Evaluating the Quality of Experience of Supplemental Instructional Videos

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Evidence shows that the college-age generation prefers learning by video to all other methods. However, many instructional videos produced by faculty and staff amount to little more than recorded lectures, causing students to report that they are long, dull, low-quality, and ineffective. As part of a broader study on object-based learning, this paper reports the attitudes that construction management students have toward a popular 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 an interdisciplinary curation of the latest literature covering the proper design and development of instructional videos. Data were collected using mixed methods and the Quality of Experience (QoE) strategy, relying on surveys and interviews to draw conclusions about student perspectives. Overwhelmingly, participants stated their preference for SIVs and reported that they improved their understanding of the subject matter. In spite of this, surprisingly, students were divided as to whether the SIVs had any real impact on their performance in terms of grades. The research also confirmed that SIVs are most appropriate for complex learning topics.

Key Words: Construction Education, Instructional Videos, Quality of Experience

Introduction

In 2005, Leonard Bernold (2005), a construction professor and researcher at North Carolina State University, documented the complaint of one undergraduate construction student: "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 student's frustration to illustrate the well-documented shortcomings of the traditional, reading-and-lecture-based learning method in construction education (e.g., Hoxley & Rowsell, 2006), it also reflects the simple reality that many undergraduate construction students find unassisted readings on unfamiliar topics to be challenging, often preferring to avoid them altogether. In 2018, Pearson Education commissioned a national, online survey aimed at understanding the differences in educational interests, outlooks, and values of Millennials (individuals born between 1980-1994) and Generation Z (individuals born between 1995 and 2015), who now constitute the majority of undergraduate students. 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 previous research by Chan (2010), who found that college students preferred video to textbooks. Chan noted 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 (Wiley, 2002). LOs include a wide array of e-learning-based instruments such as digital images, animations, photographs, and videos. Currently, one of the most common types of LOs is instructional videos (Kay, 2012). Instructional videos fall into four categories: lecture-based, enhanced, worked examples, and supplementary (Kay, 2014). Lecture-based are the most common and basic. They are recordings of classroom lessons. Enhanced videos are designed to be motivating and exciting, helping students to take an interest in the subject matter. Worked examples are procedural in nature, typically used to guide students step-by-step through calculations or a process. Supplemental instructional videos (SIVs) are provided to complete the learning experience, either as introductory tools for unfamiliar concepts or to fill any gaps in understanding left by readings or lectures. Of the four, SIVs are recommended due to their ability to provide greater educational value and higher cognitive learning outcomes (McGarr, 2009).

Because the OBL approach is still relatively new, fundamental questions about the educational impact of SIVs remain unanswered, including how students feel about SIVs as part of their curriculum. The aforementioned 2018 Pearson Education survey suggests that students 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. Construction management is no exception. This paper helps fill this gap by presenting the findings of an explanatory investigation of CM students' perceptions of SIVs which were 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 CM classroom.

Literature Review

A limited number of studies have been published that consider how construction management (CM) students feel about 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 generally preferred them over reading a book. Hoxley & Rowsell also found that instructional videos are most helpful to students 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. Students 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 students who were behind in their work. In agreement with Hoxley & Rowsell (2006), survey data indicated that students felt that content delivered by video was beneficial. However, like Cherrett et al. (2009), Liu & Hatipkarasulu warned that the instructional videos alone were insufficient in providing a deep understanding of the 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 students were taught using the model and then surveyed. The study found that "students were satisfied with [the] 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 student satisfaction in response to course topics being taught with instructional videos. Following the study, 67 students were questioned with an online survey administered through the university learning management system (LMS). Overall, students were "satisfied with the contents of the instruction [*sic*] videos and benefited from these videos" (Zaneldin et al., 2019, p. 475). The students commented that they preferred the blended model that included online instructional videos because they had greater access to course content. Notably, of these studies mentioned, none clearly defined the type of instructional video administered or even provided satisfactory descriptions of the video themselves (e.g., recorded lectures, written examples, or narrated animations). Nor did they provide sufficient qualitative details regarding the quality, pace, engagement, and duration of the videos.

Research Questions

Building upon previous research, this study was aimed at exploring the perceptions that CM students have toward supplemental instructional videos (SIVs). Specifically, this study asked:
- Research Question 1 (RQ1): Do CM students feel that the use of SIVs as supplemental, educational tools for traditional learning materials (i.e., readings) improves their understanding of course subject matter?
- Research Question 2 (RQ2): For which construction topics (e.g., plumbing, foundations, framing) do CM students feel SIVs are most helpful?
- Research Question 3 (RQ3): Are CM students satisfied with the quality, pace, engagement, and duration of the SIVs as the literature recommends?

