

Hololens – A New Teaching Tool in Construction Education

Pavan Meadati, PhD

*Department of Construction Management, Kennesaw State University, Marietta, Georgia, USA
pmeadati@kennesaw.edu*

Amin Akhnoukh, PhD, PE

*Department of Construction Management, East Carolina University, Greenville, North Carolina, USA
Akhnoukha17@ecu.edu*

Abstract

Students have different learning styles and the use of technological gadgets became an integral part of their life. Engaging these technology savvy students in the learning process with their preferred learning style is a challenging task. The differences in teaching and learning styles result in problems such as disengagement of students and loss of learning aptitude. This active student engagement challenge can be addressed by using hologram-learning environment provided by Microsoft Hololens. This learning environment engages students in active learning processes and helps them to focus on their learning. It also encourages students to take more responsibility for their own learning process. This learning environment provides a new teaching style and helps the instructor to address some of the needs of the students' learning styles. This paper discusses about the hologram-learning environment. This paper also discusses about the progress of the pilot study conducted to engage the technology savvy visual learners in a concrete formwork course.

Keywords

Hologram, Hololens, learning styles, concrete formwork, construction management

1. Introduction

Technology became an integral part of Construction Management (CM) students' life. CM students using the technologies for school related work will continue to grow in future. Students have different learning styles. Traditional lecture is one of the styles, which is widely used for teaching CM courses. Additionally, two-dimensional (2D) drawings are most widely used as pedagogical tools for teaching CM courses to the students. The interpretation of 2D drawings by students varies based on their educational background, previous practical experience, and visualization capabilities among other factors. Students are required to develop three-dimensional (3D) models mentally by visualizing the different components of the project. Students with little or no practical experience often face challenges and spend more time in developing 3D visual models. Sometimes construction site visits are included to complement the lecture format style. This teaching style provides visual and verbal learning environment. However, inclusion of site visits within the course schedule is not always feasible due to reasons such as unavailability of construction sites meeting the class needs, class schedule conflicts, and safety issues (Haque, 2007). Due to the lack of adequate visual learning environment, currently CM students are unable to gain the required skills to solve real world problems (Irizarry et al, 2012). The differences in teaching and learning styles result in problems such as disengagement of students and loss of learning aptitude (Wasim et al. 2011). Engaging these technology savvy students with their preferred learning style in the learning process is a challenging task. Hologram-learning environment helps to address this active student engagement challenge. Microsoft Hololens helps to accomplish this type of learning environment. This learning environment engages students in active learning processes and helps them to focus on their learning. It also encourages students to take more responsibility for their own learning process. This learning environment provides a new teaching style and helps the instructor to address some of the needs of the students' learning styles. The following sections

discuss about the hologram-learning environment followed by the details of the pilot study that is in progress to engage the technology savvy CM students.

2. Hologram-Learning Environment

“Holography is a technique that enables a light field, which is generally the product of a light source scattered off objects, to be recorded and later reconstructed when the original light field is no longer present, due to the absence of the original objects.” (Wikipedia 2018). Holography is one of the emerging technologies and one of its potential applications include holographic telepresence (Walsh, 2012). This facilitates users to interact live in person in 3D. This enables the students to have remote collaboration, conduct experiments, have virtual site visits, interact with the gaming environment, design and print project in three dimensions and helps instructors to teach multiple classrooms across globe simultaneously (Team ISTE, 2015 & Walsh, 2012). Hololens is the first self-contained holographic computer developed by Microsoft, which facilitates to view and interact with 3D images. The following section discusses about Microsoft Hololens.

2.1 Hololens

Microsoft Hololens is the self-contained, holographic computer. This enables to engage with the digital content and interact with holograms in the world around the user (Microsoft 2018 a). It is made up of specialized components such as HoloLens Processing unit (HPU) and advanced sensors. These components together enable holographic computing. It’s advanced sensors capture information about what user is doing and the environment in which the user is in. It can see, map, and understand the physical places, spaces, and things around the user. It understands gestures and where user looks, and maps the world around the user, all in real time. It has a “see-through holographic high-definition lenses” and an advanced optical projection system. This generates a multi-dimensional full-color images with very low latency so that user can see holograms in their own world. It’s headband is designed to distribute the weight around the crown of the user head and saves ears and nose from undue pressure. Headband has an adjustment wheel which ensures comfortable fit for a wide range of adult head sizes. Though it has more computing power than the average laptop, it is passively cooled without fans. Lack of wires, external cameras, or phone or PC connection required makes the user to move freely (Microsoft 2018 b).



