conditional on the design and execution of the videos.

Hurtado et al., (2014) noted the impact that video production technique and implementation had on student performance. Drawing upon best practice guidelines for instructional video design and development from the fields of Educational Technology and Instructional Design, this research team developed and tested a quality assessment tool for the effectiveness of instructional videos in a CM statistics course. Notably, the quality and utility of instructional videos, not the achievement of the learners, was the primary subject of evaluation. Nevertheless, attention was still given to student performance. The researchers commented that over the course of three semesters, as the instructional videos received greater utilization (i.e., minutes watched and number of views), learner performance increased.

This thin and fragmented body of empirical research emphasizes the gap that exists in the field of CM education regarding the effectiveness of instructional videos. Importantly, the knowledge gaps on these topics are not unique to CM. Basic questions on a variety of related topics currently remain unanswered across many fields. For example, in 2018, Jensen et al. (2018), a research team focused on general undergraduate education, published a literature review as part of an exploratory investigation of the best pre-class learning content in a flipped classroom. In their review, the team found that "only one [previous] systematic, controlled comparison has been made between various pre-class content delivery methods to determine which is most effective for student learning" (p. 525). Jensen et al. (2018) concluded their research by stating that the medium of video appears to be the superior method (over interactive tutorials or textbook-style readings) for pre-class learning, however, additional research is still needed before any causal relationships could be determined.

One hindrance to better research on the effectiveness of instructional videos comes from uncontrolled variability in video quality, length, pace, personalization, and level of engagement. Until very recently, many instructional videos were produced without informed guidance (Hurtado et al., 2014), falling short of student expectations on account of design or execution flaws and giving instructional videos a poor reputation (Choe, 2017). This, in part, may have contributed to the mixed results researchers have reported on of the effectiveness of instructional video LOs in applied, non-construction fields (Bowen et al., 2012; Jensen et al., 2018; Kelly et al., 2009; Kozma, 1991; Sever et al., 2013). Attending to the need for better guidance on the design and development of instructional videos, over the past few years, scholarship has produced a wave of domain-specific, best-practice theory to guide researchers and practitioners as they attempt to produce effective instructional videos (Brame, 2016, Choe, 2017). Some of this best practice comes directly out of the CM field (Hurtado et al., 2014; Nasir & Bargstädt, 2017). Despite current progress, the literature is clear, explicitly and implicitly, that more empirical research is needed to determine the effectiveness of instructional videos.

A second problem with the current body of literature is a failure to consistently and clearly describe the type of video being used in research. In 2012, Robin H. Kay (2012) conducted an extensive literature review on the use of videos in higher education and found that nearly all instructional videos fit into one of four categories: lecture-based, enhanced, worked examples, and supplementary. Lecture-based videos are those that substitute for in-person lectures, while enhanced videos amplify existing presentations by converting visuals to video, and layering in a narrated audio track. Worked examples provide meticulous explanations of specific problems and are mostly used in math and science. Finally, supplementary videos, or supplemental instructional videos (SIVs), "augment the teaching and learning of a course and include...summaries of class lessons or textbook chapters…or additional material that may broaden or deepen student understanding (Kay, 2012, p. 821). This study focused on the latter of these categories, SIVs, for their ability to provide "significantly more educational value" and to "broaden or deepen the student's understanding" of the subject matter (McGarr, 2009 p. 317).

Research Questions & Expectations

This study explores whether instructional video LOs are an effective way to supplement traditional pre-class learning materials (readings) in a flipped CM environment. More specifically, the focus was on the following research questions:

- RQ1: *Does the use of instructional video LOs, as supplemental, educational tools for traditional learning materials (i.e., readings), improve objective measures of learner performance?* Based on research by Choudhury (2011), I expected that learners who received instructional video supplementation of pre-class learning activities would have better learning outcomes (i.e., greater improvement in their scores) than learners who did not receive instructional video supplementation.
- RQ2: *Which construction topics (e.g., plumbing, foundations, framing) are most conducive to using instructional videos?* Based upon the research by Liu & Hatipkarasulu (2014), I expected that instructional videos would be associated with better learning outcomes (i.e., greater improvement in student scores between the pretest and posttest) for more complex and difficult-to-understand subjects than for simpler subjects.
- RQ3: *Which learner groups, in terms of gender, age, years in school, and final grade in class benefit most from instructional video LOs?* Based upon the research by Nasir and Bargstädt (2017), I hypothesized that instructional videos would be more impactful for learners who traditionally have less construction experience (i.e., younger students, females, underclassmen, and participants with lower final grades in class) and therefore expected to see greater improvement in their performance.
- RQ4: *What effect does the COVID-19 shutdown have on the performance of CM learners?* Due to the original FC course design, that relies on technology and elements of blended learning (i.e., partially online and partially in-class), I hypothesized that the COVID-19 shutdown of all in-person instruction would have no measurable effect on student performance.

Materials and Methods

In the Spring Semester of 2020, 46 undergraduate learners in a course titled Residential Construction Technologies consented to participate in the research study on OBL. Prior to signing up, students in the class were given a short presentation and handout describing the research activities and objectives. All research activities were approved by and conducted in accordance with the Virginia Tech Institutional Review Board (protocol 19-853). Because the course was a first-time offering, researchers had the ability to structure the course and research in a way that concurrently served the needs of the learners and the inquiry. The literature was first reviewed to inform the methodology. After careful consideration, the research team chose a flipped classroom (FC) for the course structure, supplemental instructional videos (SIVs) as the LOs, and employed a repeated measures experimental design (RMED) for data collection. Consistent with previous research (Kedar & Kumar, 2013), effectiveness was measured in terms of improvement between pretest and posttest scores and was used to answer the four research questions (i.e., RQ1, RQ2, RQ3, and RQ4). The pretest and posttest score data were collected from the gradebook in the university learning management system (LMS), Canvas. Demographic information needed to answer RQ3 was provided by the participants in a Qualtrics survey. Further details of the methodology are outlined below.

The Course: Residential Construction Technologies

Similar to previous research on OBL (Lee & McCullouch, 2005) the course, Residential Construction Technologies, was organized so that each week of the semester covered a different construction topic (e.g., foundation, framing, plumbing, interior floor finishes). Within each topic, learners were introduced to two competing construction technologies: 1) a conventional technology and 2) a more technologically-advanced alternative, termed ‘conventional-plus technologies.’ The conventional-plus technologies were chosen based upon their promise of improved efficiency in terms of cost, quality, time, safety, or sustainability. The main learning objective in the course was for learners to effectively contrast the conventional-plus technologies and with their conventional counterparts. To meet this objective, each week all learners in the class were given readings covering both technologies (i.e., conventional and conventional-plus technologies) to prepare them for an in-class quiz and later, group project work that were used to assess their mastery of the technologies.

I was interested in evaluating whether SIVs provided learners with a better understanding of unfamiliar topics in the readings, and if the improved understanding translated to improved performance on the in-class quizzes. To execute this quasi-experiment (Fellows & Liu, 2015), half of the class each week was randomly selected to receive an additional learning assignment to privately watch a short, supplementary instructional video before completing the readings on the conventional-plus technologies. These instructional videos were the treatment in the experiment and served as the main independent variable of the research. For equity, by the end of the semester, all learners received the same number (i.e., six) instructional videos to supplement their readings. To provide an example of this process, in week seven, a standard 50-gallon storage-tank water heater was contrasted with a condensing storage water heater. All learners were assigned readings covering both water heaters to be completed before the in-class quiz and group project work. Half of the learners in the class were also provided with an instructional video on condensing storage water heaters to be watched before completing the reading on that conventional-plus technology.

The Flipped Classroom Approach

To support the course learning objectives and research on OBL, the course was designed as a flipped classroom (FC), a student-centered teaching approach that switches, or flips, classroom tasks with at-home learning tasks (Bergmann & Sams, 2012). In a FC, traditional classwork assignments (e.g., lecture or discussions about readings) are completed at home (i.e., not with immediate access to the instructor), facilitated by technology, in preparation for teacher-guided classwork (Abeysekera & Dawson, 2015). Traditional homework assignments (e.g., worked problems or group work) are done during class where learners have access to immediate help from the instructor and their peers (Jensen et al., 2018).

OBL is a complementary pedagogy to FC because FCs are designed specifically to provide space for the use of supporting technologies, in particular, instructional videos, during pre-class learning segments (Abeysekera & Dawson, 2015). Reciprocally, the FC is a good match for OBL because LOs are designed to be components of a broader learning framework (McGreal, 2004). Instructional videos are teaching tools, like books, that are of themselves insufficient to deliver complete and transformative learning experiences (Liu & Hatipkarasulu, 2014). To emphasize this point, the literature is clear that technology-enabled learning mediums, such as instructional videos, are unable to substitute for either teachers or classrooms (Willcox et al., 2016). However, when instructional videos are combined with an appropriate classroom context, such as a well-implemented FC, the pedagogical tool becomes powerfully effective (Bergmann & Sams, 2012; Yadav et al., 2011).

The role of the FC in the Residential Construction Technologies course was, first, to provide an optimal classroom environment for active, mentored, student-centered, experiential learning opportunities (Jensen et al., 2018) and second, but not secondarily, to provide a suitable research environment for investigating OBL (Bishop & Vergler, 2013b). In accordance with the literature on FCs, the course was divided into three distinct learning segments: pre-class, in-class, and post-class (Lo & Hew, 2017).

- <u>Pre-class</u> work was strictly independent and primarily involved the completion of assigned readings. For learners who received the additional assignment to watch an instructional video on the conventional-plus technology, this was to be completed before the readings.
- <u>In-class</u> work was dedicated to group work that required students to apply knowledge from the readings to complete an estimating and impact assessment for a residential construction project. Weekly in-class quizzes covered only material found in the pre-class readings.
- <u>Post-class</u> work required learners to revisit the subject matter covered during the pre-class and in-class segments with online discussions, reflections, and collaborations.

Importantly, the FC was carefully designed and implemented to not become a variable in the research, but instead, remain an operationalized construct that was held constant to support the real focus of evaluating OBL for CM learners.

Supplemental Instructional Videos

The design and development of the SIVs was informed by contemporary best practice guidelines from the literature (Brame, 2016; Choe, 2017; Kulgemeyer, 2018; Nasir & Bargstädt, 2017). Briefly, this meant that the SIVs needed to be: as short as necessary (i.e., less than 10 minutes, but closer to 5), scripted, segmented (i.e., focused on a single topic), high-quality in terms of production, instructor-made, engaging, clear, personalized (i.e., first-person voice), interactive (i.e., corresponding quiz questions to be answered while watching), connecting, and properly paced.

Twelve SIVs were developed, one for each conventional-plus technology covered in the semester. The software used to produce the SIVs was a home-license of TechSmith Camtasia 2018. Nearly all elemental content (i.e., images, graphics, videos, music, and sounds effects) used during production came from license-free, attribution-free, creative commons, and public domain sources including Pixabay.com, the YouTube Audio Library, Google Images, Archive.org, and FreeSounds.org. Any content taken from outside of the public domain was attributed in the video and adhered to the fair use doctrine under the Copyright Act of 1976 (Adler, 2016). A basic, standard outline was consistently applied to each SIV, including a routine introduction, complete with music and motion graphics. All SIVs went through a consistent pre-production, production, and review process to ensure that they were all qualitatively similar.

Experimental Design

This study on OBL evaluated the effectiveness of SIVs. Although "effectiveness" in teaching remains a "contested concept" without a universally-accepted definition (Devlin & Samarawickrema, 2010, p. 112), scholars generally agree that effective teaching can be broadly summarized as "that which causes students to learn and grow or is accepted by teachers and other educational professionals" (Tuckman, 1995 p. 127). In education research, effectiveness has been measured using assessments (Bishop & Verleger, 2013a; Burgett, 2014; Jensen et al., 2018; Lee, Lee, & Kovel, 2016; Lee, Salama, & Kim, 2016; Tuckman, 1995), often in the form of pretests and posttests (Kedar & Kumar, 2013; Kulgemeyer, 2018; Rokooei & Goedert, 2015). Measuring effectiveness should not be confused with measuring retention or depth of learning. Specific and specialized measurement instruments (e.g., permanency tests, retention tests, and Webb's depth-of-knowledge assessments) have been developed and are available for these types of inquiry (Hess et al., 2009; Johnson & Mayer, 2009; Sever et al., 2013).

To evaluate the effectiveness of SIVs in terms of improvement between pretest and posttest scores, I applied a repeated measures experimental design (RMED), which is characterized by taking multiple measurements on individual participants. More specifically, I conducted a within-subject, withdrawal-of-treatment, crossover experiment. The crossover RMED has the ability to boost statistical power from a relatively small sample size (Minke, 1997; Yadav et al., 2011) because each participant receives both the treatment and comparison conditions repeatedly at different times, generating a larger quantity of total measurements (Salkind, 2010). The RMED is highly effective at neutralizing potentially confounding variables (e.g., intelligence, GPA, experience, year in school, gender, and age) because the participants in the treatment group are the same as those in the comparison group (Minke, 1997). In a real classroom environment, controlling as many confounding variables as possible was imperative to preserve a functional and reliable, quasi-experimental setting.

Independent & Dependent Measures

Typical of a crossover RMED that employs a pretest and posttests, two independent variables were introduced during the study. The main independent variable, or focal variable used to answer RQ1, was the treatment of supplemental instructional videos (SIVs). SIVs were introduced to support the conventional-plus technology readings during the pre-class learning segments of the flipped classroom (FC). The second independent variable was time, the periodic treatment of the SIVs over the course of the semester. For RQ2 and RQ3, gender, age, learning topic, and year in school were examined as qualitative moderator variables in order to explore which, if any, course topics and student populations are most likely to be impacted by the treatment of SIVs.

Because the research sought to measure the effectiveness of SIVs through the performance of learners on their assessments, the effectiveness construct was operationalized by the scores collected from the pretest and posttest. Thus, student performance, measured as the difference in scores between the pretest and posttest, was the dependent variable, i.e. the target problem or main focus under observation (Bishop & Verleger, 2013a; Check & Schutt, 2012).

Executing the Crossover RMED in Residential Construction Technologies

The crossover RMED was ideal for Residential Construction Technologies because the course content was siloed into weekly, non-accumulative sections that were identical in structure, but distinct in content; no instructional materials or corresponding work assignments were linked with previous or future course topics or materials. This format provided multiple opportunities for testing the effects of the independent variables (i.e., the SIVs) that were not biased by previous instruction from earlier in the course (Lee & McCullouch, 2005), and thus preserved statistical independence between measurements. This was important because a common weakness of single-participant (i.e., when the same individual is used for both the treatment and control) repeated measures design is the additive, or multiplicative effect, where, over time, the treatment group inadvertently influences the control group (Girón et al., 2003). Furthermore, the RMED was a good match for the course because of the FC setting. The RMED features repeated measurements of the same sample in a simple, consistent, and iterative format (Frey, 2018), consonant to the FC which offers a predictable and modularized structure by repetitiously cycling through three defined learning periods (i.e., pre-class, in-class, and post-class).

The research study deployed the pretest and posttest strategy (Minke, 1997), a common variation of the RMED in which before-and-after observations are made, documented, analyzed, and reported (Salkind, 2010). The pretest and posttests allowed us to measure student performance more precisely by calculating the difference in scores between the two assessments. Using the difference, rather than weekly posttests alone, accounted for learners' existing knowledge of the topics that had been acquired before the course.

The pretest consisted of 84 multiple-choice questions that were administered during the first two class sessions of the semester. The goal of the pretest was to measure learners' existing knowledge about the spectrum of conventional-plus technology topics to be covered throughout the course. The logic behind a single, comprehensive pretest, instead of weekly, topic-specific pretests, was for convenience, time savings, and to reduce possible carryover effects including boredom and testing fatigue (Salkind, 2010). Learners did not have the ability to review their scores or the questions after the pretest was submitted. The pretest was counted towards learners' grades for completion only.

For the posttests, in-class quizzes were administered each week throughout the semester covering that week's conventional-plus topics, which were described in pre-class reading assignments. Following previous studies (Lee, Salama, & Kim, 2016), the posttest questions were identical in number, content, and structure to the pretest questions, but occasionally varied slightly in wording and answer option ordering. The scores and questions from these posttests were available for learners to review and counted toward their final grades in the class.

Pretest and posttest questions covered material exclusively from the reading assignments, not the SIVs, so that learners in the control groups each week were not being quizzed on subject matter they had not been exposed to. The purpose of the SIVs was to introduce and supplement the readings, not substitute for them, so they could be used to help learners gain a better understanding of the new and unfamiliar topics in the readings specifically.

