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Student Perceptions of Construction Scheduling Teaching Methods

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To effectively prepare construction and engineering students for their careers as building professionals, it is imperative for educators to understand what teaching methods are effective to enhance student learning in project scheduling. Technical skills, like project scheduling, rely heavily on practical experience and instructors face the difficult task of how to replicate this experience to enhance student learning. This paper provides a summary of the current instructional delivery methods utilized in a scheduling course at a major university and evaluates the delivery methods and what students perceive as most, and least effective in regard to learning how to create, manage and update a project schedule. The major finding, based on student feedback was the demand for additional visual learning experiences to further develop students' understanding of construction scheduling. These visual experiences include the implementation of visuals exploring jobsite examples as well as time-lapse videos showing the processes and sequence of activities. In addition, the overall results of the student surveys are presented, discussed, and evaluated. This information may assist educational and industry programs interested in developing scheduling course material, based on the needs reported by students.

Key Words: project scheduling, experiential learning, student perceptions, virtual learning, construction management

Introduction

A construction schedule is one of the key indicators of a project's success and is one of the primary tasks involved in project management. Effective schedules mitigate uncertainties, risks, and unforeseen conditions, but these schedules require a high level of domain-specific knowledge to generate and manage (Fu, 2018). Before students and practitioners can effectively define a construction schedule, they must understand how a project operates and be able to visualize these complexities. This understanding is necessary for planning, as well as cost forecasting, project control, managing subcontractors, understanding claims, resource planning, and project reporting (Mattila et al., 2006). In construction and engineering education, scheduling is one of the core subjects taught throughout the curriculum (Chinowsky et al., 2006), but it is difficult for students to fully grasp

the skills required without prior construction experience as they try to understand what an activity is, its duration, and how it relates to other activities in the schedule (Lindhard, 2014).

To prepare students for engineering and construction careers, it is essential for universities to empower students to make connections between theoretical concepts taught in the classroom and real-world applications (Seifan et al., 2020). As students are introduced to large amounts of knowledge with no previous understanding of the subject, it is increasingly important to relate this new content to practical experience (Paez and Rubio, 2015). This form of experience is particularly important for specific skills like project scheduling, as students need to be exposed to as many real-life projects as possible (Karshenas and Haber, 2012) to fully understand how to manage a project schedule. To create and manage a successful schedule, students must be taught various construction types, phases, durations, means and methods, terminology, activity relationships, and overall planning and logistics. In addition, there are various software systems that must be understood to create a schedule, such as Primavera and Microsoft (MS) project. Scheduling is a skill that has historically been learned through practical experience, but given the demand for this skill among new graduates *(BLS Job Openings and Labor Turnover Summary*, 2021), educators are motivated to define new ways of providing learning experiences to replicate similar learning in the classroom.

Educators are faced with a difficult task on how to replicate these jobsite experiences to better equip their graduates and to evaluate whether their teaching techniques are successful. A few innovative techniques have been explored and evaluated in previous research, such as Kolegraff et al. (2019) who focused on implementing hands-on building activities into a college course to improve student learning. In addition, a number of construction and engineering programs have implemented project-based learning (PBL) and seen the benefits as students are able to work in teams, similar to what they will experience in industry (Gunderson and Moore, 2008). Prior studies show that many aspects of construction can be simulated in a classroom context, but scheduling is particularly challenging as it is the actual construction tasks that are often necessary for learning this content, yet nearly impossible to replicate in the classroom.

The objective of this paper is to examine student perspectives to further develop university scheduling courses and methods of delivery that support their learning needs. This paper provides an evaluation of the traditional instructional delivery methods students perceive as most, and least effective in regard to learning how to create, manage and update a project schedule. This paper also provides a summary of the instructional delivery methods currently utilized in a scheduling course taught at a major university and includes survey findings on students' perspectives. This work contributes to the body of knowledge related to construction scheduling education by documenting the specific learning preferences voiced by students related to different teaching modes and also the specific challenges reported related to different aspects of construction scheduling.