Figure 1: Microsoft Hololens (Microsoft 2018 a)

3.0 Pilot Study

A pilot study to demonstrate the feasibility of hologram-learning environment to address the challenge of actively engaging technology savvy CM students is in progress at Construction Management Department of Kennesaw State University. The study includes three steps: (a) Students learning styles assessment (b) Formwork repository development, and (c) Usability study. Below sections present the overview of these step.

3.1 Students learning styles assesment

The objective of this step is to assess the learning styles of the students enrolled for the concrete formwork course. The assessment helps to assess the applicability of the hologram-learning environment to address the 3D visualization challenge faced by CM students. Index of learning styles questionnaire proposed by Solomon and Felder of North Carolina State university (Felder and Solomon, 2017) was used to assess the learning styles. It is an on-line instrument questionnaire and has 44 questions. Once the survey is submitted the learning styles of the student are presented on scale score ranging from 1 to 11 in increments of 2 for each learning style. Depending on the score, the students preference to particular learning can be classified as “fairly well balanced” (score on scale 1-3), “moderate” (score on scale 5-7), and “very strong” (score on scale 9-11) (Felder and Solomon, 2017). Fairly well balanced indicate that the student is flexible in adopting either learning style. Moderate indicates student’s moderate preference to particular learning style. Very strong indicates student’s strong preference to particular style (Felder and Solomon, 2017). A screen shot of the submitted survey results is shown in Figure 2. For this study, visual and verbal category was only considered. Each student of the course was asked to complete the survey. The results of the survey were then analyzed to assess the different learning styles of the students in the course. Total 16 students were enrolled in the course. The survey results indicated that all students are visual learners. As shown in Figure 3, based on the scores 6%, 44% and 50% were considered as fairly well balanced, moderate and very strong visual learners respectively. The following sections discuss how HoloLens was used for engaging students and their experiences on the usability of the hologram-learning environment.



Figure 2: Screen shot of the learning styles survey results

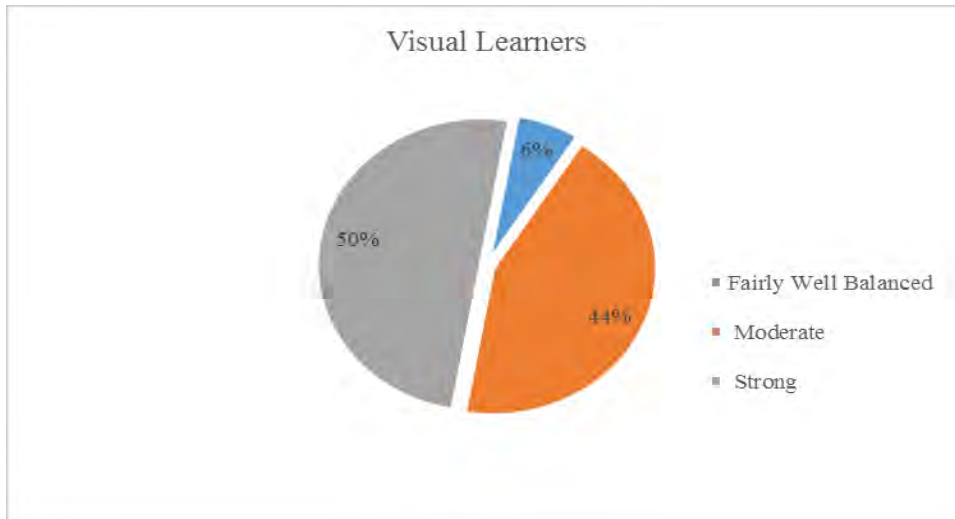


Figure 3: Visual Learners and their preferences

3.2 Formwork repository development

In this step, a repository of 3D models and holograms of the concrete formwork were developed. The 3D models were developed using Revit 2017. These were developed using existing families and creating new families. The developed 3D models include column formwork (see Figure 4), slab formwork (see Figure 5), wall formwork (see Figure 6) and a multistory building formwork (see Figure 7). These 3D models were converted into appropriate hololens readable hologram file format.