To control the research environment, all in-class instruction was taught by the same instructor that produced the instructional videos. Also, consistent with a crossover design, the assignment of learners to the treatment group was randomized each week so each repeated measure consisted of a new, dynamic assortment of participants from the sample pool (Figure 4.1). All course material presented in each repeated measure was considered to be “new knowledge” subject matter (Burgett, 2014 p.2) to establish independent measurements and eliminate existing knowledge biases. The research was designed so carryover effects and measurement sequencing could be statistically accounted for during analysis. The course did not allow for counterbalancing which, for this research, would manifest as distributing treatment topics (e.g., roof framing, plumbing, exterior finishes) to different learners at different times throughout the course (Suter, 2012). Finally, to identify any unclear, ambiguous, redundant, or gameable questions, all pretest and posttest questions were piloted by multiple undergraduate CM learners in the same department who were not participants of the study.

	Topics										
Learner ID	Foundation	Framing: Walls	Framing: Floors	Framing: Roofs	Mechanical	Electrical	Plumbing	Windows	Roofing	Insulation	Exterior Wall Finishes
Learner 1	N	N	Y	Y	N	Y	N	Y	Y	N	N
Learner 2	N	N	N	Y	N	Y	Y	Y	Y	N	Y
Learner 3	Y	N	N	N	N	Y	Y	Y	Y	N	N
Learner 4	N	Y	Y	Y	Y	N	N	N	N	N	Y
Learner 5	N	Y	Y	N	N	Y	N	Y	Y	Y	N
Learner 6	N	N	N	Y	N	Y	Y	Y	Y	N	Y
Learner 7	N	Y	Y	Y	Y	N	N	N	N	N	Y
Learner 8	N	Y	N	Y	N	Y	Y	N	Y	Y	N
Learner 9	N	Y	Y	Y	N	Y	N	N	Y	N	N
Learner 10	Y	Y	N	N	Y	Y	N	Y	N	N	Y
Learner 11	Y	N	N	N	Y	N	Y	Y	Y	Y	N
Learner 12	N	Y	Y	Y	N	Y	N	N	Y	N	N
Learner 13	Y	N	Y	N	Y	N	N	N	N	Y	Y
Learner 14	Y	Y	Y	N	N	N	Y	N	N	Y	N
Learner 15	N	N	Y	Y	N	Y	N	Y	Y	N	N
Learner 16	Y	Y	Y	N	N	N	Y	N	N	Y	N
Learner 17	Y	N	Y	N	Y	N	N	N	N	Y	Y
Learner 18	Y	N	N	Y	N	N	Y	Y	N	Y	Y
Learner 19	Y	N	N	Y	N	N	Y	Y	N	Y	Y
Learner 20	N	N	Y	N	Y	N	Y	Y	N	Y	Y
Learner 21	N	N	Y	Y	N	Y	N	Y	Y	N	N
Learner 22	Y	N	Y	Y	Y	N	Y	N	N	N	N
Learner 23	Y	N	N	N	Y	N	Y	Y	Y	Y	N
Learner 24	Y	N	Y	Y	Y	N	Y	N	N	N	N
Learner 25	N	Y	Y	Y	Y	N	N	N	N	N	Y
Learner 26	Y	N	N	Y	N	N	Y	Y	N	Y	Y
Learner 27	Y	N	N	N	N	Y	Y	Y	Y	N	N

Figure 4.1 Randomized assignment of learners to treatment and control topics for each week of the semester.

The course learning management system (LMS), Canvas, was used to administer all instructional videos exclusively to the treatment group each week, minimizing or eliminating the opportunity for diffusion to members in the control group. This modern technique of using technology to create a virtual separation of treatment and control groups has precedence in the fields of both education (Gabarre et al., 2013; Qiang, 2014; Sao Pedro et al., 2009; Shermis et al., 2008; Walton, 2018; Ward, 2009) and engineering education (Kedar & Kumar, 2013; Pappas, 2013).

COVID-19 Adjustments to the Research

Fortunately, the COVID-19 pandemic, which required all instruction exclusively online, had no effect on the treatment of pre-class SIVs that were already being administered online. Likewise, the pretest, which was administered in aggregate during the first two class sessions of the course, remained unaffected. The primary disruption came at the point of classroom activities including mentored instruction, group work, and the posttests, which, for weeks 1-6 of the study, were administered in-person. After the COVID-19 shutdown, these classroom activities continued, but were conducted synchronously online rather than in-person. Despite these disruptions, after the quick approval of the University IRB, the study proceeded as initially planned, with the added goal to explore how the effectiveness of OBL would be affected by moving the flipped classroom online (i.e., by moving the synchronous components of the course to an online setting with Zoom web conferencing).

Population and Sample

The target population for the research was undergraduate CM learners. However, broadly, all learners in the domain of construction education were considered to be part of the population that can contribute to and benefit from this research. This is because construction education extends beyond learners majoring solely in CM (Puddicombe & Johnson 2011) to include those majoring in a variety of other fields such as construction and engineering, real estate, facility management, interior design, engineering, and architecture, among others (Bhattacharjee, 2014). Even more broadly, all learners throughout many fields and tiers of education (i.e., primary, secondary, higher education), and especially in the applied disciplines, have the potential to benefit from this research that, fundamentally, is seeking a better way to introduce new and unfamiliar topics to a specific learning audience.

During the study, a survey was conducted asking participants to provide demographic information needed for RQ3. The majority of the 46 learners in the research course were male (78%, n=36) and majoring in Building Construction (89%, n=41) — representative of the population of undergraduate learners the research was primarily designed to benefit (Morello, Issa, & Franz, 2018). Students were primarily in their second (n=10), third (n=17), or fourth (n=12) year of college, with few in their first (n=1) or fifth year (n=2).

Data Analysis

Student performance data for this study were collected using the university LMS, Canvas. Grades were downloaded as an Excel spreadsheet and combined with demographic data which was collected from students in a Qualtrics survey at the end of the course. The data files were stored on a secure enterprise system, the university portal to Google Drive.

All statistical analyses were conducted in SPSS (version 25). To begin the data analysis and see how it should proceed, a mixed model ANOVA — a statistical test often used in studies in which data were collected by using repeated measures (Frey, 2018) — was conducted on the data to account for sequencing and carryover effects. Based upon the mixed model ANOVA, no significant results were found for either sequences or carryover effects, indicating that first, *the research was not statistically influenced by the random sequence of treatment topics* ($p = .246$), and second, that *none of the previous weeks' treatments carried over to have an undue impact on subsequent trials* ($p = .899$). Following the mixed model ANOVA, to answer RQ1, an independent t-test was used to evaluate the interaction effects between the main independent variable (i.e., the administration of the SIVs to the treatment group) and the dependent variable (i.e., the difference between pretest and posttests scores). Next, for RQ2 and RQ3, a two-way, between-subjects ANOVA was used to evaluate differences in the treatment and control groups for the moderating variables (i.e., gender, year in school, age, topic, final grade in class, impact of the shift to exclusively online learning from in-person due to COVID-19). Finally, post-hoc independent t-tests were executed discriminately based upon significant results identified.

Results

Assumptions of the Statistical Tests

For both the two-way ANOVAs and the independent t-tests, six assumptions were reviewed or tested. These included: 1) confirmation of a continuous dependent variable, 2) two or more categorical variables, 3) independence of observations, 4) tests for outliers using boxplots, 5) normality, using Shapiro-Wilk test of normality, and 6) homogeneity of variances using Lavene's test of equality of error variances.

Following the first iteration of each statistical test, outliers greater than 1.5 box-lengths or more from the edge of the box in a boxplot were reviewed and removed. These outliers were removed so that the individual data points did not have undue influence on the generalization of the results. Any outliers that emerged following this first iteration of removal were left in place. After the outliers were removed, the two-way ANOVA was re-executed.

The Shapiro-Wilk test scores were reviewed to identify violations in normality. Assumptions of normality were violated in about half of the tests because the pretest scores were predictably low and skewed the curve to the right. Conversely, overall, the learners did well on posttests, making the curve skew left. However, because ANOVAs are considered to be fairly "robust" to deviations from normality (Maxwell & Delaney, 2004) testing could proceed.

Lavene's test of equality of error variances was upheld in all two-way ANOVA tests with the exception of two moderating variables: course topic and final grade in the course. Because the p-value of the course topic was significant at a $p < .10$ level ($p = .079$), post-hoc independent t-tests were used to evaluate differences in the dependent variable at the topic level. Independent t-tests were advisable in this situation because they provide "Equal Variances Not Assumed" results that can be used when violations in Lavene's score are detected. All statistical tests assumed a 95% confidence interval.

Results of the Main Independent Variable (RQ1)

For RQ1, I found that, on average and across course topics, students in the treatment group, which received SIVs to accompany pre-class readings, scored 3.99 points higher on their posttests than on their pretests. Students in the control group, which received no SIV supplementation, had a mean increase in performance of 3.92. *An independent t-test indicated that this difference between the treatment group and the control group was not statistically significant* ($p = .610$) (Table 4.1).

Table 4.1 Results of the independent t-test for the SIV treatment. The "Mean Improvement Score" refers to the difference between the pretest and posttest.

Group	N	Mean Improvement Score	Sig. (2-tailed)	Mean Difference	Standard Error Difference	Lower	Upper
SIV	242	3.99	0.610	0.073	0.143	-0.207	0.353
No SIV	259	3.92					

95% C.I.

Results of the Moderating Variables (RQ2 and RQ3)

For RQ2 and RQ3, a two-way ANOVA was applied to the moderator variables: gender, year in school, age, course topic, and the final grades in class, to explore whether they have any influence on the ability of the SIVs to improve student performance. *At the* $p < .05$ *level, no significant differences were identified between the treatment group and control group for any of these moderator variables*, however, some practically significant trends emerged. First, with SIV treatment, men improved more than women, on average. As shown in Table 4.2, between the pretest and posttest, men who received the SIV improved by an average of 0.07 points, while women's scores dropped by 0.35 points. This is true despite women showing greater overall improvement from pretest to posttest than men. Second, students who were in their fourth and fifth year of college tended to have higher mean improvement scores when given SIVs than those in their first, second, and third years, as shown in Table 4.3. Third, students who received a C or an F as their final grade in the class (none in the class received a D) showed greater improvement between the pretest and posttest when given SIVs than students who received higher final grades in the class (Table 4.4). For a complete summary of the two-way ANOVA for each moderating variable, see Appendix 4.1.

Table 4.2 Results of the two-way ANOVA for the *Gender* variable. The "Mean Improvement Score" refers to the difference between the pretest and posttest.

Gender	Group	N	Mean Improvement Score	Mean Difference	Standard Deviation	F	P-Value
Male	SIV	198	4.01	0.07	1.58	1.069	0.302
	No SIV	203	3.94		1.45		
Female	SIV	30	4.10	-0.35	1.40		
	No SIV	33	4.45		1.30		

95% C.I.

Table 4.3 Results of the two-way ANOVA for the *Year in School* variable. The "Mean Improvement Score" refers to the difference between the pretest and posttest.

Year in School	Group	N	Mean Improvement Score	Mean Difference	Standard Deviation	F	P-Value
First	SIV	6	4.17	-0.50	0.98	1.173	0.322
	No SIV	6	4.67		1.37		
Second	SIV	50	4.64	0.09	1.31		
	No SIV	49	4.55		0.98		
Third	SIV	87	3.99	-0.13	1.48		
	No SIV	94	4.12		1.39		
Fourth	SIV	62	3.84	0.51	1.48		
	No SIV	69	3.33		1.75		
Fifth	SIV	11	4.27	0.52	1.49		
	No SIV	12	3.75		1.60		

95% C.I.

Table 4.4 Results of the two-way ANOVA for the *Final Grade in Class* variable. The "Mean Improvement Score" refers to the difference between the pretest and posttest.

Final Grade in Class	Group	N	Mean Improvement Score	Mean Difference	Standard Deviation	F	P-Value
A	SIV	68	4.22	-0.08	1.34	1.118	0.351
	No SIV	66	4.30		1.05		
A-	SIV	111	4.22	0.23	1.57		
	No SIV	120	3.99		1.60		
B+	SIV	22	3.64	-0.32	2.01		
	No SIV	28	3.96		1.71		
B	SIV	25	3.36	0.00	1.63		
	No SIV	22	3.36		1.40		
B-	SIV	7	3.00	-0.60	0.00		
	No SIV	10	3.60		1.43		
C	SIV	4	1.75	1.25	2.36		
	No SIV	6	0.50		2.17		
F	SIV	2	4.00	2.33	0.00		
	No SIV	3	1.67		2.89		

95% C.I.

Relevant to RQ2, at the $p < .10$ level, *Course topic* became a significant moderating variable in the ANOVA. Post-hoc independent t-tests indicated significant differences in student performance between the treatment and control groups in two of the twelve course topics. First, the treatment group significantly outperformed the control group in terms of their mean improvement in assessment scores for the week 9 topic, *Roofing: Solar Shingles* ($p = .003$). Second, the control group significantly outperformed the treatment group in week 11 on the topic of *Exterior Wall Finishes: Insulated Vinyl Siding* ($p = .010$). In both cases, the boxplots for the control groups were heavily skewed, but in opposite directions. The boxplot for the control group in *Roofing: Solar Shingles* had no scores in the lower quartile, even after initial outliers were removed, indicating a strong skew to the right. The boxplot of the control group scores for *Exterior Wall Finishes: Insulated Vinyl Siding* had no scores in the upper quartile range, indicating a strong skew to the left. No outliers were detected in the treatment group for either topic (Table 4.5). For a summary of post-hoc t-tests for all course topics, see Appendix 4.2.

Table 4.5 Significant results of the two-way ANOVA for the *Course Topic* variable. The "Mean Improvement Score" refers to the difference between the pretest and posttest.

	Course Topic Description	Group	N	Mean Improvement Score	Sig. (2-tailed)	Mean Difference	Standard Error Difference	Lower	Upper
9	Roofing: Solar Shingles	SIV	20	4.85	0.003	1.144	0.353	0.427	1.861
		No SIV	17	3.71					
11	Exterior Wall Finishes: Insulated Vinyl Siding	SIV	17	3.76	0.010	-1.235	0.455	-2.16	-0.31
		No SIV	23	5.00					

95% C.I.

As with the other moderating variables, a two-way ANOVA was used to test whether the transition to fully online learning due to the *COVID-19* shutdown had any significant impact on the effectiveness of SIVs. The test failed to detect any significant differences in student performance between the treatment and control groups before and after COVID-19 ($p = .741$), as shown in Table 4.6 below.

Table 4.6 Results of the two-way ANOVA for the *Student Performance* & *COVID-19* variables. The "Mean Improvement Score" refers to the difference between the pretest and posttest.

Type of Instruction	Group	N	Mean Improvement Score	Mean Difference	Standard Deviation	F	P-Value
In-person Instruction (First half of semester)	SIV	124	3.87	0.07	1.58	0.109	0.741
	No SIV	134	3.80		1.60		
Online Instruction (Second half of semester)	SIV	118	4.12	-0.02	1.64		
	No SIV	122	4.14		1.46		

95% C.I.

However, the ANOVA indicated that across all students, irrespective of SIV treatment and control groups, there were significant differences in student performance before and after the COVID-19 disruption ($p = .037$). In the first half of the semester, during which instruction was partially in-person, students had a mean performance increase of 3.83, compared to a mean performance increase of 4.13 across the weeks in which instruction was fully online (Table 4.7).

Table 4.7 Results of the two-way ANOVA for the *COVID-19* variable. The "Mean Improvement Score" refers to the difference between the pretest and posttest.

Type of Instruction	N	Mean Improvement Score	Standard Deviation	Mean Difference	F	P-Value
In-person Instruction (First half of semester)	258	3.83	1.59	0.30	4.354	0.037
Online Instruction (Second half of semester)	240	4.13	1.546			

95% C.I.

Discussion

The first research question (RQ1) focused on whether supplementary instructional videos (SIVs) that are administered to support pre-class readings have any impact on learner performance in terms of improvement from the pretest to the posttest. Contrary to the results that Choudhury (2011) reported, I found that, in aggregate, student performance was not significantly improved by the use of SIVs. The difference between the two studies may be due to a number of factors. First, the environment and conditions that the videos were administered could have an effect. Choudhury (2011) showed the videos during class to magnify understanding of the lecture. Our SIVs, in contrast, were administered at home by the learners themselves before completing the readings. In Choudhury's study, additional explanations were likely provided and questions could be answered immediately, which resulted in the classroom supplementing the videos, rather than the videos acting as the supplements. Second, the qualitative aspects and magnitude of the intervention may be influential in the findings. Choudhury (2011) used "video clips" to supplement the classroom lecture but offered little information about the number of videos shown, the duration of each video, or the frequency of the video treatment. From a close read, I assume that the videos were more generic, covering a broader range of topics, and were used more abundantly than the SIVs in our study. In our SIV research, a single video was provided for each pre-class reading assignment and, to stay in compliance with the latest literature, they were made intentionally short (Moradi et al., 2016). The average duration of the SIVs produced for the course was just under three minutes.

The second research question (RQ2) focused on the complexity of the course topic. I expected that more complex topics would include those with many interconnected parts and complicated functions, such as solar shingles, condensing storage water heaters, and fiber optics.