Background

Construction scheduling has historically been taught in a lecture format as a standalone class (Chinowskly, et al, 2006). A common practice for teaching project scheduling is providing students with a set of plans and specifications and requiring them to create a project schedule (Karshenas and Haber, 2012). The typical process of creating a schedule after reviewing the 2D set of drawings is: (1) breaking the project down into activities and durations, (2) transferring activity information into a software system, (3) developing project logic or the sequence of activities, and (4) scheduling project activities. This process requires project experience and the ability to read plans and convey a project

schedule, (Karshenas and Sharma 2010) which is paradoxically not a skill that students possess because of their lack of experience. To supplement this lack of experience, researchers have implemented different techniques, such as: creating visual schedule applications (Karshenas and Sharma, 2010), developing 4D interactive models which combine the 3D model and project schedule (Messner et al, 2003), and creating virtual reality (VR) walkthroughs to visualize a jobsite (Eiris and Gheisari, 2018). Preliminary studies illustrate the interest among scholars in trying to innovate in order to improve students' learning of this challenging educational concept.

Understanding students' perspectives is essential for defining teaching strategies for that support their learning preferences, and ultimately their learning gains (Kumar et al, 2004). Kolegraff et al (2019) evaluated which instructional delivery method students perceived as effective in a construction management course. This study discussed the development of hands-on activities and how they improved the overall student perception of the general course but the results evaluated the whole course and did not focus on specific areas, such as scheduling. There has also been extensive research on the overall use of visualization techniques such as augmented reality (AR) and virtual reality (VR) in construction education (Wang et al, 2020) but limited research on students' overall perception of the different types of visualization and teaching methods they prefer in relation to construction scheduling. Evaluating student perceptions in a university scheduling course will provide useful information for educators as well as industry, to understand the tools and methods that need improvement. This paper will provide an integrated approach by evaluating students' overall perceptions as well as analyzing these perceptions compared to the various methods used to teach project scheduling.

Research Methodology

This study aims to provide an exploratory overview of students' perspectives of various instructional delivery methods that are currently being implemented in an existing scheduling course taught at a major university. The course was delivered using a traditional format, and utilized the following teaching methods: lectures, instructor led demonstrations, picture and video examples, readings, and external research. After the course was complete, an email was sent to the entire class asking for their voluntary participation in a survey. The resulting responses were analyzed using a qualitative research methodology to produce conclusions to inform future construction scheduling teaching strategies.

The students were asked for demographic information that included: academic level, major of study, and gender. Next, the students were requested to rate their confidence level with various scheduling concepts before and after completing the course, using a 5-point Likert scale (i.e., extremely unconfident to extremely confident). The targeted topics included: 1) visualizing activities and understanding the work being complete and the phase of construction, 2) understanding durations, 3) understanding scheduling technology, software used to build a schedule, 4) understanding activity relationships/links, and 5) organizing a schedule.

Subsequently, students were asked to identify which teaching mode introduced in the course helped to: identify activities; and understand activity durations. Students could choose from the following options to indicate their perceptions: 1) actual construction examples (ie: photos, videos, real world walkthroughs), 2) verbal description of activity (i.e.: lecture using PowerPoint), 3) readings (ie: textbook, articles, journals), 4) external research (i.e.: internet search). After selecting their preferred modes of learning, students were given free-response follow up questions which asked them to explain how they would want to see their selected teaching mode implemented or improved for future

cohorts of students. Prior to sending out the survey, the survey questions were validated through focus groups with other students to illustrate a consistent understanding of question topics.

Once the data was collected, it was evaluated using a thematic analysis. Surveys were an ideal method to evaluate student perspectives and open-end responses provided additional thematic data. The latent level of thematic analysis was used to identify common themes, as well as to identify the underlying ideas and ideologies (Braun and Clarke, 2006). After evaluating the short responses, codes (key phrases) were identified which represented the meanings and patterns observed. The common codes were then grouped into themes which formed the narrative. Themes were identified from the data and not created from the research questions. The resultant themes provided the basis to inform the overarching conclusions from this research.

Results & Discussion

Survey data was conducted over one quarter in a scheduling course, with one instructor providing course instruction. Of the 31 students enrolled, 18 students completed the survey, for a response rate of 58%. The respondents were made up of nine females and nine males, 14 students were majoring in construction management and four were majoring in civil engineering. The respondents were composed of one second year, three third year, eight fourth year, and six fifth year students in their university studies. Students were required to complete similar prerequisites in order to enroll in this upper division scheduling course. Even though the participants varied in year of study, they all had similar scheduling education and courses complete.

The first section of the survey asked students to rank their confidence in their overall scheduling capabilities before and after the course. Prior to taking the course, the confidence rating was a 2.5.

