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The Impact of Virtual Construction Field Trips on Students' Perceptions in Commercial Construction

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Field trips are an integral part of students' education, especially for those pursuing a degree in construction or engineering where practical experience is needed to understand the complexities of the profession. University programs struggle to provide adequate field trip experiences due to several reasons, including limited project availability, travel costs, and safety concerns. One option that has become increasingly prevalent, is the implementation of virtual field trips (VFTs). VFTs provide educators and students a flexible option to view and experience various projects from their personal computer or mobile device. This paper provides an exploratory overview of students' perspectives of real field trips (RFTs) in comparison to VFTs. A VFT was created using StructionSite, Inc. and a 360-degree camera, and compared to the same project that was visited in person, as a RFT by a different group of students. Pre and post surveys were used to sample construction management students studying commercial construction at a major university. The main findings were VFTs and RFTs both contributed to students' interest in commercial construction. Students perceived VFTs as a valuable resource that can be used to contribute to knowledge and skill attainment. In addition, VFTs were viewed as a valuable aspect in a students' education that can supplement certain types of RFTs, but students agreed VFTs should not replace RFTs completely.

Key Words: virtual field trip, experiential learning, student perceptions, construction management

Introduction

Construction management and engineering are practical professions that require pragmatic and innovative experiences to successfully prepare students for their future careers. As students are introduced to large amounts of knowledge in the classroom, with no previous knowledge on the subject, it is increasingly important to relate this new knowledge to practical experience (Paez & Rubio, 2015). Universities are tasked to provide students an opportunity to make connections between theoretical concepts taught in the classroom and real-world applications (Seifan et al., 2020). In order to provide construction and engineering students with practical knowledge, educators rely heavily on field trips, specifically jobsite visits, also referred to as a real field trip (RFT). These jobsite visits allow

students to visualize and identify construction components, means and methods, durations, and safety elements which they are currently learning in the classroom.

As researched in a number of previous studies, field trips are an important element of students learning as they are exposed to different activities that increase cognition, confidence, and enjoyment of a specific subject (Seifan et al., 2020). A critical goal of field trips is to provide students with experiential learning. Kolegraff et al. (2019), determined that experiential learning is not only a preferred method for learning but is also perceived by students to be one of the most effective methods in construction education. Experiential learning provides students an avenue to “learn-by-doing” and gives them an opportunity to observe and further understand the dynamic construction processes onsite (Murray & Tennant, 2016). Adding field trips to a course can increase overall learning by providing students an opportunity for exploration of original experiences. A field trip enables students to visualize the theoretical concepts covered in a course and students are able to relate their experiences to the classroom content (Seifan et al., 2020).

However, implementing RFTs into a course can be time consuming and costly. RFTs are also becoming more difficult to implement due to concerns about safety, reduced university budgets, and increased class sizes (Leydon & Turner, 2013). Specifically, it can be difficult for universities in rural areas with limited local jobsites to visit. University courses typically cover specific topics, such as pavement design, commercial construction, or heavy timber framing. In addition, many courses cover specific phases of construction, such as underground utilities, foundations, structure, exteriors, and interiors. Finding a project relating to a specific phase or topic can be challenging in certain geographical areas. To adapt to these restrictions, a potential option is virtual field trips (VFTs). It has been reported that VFTs can be a successful alternative to RFTs to simulate the realities of the outside world in the classroom (Spicer & Stratford, 2001). Researchers have explored how to effectively implement VFTs to provide easier access to a construction jobsite compared to traditional trips (Stoddard, 2009).

The use of VFTs has increased in recent years as the technology has improved, giving students and faculty the ability to create an immersive experience. VFTs are described as the ability to provide an experiential learning environment that observes the physical elements, and has the ability to be assessed using a virtual tool, such as a mobile or desktop device (Eiris et al., 2019; Jaselskis et al., 2010). They are also able to be viewed at anytime and anywhere by a student. Pham et al. (2018) successfully applied a 360-degree panoramic virtual reality to assist in construction safety education. Eiris et al. (2021) created virtual 360-degree panoramic site visit experiences enhanced with virtual humans (avatars) to produce realistic site visits for students to practice collaborative problem-solving skills. Eiris et al. (2020) successfully used immersive storytelling with digital 360-degree panoramas to improve hazard recognition and risk perception.