Topics assumed to be less complex included those with fewer assemblies and operating parts, such as three-pane windows and luxury vinyl plank flooring. Results from post-hoc, independent t-tests indicated that the treatment group in the week 9 topic, *Roofing: Solar Shingles* topic performed significantly better than the control group. Conversely, the control group in the week 11 topic of *Exterior Wall Finishes: Insulated Vinyl Siding* significantly outperformed the treatment group. Because the directions of these differences are inconsistent (i.e., in Topic 9 the treatment group had a higher mean score, and in Topic 11 the control group had a higher mean score), no inferences about the effectiveness of SIV treatment could be made. As reported in the results, the data for the control groups were heavily skewed in both cases, and it is possible that the statistical tests used to evaluate the data were impacted by this non-normal distribution. Thus, unlike Liu & Hatipkarasulu (2014), I found that the level of difficulty or complexity of the topic had no bearing on the effectiveness of SIVs. It is possible that this surprising lack of difference stems from the additional effort that learners may have exerted to understand the more complex topics. Explanatory qualitative data (i.e., learner surveys and interviews) could help reveal whether this is the case. In a real research environment, it is difficult, if not impossible, to measure or control intrapersonal effort, however, it would be valuable to conduct SIV research in a highly-controlled environment that holds variability of learning time, learning environment, and outside resources constant.

The third research question (RQ3) focused on the impact of students' demographic characteristics (i.e., gender, age, year in school) and their final grade in class on the effectiveness of SIVs. I found no statistically significant differences across student groups. However, in terms of practical significance, our findings opposed some of Nasir & Bargstädt's (2017) assertions that learners with less knowledge were likely to receive greater benefits from video-based learning. On average, men and students in their fourth and fifth years in college tended to perform better than their counterparts when given SIVs. Congruous with our own predictions, students who received a C or F as a final grade in the course also tended to show greater improvement between the pretest and posttest with SIVs. When these students did not have the SIVs to help with the readings, they did not improve nearly as much. This result is likely heavily influenced by the very low number of measurements ($n < 7$) in both of these final grade categories. Also, the only learner who received an F was an international student who needed to return home early after the sixth week of class on account of the COVID-19 pandemic.

Counter to our hypothesis in RQ4, I observed that the switch to exclusively online learning in response to the COVID-19 pandemic had a statistically significant positive impact on student performance. It is possible that online instruction itself could be the variable that triggered the improvement. However, it could also be a result of the students being more familiar with the course structure in the latter half of the semester. The specific combination of topics in the first and second halves of the study may have also been influential to the outcome. To better understand why the move to exclusively online instruction had a significantly positive impact on learning, more research would need to be conducted that counterbalances the order of treatment. For example, one section of students should receive online learning in the first half of the semester while the other section receives online learning in the second half. Whatever the reason for the improvement in performance as a result of the switch to exclusively online learning, this result seems to indicate that modern educational technology has the ability to rival certain aspects of in-person CM classroom learning in circumstances in which classroom technology is already a sizable dimension of the experience (i.e., a flipped classroom). It is likely that even a decade ago, before the widespread adoption of many advances in educational technology, such as live classroom video streaming, high quality recorded lectures, intuitive video editing software, and widespread and robust LMS technology, COVID-19 would have been far more disruptive and devastating to the learning experience.

Limitations

This study was limited in a few key ways that could be addressed in future research. First, the SIVs in this study were self-administered, learners were asked to watch the videos at home, alone, and before completing the readings. While controls were installed to improve the likelihood that these instructions were followed, the potential for minor inconsistencies across research participants still existed. For example, some students may have been sharing living or study space with classmates outside of class. Additionally, the type of device used to watch the video (e.g., a phone versus a computer) and the time that elapsed between when a student watched the video, completed the reading, and took the posttest may have impacted student improvement as a result of the SIVs. A second limitation, as stated previously, was the COVID-19 pandemic, which precipitously shut down all in-person instruction after the sixth week of the study. For a FC, which already relied heavily on technology, this disruption was fortunately minimized, nevertheless, the switch from blended instruction to full, synchronous, online meetings should be taken into account.

Conclusion

Due to the work of Wayne Hodgins and other computer science visionaries, instructional video object-based learning (OBL) has become a highly common and accessible medium for learning. Consequently, for higher education, OBL has allowed teachers to rethink the traditional classroom structure. Instruction that previously had to be delivered in-class and in-person can now be economically captured and delivered with video. However, despite these substantial leaps forward in computer science, certain pedagogical questions around instructional video OBL remained unanswered. Most of all, do instructional videos have the ability to improve learner performance? I asked this question in a construction management (CM) context for supplemental instructional videos (SIVs), which have been touted in the literature for their ability to “broaden or deepen the student’s understanding” (McGarr, 2009 p. 317). While some useful, practically significant results and trends were detected from the experiment, little statistically significant evidence was found to indicate that SIVs contributed to an improvement of learner performance, despite accounting for moderating variability in age, year in school, gender, final grade in the class, and complexity of the learning topic.

These negative results are beneficial in a few ways. First, they confirm similar findings by previous construction education researchers including Burgett (2014), who likewise failed to detect significant improvement in student performance based upon a video intervention. Also, Hoxley & Rowsell (2006) who concluded “that video-based teaching is at worst no less effective than more traditional methods and that students seem to prefer it as a method” (Hoxley & Rowsell, 2006, p. 116). Second, the experiment suggests that CM educators should not expect large or significant changes in their learners’ performance from small SIV interventions. As discussed, in this study, SIVs were produced deliberately to be as-short-as-necessary to comply with the literary guidelines for the design and development of instructional videos. Future work should consider magnifying the impact of SIVs by increasing the length or quantity of videos used, or increasing learners’ interaction with the intervention, for example, through additional video quiz questions or real-time, online discussions about the videos. Finally, the study demonstrated that instructors have the ability to tailor their own digital educational content quickly, skillfully, economically, in accordance with best practices, and using readily available equipment (e.g., cell phone cameras and personal computers) and technology (i.e., low-cost, highly intuitive video editing software that can be downloaded remotely).

References

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. Higher Education Research & Development, 34(1), 1–14. https://doi.org/10.1080/07294360.2014.934336

Adler, A. (2016). Fair use and the future of art. NYUL Rev., 91, 559.

Al-Ubaydli, O., List, J. A., & Suskind, D. (2019). The Science of Using Science: Towards an Understanding of the Threats to Scaling Experiments. National Bureau of Economic Research Working Paper Series. Retrieved from https://www.nber.org/papers/w25848

Arrington, M. (2009, March 26) YouTube EDU Launches, So Go Learn Something. TechCrunch. https://techcrunch.com/2009/03/26/youtube-edu-launches/

Bergmann, J., & Sams, A. (2012). Flip your classroom: Reach every student in every class every day. International society for technology in education.

Bhattacharjee, S. (2014). Effectiveness of Role-Playing as a Pedagogical Approach in Construction Education. 7. https://pdfs.semanticscholar.org/d1f0/545f776b79c6f3925ae4a06eb18c76c1558b.pdf

Bishop, J., & Verleger, M. (2013a). Testing the flipped classroom with model-eliciting activities and video lectures in a mid-level undergraduate engineering course. 2013 IEEE Frontiers in Education Conference (FIE), 161–163. https://doi.org/10.1109/FIE.2013.6684807

Bishop, J., & Verleger, M. (2013b). The Flipped Classroom: A Survey of the Research. 18. https://www.asee.org/public/conferences/20/papers/6219/view

Bowen, W. G., Chingos, M. M., Lack, K. A., & Nygren, T. I. (2012). Interactive Learning Online at Public Universities: Evidence from Randomized Trials. 53. https://doi.org/10.18665/sr.22464

Brame, C. J. (2016). Effective Educational Videos: Principles and Guidelines for Maximizing Student Learning from Video Content. CBE—Life Sciences Education, 15(4), es6. https://doi.org/10.1187/cbe.16-03-0125

Burgett, J. M. (2014). Can “Flipping the Classroom” Improve the Educational Experience in Construction Management Courses: A Case Study in Teaching HVAC Psychrometrics. 8. http://ascpro0.ascweb.org/archives/cd/2014/paper/CEUE127002014.pdf

Chitwood, K., May, C., Bunnow, D., & Langan, T. (2000). Battle stories from the field: Wisconsin online resource center learning objects project. In D. A. Wiley (1), The

Instructional Use of Learning Objects: Online Version. Retrieved June 2, 2020 from the World Wide Web: http://reusability.org/read/chapters/chitwood.doc

Check, J., & Schutt, R. K. (2012). Research Methods in Education. https://doi.org/10.4135/9781544307725

Choe, E. (2017). Optimizing Video for Learning: A Case Study-Based Primer of Informal, Educational, Digital Video Best Practices. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2909769

Choudhury, I. (2011). The Effect of Watching Video Clips on Student Performance in a Construction Science Course at an Undergraduate Level on Student Performance in a Construction Science Course at an Undergraduate Level. 8. https://www.asee.org/public/conferences/1/papers/50/view

Craven, R. G., Marsh, H. W., Debus, R. L., & Jayasinghe, U. (2001). Diffusion effects: Control group contamination threats to the validity of teacher-administered interventions. Journal of educational psychology, 93(3), 639.

Devlin, M., & Samarawickrema, G. (2010). The criteria of effective teaching in a changing higher education context. Higher Education Research & Development, 29(2), 111–124. https://doi.org/10.1080/07294360903244398

Fellows, R. F. Liu, L. (2015). Research Methods for Construction Fourth Edition. Oxford: John Wiley & Sons, Ltd. https://doi-org.ezproxy.lib.vt.edu/10.1002/j.2168-9830.2005.tb00829.x

Frey, B. B. (2018). The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation. SAGE Publications, Inc. https://doi.org/10.4135/9781506326139

Gabarre, S., Gabarre, C., Din, R., & Yong, M. F. (2013) Improving the Language Classroom with Facebook on Mobile Phones.The Inaugural European Conference on Technology in the Classroom 2013.

Girón, F. J., MartÃnez, M. L., & Moreno, E. (2003). Bayesian analysis of matched pairs. Journal of Statistical Planning and Inference, 18.

Goh, O. S., Ghani, M. K. Abd., Kumar, Y. J., Choo, Y.-H., & Muda, A. K. (2014). Massive Open Online Course (MOOC) with Learning Objects and Intelligent Agent Technologies. 2014 International Conference on IT Convergence and Security (ICITCS), 1–4. https://doi.org/10.1109/ICITCS.2014.7021786

IEEE Computer Society. (2020). H. Wayne Hodgins. Available at https://www.computer.org/profiles/wayne-hodgins

Hess, K.K., Jones, B.J., Carlock, D., & Walkup, J.R. (2009). Cognitive Rigor: Blending the Strengths of Bloom's Taxonomy and Webb's Depth of Knowledge to Enhance Classroom-Level Processes.

Hodgins, H. W. (2002). The future of learning objects. Proceedings of the 2002 eTEE Conference, 76-82.and Higher Education, 33, 15–23. https://doi.org/10.1016/j.iheduc.2017.01.001

Hoxley, M., & Rowsell, R. (2006). Using Video in the Construction Technology Classroom: Encouraging Active Learning. Architectural Engineering and Design Management, 2(1–2), 115–122. https://doi.org/10.1080/17452007.2006.9684609

Hurtado, K. C., Kashiwagi, D. T., & Sullivan, K. T. (2014). An Assessment Tool for Using Videos and Rich Media in Construction Management Curriculum—A Case Study. 11.

Jensen, J. L., Holt, E. A., Sowards, J. B., Heath Ogden, T., & West, R. E. (2018). Investigating Strategies for Pre-Class Content Learning in a Flipped Classroom. Journal of Science Education and Technology, 27(6), 523–535. https://doi.org/10.1007/s10956-018-9740-6

Johnson, C. I., & Mayer, R. E. (2009). A testing effect with multimedia learning. Journal of Educational Psychology, 101(3), 621–629. https://doi.org/10.1037/a0015183

Kay, R. H. (2012). Exploring the use of video podcasts in education: A comprehensive review of the literature. Computers in Human Behavior, 28(3), 820–831. https://doi.org/10.1016/j.chb.2012.01.011

Kedar, S. S., & Kumar, A. (2013). Effectiveness of Different Multimedia Design with Respect to Achievement of Engineering Students. International Journal of Advancement in Education and Social Sciences. 10.

Kelly, M., Lyng, C., McGrath, M., & Cannon, G. (2009). A multi-method study to determine the effectiveness of, and student attitudes to, online instructional videos for teaching clinical nursing skills. Nurse Education Today, 29(3), 292–300. https://doi.org/10.1016/j.nedt.2008.09.004

Kozma, R. B. (1991). Learning with Media. Review of Educational Research, 61(2), 179. https://doi.org/10.2307/1170534

Kulgemeyer, C. (2018). A Framework of Effective Science Explanation Videos Informed by Criteria for Instructional Explanations. Research in Science Education. https://doi.org/10.1007/s11165-018-9787-7

Lee, N., Lee, L. W., & Kovel, J. (2016). An Experimental Study of Instructional Pedagogies to Teach Math-Related Content Knowledge in Construction Management Education. International Journal of Construction Education and Research, 12(4), 255–269. https://doi.org/10.1080/15578771.2016.1141440

Lee, J. H., & McCullouch, B. G. (2005). Lessons Learned from a Design Course Utilizing Object-Based Learning Method. Construction Research Congress 2005, 1–10. https://doi.org/10.1061/40754(183)45

Lee, J. H., McCullouch, B. G., & Chang, L.-M. (2003). Object-Based Learning Method in Engineering. Towards a Vision for Information Technology in Civil Engineering, 1–17. https://doi.org/10.1061/40704(2003)38

Lee, N., Salama, T., & Kim, S. J. (2016). Using the Flipped Classroom Model to Improve Construction Engineering and Management Education. 2016 ASEE Annual Conference & Exposition Proceedings, 27168. https://doi.org/10.18260/p.27168

Liu, R., & Hatipkarasulu, Y. (2014). Introducing Building Information Modeling Course into a Newly Developed Construction Program with Various Student Backgrounds. 8.

Lo, C, & Hew, K. (2017). A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. Research and Practice in Technology Enhanced Learning, 12(1), 4. https://doi.org/10.1186/s41039-016-0044-2

Maxwell, S. E., & Delaney, H. D. (2004). Designing experiments and analyzing data: A model comparison perspective (2nd ed.). New York: Psychology Press.

McGarr, O. (2009). A review of podcasting in higher education: Its influence on the traditional lecture. Australasian Journal of Educational Technology, 25(3). https://doi.org/10.14742/ajet.1136

McGreal, R. (2004). Learning objects: A practical definition. https://auspace.athabascau.ca/handle/2149/227

Meisel, S. (1998). Videotypes: Considerations for effective use of video in teaching and training. Journal of Management Development, 17(4), 251–258. https://doi.org/10.1108/02621719810210163

Minke, A. (1997). Conducting Repeated Measures Analyses: Experimental Design Considerations. Ericae.net http://ericae.net/ft/tamu/Rm.htm

Moradi, M., Liu, L., & Luchies, C. (2016). Identifying Important Aspects in Developing Interactive Instructional Videos. 8.

Morello, A., Issa, R. R. A., & Franz, B. (2018). Exploratory Study of Recruitment and Retention of Women in the Construction Industry. Journal of Professional Issues in Engineering Education and Practice, 144(2), 04018001. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000359

Nasir, A. R., & Bargstädt, H.-J. (2017). An Approach to Develop Video Tutorials for Construction Tasks. Procedia Engineering, 196, 1088–1097. https://doi.org/10.1016/j.proeng.2017.08.066

Pappas, J. (2013). Multisource feedback for STEM students improves academic performance. In Annual Conference Proceedings of American Society of Engineering Education.

Puddicombe, M. S., & Johnson, B. (2011). Research and Theory Building in Construction Management. International Journal of Construction Education and Research, 7(2), 126–142. https://doi.org/10.1080/15578771.2011.557142

Qiang, Z. (2014). An Experimental Research on Applying Automated Essay Scoring System to College English Writing Course. International Journal of English Language Teaching, 1(2), p35. https://doi.org/10.5430/ijelt.v1n2p35

Rockenbach, B. (2011). Archives, Undergraduates, and Inquiry-Based Learning: Case Studies from Yale University Library. The American Archivist, 74(1), 297–311. https://doi.org/10.17723/aarc.74.1.mml4871x2365j265

Rokooei, S., & Goedert, J. (2015). Lessons Learned from a Simulation Project in Construction Education. 2015 ASEE Annual Conference and Exposition Proceedings, 26.1083.1-26.1083.11. https://doi.org/10.18260/p.24420

Sao Pedro, M., Gobert, J., Heffernan, N., & Beck, J. (2009). Comparing pedagogical approaches for teaching the control of variables strategy. In NA Taatgen & H. vanRijn (Eds.), Proceedings of the 31st Annual Meeting of the Cognitive Science Society (pp. 1294-1299).