Methods

Surveys and interviews were used to investigate CM students' opinions of SIVs. Consistent with previous research on video- and multimedia-based instruction (Ljubojevic et al., 2014), the Quality of Experience (QoE), a strategy commonly used in customer service and telecommunications, was deployed to measure students' 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, p. 6). Modeling Ljubojevic et al. (2014), who evaluated the QoE "to investigate [the] efficiency of use of supplementary video content in multimedia teaching" (p. 275), a survey was given to participants to evaluate their QoE with SIVs. The survey also asked students to rate the quality, duration, and pace of the instructional videos. Survey questions were composed of both closed-ended, ordinal questions on a traditional five-point Likert scale and a few open response follow-up questions. Following the survey, a short, approximately five- to ten-minute interview, was conducted one-on-one with all participants to gain further explanatory insights into the students' QoE. Each interview was semi-

structured, allowing for some deviation from a set of five predetermined, guiding questions that asked participants to describe their experiences with and perceptions of the SIVs. 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 then edited for accuracy. The survey was piloted under real conditions by three current undergraduate CM students in the same department who were not participants in the study. All research activities were reviewed and approved by the Institutional Review Board (protocol 19-853).

Course, Population, and Sample

The study was conducted at a large, public university in the United States in a second-year course called Residential Construction Technologies in which students critically examined emerging construction technologies and compared them with their more conventional alternatives. The course was structured to introduce innovative construction technologies (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 student in the class was assigned a random set of six SIVs throughout the semester. The SIVs were distributed through the university learning management system with all other course assignments. Participants of the study were instructed to watch the SIVs alone, before class, and before completing the course readings that they were designed to support. 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%), proportionally representing the current overall population of undergraduate students in CM classes at the university. 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%).

Supplemental Instructional Videos

The SIVs for the course were produced by the instructor in compliance with a synthesis of interdisciplinary guidelines from the literature (Barnes, 2021). Hence, they were short (i.e., about 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 SIV 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, interactive (i.e., incorporated guiding quiz questions), direct, relevant, and paced for maximum learning and engagement. All SIVs were developed with a home license of TechSmith Camtasia 2018. Visual and audio material came from open-access and license-free sources such as Pixabay.com, the YouTube Audio Library, and FreeSounds.org. A standardized preproduction, production, and review process was used to ensure compliance with best-practice guidelines, save time, and make each video qualitatively consistent with the others. The total production time of each video averaged just under four hours from writing the script to the final rendering.

Analysis

Survey responses were exported from Qualtrics into SPSS (version 25) for data management and analysis. All qualitative data were selectively coded for themes that provided additional insight into closed-ended survey questions. For RQ1 and RQ3, frequencies and descriptive statistics were

calculated for corresponding closed-ended survey questions. For RQ2, participants were directly asked during interviews which SIVs were most helpful, and responses were analyzed to quantify favorable mentions by name. For comparison, each conventional-plus technology was assigned a binary category of complexity. "Complex" technologies were those with many interconnected parts, intricate assemblies, and complicated functions, such as the mini-split system, fiber optics, and condensing storage water heaters. "Simple" technologies were those with fewer assemblies and operating parts, such as triple-pane windows and laminated vinyl tile.

Results

Eight of the closed-ended survey questions were dedicated to understanding whether students felt that the SIVs had any impact on their performance and the quality of their learning experience (QoE) in terms of utility (RQ1). Across all students, 95.3% (n=33) 'agreed' or 'strongly agreed' that the SIVs made unfamiliar construction topics in the readings easier to understand (Figure 1). In an open response follow-up question, one participant 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." About three-quarters of the students, 71.5% (n=30), 'disagreed' or 'strongly disagreed' that watching a video made them less likely to do the assigned readings, while 81% (n=34) felt like the videos made the assigned reading go faster. Students were most divided on whether they believed the videos helped them with their graded assignments. Agreement and disagreement were equal, totaling 35.7% (n=15) each, with the remaining 28.6% (n=12) 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 some students to perform to a certain standard regardless of the demands on their effort. 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…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.
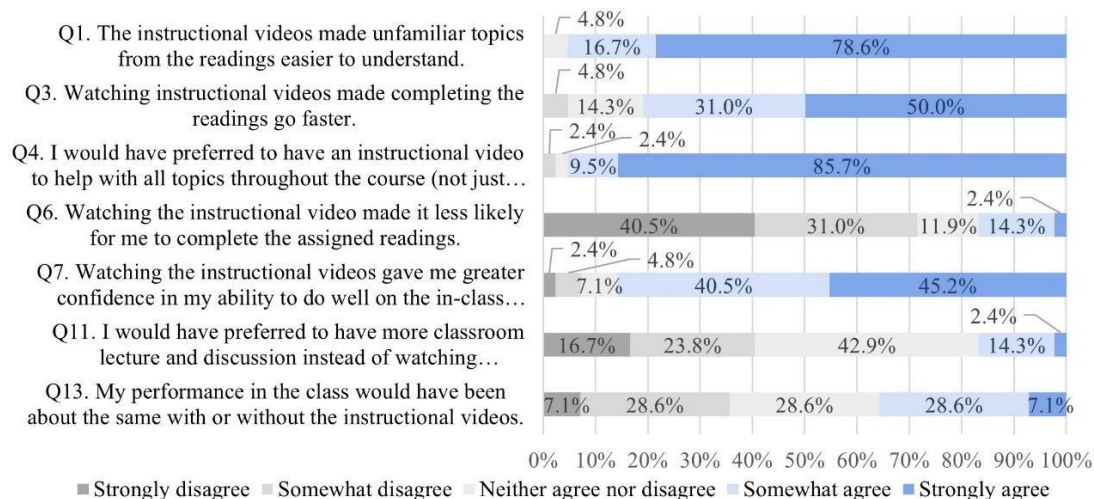