A recent study conducted by Seifan et al. (2020) examined student perceptions on the use of VFTs as part of their university experience and the extent to which it could replace the traditional RFTs. The study concluded that students consider VFTs an enjoyable way to learn but it is not a suitable replacement for RFTs. It is unclear if general videos were used for this study, rather than a similar experience to those that evaluated the RFT. To determine the direct value of VFTs it is important to provide students a similar experience to those evaluating the RFT to clearly understand the value of substituting VFTs for RFTs. The research to date, examines the different tools and methods to implement VFTs but does not provide specific findings comparing one specific jobsite utilizing an RFT and compare it to the same jobsite using VFT. In addition, there is limited research evaluating the current virtual walkthrough software systems utilized in construction and whether these can be used in higher education to enhance student learning.

The objective of this paper is to study initial findings of a specific type of VFT, StructionSite, Inc., which is a software system used in the architecture, engineering, and construction (AEC) industry that utilizes 360-degree panoramas and virtual site walks. This paper will examine construction management students' perspectives after experiencing a VFT utilizing StructionSite, Inc. and compare these results to students who experienced a traditional RFT of the same project. Specifically, the study sought to assess: (1) do VFTs or RFTs contribute to students' interest in commercial construction, (2) do students perceive VFTs or RFTs to contribute to knowledge and skills attainment in a commercial construction course, and (3) can VFTs be successfully utilized in construction management. This work contributes to the body of knowledge related to construction and engineering education by documenting the specific learning preferences voiced by students related to VFTs and the overall implementation of immersive learning.

Research Methodology

Participants

This study aims to provide an exploratory overview of students' perspectives of RFTs in comparison to their perspectives of VFTs. The target population was undergraduate students studying construction management at a major university. One specific course was selected for the study, and two sections were surveyed. Both sections were asked to complete the same pre-field trip survey. After the field trip, students were asked to complete a post-field trip survey. There were two different post-field trip surveys, one for the RFT student population and one for the VFT group. The responses were analyzed using a qualitative and quantitative research methodology to produce conclusions to inform future field trip teaching strategies.

Field Trip Project and Location

The project selected was a multi-family and mixed-use development. It consisted of 78 units, Type VA construction on top of a 1.36 acre Type IA parking garage, also referred to as a podium parking structure. Within the podium there are five retail spaces totaling 6,800 square feet. Atop the podium, the residential portion included eight 3-story buildings connected by a network of breezeways and



Figure 1 and 2. 790 Foothill in San Luis Obispo, CA

courtyards. Building amenities included a rooftop deck and multiple amenity spaces. As shown in Figure 1, the project was 80% complete with the podium deck concrete and mechanical, electrical, and plumbing (MEP) trades and the framing was 35% complete which started at the first phase of the

building. During the field trips, both RFT and VFT, students were exposed to concrete shoring, rebar installation, MEP deck rough-in, framing, MEP unit rough-in, safety protocols, and storm water pollution prevention plans, and others.

Pre-Field Trip Survey

To investigate the objectives of this study two anonymous surveys, pre and post-field trip, were designed using a similar methodology for VFTs assessment from a study conducted by Siefan et al. (2020), with pre and post survey questions modified to reflect the course and circumstances. The pre-field trip survey was distributed to all students prior to their RFT or VFT. In addition to the demographic information of academic level, major of study, and gender, the students were asked to indicate their level of agreement with the 14 statements presented in Table 1. The statements were scored based on a 5-point Likert scale. The students were also asked for free response answers about their experience in statements 13 and 14. Table 1 shows the pre field trip survey that every student completed, and two versions of the post-field trip. Students either completed the post RFT survey (wording where different, in bold) or the post VFT survey (wording where different, underlined).