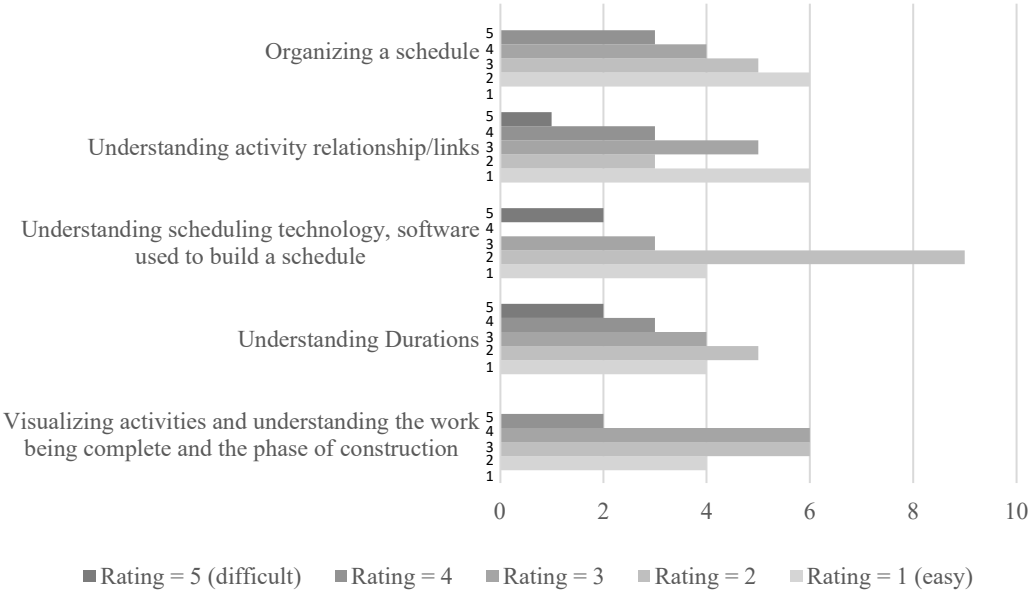

Figure 1. Students' ratings of scheduling tasks

After taking the course, student confidence ratings increased by 1.95 with an overall average rating of 4.45. This was a positive indicator of student overall confidence in the course content, but as educational technologies continue to develop, student learning will need to be improved to align with these new standards rather than with the outdated course structure.

Next, students were asked to rate specific scheduling tasks performed in the course by difficulty, tasks and overall ratings are detailed in Figure 1. Using a five-point Likert scale, a rating of five was perceived most difficult and a one was perceived as easiest. Based on the overall mean rating, students rated understanding durations as the most difficult, second most difficult was understanding activity relationships, and the third most difficult was visualizing activities and understanding the work being complete and the phase of construction. The least difficult, based on student responses was organizing a schedule and the second easiest task for students was understanding scheduling technology that was used to build a project schedule. As shown in Figure 1, the results in each category showed clustered data, but with a spread of overall ratings emphasizing differing opinions. Students perceived that the most difficult tasks were all related to project experience. Results also highlighted the need for practical experience for students to feel better equipped to create and understand a schedule.

The next two questions focused on two of the main challenges and focuses of the course which were: 1) understanding a scheduling activity and 2) properly identifying an activity's duration. Students were asked to select one of the four teaching modes they preferred in order to better understand both tasks. In both responses, the students overwhelmingly selected actual construction examples as there preferred teaching mode, as shown in Figure 2. 89% of respondents selected actual construction examples for the mode that helped them understand an activities identification and 78% of students selected this mode as the preferred method to help them understand an activities duration. To date, extensive research has focused on improving students practical experience based on positive student feedback (Kolegraff et al., 2019; Seifan et al., 2020), and these results show similar findings when relating to project scheduling. Traditional methods both ranked low compared to real-world examples and visual teaching methods. Based on the results, students identified the areas they struggled to understand were related to lack of real-world experiences, that included: visualizing activities, understanding durations, and understanding project relationships/links.