Salkind, N. (2010). Encyclopedia of Research Design. https://doi.org/10.4135/9781412961288

Sever, S., Oguz-Unver, A., & Yurumezoglu, K. (2013). The effective presentation of inquiry-based classroom experiments using teaching strategies that employ video and demonstration methods. Australasian Journal of Educational Technology, 29(3). https://doi.org/10.14742/ajet.229

Shermis, M. D., Garvan, C. W., & Diao, Y. (2008). The Impact of Automated Essay Scoring on Writing Outcomes. Online Submission. https://eric.ed.gov/?id=ED501148

Suter, W. (2012). Introduction to Educational Research: A Critical Thinking Approach. SAGE Publications, Inc. https://doi.org/10.4135/9781483384443

Teachers—YouTube. (n.d.). Retrieved July 11, 2020, from https://www.youtube.com/user/teachers/about

Tuckman, B. W. (1995). Assessing effective teaching. Peabody Journal of Education, 70(2), 127–138. https://doi.org/10.1080/01619569509538827

Walton, J. M. (2018). Evaluating the impact of a tablet-based intervention on the mathematics attainment, receptive language and approaches to learning of preschool children (Doctoral dissertation, University of Nottingham).

Ward, M. (2009). Squaring the Learning Circle: Cross-Classroom Collaborations and the Impact of Audience on Student Outcomes in Professional Writing. Journal of Business and Technical Communication, 23(1), 61–82. https://doi.org/10.1177/1050651908324381

Wiley, D., (2002). The instructional use of learning objects (1st ed). Bloomington, Ind: Agency for Instructional Technology: Association for Educational Communications & Technology. https://members.aect.org/publications/InstructionalUseofLearningObjects.pdf

Wiley, D. A. (2008). The learning objects literature. Handbook of research for educational communications and technology: A project of the association for educational communications and technology, 345-353.

Willcox, Karen E; Sarma, Sanjay; Lippel, Philip (2016). “Online Education: A Catalyst for Higher Education Reforms. Online Education Policy Initiative.” Massachusetts Institute of Technology: Online Education Policy Initiative, https://dspace.mit.edu/bitstream/handle/1721.1/103912/MIT%20Online%20Education%20Policy%20Initiative%20April%202016_0.pdf?sequence=1

Yadav, A., Subedi, D., Lundeberg, M. A., & Bunting, C. F. (2011). Problem-based Learning: Influence on Students' Learning in an Electrical Engineering Course. Journal of Engineering Education, 100(2), 253–280. https://doi.org/10.1002/j.2168-9830.2011.tb00013.x

Appendices

Appendix 4.1 Results of the two-way ANOVA for moderating variables. The "Mean Improvement Score" refers to the difference between the pretest and posttest.

	Level	Group	N	Mean Improvement Score	Mean Difference	Standard Deviation	F	P-Value
Gender	Male	SIV	198	4.01	0.07	1.58	1.069	0.302
		No SIV	203	3.94		1.45		
	Female	SIV	30	4.10	-0.35	1.40		
		No SIV	33	4.45		1.30		
Year Born	1991	SIV	6	0.83	-0.67	1.47	0.526	0.815
		No SIV	6	1.50		1.64		
	1994	SIV	6	4.17	0.84	1.33		
		No SIV	6	3.33		1.86		
	1996	SIV	6	3.67	-0.33	1.86		
		No SIV	4	4.00		0.00		
	1997	SIV	38	4.00	0.41	1.40		
		No SIV	39	3.59		1.83		
	1998	SIV	69	3.80	-0.07	1.65		
		No SIV	75	3.87		1.32		
	1999	SIV	75	4.20	0.06	1.41		
		No SIV	79	4.14		1.53		
	2000	SIV	23	4.74	0.28	1.48		
		No SIV	24	4.46		1.18		
	2001	SIV	6	4.17	-0.50	0.98		
		No SIV	6	4.67		1.37		
Year in School	First	SIV	6	4.17	-0.50	0.98	1.173	0.322
		No SIV	6	4.67		1.37		
	Second	SIV	50	4.64	0.09	1.31		
		No SIV	49	4.55		0.98		
	Third	SIV	87	3.99	-0.13	1.48		
		No SIV	94	4.12		1.39		
	Fourth	SIV	62	3.84	0.51	1.48		
		No SIV	69	3.33		1.75		
	Fifth	SIV	11	4.27	0.52	1.49		
		No SIV	12	3.75		1.60		
Course Topic	1 - Foundation: Sealed Crawl	SIV	19	2.89	-0.19	1.73	1.663	0.079
		No SIV	25	3.08		1.53		
	2 - Framing Walls: ZIP System	SIV	19	4.00	-0.29	1.16		
		No SIV	24	4.29		1.20		
	3 - Framing Floors: Weyerhaeuser Edge Gold	SIV	23	4.13	-0.66	1.55		
		No SIV	19	4.79		0.98		
	4 - Framing Roofs: Trusses	SIV	19	4.26	0.30	1.33		
		No SIV	24	3.96		1.90		
	5 - Mechanical: Mini Split System	SIV	20	3.10	0.54	1.55		
		No SIV	25	2.56		1.98		
	6 - Communication: Fiber Optics	SIV	24	4.63	0.78	1.50		
		No SIV	20	3.85		1.46		
	7 - Plumbing: Condensing Storage Water Heater	SIV	18	3.83	-0.05	2.20		
		No SIV	16	3.88		0.72		
	8 - Windows: Three-pane Windows	SIV	19	4.74	0.58	0.73		
		No SIV	19	4.16		1.21		
	9 - Roofing: Solar Shingles	SIV	20	4.85	1.02	1.31		
		No SIV	18	3.83		0.86		
	10 - Insulation: Radiant Barrier	SIV	22	4.32	-0.41	1.67		
		No SIV	15	4.73		0.88		
	11 - Exterior Wall Finishes: Insulated Vinyl Siding	SIV	15	4.27	-0.73	0.96		
		No SIV	23	5.00		1.21		
	12 - Flooring: Luxury Vinyl Plank	SIV	17	3.41	-0.39	1.00		
		No SIV	20	3.80		1.51		

95% C.I.

	Level	Group	N	Mean Improvement Score	Mean Difference	Standard Deviation	F	P-Value
Final Grade in Class	A	SIV	68	4.22	-0.08	1.34	1.118	0.351
		No SIV	66	4.30		1.05		
	A-	SIV	111	4.22	0.23	1.57		
		No SIV	120	3.99		1.60		
	B+	SIV	22	3.64	-0.32	2.01		
		No SIV	28	3.96		1.71		
	B	SIV	25	3.36	0.00	1.63		
		No SIV	22	3.36		1.40		
	B-	SIV	7	3.00	-0.60	0.00		
		No SIV	10	3.60		1.43		
	C	SIV	4	1.75	1.25	2.36		
		No SIV	6	0.50		2.17		
	F	SIV	2	4.00	2.33	0.00		
		No SIV	3	1.67		2.89		

95% C.I.

Appendix 4.2 Results of the post-hoc t-tests for all course topics. The "Mean Improvement Score" refers to the difference between the pretest and posttest.

	Course Topic Description	Level	N	Mean Improvement Score	Sig. (2-tailed)	Mean Difference	Standard Error Difference	Lower	Upper
1	Foundation: Sealed Crawl	SIV	19	2.89	0.708	-0.185	0.492	-1.18	0.807
		No SIV	25	3.08					
2	Framing Walls: ZIP System	SIV	19	4.00	0.425	-0.292	0.362	-1.02	0.439
		No SIV	24	4.29					
3	Framing Floors: Weyerhaeuser Edge Gold Subfloor	SIV	23	4.13	0.102	-0.659	0.393	-1.45	0.136
		No SIV	19	4.79					
4	Framing Roofs: Trusses	SIV	19	4.26	0.556	0.305	0.513	-0.73	1.342
		No SIV	24	3.96					
5	Mechanical: Mini Split System	SIV	20	3.1	0.324	0.54	0.541	-0.55	1.632
		No SIV	25	2.56					
6	Communication: Fiber Optics	SIV	24	4.63	0.091	0.775	0.449	-0.13	1.68
		No SIV	20	3.85					
7	Plumbing: Condensing Storage Water Heater	SIV	18	3.83	0.940	-0.042	0.549	-1.184	1.101
		No SIV	16	3.88					
8	Windows: Three-pane Windows	SIV	20	4.6	0.21	0.442	0.347	-0.26	1.145
		No SIV	19	4.16					
9	Roofing: Solar Shingles	SIV	20	4.85	0.003	1.144	0.353	0.427	1.861
		No SIV	17	3.71					
10	Insulation: Radiant Barrier	SIV	22	4.32	0.386	-0.415	0.473	-1.37	0.544
		No SIV	15	4.73					
11	Exterior Wall Finishes: Insulated Vinyl Siding	SIV	17	3.76	0.010	-1.235	0.455	-2.16	-0.31
		No SIV	23	5.00					
12	Flooring: Luxury Vinyl Plank	SIV	17	3.41	0.372	-0.388	0.429	-1.26	0.484
		No SIV	20	3.8					

95% C.I.

CHAPTER 5

THE QUALITY OF EXPERIENCE OF OBJECT-BASED LEARNING IN A FLIPPED CONSTRUCTION MANAGEMENT CLASSROOM

Target Journal: Educational Media International

Abstract

Generation Z (i.e., those born between 1995 and 2015) now comprises the majority of the current undergraduate population. Some evidence shows that they prefer learning by video to all other methods. Recognizing this trend, and assuming that all instructional videos are not equally preferential for all college students, researchers across various fields are exploring their best use for college classrooms. As part of a broader study on object-based learning (OBL), this paper reports the perceptions that study of second-year construction management (CM) students have of a specific type of instructional video called supplemental instructional videos (SIVs). SIVs are designed to aid and reinforce primary learning materials and methods, not replace them or merely enhance them. The SIVs were produced by the instructors in accordance with OBL theory and based on an interdisciplinary curation of the latest literature covering the proper design and development of instructional videos. They were administered in a flipped CM classroom and delivered online to help the students with unfamiliar topics found in pre-class readings. Data was collected through the Quality of Experience (QoE) strategy that relies on surveys and interviews. Overwhelmingly, learners in the course reported their appreciation and preference for having SIVs as a teaching aide. However, when asked about the ability of SIVs to improve their actual class performance, they expressed uncertainty as to whether any real difference was made.

Keywords: Object-Based learning, Supplemental Instructional Videos, Construction Management, Quality of Experience, Flipped Classroom

Introduction

A little more than a decade and a half ago, Leonard Bernold (2005), a construction professor and researcher at North Carolina State University, documented one undergraduate construction learner's complaint: "How can you expect me to read something when I don't understand it... In my job, I will not be required to write because I will work on a construction *sight* [*sic*]" (Bernold, 2005, p. 538). While Bernold was using this learner's frustration to illustrate the well-documented shortcomings of the traditional, reading-and-lecture based system in construction education (e.g., Behzadan & Kamat, 2013; Deshpande & Salman, 2016; Friedrich et al., 2008; Holt et al., 2018; Hoxley & Rowsell, 2006; McGarr, 2009; Rogers & Tingerthal, 2013; Rokooei & Goedert, 2015), it also reflects the simple reality that many undergraduate learners perceive unassisted readings on unfamiliar topics to be challenging and prefer to avoid them. Sharing Bernold's observation that undergraduates seem to prefer certain learning mediums over others, over the past few years interested researchers, practitioners, and educational institutions have paid increasing attention to trends in learning preferences for rising generations.

In 2018, Pearson Education commissioned a national, online survey through The Harris Poll, a global market research firm based in New York, which was aimed at understanding the differences in educational interests, outlook, and values between Millennials (i.e., those born between 1980-1994) and Generation Z (i.e., those born between 1995 and 2015), who now constitute the majority of undergraduate learners. Responses from 2,587 individuals ages 14 to 40 revealed that Generation Z prefers YouTube over all other learning methods listed in the survey, including books, interactive group activities, and learning apps and games. This study confirmed some previous research by Chan (2010) who found that college students preferred video to textbooks. Chan noted that "that video instructions are favorable to these university students and have a tremendous potential as a supporting tool for formal learning beyond the traditional classroom setting" (Chan, 2010, p. 1317). The Pearson survey also showed that Millennials still prefer books to YouTube by a small, 5% margin (Pearson Education, 2018).

Hypothesizing that future generations are likely to continue favoring video-based learning over more traditional, reading-based methods, researchers across fields have begun to explore a new pedagogical alternative called object-based learning (OBL). OBL is an active, student-centered teaching approach that relies on digital educational resources called learning objects (LOs) to facilitate tailored learning experiences for a specific audience (Lee & McCullouch, 2005; Wiley, 2002). LOs include a wide array of e-learning-based instruments such as “text[s], graphics, photographic[s], animation[s], or video[s]” (Chitwood et al., 2000, p. 14). Currently, one of the most common types of LOs are supplemental instructional videos (SIVs) (Kay, 2012). SIVs, in contrast with other categories of instructional video LOs (i.e., lecture-based, enhanced, worked examples), are deployed to support primary learning methods, mediums, and materials, but not substitute for them (Kay, 2014). To offer an example of when an SIV may be appropriate and useful, an instructor may decide to include a SIV with a particularly challenging textbook reading. Theoretically, if watched before completing the reading, the SIV could help introduce any unfamiliar or complex concepts to give the learner a better grasp of the subject and improve learning outcomes.

OBL, and specifically video-based LOs such as SIVs, are frequently used in flipped classrooms (FCs), another budding pedagogical intervention designed to disrupt traditional models of education (Barett, 2012; Lee et al., 2016). A FC has been defined as an instructional strategy in which learners are provided with additional learning materials at home, often in the form of video (Abeysekera & Dawson, 2015), so scarce class time can be spent focusing on active, mentored, experiential learning opportunities (Jensen et al., 2018). The literature suggests that FCs and OBL are naturally integrative. FCs depend on supporting technologies for outsourcing portions of instruction (Abeysekera & Dawson, 2015), and OBL is most effective when nested within a larger pedagogical framework (McGreal, 2004).

Because the OBL approach is still relatively new, fundamental questions about the educational impact of SIVs remain unanswered (Lockyer et al., 2009), including how learners across all tiers of education feel about SIVs as part of their curriculum (Kay, 2007). The aforementioned 2018 Pearson Education national survey suggests that learners in rising generations have an affinity for instructional videos, however, the exploratory survey is only a starting point, useful for identifying a general trend, but far too broad in scope to provide targeted guidance for instructors working in formal classrooms. Hence, many academic fields need more domain- and intervention-specific research. CM is no exception. In CM, only a few studies have been published that consider how CM learners feel about teacher-prescribed instructional videos (Cherrett, et al. 2009; Hoxley & Rowsell, 2006; Liu & Hatipkarasulu, 2014; Wong et al., 2018; Zaneldin et al., 2019). This low volume of literature is insufficient to cover the extensive and still-expanding landscape of open and unaddressed inquiry related to the value of instructional videos for CM learners.

This study, as part of a larger investigation of OBL and LOs, is an explanatory investigation of CM learners' perceptions of SIVs that are made to support traditional reading materials. Surveys and interviews were used to evaluate how students' quality of experience (QoE) was related to the use of SIVs in a flipped CM classroom.

Literature Review

In general, the current literature supports the idea that CM learners hold a favorable view of instructional videos. In 2006, Hoxley & Rowsell researched the best way to use video with lectures. Their survey showed overwhelmingly that 98.6% of their construction students supported videos being used and, similar to the 2018 Pearson survey, they "preferr[ed] to watch a video [over] read[ing] a book" (p. 118). Hoxley & Rowsell also found that instructional videos are most helpful to learners when used with a concentration aid, like a quiz, and if "the main purpose of the lecture is to deliver technical detail, then this is certainly best delivered after the viewing of the video" (Hoxley & Rowsell, 2006, p. 121).

The findings from the Hoxley & Rowsell (2006) study are largely confirmed by Cherrett, et al. (2009), who reported that 75% of second-year undergraduate students in their study stated that video had enhanced their learning experience with safety topics. They cautioned instructional designers and practitioners that passively viewing a video is not sufficiently stimulating. Learners must actively engage with the content presented by the videos.

Liu & Hatipkarasulu (2014), in their research on building information modeling (BIM) education, found that providing instructional videos to support complex procedural instructions seemed to be effective. They reported that instructional videos were particularly beneficial for learners who were behind in their work. In agreement with Hoxley & Rowsell (2006), survey data indicated that learners felt that content delivered by video was beneficial. However, similar to Cherrett et al. (2009), Liu & Hatipkarasulu warned that the instructional videos alone were insufficient in providing a deep understanding of subject matter.

Wong et al. (2018) experimented with video-based learning in a CM course utilizing a blended teaching model (i.e., both in-class and online). Seventy-six learners were taught using the model and then surveyed. I found that "students were satisfied with design and content of the instruction videos" and "considered e-learning approach useful because it allows them to control their pace, time, and location for learning" (Wong et al., 2018, p. 1).