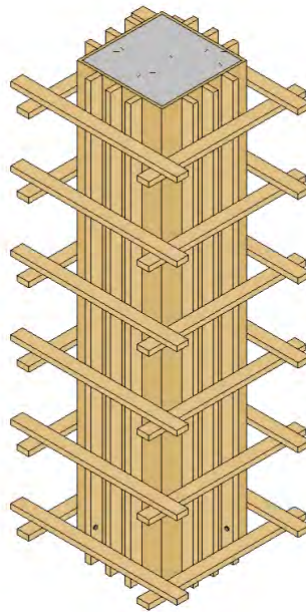


Figure 4: 3D model of a column formwork

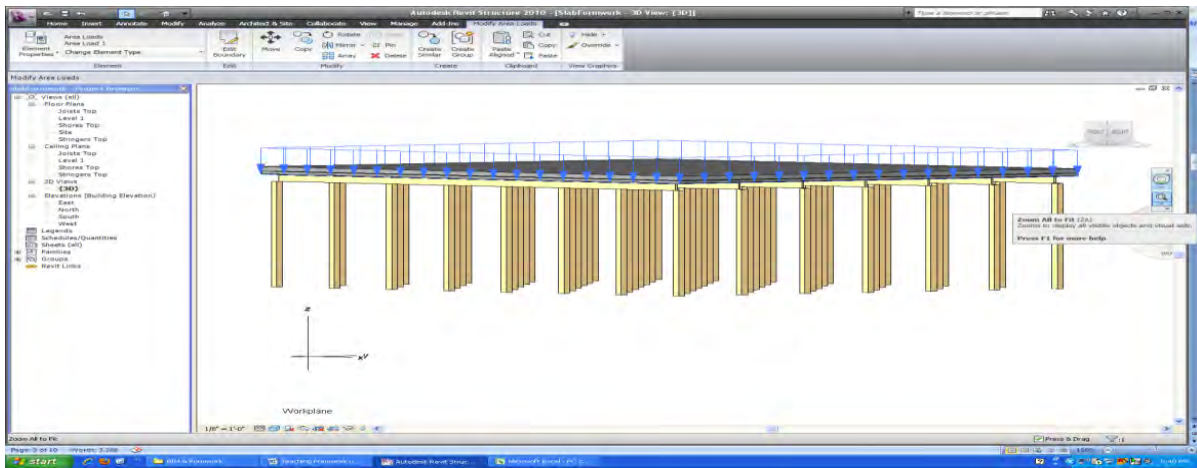


Figure 5: 3D model of an elevated slab formwork with vertical load

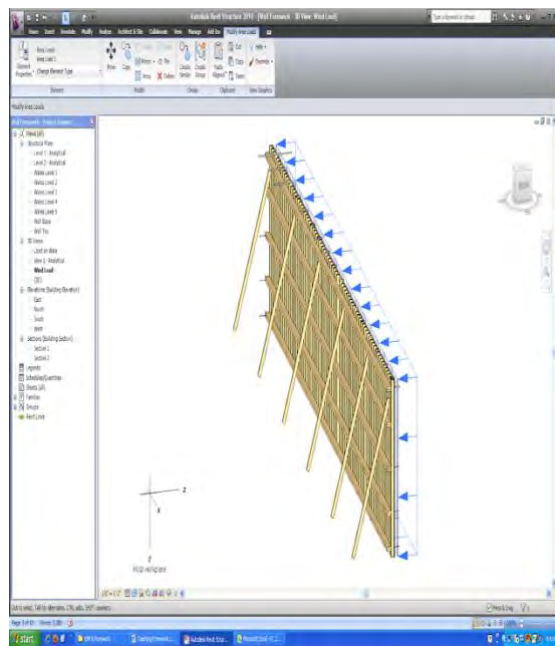


Figure 6: 3D model of a wall formwork with wind pressure

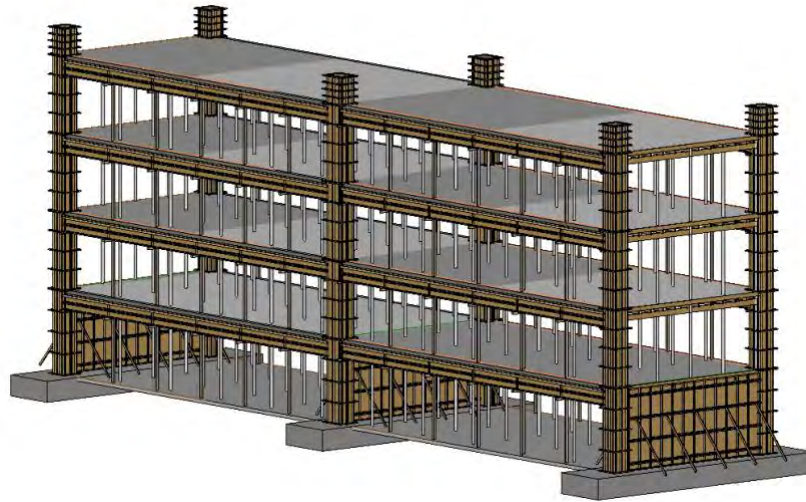


Figure 7: 3D model of a multistory formwork

3.3 Usability study

A usability study is in progress. In this study, the CM students use Hologens to view and interact with holograms in the hologram-learning environment (see Figure 8). After interaction with the holograms, the students are asked to express their satisfaction on usefulness, ease of use and ease of learning of hologram-learning environment with 5-point Likert-type scale (1= Strongly Agree, 2 = Agree, 3=neutral, 4= Disagree, and 5=Strongly Disagree). The data collection in this step is in progress. Table 1 includes the survey questions included under usefulness, ease to use and ease of learning to use categories.

Table 1: Survey questions included in the Usability Study

<i>Usefulness Category</i>
1. It helps me be more effective. <input type="checkbox"/> It helps me to be more productive. <input type="checkbox"/> It is useful. <input type="checkbox"/> It saves me time when I use it.
<i>Use Category</i>
1. It is easy to use. <input type="checkbox"/> It is simple to use. <input type="checkbox"/> It is user friendly. <input type="checkbox"/> It requires the fewest steps possible to accomplish what I want to do with it. <input type="checkbox"/> Using it is effortless.
<i>Learning to Use Category</i>

1. I learned to use it quickly.
- I easily remember how to use it.
 - It is easy to learn to use it
 - I quickly became skillful with it.

4. Conclusion

Hologram-learning environment serves as a new teaching tool and helps the instructors to be more effective in communicating the information to the students. This learning environment provide 3D visualization and helps students to be actively engaged in the learning process. The hologram-learning environment has the potential to make a paradigm shift in teaching and learning process. The pilot study discussed in this paper serves as an initial step to extend the hologram-learning environment to various CM courses.