Figure 1. Student perceptions of the impacts of SIVs on their performance.

When asked what, if any, recommendations they had for the use of instructional videos in the course, participants frequently responded that SIVs should be provided for all topics, not just half of them. In many cases, students stated that they wanted to see SIVs used in their other courses as well. Encapsulating this viewpoint, one student said:

> 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.

Only 16.7% (n=7) either 'agreed' or 'strongly agreed' that they would have preferred to have more classroom lecture and discussion instead of watching instructional videos, suggesting that students were generally satisfied with the balance of video- and lecture-based learning in the course.

RQ2 focused on which SIVs were most helpful for students. In general, the topics with more complex technologies received the most mentions during interviews, while the simple technologies were mentioned less frequently or not at all (Table 1). Students provided additional support for this relationship between topic complexity and the value of SIVs. One participant 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 student, while discussing condensing storage water heaters, explained why more complex topics are conducive to video supplementation. He said,

> "Before 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."

This trend has exceptions. While solar shingles used in roofing would normally be considered a more complex topic than premium sheathing systems used in wall framing, more students mentioned the SIV for premium wall sheathing than the SIV for solar shingles.

Table 1. Frequencies of mentions of each conventional-plus topic in the interviews.

Technology	Topic Complexity	# Students who received the SIV	# of Topic mentions	% of Topic mentions
Mini-split system	Complex	21	8	38%
Condensing storage water heater	Complex	24	5	21%
Fiber optics	Complex	25	5	20%
Closed crawl space	Complex	21	4	19%
Premium sheathing	Simple	21	4	19%
Insulated vinyl siding	Simple	21	2	10%
Solar shingles	Complex	22	2	9%
Premium subfloors	Simple	25	1	4%
Trusses	Simple	22	0	0%
Triple-pane windows	Simple	25	0	0%
Radiant barrier	Simple	24	0	0%
Laminated vinyl tile	Simple	25	0	0%

The final research question (RQ3) focused on student perceptions of the design and development of the SIVs and how they impact their QoE through viewing ease and enjoyability. Overwhelmingly, 97.6% (n=41) of students reported in the survey that they 'strongly agree' or 'somewhat agree' that

the videos were engaging, making good use of images, text, animations, sounds, and voice narration. Three survey questions asked about the pace, duration, and quality of the videos. 85.7% (n=36) of the class reported the pace of the SIVs was 'about right'. The remaining 14.3% (n=6) of respondents thought the videos were 'too slow.' 81.0% (n=34) of the class reported that the roughly 3-minute duration of the videos was 'about right'. One student explained in an interview that "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." The remaining 19.0% (n=8) of students, nearly a fifth of the class, felt that the videos were either 'too short' or 'far too short.' During the interviews, one student said that "around 10-to-12 minute length [for the SIVs] would really be good." 33.3% (n=14) of the class thought the quality of the SIVs in terms of audio and visuals was 'excellent,' while 38.1% (n=16) thought the quality was 'above average,' and 26.2% (n=11) thought the quality was 'average.' One person (2.4%) thought the quality was 'below average.'