Most recently, Zaneldin et al. (2019) studied undergraduate CM learner satisfaction in response to course topics being taught with instructional videos. Following the study, 67 learners were questioned with an online survey administered through the university learning management system (LMS). Overall, learners were "satisfied with the contents of the instruction [*sic*] videos and benefited from these videos" (Zaneldin et al., 2019, p. 475). The learners commented that they appreciated and preferred the blended model that included online instructional videos because they had greater access to course content.

Research Questions & Expectations:

Building upon this literature, I explored the perceptions of construction management students towards supplemental instructional videos (SIVs) in a flipped learning environment. More specifically, this study investigated the following research questions:

- RQ1: *Does the use of instructional videos, as supplemental, educational tools for traditional learning materials (i.e., readings) in a FC improve CM learners' subjective perception of their own performance?* Based upon the preliminary work of Hoxley & Rowsell (2006) and Cherrett et al. (2009), our expectation was that CM learners would perceive the SIVs to have a positive impact on their performance.
- RQ2: *Which construction topics (e.g., plumbing, foundations, framing) do CM learners believe are most conducive to using SIVs?* Based upon the research by Liu & Hatipkarasulu (2014), I expected that learners would express more appreciation for SIVs covering complex construction topics.
- RQ3: *Are CM learners satisfied with the quality, pace, engagement, and duration of the SIVs?* Based upon the research by Wong et al. (2016), who used the latest technology and expert guidance to create instructional videos, I expected that learners would be satisfied with SIVs developed in accordance with best practice guidelines.

Methods

I conducted a mixed-methods triangulation study (Creswell & Creswell, 2017) to understand student perceptions of SIVs in a flipped CM classroom. Consistent with previous research on video- and multimedia-based instruction (Brunnström et al., 2013; Ljubojevic et al., 2014), I used the Quality of Experience (QoE), a metric commonly used in customer service and telecommunications, to measure learners' subjective impressions of instructional videos. The QoE is defined as "the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user's personality and current state" (Le Callet et al., 2012). Modeling Ljubojevic et al. (2014), who evaluated the QoE "to investigate efficiency of use of supplementary video content in multimedia teaching" (p. 275), I administered a survey to study participants to evaluate their QoE with SIVs. After which, I conducted one-on-one interviews to gather further explanatory information. All research activities were reviewed and approved by the Virginia Tech Institutional Review Board (protocol 19-853).

Course and SIVs

I conducted this study in a course on Residential Construction Technologies, in which students critically examined emerging construction technologies and compared them with their more conventional counterparts. The course was structured to introduce a new and innovative construction technology (e.g., solar roof tiles, condensing storage water heaters, ZIP framing systems) each week for twelve consecutive weeks of the semester. Short SIVs were produced for each of the emerging technologies to aid with pre-class readings on their design and function. Each learner in the class was assigned a random set of six SIVs throughout the semester. The SIVs were distributed through the university LMS with all other course assignments. Learners were instructed to watch the SIVs alone, before class, and before completing the course readings that they were designed to support.

SIVs for the course were developed in compliance with a synthesis of interdisciplinary guidelines from the literature (Brame, 2016; Choe, 2017; Hurtado et al., 2014; Kay, 2014; Krämer & Böhrs, 2016; Moradi et al., 2016; Van der Meij & Van der Meij, 2013). Hence, they were short (i.e., approximately three minutes each), narrated with a script, focused on a single topic, and rendered in high definition with only high-quality audio and visual elements. Each was designed and produced by the same instructor teaching the course and made to be engaging for an undergraduate audience. They were organized, clear, purposeful, narrated with a personalized, first-person voice, and interactive (i.e., incorporated guiding quiz questions). Finally, the SIVs were designed to be direct and relevant, and paced for maximum learning and engagement. The videos were produced using a home-license of TechSmith Camtasia 2018 software, which allowed piecing together elemental media from a variety of sources including Google Images, FreeSounds.org, Pixabay.com, and the YouTube Audio Library. All SIVs started with a standard template, using the same introduction and conclusion, and underwent a consistent design, production, and review process to make them as similar as possible. Following the guidance by Hoxley & Rowsell (2006) and Cherrett, et al. (2009) each SIV was accompanied by a short quiz to ensure that the videos were actively watched.

Surveys

I developed a survey instrument with questions modeled after those asked used by Ljubojevic et al. (2014). They used a five-level opinion survey to ask subjective questions about perceived changes in performance, quality of the video, attention span, and whether the video made answering content questions easier. Our survey asked similar questions focused on learners' perception of how their own performance was impacted by the SIVs; their opinion of the quality and effectiveness of the SIVs; which course topics learners believed they had the best grasp of; and how learners felt about the SIVs generally. The survey also asked students to rate the quality, duration, and pace of the instructional videos. The survey was composed of both closed-ended, ordinal questions on a traditional 5-point Likert scale and a few open response follow-up questions. The full list of IRB-approved survey questions can be found in Appendix 5.1.

The survey was piloted under real conditions by 3 current undergraduate CM learners in the same department who were not participants of the study. The purpose of the pilot was to check for unclear or confusing questions, ambiguity in answer options, and to preview the format of the data output. The 25-question survey was then administered online through Qualtrics survey software to all 46 learners in the course after the final week of instruction. Survey responses were exported from Qualtrics into SPSS (version 25) for data management and analysis. For each closed-ended question, I calculated frequencies and descriptive statistics.

Interviews

Following the survey, a short, approximately 5 to 10-minute interview was conducted with participants to gain further insights into the learners' QoE. The purpose of the interviews was to build upon the surveys and further strengthen the explanatory nature of the research. Unlike the surveys, which were focused on extracting data from participants, the interviews helped derive interpretations from the findings (Gubrium & Holstein, 2001). Each interview was semi-structured, allowing for some deviation from a set of 5 predetermined, guiding questions that asked participants to describe their experiences with and perceptions of the SIVs and the OBL approach. The interviews were conducted remotely using Zoom web conferencing software. The Zoom platform was also used to audio-record and transcribe the interviews. The computer-generated transcripts were edited for accuracy and then selectively coded for themes that provided additional insight into survey questions. The full list of IRB-approved interview questions is available in Appendix 5.2.

Results

Study Sample

All 46 students in Residential Construction Technologies were invited to participate in the study. 42 students completed surveys and participated in follow-up interviews for a response rate of 91%. Participants were predominantly male (n = 36; 86%) and composed almost entirely of Building Construction majors (n = 41; 98%), representing the current overall population of undergraduate CM learners the research targeted. A single study participant was majoring in Real Estate (2%). Participants of the study were primarily in their second (n=10; 24%), third (n=17; 40%), and fourth (n=12; 29%) years of school. Very few were in their first year (n=1; 2%) or fifth year (n=2; 5%).

RQ1: Does the use of instructional videos, as supplemental, educational tools for traditional learning materials (i.e., readings) in a FC improve CM learners' perception of their own performance?

Eight of the closed-ended survey questions, listed in Table 5.1, were dedicated to understanding whether learners felt that the SIVs had any impact on their performance and experience in the course. Overall, the learners felt strongly that the SIVs improved their understanding of the construction topics. They were divided, however, on whether the videos had any real impact on their performance in terms of grades.

Table 5.1 Class averages of the learners' perceptions of the impacts of SIVs on their course performance and experience.

	Perceived impacts of SIVs on performance and experience	Mean	Std. Dev.	Scale
Q1	The instructional videos made unfamiliar topics from the readings easier to understand.	4.738	0.544	1 (Strongly disagree) - 5 (Strongly agree)
Q3	Watching instructional videos made completing the readings go faster.	4.262	0.885	1 (Strongly disagree) - 5 (Strongly agree)
Q4	I would have preferred to have an instructional video to help with all topics throughout the course (not just half).	4.786	0.606	1 (Strongly disagree) - 5 (Strongly agree)
Q6	Watching the instructional video made it less likely for me to complete the assigned readings.	2.071	1.156	1 (Strongly disagree) - 5 (Strongly agree)
Q7	Watching the instructional videos gave me greater confidence in my ability to do well on the in-class quizzes.	4.214	0.951	1 (Strongly disagree) - 5 (Strongly agree)
Q11	I would have preferred to have more classroom lecture and discussion instead of watching instructional videos.	2.619	1.011	1 (Strongly disagree) - 5 (Strongly agree)
Q13	My performance in the class would have been about the same with or without the instructional videos.	3.000	1.082	1 (Strongly disagree) - 5 (Strongly agree)
Q15	Of the six instructional videos that you were provided over the course of the semester, how many did you watch more than once?	3.571	2.390	1-6

N = 42

Across all learners, 95.2% of them 'agreed' or 'strongly agreed' that the SIVs made unfamiliar construction topics in the readings easier to understand (Figure 5.1). In the open response follow-up question, one learner explained that the SIVs "gave a visual background to the technology, that for me, were totally new topics. By having the images narrated, it gave a deeper understanding than view[ing] textbook pictures." Another wrote that the SIVs "[provided] a clear and concise introduction to a topic with visuals, [which] helped before getting into greater detail."

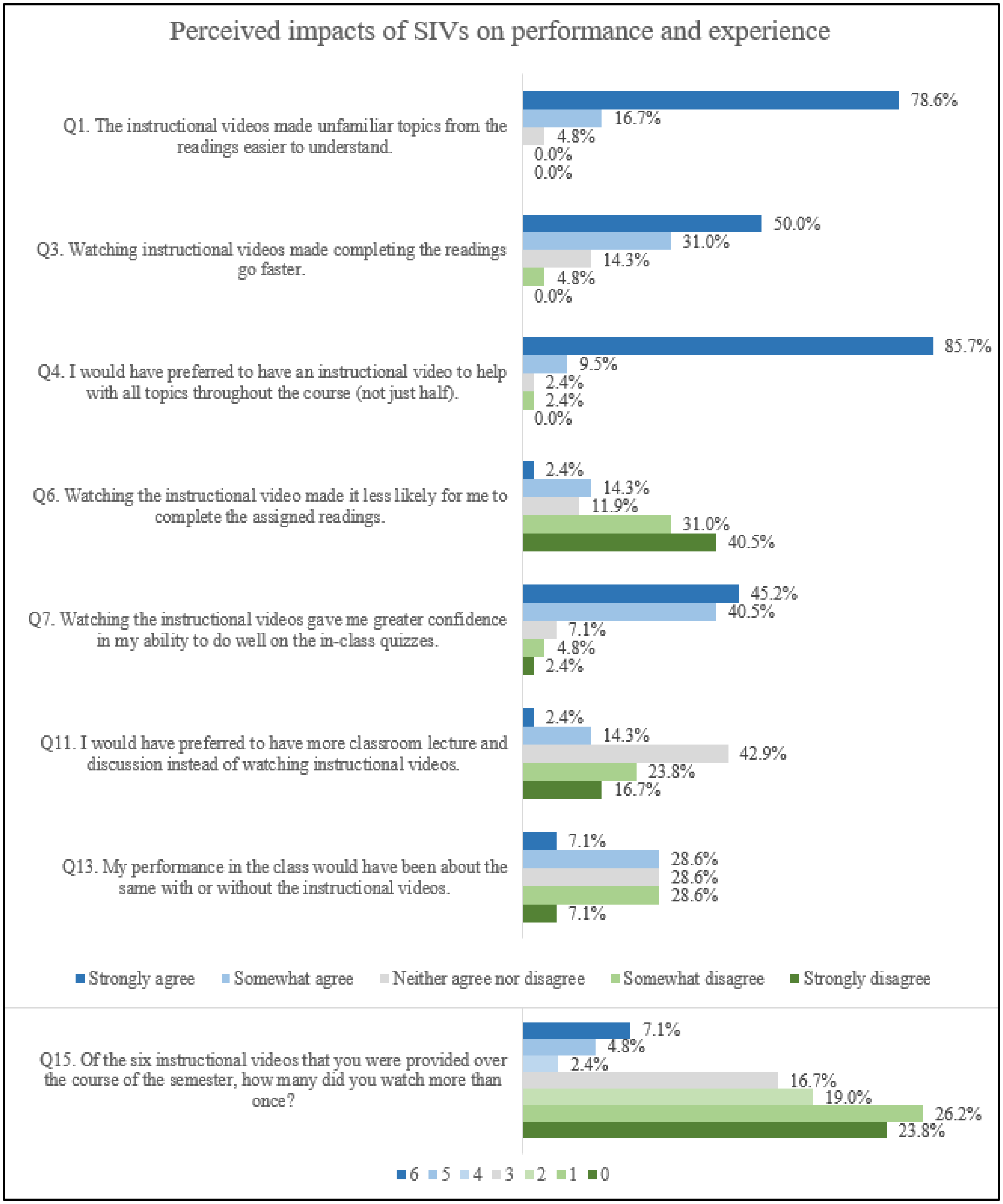


Figure 5.1 Class distributions of the learners' perceptions of the impact of SIVs on their course performance and experience.

However, students were divided on whether or not the SIVs ultimately improved their performance in the course. The question with the most distributed responses was Q13, which asked learners whether they believe the video helped them with classroom performance. Agreement and disagreement were equal, totaling 35.7% each, with the remaining 28.6% indicating that they 'neither agree nor disagree.' Interview data suggest that the near-normal distribution of responses to this question may be attributable to the determination of learners to perform to a certain standard regardless of the aid provided by SIVs or the demands on their effort. About three quarters of the students, 71.5%, disagreed or strongly disagreed that watching a video made them less likely to do the assigned readings. A few more, 81%, felt like the videos made the assigned reading go faster. As one student stated in the open-response follow-up question in the survey: "[The SIVs] did not change how I worked." Another learner in the class wrote: "I believe my performance would've been the same. The videos were an additional background that made the learning easier, but I performed well in the class without the videos as well." This sentiment was shared by a number of other students who indicated that while the videos were helpful, they learned the material and succeeded even in weeks in which they were not assigned a SIV.

Interview data were consistent with and provided additional depth to survey data on student perceptions of the impact of SIVs. Regarding questions of performance, the most prominent theme was the tension between the SIVs only seeming helpful and being actually, demonstrably helpful. One participant's response best exemplifies this sentiment: "I don't know how much [the SIVs] really helped my quiz grade, to be honest. But like I said, I feel like I genuinely learn more by watching them [sic]…. instead of reading 10 pages of PDF and still being semi-confused…. I don't know if it helped my grade, but it made me learn [the material] instead of just read[ing] it."

Learners responded most uniformly to Q4, which asked if they would have preferred a video for all twelve topics instead of only six. Nearly all of them, 95.2%, reported that they 'agree' or 'strongly agree', with 85.7% responding that they 'strongly agree.' Responses from the surveys strongly correlated with findings from the interviews. When asked openly whether they had any recommendations for the use of instructional videos in the course, participants frequently responded that SIVs should be provided for all topics, not just the half that each learner received. In many cases, students stated that they wanted to see SIVs used in their other courses as well. Encapsulating this feeling, one learner said:

> I would have liked to have [SIVs] for all [course topics]. Honestly,...sometimes I feel like, in a lot of classes I'm taking, [teachers] assume I know exactly what [they're] talking about. [T]hey...use terms that I actually haven't heard before...[and] I end up trying to look them up [during the discussion]. So, I think, [the SIVs] give a quick basis of what we're talking about before going into readings and...class discussions. I think that [the SIVs] really helped.

Learners also had a diverse range of responses to a survey question about their relative preference for watching videos versus classroom discussion and lecture. The largest group of the class (n=18; 42.9%) stated they 'neither agree nor disagree' that they would have preferred to have more classroom lecture and discussion instead of watching instructional videos (Figure 5.1). Another 40.5% of students 'strongly' or 'somewhat disagreed' with this statement. Collectively, this suggests that students were generally satisfied with the balance of video- and lecture-based learning in the course. As one student wrote in the open-response follow-up question:

> I have really enjoyed this class structure. [I] like how we get introduced to the topic through online modules, then we get a chance to ask questions and have classroom discussions. I feel like it helps because not everyone learns at the same pace. One reason why I tend to dislike a class is because of too much forced classroom discussion.

Other students similarly saw value in a combination of SIVs, lecture, and discussion, and felt that the videos, as designed, were effective supplements to the other classroom activities: "I think doing both [watching the SIVs and engaging with classroom lecture] would have helped the most. The videos were simple to give a[n] introduction. The addition of more classroom lecture[s] would have added onto that introduction."

RQ 2: Which construction topics (e.g., plumbing, foundations, framing) do CM learners believe are most conducive to using SIVs?

The second research question inquired about which construction topics (e.g., plumbing, foundations, framing, etc.) the learners felt were most conducive to video supplementation. Question 4 of the interview asked, "Which instructional videos, if any, stand out to you and why?" Response data from the interviews was analyzed to determine which SIV topic had the most voluntary mentions by name because students found it to be particularly helpful. Most of the participants mentioned at least one topic that stood out, and some mentioned multiple topics. A few did not feel like any SIVs were particularly helpful or replied that they could not remember any of the SIVs well enough to answer.