Table 1

Pre and Post Survey Statements

#	Pre Field Trip Statements	#	Post Real or <u>Virtual</u> Field Trip Statements
1	A field trip (real site visit) can increase my interest in Commercial construction.	1	A field trip (real or <u>virtual</u> site visit) increased my interest in Commercial construction
2	Taking the Commercial construction course WITHOUT a jobsite visit enables me to think creatively and innovatively.	2	Taking the Commercial construction course WITH a (real or <u>virtual</u>) jobsite visit enabled me to think creatively and innovatively.
3	Taking the Commercial construction course WITHOUT a jobsite visit enables me to identify and solve practical problems.	3	Taking the Commercial construction course WITH a (real or <u>virtual</u>) jobsite visit enabled me to identify and solve practical problems.
4	Taking the Commercial construction course WITHOUT a jobsite visit enables me to work as a part of a team.	4	Taking the Commercial construction course WITH a (real or <u>virtual</u>) jobsite visit enabled me to work as a part of a team.
5	I prefer taking the Commercial construction course WITHOUT a jobsite visit.	5	I prefer taking the Commercial construction course WITH a (real or <u>virtual</u>) jobsite visit.
6	I can understand most aspects of Commercial construction WITHOUT a jobsite visit.	6	I can understand most aspects of Commercial construction WITH a (real or <u>virtual</u>) jobsite visit.

7	In class materials (lectures, activities, group work) are sufficient to understand different scopes of work in Commercial construction.	7	Attending a commercial (real or <u>virtual</u>) jobsite visit is essential in supplementing (adding to) lecture material.
8	In class materials (lectures, activities, group work) enhances my learning and gives me insight on implementing theory (ie: understanding) Commercial construction.	8	The (real or <u>virtual</u>) jobsite visit enhanced my learning and gave me insight on implementing theory (ie: understanding) of Commercial construction.
9	In class materials (lectures, activities, group work) are sufficient to help me understand different aspects of Commercial construction.	9	The (real or <u>virtual</u>) jobsite visit was a sufficient activity to help me understand different aspects of Commercial construction.
10	In class materials (lectures, activities, group work) increase my overall confidence that I can be successful working in the Commercial construction industry.	10	The (real or <u>virtual</u>) jobsite visit increased my overall confidence that I can be successful working in the Commercial construction industry.
11	In class materials (lectures, activities, group work) have had a positive impact on my interest in Commercial Construction.	11	The (real or <u>virtual</u>) jobsite visit had a positive impact on my interest in Commercial Construction.
12	Do you think you can be motivated to choose a career in Commercial construction based of In class materials (lectures, activities, group work).	12	Do you think you can be motivated to choose a career in Commercial construction based off of the (real or <u>virtual</u>) jobsite visit.
13	Do you think you can be motivated to choose a career in Commercial construction based of In class materials (lectures, activities, group work). (short answer)	13	Do you think you can be motivated to choose a career in Commercial construction based off of the (real or <u>virtual</u>) jobsite visit? (short answer)
14	In the Commercial construction industry, I prefer to work in the following discipline? And the following building type? (short answer)	14	In the Commercial construction industry, I prefer to work in the following discipline? And the following building type? (short answer)
15	I prefer to watch a virtual site tour (e.g., video) rather than visiting a jobsite in person.	15	I prefer to watch a virtual site tour (e.g., video) rather than visiting a jobsite in person.
16	Watching videos provides the same sort of information as visiting a jobsite in person.	16	Watching videos provides the same sort of information as visiting a jobsite in person.

Creating the Virtual Field Trip

To provide students a similar experience as the students who completed the RFT, the instructor created a VFT of the same construction project, and on the same day the RFT was completed. The instructor used an Insta360 ONE X2 360-degree camera and processed the photos and videos using StructionSite, Inc. As shown in Figure 3, this created a visual walkthrough of the project. The

instructor used 360-degree videos and photos to document the different locations and uploaded all of the information on StructionSite, Inc. After the data was uploaded, the instructor created an 11-minute video utilizing a video software tool. The instructor narrated the video as he walked through the virtual jobsite using StructionSite, Inc. In addition, to deliver the same amount of information as the RFT, the instructor documented all of the talking points, and certain areas of focus, and provided this same amount of information during the VFT.



Figure 3. StructionSite, Inc. VFT Walkthrough Visual Example

Course Format

The curriculum of the construction management program at Cal Poly San Luis Obispo is integrated. The program defines this integrated curriculum as a method of combining all the core academic subjects such as scheduling, estimating, materials and methods into a single course under an overarching theme, such as residential construction, commercial construction, or civil construction. Construction management majors must take seven practice-specific integrated lab courses. These labs cover fundamentals, residential, commercial, specialties, heavy civil, jobsite, and program management. Each of the integrated labs includes technical foundational information, estimating, scheduling, methods, material and a project based learning (PBL) component. Taken in sequence, these courses form a spiral learning (SL) framework.