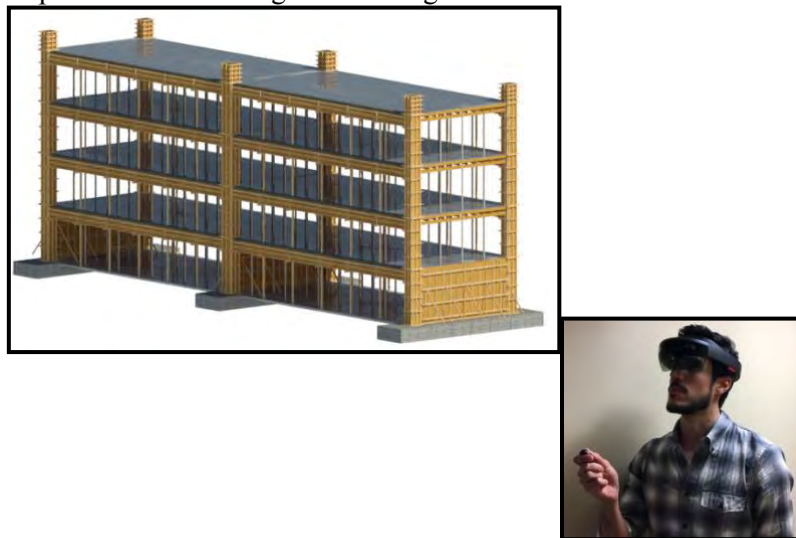


Figure 8: Student interacting with hologram using hololens

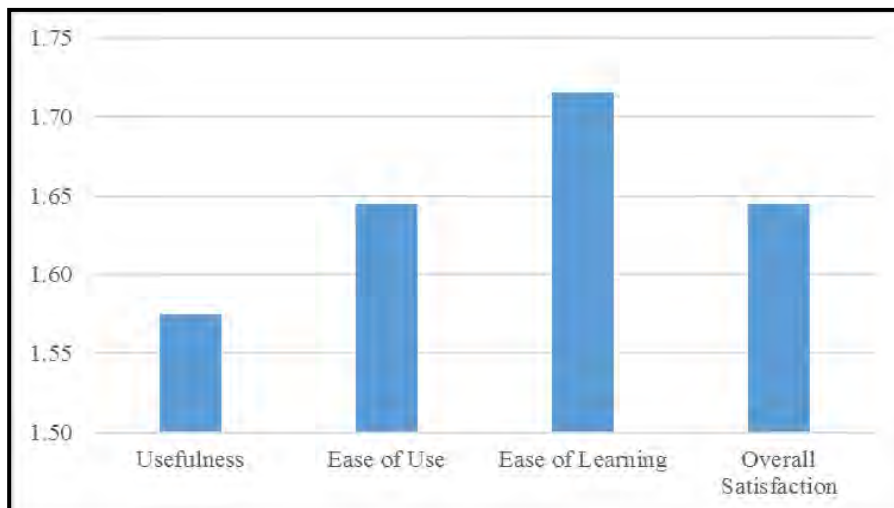


Figure 9: Hologram-learning environment usability results

5. References

- Felder, R. M. and Soloman, B. A. (2017). Index of learning styles questionnaire. Online at <https://www.webtools.ncsu.edu/learningstyles/>. Accessed on January 15, 2018
- Haque, M.E. (2007). n-D Virtual Environment in Construction Education. *Proceedings of The 2nd International conference on Virtual Learning, ICVL 2007*. Online at <http://www.cniv.ro/2007/disc2/icvl/documente/pdf/met/2.pdf>. Accessed on December 10, 2017.
- Irizarry, J., Meadati, P., Barham, W. S., Akhnoukh, A. (2012). “Exploring Applications of Building Information Modeling for Enhancing Visualization and Information Access in Engineering and Construction Education Environments”. *International Journal of Construction Education and Research*, Vol. 8, No 2, pp 119-145.
- Microsoft (2018a). Microsoft Hololens. Online at <https://www.microsoft.com/en-us/hololens>. Accessed on January 25, 2018.
- Microsoft (2018b). A new way to see your world. Online at <https://www.microsoft.com/en-us/hololens/hardware>. Accessed on February 15, 2018.
- Meadati, P. and Irizarry, J. (2015) BIM and QR Code for Operation and Maintenance. *Proceedings of Computing in Civil Engineering 2015*, June 21–23, 2015, Austin, Texas, pp. 556-563
- Team ISTE (2015). 8 classroom uses for holographic technology. Online at <https://www.iste.org/explore/articleDetail?articleid=271>. Accessed on January 5, 2018.
- Wikipedia (2018). Holography. Online at https://en.wikipedia.org/wiki/Holography#Overview_and_history. Accessed on February 15, 2018.
- Walsh, K. (2012). 7 ways holographic technology will make learning more fun. Online at <http://www.emergingedtech.com/2012/11/7-ways-holographic-technology-will-make-learning-more-fun/>. Accessed on January 25, 2018.
- Wasim, B., Meadati, P., and Irizarry, J (2011). “Enhancing Student Learning in Structural Courses with Building Information Modeling.” *Proceedings of 2011 ASCE International workshop on Computing in Civil Engineering*, June 19-22, 2011, Miami, Florida.