As displayed in Table 5.2, participants in the study had diverse opinions about the topics that were most helped by the videos. The topic that was mentioned the most, with eight separate mentions, comprising 38% of the learners who received the SIV, was mechanical. After this, plumbing, electrical, foundation, and framing walls were all mentioned relatively frequently. Exterior wall finishes, roofing, and framing floors were mentioned, but less frequently, while framing roofs, windows, insulation, and flooring were not mentioned at all.

Table 5.2 Frequency of each topic mentioned in the interviews.

Topic #	Topic	Technology	Topic Complexity	# Learners who received the SIV for the topic	Topic mentions	% of learners who mentioned the topic
5	Mechanical	Mini-split system	Complex	21	8	38%
7	Plumbing	Condensing storage water heater	Complex	24	5	21%
6	Electrical (low volt.)	Fiber optics	Complex	25	5	20%
1	Foundation	Closed crawl space	Complex	21	4	19%
2	Framing walls	Premium sheathing (i.e., Huber ZIP System)	Simple	21	4	19%
11	Exterior wall finishes	Insulated vinyl siding	Simple	21	2	10%
9	Roofing	Solar shinges	Complex	22	2	9%
3	Framing floors	Premium subfloors (i.e., Weyerhaeuser Edge Gold)	Simple	25	1	4%
4	Framing roofs	Trusses	Simple	22	0	0%
8	Windows	Triple-pane windows	Simple	25	0	0%
10	Insulation	Radiant barrier	Simple	24	0	0%
12	Finished Flooring	Laminated vinyl tile	Simple	25	0	0%

In general, the topics with more complex technologies — those with many interconnected parts, intricate assemblies, and complicated functions, such as the mini-split system, fiber optics, and condensing storage water heaters, received the most mentions. Meanwhile, simpler, more straightforward technologies with fewer assemblies and operating parts such as triple-pane windows and laminated vinyl tile were mentioned less frequently or not at all. This relationship between topic complexity and number of mentions has some qualitative support. During the interviews, one learner offered his recommendation of when SIVs should be used: “Include the [SIVs] as much as possible, [but] I don't think it's necessary for everything. I think [they] should only be used for the more complicated technologies.” Another learner, while discussing the “Plumbing” topic during an interview, provided some insight into why the more complex topics are conducive to video supplementation. He said,

> [Before learning about condensing storage water heaters] I just thought it was a big tub of water... I didn't really know how it worked at all. And it's a pretty complex system. So, seeing that visual and actually going through the process of how [water] actually goes through the coils and everything. I didn't know any of that was in there. So that was the best one for me...

There are a few notable exceptions to this trend. Roofing — solar shingles, would normally be considered a more complex topic, while framing walls would be less complex, however, more students mentioned the SIV for premium wall sheathing than the SIV for solar shingles.

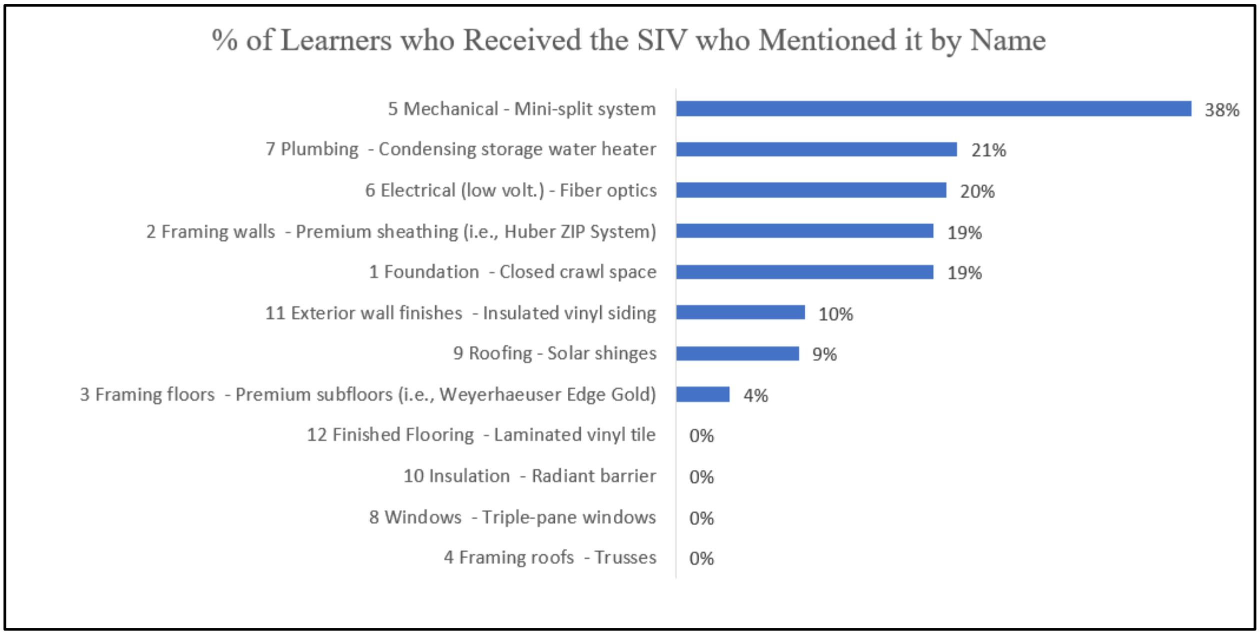


Figure 5.2 Learners who mentioned the SIVs in their interviews as a percentage of those who were given the SIVs.

RQ 3: Are CM learners satisfied with the quality, pace, engagement, and duration of the SIVs?

The final research question focused on student perceptions of the design and development of the SIVs. Seven of the survey questions, listed in Table 5.3, asked learners how engaging the videos were and how they felt about the quality, pace, and duration of the videos overall. Figure 5.3 displays the detailed Likert scale response summary.

Table 5.3 Class averages about the perception of the supplemental instructional videos.

	Video Questions	Mean	Std. Dev.	Scale
Q9	My mind would wander or I would be easily distracted while watching the instructional videos.	1.595	0.587	1 (Never) - 5 (Always)
Q10	The quiz questions that were assigned with the instructional videos helped me pay closer attention to the videos.	4.381	0.936	1 (Strongly disagree) - 5 (Strongly agree)
Q16	It was helpful to know that the instructional videos were produced specifically for this course by the instructor.	4.571	0.941	1 (Strongly disagree) - 5 (Strongly agree)
Q18	The pace of the instructional videos was...	2.857	0.354	1 (Far too slow) - 5 (Far too fast)
Q19	The instructional videos were engaging (i.e. good use of images, text, animations, sounds, voice narration).	4.643	0.533	1 (Strongly disagree) - 5 (Strongly agree)
Q20	The length of the instructional videos was...	2.786	0.470	1 (Far too short) - 5 (Far too long)
Q21	The quality (i.e. clear and coherent audio and visuals) of the instructional videos was...	4.024	0.841	1 (Very poor) - 5 (Excellent)

N = 42

Q9, Q10, and Q19 focused on engagement. Q19 asked directly how engaging the learners felt the SIVs were in terms of images, text, animations, sounds, and voice narration. Overwhelmingly, 97.7% reported that they 'strongly agree' or 'somewhat agree' that the videos were engaging. This number correlates strongly with Q9 which indirectly evaluated how engaging the SIVs were for learners by asking them how distracted they were while watching the videos. The vast majority, 95.2% answered either 'rarely' or 'never.' Q10 asked learners whether the guiding quizzes that went with the SIVs helped them pay closer attention to the videos. Consistent with Q19 and Q9, a majority of the class, 85.7%, either 'strongly agree' or 'somewhat agree' that video quizzes improved their engagement with the videos.

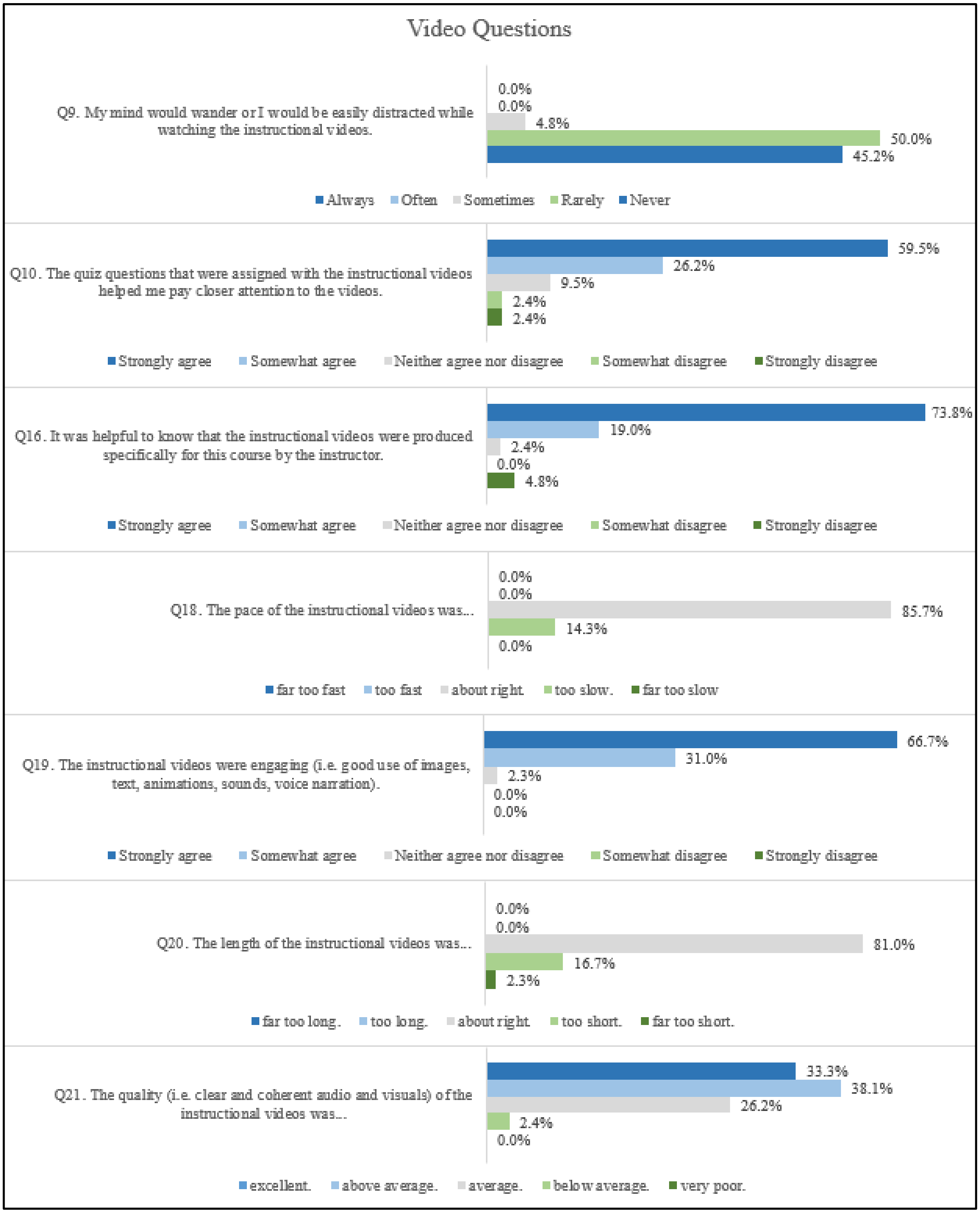


Figure 5.3 Class distributions about the perceptions of the supplemental instructional videos.

Q16 asked learners how they felt about having their instructors produce the videos. Most, 92.8%, reported that they either ‘strongly agree’ or “somewhat agree’ that it was helpful to know the videos were made by the instructor specifically for the course they were in. This survey result is supported by qualitative data from the interviews, in which multiple learners expressed their preference for instructor-made SIVs. One learner said,

> I've had classes in the past that [teachers] would supplement with videos. A lot of times they weren't made by the TAs or the professors. They were videos they found on YouTube or somewhere else, and some of it relates to the information that we're talking about, but not all of it, so you had to pick out the important information. Whereas these videos were exactly what we are learning about. Exactly what we needed to know for the quizzes…

Q18, Q20, and Q21 asked about the pace, duration, and quality of the videos, respectively. For Q18, 85.7% of the class reported the pace of the SIVs was ‘about right’. The remaining 14.3% of respondents thought the videos were ‘too slow.’ For Q20, 81.0% of the class reported that the duration of the videos was ‘about right’. The remaining 19.0%, nearly a fifth of the class, felt that the videos were either ‘too short’ or ‘far too short.’ During the interviews, one learner said that “around 10-to-12-minute length [for the SIVs] would really be good.” Another learner disagreed with this minority view. He said, “even though [the SIVs are] only three and a half minutes, they definitely convey a lot of information that you can retain easily through the graphics and the sounds.” For Q21, 33.3% of the class thought the quality of the SIVs in terms of audio and visuals was ‘excellent,’ while 38.1% thought the quality was ‘above average,’ and 26.2% thought the quality was ‘average.’ One person, 2.4%, thought the quality was ‘below average.’ Speaking about the quality and length of the SIVs, one learner said in his interview that “in terms of the formatting and the transitions, I thought [the SIVs] looked really nice. And I think that helped [to] keep them interesting. I think all of them were a perfect length. I think it's key to have something that's engaging.”

Discussion & Conclusion

Recent data show that broadly, videos are the preferred method for learning amongst current college-age generations (Pearson Education, 2018). This study examined specific implications of these recent trends for the field of construction management (CM). Guided by both object-based learning theory and the latest guidelines on the design and development of instructional videos from the literature, a batch of supplemental instructional videos (SIVs) were produced to support pre-class readings in a second-year undergraduate CM course. This course was optimal for a study on video due to its flipped classroom structure. In accordance with the Quality of Experience method, surveys and interviews were used to ask the learners subjective questions about the effectiveness of the SIVs. They were also asked to describe which course topics were best suited for video and how they felt about the design and development of the videos themselves.

Results analyzed from both surveys and interviews show that the participants in this study give clear support for using SIVs in CM classrooms. They reported overwhelmingly their belief that the SIVs positively affected their understanding of the topics. They also clearly expressed that the videos enhanced the quality of experience. This result is similar to and confirms the findings of both Hoxley & Rowsell (2006), Cherrett, et al. (2009), and Liu & Hatipkarasulu (2014) in this way. When asked about whether the SIVs had any measurable impact on their performance in terms of grades, participants were divided. Half of the class felt that the videos boosted their grades. The other half were skeptical, expressing uncertainty as to whether the short SIVs made any real difference. This result reflects the mixed findings of some studies in which performance was measured objectively. For example, Hurtado et al., (2014) found that performance increased as instructional video use increased. Also, while studying the effectiveness of instructional videos, Lee, Salama, and Kim (2016) found that using video has the tendency to produce greater positive changes in performance. Other studies (Burgett, 2014; Kulgemeyer, 2018) however, report that utilization of instructional videos yields small or no positive performance results. In the interviews, learners were asked to name any SIVs that stood out to them as particularly helpful. In general, the complex topics were named more frequently, which is the same result that Liu & Hatipkarasulu (2014) reported. Finally, the results of this study were similar to Wong et al. (2018), in that participants were overall pleased with the design of the SIVs in terms of pace, duration, and quality. While this study focused on CM students, learners across all fields, levels of education, and backgrounds, can benefit from this research that is designed to provide insight into how to improve understanding of new and unfamiliar topics.

Generational learning preferences are likely to evolve and shift over time. This seems to be especially true for technology-reliant pedagogies like instructional video object-based learning. While researchers can attempt to forecast learning preferences, it is imperative that past and current research, including this study, be regularly reviewed and updated for relevance. This research study was conducted in the Spring Semester of 2020. At the beginning of March, at exactly the half-way mark (i.e., week 6 of 12), the COVID-19 pandemic abruptly shut down all in-person instruction across the University. Fortunately, the study was being conducted in a flipped classroom in which the SIV treatments were self-administered by the learners themselves while at home. Nevertheless, though minimized, the disruption still required one international student to return home early and withdraw from the study before providing any feedback in either the survey or interview. Also, this study was conducted in a real-world setting in which the participants were responsible for self-administering the supplemental instructional videos (SIVs) in their own environments, at their leisure, and on their own devices. Future research might consider removing any corresponding variability (e.g., viewing devices and environmental distractions) by reproducing these results in a highly controlled setting in which I administer the SIVs. Finally, in accordance with the literary guidelines, the SIVs in this study were intentionally designed to be as short as necessary. On average the videos were just under three minutes long. Future work should consider amplifying the impact of SIVs by using longer videos to see how this changes the results of Q13 in which learners were asked to rate their performance in the class based upon the videos.