Two sections of the commercial course met during the fall quarter 2021 with 21 and 23 students. Students were divided into teams of five or six students for group assignments and building activities. The sections met in-person, with the course content delivered in a range of instructional methods including reading assignments, lectures, video content, discussions, activities, quizzes and exams, assignments, working with a team, hands-on building, and VFTs or RFTs.

The commercial course concerns all aspects associated with large commercial and institutional construction operations and include topics such as building system analysis of foundations, waterproofing, structural framing, exterior cladding, and finishes. Students received safety and shop training for the hands-on activities where each group builds a ten-foot long, ten-foot tall commercial exterior wall system. Students alternated building activities with classroom instruction, requiring students to apply what they had learned through various learning methods with hands-on building activities including forming and pouring concrete, installing CMU, metal studs, exterior sheathing, siding, stucco, and finishing. These learning activities culminate in a construction project proposal for a commercial project based on the full set of plans and specifications.

Results & Discussion

A side-by-side comparison of the aggregate response of the pre-trip survey and post RFT and VFT surveys is provided for statements 1, 5, and 10-12 in Figure 4, for statements 2, 3, and 6-9 in Figure 5. Students scored the statements based on a 5-point Likert scale where 1 = strongly disagree, 2 = disagree, 3 = unsure, 4 = agree, 5 = strongly agree. The responses were compiled to establish the aggregate response for each statement.

The study sought to assess:

- (1) do VFTs or RFTs contribute to students' interest in commercial construction,
- (2) do students perceive VFTs or RFTs to contribute to knowledge and skills attainment in a commercial construction course,
- (3) can VFTs be successfully utilized in a construction management curriculum.

The online anonymous surveys were conducted over one quarter in a commercial construction management integrated lab course with one separate instructor providing course instruction for each section. The 21 and 23 students enrolled in the course sections all completed the pre field trip survey. In one section, 18 of 23 students completed the post trip survey, for the RFT, for a response rate of 78%. All 21 students completed the post field trip survey for the VFT for a response rate of 100%.

There were five questions intended to assess students' interest in the commercial construction industry prior to the field trip and following a VFT or RFT, in addition two opportunities for free responses were provided: statements 1, 5, and 10-14 (13 and 14 free response) as shown in Figure 4. These questions indicate that most students perceive course materials, RFTs, and VFTs can all contribute to and have a positive impact on their interest in commercial construction. Further, the majority of students prefer RFTs at a higher rate than VFTs, and both significantly more than no field trip. In addition, 18 students indicated in the free responses that they were interested in the commercial construction industry from course materials, as well as 6 from the RFT, and 6 from the VFT. Of interest, four additional students attending the VFT noted that a VFT alone was not enough to interest them in commercial construction but that it could contribute to their overall interest. These responses clearly indicate the value of a VFT in a commercial construction management course, but not as a replacement for RFT.

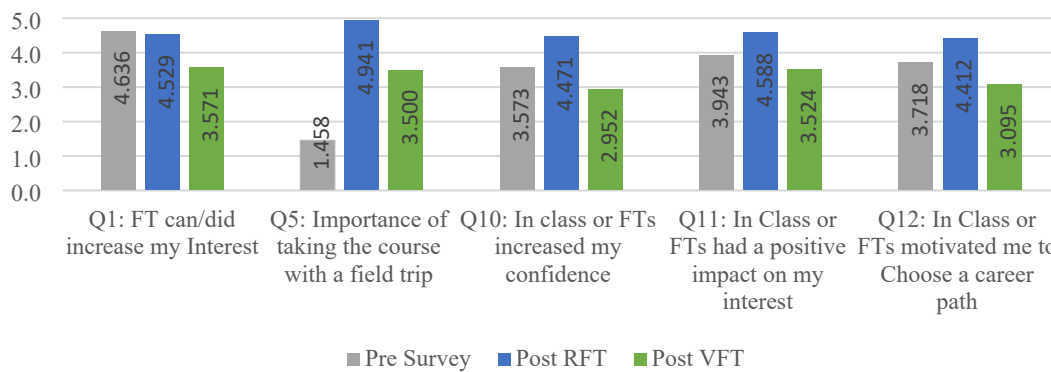


Figure 4. Interest in commercial construction

There were six questions intended to assess students' perception on the effectiveness of a VFT or RFT and the skills associated with the construction management course: creative and innovative thinking, problem solving, and understanding the material; statements 2, 3, and 6-9 as shown in Figure 5. The