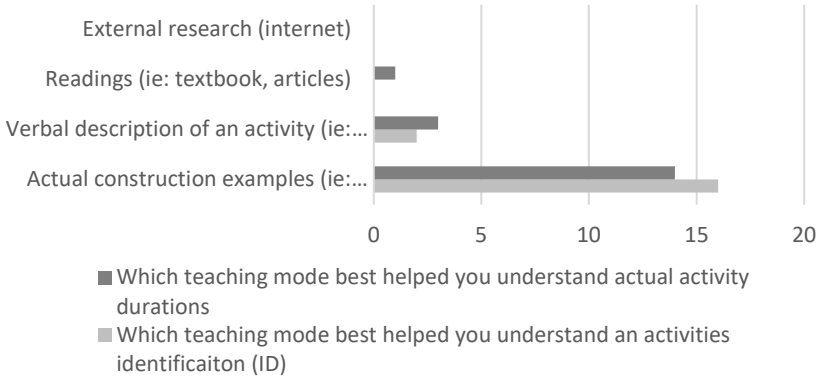

Figure 2. Students' preferred teaching method

There were common themes among the free responses to the follow up questions which asked how the teaching modes students selected can be improved to help students: 1) understand activity identification and 2) understand activity durations. After reviewing the short responses and conducting a thematic analysis, some of the common themes based on student feedback to improve the current instructional methods were: provide visuals of jobsite examples (historical jobsite data), time-lapse videos, and step-by-step video demonstrations.

One observation that came out quite clearly from the free responses was the interest for more real-world examples and visuals providing jobsite experiences. Students clearly recognize the value of project experience and based on their responses realize that without this knowledge it is challenging to create an accurate schedule. Without this experience, they did see the value for implementing visual examples of past projects into the course. They wanted to see what an actual activity looked like, such as concrete formwork or first floor framing instead of trying to visualize these activities from a 2D plan set. For the first question, about 62% of students mentioned the importance of real-world jobsite examples to understand activity identification, some excerpts are:

> "I think something that could be improved on is giving us an idea of how things are built because not everyone may be familiar with it. I really liked the one assignment when you provided us pictures of the project throughout its phases and we had to figure out what was going on."

> "Workshops of real-life projects that have been completed and recorded to compare schedule vs actual project."

For the second free response question, which asked how their selected teaching mode can be improved to help with understanding an activities duration, students also highlighted the importance of real-world examples. About 83% of students mentioned the importance of real-world examples, some citations are:

> "Giving more visual examples or maybe having posted jobsite photos for us to see different types of projects."

> "Perhaps provide students with real schedule examples of different projects done in the past."

> "I am more of a visual learner, so I need visual aspects in order to understand what is going on."

Interest in video examples, such as time-lapse videos was also a common theme in the free responses. It was clear that students saw the value of visualizing how a project, or an individual activity was constructed in order to create an accurate schedule. As previously researched, it is difficult to fully understand the sequence and flow of a schedule and students identified one of the preferred ways to fully comprehend a project's activities and durations is by seeing it first-hand. The importance of visualization, and utilizing tools like a project time-lapse, were highlighted in several responses:

> "I think at this stage in our lives we do not really have the experience of understanding all stages of construction. I think what would be interesting is including a video of a construction project and having students build a schedule based on the video. This would show both sequence of events and could potentially help with durations. This would be helpful in visualizing what an entire build entails."

> "I want to view an activity in real time or a video showing the start, to completion of a specific activity to see the actual durations and any conflicts that might arise to understand how a schedule either stays on schedule, falls behind, or is ahead."

> "Understanding durations is all about seeing construction take place and the timeline of events. A time lapse video would be great to implement because students would have to break down the different pieces of the video having to understand the order of events and how long each part took place. By visualizing it we might even start to understand key scope durations for a project."

For both questions, students also emphasized a preferred teaching style, which was instructor led recorded video walkthroughs. This gave students the freedom to learn at their own pace, as well as to rewind or pause if they missed any section of the exercise.

> "I think the videos were the best way to teach the class going step by step, because it's a pretty lengthy process, and can get lost in translation pretty quick if taught a different way."

> "I really liked the video walkthroughs used as well as being able to visualize how the construction process works."

Based on student responses and overall survey data, the most difficult tasks throughout the course were all related to project experience. Visualization is one of the major factors that students prefer and deem most important when learning how to project schedule. These results highlight the importance for experiential learning when teaching a practical skill, like scheduling. Students also indicated that at this point in their education, their lack of experience is a limitation and understand the importance of exposure to real-world scenarios to enhance their understanding.