References

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. Higher Education Research & Development, 34(1), 1–14. https://doi.org/10.1080/07294360.2014.934336

Bernold, L. E. (2005). Paradigm Shift in Construction Education is Vital for the Future of Our Profession. Journal of Construction Engineering and Management, 131(5), 533–539. https://doi.org/10.1061/(ASCE)0733-9364(2005)131:5(533)

Barett, D. (2012) How Flipping the Classroom Can Improve the Traditional Lecture. The Chronicle of Higher Education. https://people.ok.ubc.ca/cstother/How_Flipping_the_Classroom_Can_Improve_the_Traditional_Lecture.pdf

Behzadan, A. H., & Kamat, V. R. (2013). Enabling discovery-based learning in construction using telepresent augmented reality. Automation in Construction, 33, 3–10. https://ascelibrary-org.ezproxy.lib.vt.edu/doi/abs/10.1061/40704%282003%2938

Brame, C. J. (2016). Effective Educational Videos: Principles and Guidelines for Maximizing Student Learning from Video Content. CBE—Life Sciences Education, 15(4), es6. https://doi.org/10.1187/cbe.16-03-0125

Brunnström, K., Beker, S. A., de Moor, K., Dooms, A., Egger S., Garcia, M., Hossfeld, T., Jumisko-Pyykkö, S., Keimel, C., Larabi, M., et al. (2013). Qualinet White Paper on Definitions of Quality of Experience. 2013. https://hal.archives-ouvertes.fr/hal-00977812/document

Chan, Y. M. (2010). Video instructions as support for beyond classroom learning. Procedia - Social and Behavioral Sciences, 9, 1313–1318. https://doi.org/10.1016/j.sbspro.2010.12.326

Cherrett, T., Wills, G., Price, J., Maynard, S., & Dror, I. E. (2009). Making training more cognitively effective: Making videos interactive. British Journal of Educational Technology, 40(6), 1124–1134. https://doi.org/10.1111/j.1467-8535.2009.00985.x

Chitwood, K., May, C., Bunnow, D., & Langan, T. (2000). Battle stories from the field: Wisconsin online resource center learning objects project. In D. A. Wiley (1), The Instructional Use of Learning Objects: Online Version. Retrieved June 2, 2020 from the World Wide Web: http://reusability.org/read/chapters/chitwood.doc

Choe, E. (2017). Optimizing Video for Learning: A Case Study-Based Primer of Informal, Educational, Digital Video Best Practices. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2909769

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

Deshpande, A., & Salman, B. (2016). Think-Pair-Share: Application of an Active Learning Technique in Engineering and Construction Management Classes. 7. http://ascpro.ascweb.org/chair/paper/CEUE149002016.pdf

Friedrich, K. A., Sellers, S. L., & Burstyn, J. N. (2008). 9: Thawing the Chilly Climate: Inclusive Teaching Resources for Science, Technology, Engineering, and Math. To Improve the Academy, 26(1), 133–141. https://doi.org/10.1002/j.2334-4822.2008.tb00505.x

Gubrium, J., & Holstein, J. (2001). Handbook of Interview Research. SAGE Publications, Inc. https://doi.org/10.4135/9781412973588

Hoxley, M., & Rowsell, R. (2006). Using Video in the Construction Technology Classroom: Encouraging Active Learning. Architectural Engineering and Design Management, 2(1–2), 115–122. https://doi.org/10.1080/17452007.2006.9684609

Holt, E. A., Chasek, C., Shaurette, M., & Cox, R. (2018). The Learning Styles of Undergraduate Students in CM Bachelor's Degree Programs in the U.S. International Journal of Construction Education and Research, 14(1), 4–21. https://doi.org/10.1080/15578771.2017.1342718

Hurtado, K. C., Kashiwagi, D. T., & Sullivan, K. T. (2014). An Assessment Tool for Using Videos and Rich Media in Construction Management Curriculum—A Case Study. 11.

Jensen, J. L., Holt, E. A., Sowards, J. B., Heath Ogden, T., & West, R. E. (2018). Investigating Strategies for Pre-Class Content Learning in a Flipped Classroom. Journal of Science Education and Technology, 27(6), 523–535. https://doi.org/10.1007/s10956-018-9740-6

Kay, R. (2007). A Systematic Evaluation of Learning Objects for Secondary School Students. Journal of Educational Technology Systems, 35(4), 411–448. https://doi.org/10.2190/M770-J104-V701-8N45

Kay, R. H. (2012). Exploring the use of video podcasts in education: A comprehensive review of the literature. Computers in Human Behavior, 28(3), 820–831. https://doi.org/10.1016/j.chb.2012.01.011

Kay, R. H. (2014). Developing a Framework for Creating Effective Instructional Video Podcasts. 9(1), 10. https://pdfs.semanticscholar.org/9bcc/94d61ae0c25e2924569222cda1b5f23b8f50.pdf

Krämer, A., & Böhrs, S. (2016). How Do Consumers Evaluate Explainer Videos? An Empirical Study on the Effectiveness and Efficiency of Different Explainer Video Formats. Journal of Education and Learning, 6(1), 254. https://doi.org/10.5539/jel.v6n1p254

Kulgemeyer, C. (2018). A Framework of Effective Science Explanation Videos Informed by Criteria for Instructional Explanations. Research in Science Education. https://doi.org/10.1007/s11165-018-9787-7

Le Callet, P., Moller, S., & Perkis, A. (2012). Qualinet white paper on definitions of quality of experience. Retrieved from http://www.qualinet.eu/images/stories/whitepaper v1. 1 dagstuhl output corrected.pdf

Lee, J. H., & McCullouch, B. G. (2005). Lessons Learned from a Design Course Utilizing Object-Based Learning Method. Construction Research Congress 2005, 1–10. https://doi.org/10.1061/40754(183)45

Lee, N., Salama, T., & Kim, S. J. (2016). Using the Flipped Classroom Model to Improve Construction Engineering and Management Education. 2016 ASEE Annual Conference & Exposition Proceedings, 27168. https://doi.org/10.18260/p.27168

Liu, R., & Hatipkarasulu, Y. (2014). Introducing Building Information Modeling Course into a Newly Developed Construction Program with Various Student Backgrounds. 8.

Ljubojevic, M., Vaskovic, V., Stankovic, S., & Vaskovic, J. (2014). Using supplementary video in multimedia instruction as a teaching tool to increase efficiency of learning and quality of experience. The International Review of Research in Open and Distributed Learning, 15(3). https://doi.org/10.19173/irrodl.v15i3.1825

Lockyer, L., Bennett, S., Agostinho, S., & Harper, B. (2009). Handbook of Research on Learning Design and Learning Objects: Issues, Applications, and Technologies. https://doi.org/10.4018/978-1-59904-861-1

McGarr, O. (2009). A review of podcasting in higher education: Its influence on the traditional lecture. Australasian Journal of Educational Technology, 25(3). https://doi.org/10.14742/ajet.1136

McGreal, R. (2004). Learning objects: A practical definition. https://auspace.athabascau.ca/handle/2149/227

Moradi, M., Liu, L., & Luchies, C. (2016). Identifying Important Aspects in Developing Interactive Instructional Videos. 8.

Morello, A., Issa, R. R. A., & Franz, B. (2018). Exploratory Study of Recruitment and Retention of Women in the Construction Industry. Journal of Professional Issues in Engineering Education and Practice, 144(2), 04018001. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000359

Pearson Education, New Research Finds YouTube, Video Drives Generation Z Learning Preference. (2018). Retrieved February 22, 2020, from https://www.pearson.com/content/dam/one-dot-com/one-dot-com/global/Files/news/news-annoucements/2018/The-Next-Generation-of-Learners_final.pdf

Rogers, T., & Tingerthal, J. (2013). Blended learning and 'Flipping' The Construction Management Classroom for Improved Teaching and Learning. In Proceedings of the 49th ASC Annual International Conference, San Luis Obispo, California. http://ascpro0.ascweb.org/archives/cd/2013/paper/CEUE40002013.pdf

Rokooei, S., & Goedert, J. (2015). Lessons Learned from a Simulation Project in Construction Education. 2015 ASEE Annual Conference and Exposition Proceedings, 26.1083.1-26.1083.11. https://doi.org/10.18260/p.24420

Van der Meij, H., & Van der Meij, J. (2013). Eight guidelines for the design of instructional videos for software training. Technical communication, 60(3), 205-228.http://www.ingentaconnect.com/content/stc/tc/2013/00000060/00000003/art00004

Wiley, D., (2002). The instructional use of learning objects (1st ed). Bloomington, Ind: Agency for Instructional Technology: Association for Educational Communications & Technology. https://members.aect.org/publications/InstructionalUseofLearningObjects.pdf

Wong, J. K. W., Oladinrin, O. T., Ho, C. M. F., Guilbert, E., & Kam, R. (2018). Assessment of video-based e-learning in a construction measurement course. International Journal of Construction Management, 1–7. https://doi.org/10.1080/15623599.2018.1435152

Zaneldin, E., Ahmed, W., & El-Ariss, B. (2019). Video-based e-learning for an undergraduate engineering course. E-Learning and Digital Media, 16(6), 475–496. https://doi.org/10.1177/2042753019870938

Appendices

Appendix 5.1 Survey Questions (IRB-approved)

Choose the extent to which you agree with the statements below. When asked, provide a short, written response.

1. The instructional videos made unfamiliar topics from the readings easier to understand.

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	2	3	4	5

2. In one or two sentences, explain why you feel this way.

____
____
____
____
____
____

3. Watching instructional videos made completing the readings go faster.

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	2	3	4	5

4. I would have preferred to have an instructional video to help with all readings throughout the course.

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	2	3	4	5

5. In one or two sentences explain why you feel this way.

____
____
____
____
____
____

6. Watching the instructional video made it less likely for me to complete the assigned readings.

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	2	3	4	5

7. Watching the instructional videos gave me greater confidence in my ability to do well on the in-class quizzes.

Strongly Disagree Disagree Neither Agree or Disagree Agree Strongly Agree

1 2 3 4 5

8. In one or two sentences explain why you feel this way.

____
____
____
____
____
____

9. My mind would wander or I would be easily distracted while watching the instructional videos.

Never	Rarely	Sometimes	Often	Always
1	2	3	4	5

10. The quiz questions that were embedded inside the instructional videos helped me pay close attention to the videos.

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	2	3	4	5

11. I would have preferred to have more classroom lecture and discussion instead of watching instructional videos.

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	2	3	4	5

12. In one or two sentences explain why you feel this way.

____
____
____
____
____
____

13. My performance in the class would have been about the same with or without the instructional videos.

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	2	3	4	5

14. In one or two sentences explain why you feel this way.

____
____
____

____
____
____

15. Of the six instructional videos that you were provided, how many did you watch more than once?

1 2 3 4 5 6

16. It was helpful to know that the instructional videos were produced specifically for this course by the instructor.

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	2	3	4	5

17. In one or two sentences explain why you feel this way.

____
____
____
____
____
____

18. The pace of the instructional videos was....

Very Slow	Slow	About Right	Fast	Very Fast
1	2	3	4	5

19. The instructional videos were engaging (i.e., good use of images, text, animations, sounds, voice narration).

Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	2	3	4	5

20. The length of the instructional videos was...

Very Short	Short	About Right	Long	Very Long
1	2	3	4	5

21. The quality (i.e., clear and coherent audio and visuals) of the instructional videos was...

Very Poor	Below Average	Average	Above Average	Excellent
1	2	3	4	5

22. Year in School
   a. First
   b. Second
   c. Third

d. Fourth
e. Other (Please Specify) ____________________

23. Major
    a. Construction Management
    b. Construction Engineering and Management
    c. Real Estate
    d. Other (Please Specify) ____________________

24. In what year were you born? ____________________

25. What gender do you identify as? (please select one)
    a. Male
    b. Female
    c. Other
    d. Prefer not to respond

Appendix 5.2 Interview Questions (IRB-approved)

The interview will be semi-structured. These questions are used as a guide to determine why the student responded a certain way on the survey.

Questions:

1. Overall, how did you feel about the instructional videos you periodically watched before completing the assigned readings for class?
2. Overall, what impact do you believe the instructional videos had on your learning experience?
    a. Did completing the assigned readings seem any different after watching an instructional video?
3. Overall, what impact do you believe that the instructional videos had on your classroom performance?
    a. If any, what impact do you believe the instructional videos had on your in-class quizzes?
    b. If any, what impact do you believe the instructional videos had on your contribution to group work?
4. Which instructional videos, if any, stand out to you and why?
5. If any, what are your recommendations for the use of instructional videos in current or future construction management classes?

Potential Probes:

That is really interesting...

- ...can you provide a specific example of what you are describing?
- ...can you tell me more about that?
- ...what do you believe made you feel that way?
- ...what makes you think that?
- ...what led you to believe that?

CHAPTER 6

CONCLUSION

Summary of Dissertation

Technological, pedagogical, and economic forces are causing the traditional teaching practices of higher education to shift. The predominant, didactic, reading-and-lecture-based methods of instruction are being challenged by the unique needs of emerging academic fields, such as CM, because of their focus on preparing students for the modern industry (Holt et al, 2018). In this modern educational landscape, researchers and practitioners from across fields have begun using technology to develop more efficient and innovative ways to educate. One of these new methods is object-based learning (OBL) — a student-centered pedagogy that features digital learning objects (LOs) to deliver active learning experiences to a targeted audience (Wiley, 2002). Examples of LOs include instructional videos, images, and animations. One of the most common types of digital LOs that has considerable potential for aiding teachers are supplemental instructional videos (SIVs) (Kay, 2012). In contrast with other types of instructional video LOs (i.e., lecture-based, enhanced, worked examples), SIVs are designed to support other teaching materials and methods, not stand in for them (Kay, 2014). OBL instruments, such as SIVs, are naturally complementary and synergistic with other methods of teaching, such as the flipped classroom (FC) — an active and student-centered teaching approach that rearranges traditional pre-class, in-class, and post-class activities so that class time can be spent collaborating, solving problems, and working on projects (Abeysekera & Dawson, 2015). By outsourcing some of the traditional instruction to SIVs, teachers can spend class time working with students, rather than lecturing to them.

This dissertation began with a central research question: Are object-based learning (OBL) solutions appropriate in a CM classroom? The question was subdivided into four smaller, more specific questions that were examined in the four core chapters of the dissertation. First, in which ways do foundational learning theories inform or support the application of OBL in a flipped CM classroom (RQ1/Chapter 2)? Second, how does contemporary instructional design literature inform the design and development of SIVs for CM topics (RQ2/Chapter 3)? Third, are SIVs an effective way to support traditional learning materials in a flipped CM environment (RQ3/Chapter 4)? And fourth, do CM learners believe SIVs have a positive impact on the quality of their learning experience (RQ4/Chapter 5)? This final chapter of the dissertation begins by reviewing and synthesizing the major themes and findings of these questions and chapters including: 1) the impact of OBL on CM student performance, 2) the preference CM students have for OBL, and 3) the ability of OBL to help teachers balance the competing priorities of theoretical learning and experiential learning, in the context of scarce class time and resources. Also, in the first of the four core chapters of the dissertation a theoretical model (Figure 2.3) described how OBL in a FC could deliver a transformative learning experience for CM learners. This model is briefly revisited and re-examined by what was learned following the research study. Finally, findings from each chapter and their implications are examined in the context of previous publications and some opportunities for future research are described.

CM Student Performance

Chapter 4 evaluated the impact of SIVs on student performance objectively, by measuring improvement between pretest and posttest scores. In our study, I found no empirical evidence that the participants who received the SIV intervention performed better or worse than those without it. This remained true even after accounting for differences in age, year in school, gender, final class grade, and complexity of the learning topic. In Chapter 5, I measured the subjective impact of SIVs on student performance, using end-of-course surveys and interviews. The participants were asked the extent to which they agree with the statement: “My performance in the class would have been about the same with or without the instructional videos.” As a whole, the class was equally divided, with the same number of participants in agreement as disagreement with the statement. These neutral results (i.e., SIV intervention neither helped nor harmed student performance) from both objective and subjective measures are consistent with each other and with some previous CM research. For example, Burgett (2014) tested the effectiveness of instructional videos by comparing two sections of a course on heating, venting, and air conditioning (HVAC) - one section taught as a flipped class and the other using traditional lecture. Burgett found that the two class sections “performed nearly identically” on their exams (p. 5). In education research outside of CM, Kulgemeyer (2018) evaluated differences in posttest scores between students who received high-quality instructional videos and a control group. Kulgemeyer reported that the research “could not find a significant difference between the [treatment and control] groups in the post-test results on their conceptual knowledge” (p. 18). These studies with negative results are inconsistent with other construction research by Choudhury (2011), Lee et al. (2016), and Hurtado et al. (2014), who *were* able to detect positive learning outcomes due to video interventions. The mixed results from these various studies suggest that the design and development, production and delivery, subject matter, and classroom context of the instructional videos may all moderate the impact of instructional videos on student performance. Future research should examine these various studies, including this dissertation, by carefully reviewing and comparing their methods and findings to determine the criteria that gives instructional videos the greatest opportunity to help students make objective improvements.