responses to these questions indicate that the majority of students perceive a VFT or RFT as more effective to gaining skills than without. In addition, as indicated in the responses to question 9, a majority of students positively indicated that class materials, RFT and VFT were sufficient to help in understanding different aspects of commercial construction.

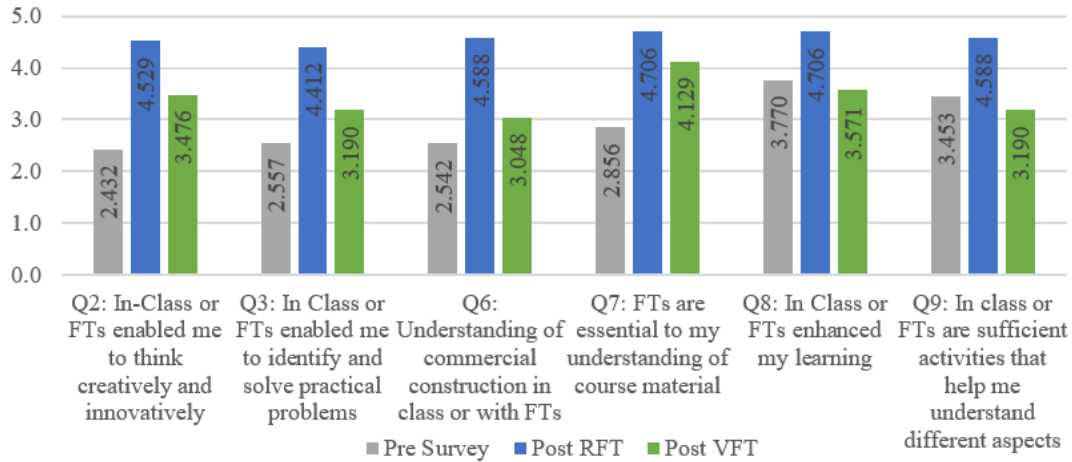


Figure 5. Perceived effect on knowledge and skills

There were two questions intended to assess students' perception of VFTs in a commercial construction management course: statements 15 and 16. Student aggregate responses to question 15 which asked if they prefer to watch a virtual tour rather than visiting in person, and responses to question 16 which asked if watching videos provides the same information as visiting a jobsite in person strongly indicate that students do not perceive VFTs or videos as providing the same information as visiting a jobsite in person. The aggregate mean rating for question 15 was 1.42 in the pre survey and 1.48 in the post VFT survey. The aggregate mean rating for question 16 was 1.71 in the pre survey and 1.62 in the post VFT survey. These were the lowest mean ratings for both the pre and post surveys and these responses are consistent with findings of Kolegraff et al. (2019) and Seifan et al. (2020) which indicated students preferred hands-on learning and RFTs.

Conclusion

Three conclusions are evident from this study. First, in a commercial construction management integrated lab course VFTs and RFTs can contribute to students' interest in commercial construction. Although students indicated that VFTs may contribute to their interest, they preferred in person experiences to virtual ones. Second, students perceive VFTs and RFTs along with course content to contribute to knowledge and skills attainment in a commercial construction course. The students surveyed clearly value VFTs but do not find them as a replacement for an RFT. Finally, VFTs can be successfully utilized in a construction management curriculum, but these responses indicate that VFTs alone are not enough for a successful commercial construction management course.

A recommendation for future study would be to investigate the aspects of VFTs that students perceive as effective to integrate with course materials. This could allow the introduction of VFTs into course work to highlight certain aspects of construction or to demonstrate sequencing or site logistic plans

using StructionSite, Inc. where a RFT is not possible due to proximity to the location, access to the site or the schedule of the activities.

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