Scales Key:
* Never, Rarely, Sometimes, Often, Always
** Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree
*** Far too slow, Too Slow, About right, Too fast, Far too fast
‡ Far too short, Too short, About right, Too long, Far too long
# Very poor, Below average, Average, Above average, Excellent
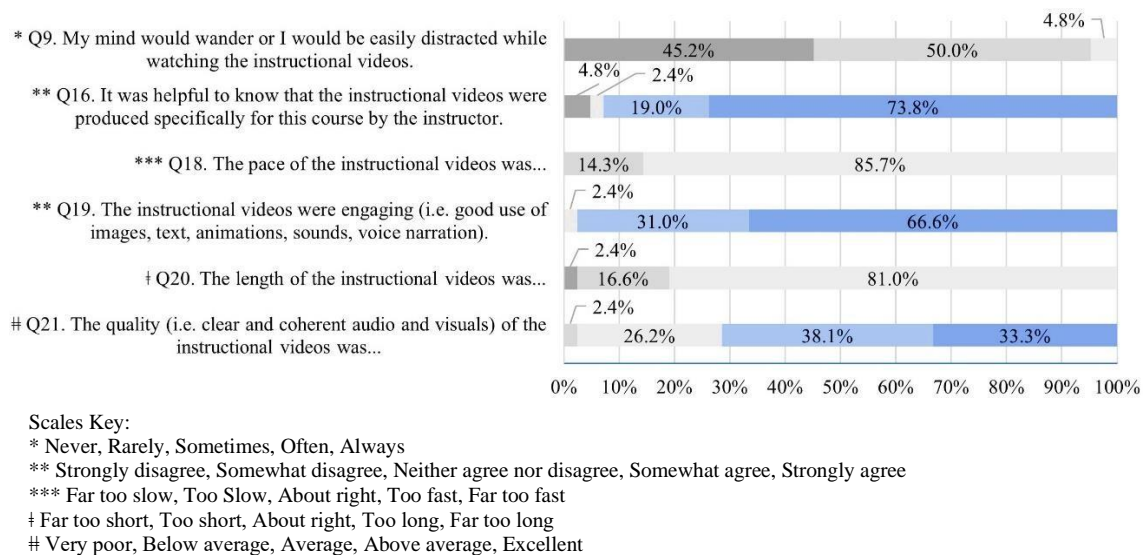
Figure 2. Student perceptions about the SIVs' design.

Discussion

This paper began with three research questions, each focused on how to improve CM students' QoE. The first (RQ1) asked if watching a SIV before completing assigned readings improved understanding of the topic. Participants of the study reported affirmatively, echoing the findings of Hoxley & Rowsell (2006), Cherrett et al. (2009), and Liu & Hatipkarasulu (2014) who found that instructional videos had a positive impact on student understanding of course content. However, surprisingly, in a follow-up question in which the participants were asked whether they believed that the SIVs had any measurable impact on their performance in terms of grades, they were starkly divided. Over a third of the class felt that the SIVs boosted their grades. The same number were skeptical, expressing uncertainty as to whether the SIVs made any real difference. The mixed findings in the literature and this research study have a few possible explanations. First, improvements in understanding may not directly correlate with better performance on quizzes. The quizzes asked precise questions with limited answer options, potentially making students reluctant to claim that their specific understanding

of each reading was adequately reflected in those questions. Alternately, for some students, improved understanding may be a more distant precursor to perceived improvements in quiz performance. Without many previous opportunities to demonstrate their understanding of the unfamiliar topics, students may still feel unsure about what they know and hesitant to claim any improvement on class assignments. Future research might change or broaden the testing instrument to give study participants more opportunities to openly express their understanding with greater confidence. Other explanations point to the uncontrolled variability in student effort. This study was conducted in a real-world setting in which the participants were responsible for self-administering the SIVs in their own environments, at their convenience, and on their own devices. In the weeks that students did not receive a SIV, they could have compensated with additional time and effort with the readings. Future research might attempt to remove these variables (e.g., study time, viewing devices, and environmental distractions) by conducting the study in a highly controlled lab setting in which the SIVs are administered by the researchers directly. Another consideration is that, in accordance with guidelines described in the literature, the SIVs were intentionally designed to be short. On average the videos were just under three minutes long. While most of the students believed this was sufficient, a few disagreed. Future work should consider amplifying the impact of SIVs by using longer videos to see how it impacts understanding, performance, and QoE. The second research question (RQ2) asked participants which SIVs helped them the most. In general, the complex topics were named more frequently, which is the same result that Liu & Hatipkarasulu (2014) reported. The final research question (RQ3) asked about the design of the SIVs. 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, engagement, and quality.

Conclusion

Video has become the preferred medium of learning for the current college-age generation. This paper presented the findings of a mixed-method study exploring the impact that SIVs have on CM students' quality of the learning experience (QoE), their understanding, the value of SIVs for different course topics, and the quality of SIVs designed in accordance with current guidelines. Insights from both surveys and interviews clearly indicate that well-designed SIVs have a substantial, positive impact on the QoE and are the most helpful with relatively complex subjects. Overall, these results add to the growing body of knowledge by providing CM teachers with an evidence-based way to update or augment their existing curriculums without extensive changes. In consultation with the latest literature on video design, instructors can build or select SIVs for their courses and apply them strategically to their most challenging topics.

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