Conclusion

This study investigated student perspectives of project scheduling delivered in a university course. The results clearly indicate the importance of practical experience and highlighted the types of examples students prefer, which were visuals of real-world jobsite examples and time-lapse videos. Students expressed the need to be able to see an activity or a phase of construction to fully understand an activities duration, identification, and relationship. Students saw the value of replicating and gaining as much visual experience possible in order to understand the different elements of a schedule. Despite the limited amount of practical examples currently built into the existing course, as well as no current uses of AR or VR, students strongly agreed that visual examples was a preferred method of learning and also strongly expressed the interest in additional experiential based learning experiences. These results emphasize the importance of introducing students to as many practical experiences as possible by utilizing virtual tools to enhance their scheduling understanding.

The study also revealed a preferred teaching method for project scheduling was instructor led step-by-step video walkthroughs. With these walkthroughs, students are able to learn at their own pace as well as understand the terminology and sequence being covered. Another interesting finding was students felt confident using the software systems and scheduling tools being introduced, which is important to highlight as many courses rely heavily of teaching a specific software system rather than spending valuable course time focusing on content.

This course will continue to implement photo, videos, and field trips, but it will also identify new forms of technology, such as virtual reality (VR) and augmented reality (AR) to focus on the themes that emerged from this study, which was providing additional real-world jobsite data and time-lapse video demonstrations. As these methods are added, further research will evaluate the impacts of these practical methods to enhance student learning. From a holistic perspective, the issue is not whether traditional methods need to be replaced, but rather how to improve these methods with visual experiences. This study can lead to future research focusing on virtual experiences in construction education, as well as ways to merge jobsite examples and video time-lapses into construction courses.

References

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3, 77-101.

Chinowcky, P., Braown, H., Szajnman, A., & Realph, A. (2006). Developing knowledge landscapes through project-based learning. Journal of Professional Issues in Engineering Issues and Practice, 132 (2), 118-124.

Eiris, R., & Gheisari, M. (2018). "Building Intelligent Virtual Agents as Conversational Partners in Digital Construction Sites". In Construction Research Congress 2018 (pp. 200-209).

Fu, M., Liu, R. (2018). *The Application of Virtual Reality and Augmented Reality in Dealing with Project Schedule Risks. Construction Research Congress 2018*, 429-438.

Gunderson, D. E., & Moore, J. D. (2008). Group learning pedagogy and group selection. *International Journal of Construction Education and Research*, *4*(1), 34–45.

Job Openings and Labor Turnover Summary. Released Oct 12, 2021. Retrieved October 28, 2021, from https://www.bls.gov/news.release/jolts.nr0.htm

Karshenas, S., & Haber, D. (2012). Developing a serious game for construction planning and scheduling education. *Construction Research Congress 2012: Construction Challenges in a Flat World*, 2042–2051.

Karshenas, S., & Sharma, A. (2010). Visually scheduling construction projects. *Construction Research Congress 2010: Innovation for Reshaping Construction Practice*, 490–499.

Kolegraff, S. A., Kline, A., & Kelting, S. (2019). Hands-On Building as an Instructional Delivery Method in an Integrated Lab Curriculum. *55th ASC Annual International Conference Proceedings*, 33–40.

Kumar, P., Kumar, A., & Smart, K. (2004). Assessing the impact of instructional methods and information technology on student learning styles. *Issues in Informing Science & Information Technology*, *1*.

Lindhard, S., & Wandahl, S. (2014). Scheduling of large, complex, and constrained construction projects–an exploration of LPS application. *International Journal of Project Organisation and Management*, *6*(3), 237–253.

Mattila, K., Pocock, J., Suermann, P. (2006). Methods to Assist in Teaching Planning and Scheduling. Associated Schools of Construction International Proceedings of the 42nd Annual Conference, 59- 66.

Messner, J., Yerrapathruni, S., Baratta, A., & Whisker, V. (2003). Using virtual reality to improve construction engineering education. *2003 Annual Conference*, 8–1266.

Paez, D., & Rubio, L. A. (2015). The Use of Field Trips in the Context of Engineering Collaborative Teaching: Experiences of Hands-On Geomatics Activities in Colombia. *Wisdom of the Ages to the Challenges of the Modern World Sofia, Bulgaria*, 17–21.

Seifan, M., Dada, O. D., & Berenjian, A. (2020). The Effect of Real and Virtual Construction Field Trips on Students' Perception and Career Aspiration. Sustainability, 12(3), 1200. https://doi.org/10.3390/su12031200

Wang, R., Lowe, R., Newton, S., & Kocaturk, T. (2020). Task complexity and learning styles in situated virtual learning environments for construction higher education. *Automation in Construction*, *113*, 103148. https://doi.org/10.1016/j.autcon.2020.103148