CM Student Preference

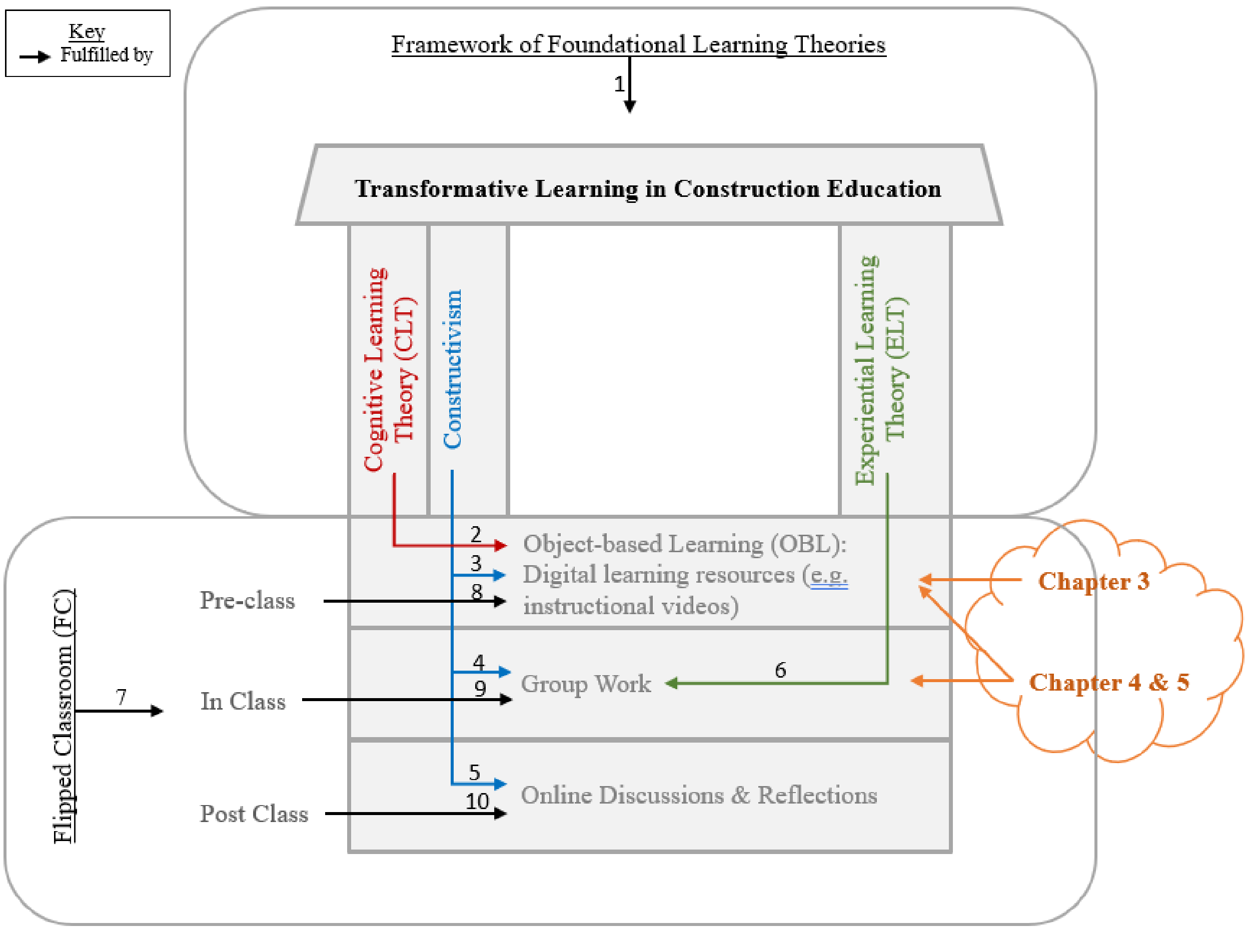
Chapter 3 provided an interdisciplinary synthesis of best practices from the literature for the design and development of instructional videos (Table 3.1). These best practices were a key focus of the survey and interviews in Chapter 5, which aimed to evaluate whether the best practices were effective and preferential according to CM students. From their responses, I learned that the participants overwhelmingly approved of the SIVs that were designed in conformity to the criteria in Table 3.1 (i.e., quality, duration, pace, and engagement). Students reported that they enjoyed the SIVs and preferred having them because they believed that they helped with their understanding of the course subject matter. This is true despite their skepticism that the improvements in understanding translated to improvements in class performance in terms of grades. Similar observations have been made by previous researchers. Hoxley and Rowsell (2006), who used medical literature to inform their research on the use of instructional videos to teach undergraduate construction learners, concluded that “video-based teaching is at worst no less effective than more traditional methods and that students seem to prefer it as a method” (p. 116). Burgett (2014) reported similar results, stating that overall, “students moderately preferred recorded over live lectures,” and that “it appears that recorded lectures are just as effective as live lectures at conveying information” (p. 3). Outside the field of CM, Sever, Oguz-Unver, and Yurumezoglu (2013) found “no significant difference between the academic achievement” in the quantitative results, but only significance in the qualitative results measuring learner preference for instructional videos (p. 454). These findings suggest that first, instructional video type and design matters to CM students. The participants of this dissertation research found the SIVs developed under the criteria of Table 3.1 to be highly favorable, while the research studies that used "lecture videos," as described in the studies by Burgett (2014) and Hoxley and Rowsell (2006) were moderately favorable. Also, drawing conclusions from this dissertation research as well as Burgett (2014) and Hoxley and Rowsell (2006), CM learners seem to prefer video as a medium for learning regardless of whether it objectively makes a positive difference to their grades. As rising generations continue to show interest in video as a learning medium (Pearson Education, 2018), future research should continue to explore the limits of CM learners' preference for instructional videos. For example, when do learners prefer video to field trips? When do CM learners prefer to watch, rather than read? When do CM learners prefer video-based instruction to teacher-based instruction? Asking and answering these and similar questions will help ensure that video-based instruction remains student-centered, prioritizing the needs and preferences of the learning audience they are supposed to serve.

Balancing Learning Priorities

In Chapter 2, I proposed a theoretical model (Figure 2.3) describing how the combination of instructional video OBL and FCs can help CM instructors balance theoretical and experiential learning in the context of scarce class time and resources (Jensen et al., 2018). The remainder of the dissertation documented the execution of the criteria contained in the theoretical model in Figure 2.3 with a research course, *Residential Construction Technologies*. In Chapter 3, I learned that instructors are capable of producing their own instructional videos in accordance with guidelines from the literature and using readily-available equipment and technology, such as cell phone cameras, personal computers, and video editing software. In Chapter 4, I learned that while SIVs do not appear to offer many performance advantages for students, they also do not detract from instruction, demonstrating that they may be a viable option for outsourcing some theory-based instruction. Chapter 5 strengthened this claim, showing that students appreciated and even preferred the OBL/FC structure. Collectively, survey participants seemed aware that the SIVs were not directly improving their grades; nevertheless, they overwhelmingly reported their preference for them as a dimension of the learning experience. Exemplifying this sentiment, one student reported during an interview: "I think...the information in those videos helps free up a lot of time in class to be able to have discussions. I like the video structure, a lot more than in-class lectures. Yes, or getting all the information in class."

Revisiting the Original Theory

The theoretical model initially proposed in Chapter 2 (Figure 2.3) used existing literature to describe how OBL in a FC is one way to provide a transformative learning experience for CM learners. One contribution of this completed dissertation research study is to continue building and strengthening the theoretical model with the insights and findings from Chapters 3, 4, and 5. Chapter 3 provides the strongest support. It focused on the design and development of instructional video for use in the OBL approach. As Figure 6.1 proposes, after publication, this chapter provides additional support for using supplemental instructional videos (SIVs) in the pre-class segment of a FC. Chapter 4, which presented the results of a repeated measures experiment on SIVs, and Chapter 5, which reported student perceptions of the OBL approach, demonstrated that instructional videos can be useful in administering the FC in both the pre-class and in class segments.



1. Adapted from Daramola, 2018
2. Hoxley & Rowsell, 2006; Mayer, 2014
3. Bannan-Ritland, Dabbagh, & Murphy, 2002
4. McWhirter & Shealy, 2018
5. McWhirter & Shealy, 2018
6. Kolb & Kolb, 2013; Jensen, Holt, Sowards, Heath, Ogden, & West, 2018
7. Ayala, Popescu, & Jovanovic, 2017
8. Lo & Hew, 2017
9. Bishop & Verleger, 2013b
10. Stewart, Bachman, & Babb, 2009

Reflection & Moving Forward

It was a privilege to help design, develop, and teach undergraduate CM courses while a graduate student. I consider it the highlight of my Ph.D. and, coupling teaching with a research study on OBL, I could not have devised a better experience-based learning opportunity for myself. The main finding of this study can be condensed into a single sentence: supplemental instructional videos appear to have little measured effect on improving learner performance, *but* they also seem to have a substantial, positive impact on the quality of the learning experience. The quality of experience is the main takeaway of this research. CM students prefer OBL in the form of SIVs. SIVs made the course a better learning experience for the students and they expressed interest in having more of them in their future courses.

This study on SIVs will guide my future research on effective and appealing ways to teach CM students. First, I would like to expand on this dissertation study to include greater numbers of other, less-represented groups, namely, ethno-racial minorities and women. The field of CM is well-positioned to benefit from an increase in diversity for a few reasons. First, CM has near-universal value. Peoples of nearly all backgrounds, nationalities, languages, cultures, ethnicities, races, genders, religions, ages, experiences, family statuses, and tastes make use of the built environment in distinct ways for purposes of both utility as well as the expression of their idiosyncrasies. It is only natural, therefore, that the process of creating the built environment be informed, if not represented directly, by a diverse professional population. The second reason is that CM routinely experiences workforce shortages. Talent is in short supply (Morello et al. 2018; Sewalk, 2013). Broadening the outreach to new, untapped, or less-tapped pools of potential talent increases the likelihood of matching the low supply to the high demand. Unfortunately, for the research in this dissertation, the student sample that registered for the research course did not allow for targeted exploration of the impact of SIVs within or across ethno-racial groups. Through future research, it would be particularly valuable to understand the impact of SIVs on the performance and learning experiences of Hispanic students, given that many, if not majority, in the workforce in some markets and construction fields are Hispanic (Bureau of Labor Statistics, 2015). The impact of SIVs on women *was* specifically examined in this dissertation research; however, their sample size was small. Given their persistent majority of enrollments and graduates (U.S. Department of Education, 2020), as well as the shortage of CM professionals that is expected in the next decade, understanding more about how women in CM learn is advisable (Morello et al. 2018).

Second, I would like to study how students who become multimedia content creators differ from those who are merely multimedia content consumers. McGarr (2009) said:

> The final and least frequently mentioned use of [instructional video] podcasts in education, is what could be described as creative use, wherein students become more engaged in the learning through constructing knowledge rather than simply receiving it. The student is required to have a deep level of knowledge of the subject matter if they are to successfully construct a suitable [instructional video] podcast, and therefore this type of use challenges the student to critically examine the material they have been exposed to previously (p. 317).

Applying this “creative use” model described by McGarr (2009, p. 317), I would help students in future courses build their knowledge of a certain CM topic by having them develop their own multimedia learning resources. For example, using the guidelines in this dissertation, particularly Chapter 3, CM students could design and develop instructional videos on residential plumbing systems, back-charging purchase orders, or critical path scheduling. As a researcher, I would then assess the extent of their understanding of these topics in comparison with others in which they were merely content consumers.

Finally, I would like to focus on students with different motivations. During my dissertation research, I worked closely with 46 individual students. Some of them are naturally gifted learners and workers. They are the students who are intrinsically motivated, focused, and ambitious, and know what they want from their university experience. These students are open to and appreciate help, but do not normally *need* it. I also had the opportunity to meet students who are still unsure of what they are looking for from their University experience. From my observations, these students need help (desperately, some of them), but aren’t typically interested in it or receptive to it. I also observed a third tier of students. These are students in the middle, that need help and are eager to work for it. They want learning to come easier and are willing to do what it takes to get ahead but can’t seem to make the traditional classroom format work for them the way it seems to for some of the naturally-gifted “A” students. This is the student profile that I would like to be my target population in future research studies. They are the individuals looking for a nudge to push them into the high-performing category of their peers, and I believe focusing my efforts on them is how I can do the most good in CM education.

References

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. Higher Education Research & Development, 34(1), 1–14. https://doi.org/10.1080/07294360.2014.934336

Bureau of Labor Statistics (2015). U.S. Department of Labor, The Economics Daily, Hispanics and Latinos in industries and occupations on the Internet at https://www.bls.gov/opub/ted/2015/hispanics-and-latinos-in-industries-and-occupations.htm (visited January 29, 2021).

Burgett, J. M. (2014). Can "Flipping the Classroom" Improve the Educational Experience in Construction Management Courses: A Case Study in Teaching HVAC Psychrometrics. 8. http://ascpro0.ascweb.org/archives/cd/2014/paper/CEUE127002014.pdf

Choudhury, I. (2011). The Effect of Watching Video Clips on Student Performance in a Construction Science Course at an Undergraduate Level on Student Performance in a Construction Science Course at an Undergraduate Level. 8. https://www.asee.org/public/conferences/1/papers/50/view

Holt, E. A., Chasek, C., Shaurette, M., & Cox, R. (2018). The Learning Styles of Undergraduate Students in CM Bachelor's Degree Programs in the U.S. International Journal of Construction Education and Research, 14(1), 4–21. https://doi.org/10.1080/15578771.2017.1342718

Hoxley, M., & Rowsell, R. (2006). Using Video in the Construction Technology Classroom: Encouraging Active Learning. Architectural Engineering and Design Management, 2(1–2), 115–122. https://doi.org/10.1080/17452007.2006.9684609

Hurtado, K. C., Kashiwagi, D. T., & Sullivan, K. T. (2014). An Assessment Tool for Using Videos and Rich Media in Construction Management Curriculum—A Case Study. 11.

Jensen, J. L., Holt, E. A., Sowards, J. B., Heath Ogden, T., & West, R. E. (2018). Investigating Strategies for Pre-Class Content Learning in a Flipped Classroom. Journal of Science Education and Technology, 27(6), 523–535. https://doi.org/10.1007/s10956-018-9740-6

Kay, R. H. (2012). Exploring the use of video podcasts in education: A comprehensive review of the literature. Computers in Human Behavior, 28(3), 820–831. https://doi.org/10.1016/j.chb.2012.01.011

Kay, R. H. (2014). Developing a Framework for Creating Effective Instructional Video Podcasts. 9(1), 10. https://pdfs.semanticscholar.org/9bcc/94d61ae0c25e2924569222cda1b5f23b8f50.pdf

Kulgemeyer, C. (2018). A Framework of Effective Science Explanation Videos Informed by Criteria for Instructional Explanations. Research in Science Education. https://doi.org/10.1007/s11165-018-9787-7

Lee, N., Salama, T., & Kim, S. J. (2016). Using the Flipped Classroom Model to Improve Construction Engineering and Management Education. 2016 ASEE Annual Conference & Exposition Proceedings, 27168. https://doi.org/10.18260/p.27168

McGarr, O. (2009). A review of podcasting in higher education: Its influence on the traditional lecture. Australasian Journal of Educational Technology, 25(3). https://doi.org/10.14742/ajet.1136

Morello, A., Issa, R. R. A., & Franz, B. (2018). Exploratory Study of Recruitment and Retention of Women in the Construction Industry. Journal of Professional Issues in Engineering Education and Practice, 144(2), 04018001. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000359

Pearson Education, New Research Finds YouTube, Video Drives Generation Z Learning Preference. (2018). Retrieved February 22, 2020, from https://www.pearson.com/content/dam/one-dot-com/one-dot-com/global/Files/news/news-annoucements/2018/The-Next-Generation-of-Learners_final.pdf

Sever, S., Oguz-Unver, A., & Yurumezoglu, K. (2013). The effective presentation of inquiry-based classroom experiments using teaching strategies that employ video and demonstration methods. Australasian Journal of Educational Technology, 29(3). https://doi.org/10.14742/ajet.229

Sewalk, S., & Nietfeld, K. (2013). Barriers preventing women from enrolling in construction management programs. International Journal of Construction Education and Research, 9(4), 239-255.

U.S. Department of Education. (2020). *Undergraduate Enrollment*. Spring 2001 through Spring 2019, Fall Enrollment component; and Enrollment in Degree-Granting Institutions Projection Model, 2000 through 2029. See Digest of Education Statistics 2019, table

303.70. Retrieved January 28, 2021, from https://nces.ed.gov/programs/coe/indicator_cha.asp

Wiley, D., (2002). The instructional use of learning objects (1st ed). Bloomington, Ind: Agency for Instructional Technology: Association for Educational Communications & Technology. https://members.aect.org/publications/InstructionalUseofLearningObjects.pdf