

# **A Virtual Immersion in Urban Sustainability: Past, Present and Future**

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*Immersive virtual reality and 360° video can be used for academic purposes with success. This article summarizes the design, implementation, and evaluation of the use of these two tools at Tecnológico de Monterrey. The objective of using immersive learning was to give university students a comprehensive view of urban sustainability in ancient times and make a comparison with the current civilizations, and the projections for the future. For the virtual travels of the past and present, the tool used was 360° video while for the future it was virtual reality. Two 360° videos were designed of Sumerian and Roman civilizations, in specific of the cities of Ur (Mesopotamia) and Pompeii. These two urban designs were contrasted with today's design of the cities of Buenos Aires, São Paulo, Hong Kong, and Bangkok. For the future, Google Earth allowed a tour at street-level of the European Green Capitals. At the end of the course the students answered a survey that showed a 91% of satisfactory opinions due to immersive learning.*

*Keywords: virtual reality, immersive virtual reality, 360° video, urban sustainability, educational innovation.*

## **INTRODUCTION**

An integral vision on urban sustainability is a must for the course of “Sustainable Cities and Communities.” In order to achieve this goal, a technological dynamic was designed at Tecnológico de Monterrey. The tools provided by the Educational Innovation of the Mexican university allowed a group of undergraduate students to travel through time and space. The tools used during the course available in the Fall Semester of 2019 were: virtual reality using Oculus Go and a 360° video immersion using HTC VIVE Pro headsets and controllers. And this seeks to provide an overview of today's cities and a vision for the future of global urban sustainability.

The students are able to see what antique civilizations, current countries, and future projections are doing in order to have sustainable cities. Urban sustainability can be understood as a systemic way in which urban subsystems, and its metabolic intensity, are provided and managed (Gándara, 2013; Lozano et al., 2008). The ultimate aim of talking about sustainability is to reach a sustainable future on Earth. By using immersive tools, the students can explore that sustainability requires the input and action of government leaders, private sector initiative, and civic action (Tecnológico de Monterrey, 2018a).

The course “Sustainable Cities and Communities” is an introductory subject for freshmen students in the Educational Model TEC21. The course seeks to provide a multidisciplinary cultural component that

improves the educational process by allowing students to understand and correlate knowledge and reality (Tecnológico de Monterrey, 2018b). By adding the virtual reality element, the students received a near-to-real experiences. This type of teaching grants the student the opportunity to get involved in a physical environment and *learning by doing* (Jerónimo, et al., 2011). Furthermore, the students are more motivated, participate more frequently, and acquire knowledge, skills, attitudes, and values (Warbunton, 2009).

## METHODOLOGY

The students enrolled in the course of “Sustainable Cities and Communities” experienced immersive learning technologies and participated in designing class activities. The two tools used, virtual reality and 360° videos, helped integrate theory and practice to create close-to-reality environments. “The immersive technologies allow students to experience in an active and flexible way, by acceding to hard to reach contexts and high-risk virtual environments in which one can develop skills and apply knowledge in a safe and easy place” (Tecnológico de Monterrey, 2019).

Immersive virtual reality is a simulated digital environment and it is 100% immersive, beyond reality, and requires a virtual reality headset. While, 360° video is generated based on the real world, allowing the user to visualize content in any direction. A 360° video can be visualized by using standard media; it can also be previously recorded or be streamed live. Both tools proved to be powerful to achieve the desired learning by exploring, questioning, and comparing. The activities took place at a laboratory called ‘Zone of Immersive Learning with Technology’ located inside the campus of Tecnológico de Monterrey.

The first part of the activity was supported by the use of immersive virtual reality. In order to virtually ‘travel to the past’ two ancient cities were recreated: Ur in Mesopotamia and Pompeii (Figure 1). The tour of the very first city built by humankind was called “Welcome to Ur, Mesopotamia.” The students were able to walk through Ur, erected in 3,500 BC, to visit the temples, the streets, watch the social organization of the Sumerian civilization. The other tour to the past was called “Welcome to Pompeii” and represented a trip of 2,000 years to the past. In the Roman civilization the students also were able to walk the streets, learn the urban structured, the way people lived, how they practiced their religion, and the location of public spaces. The tour included also the fall of the city on the year 79 AC.

**FIGURE 1**  
**STATION TO TRAVEL TO THE PAST CIVILIZATIONS**



The second part of the activity involved a ‘trip to present-day cities’ where two tours were designed for the students to travel using 360° video. The explorations included a combo of two cities considered urban binomials. The first tour visited Buenos Aires, Argentina, and Bangkok, Thailand. While the second tour visited São Paulo, Brazil, and Hong Kong, Special Administrative Region of the People's Republic of China (Figure 2). The design of the activity allowed the students to compare the current situation of both cities, by considering factors such as urban transportation, mobility, infrastructure, green areas, among others.

**FIGURE 2**  
**STATION TO TRAVEL TO PRESENT-DAY CITIES**



The third part of the activity involved the representation of future cities. The tool used for this was 360° video in the platform of Google Earth on virtual reality mode (Figure 3). With this resource, the students and professors took street-level tours of some European capital cities featured on the European Green Capital Awards. The use of 360° video provided the chance of comparing and contrasting the possible results of urban sustainability strategies. Some of these strategies proposed were non-motorized transportation, clean energy, water and residual management, urban regeneration, and so on.

**FIGURE 3**  
**FUTURE STATION**

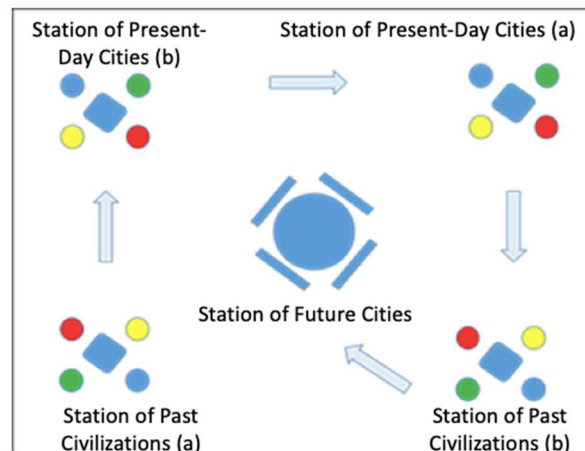


The planning and designing of the activities, such as tours and travels for the course “Sustainable Cities and Communities” took around eight months. The course took place at Tecnológico de Monterrey during the Fall Semester of 2019. The team behind the design process was integrated by experts on videogames development, pedagogy specialists, and university professors.

## **RESULTS**

The educational innovation of activities for the course “Sustainable Cities and Communities” took place in the semester of August-December 2019. The students used the laboratory ‘Zone of Immersive Learning with Technology’ where the equipment for using virtual reality and 360° video is installed. The laboratory has the purpose of creating opportunities for high-impact learning while exploring and managing objects for meaningful experiences. The laboratory has five physical stations where: two stations were used to travel to the past civilizations of Ur and Pompeii; two other stations were used to travel to present-day Buenos Aires, Bangkok, São Paulo, and Hong Kong; while the last station was to travel to the future European cities (Figure 4).

**FIGURE 4  
LAB**



The logistics of the activity were the following, the students of the course formed teams of four that would rotate among the five stations. A team would start at the station to travel to the past civilizations using virtual reality with Oculus Go. After the tour of in Ur the students of that first team had to do answered a questionnaire before touring ancient Pompeii. The five-question worksheet is:

1. Describe the Ur locations, its urban form, streets and living characteristics,
2. Describe the Ziggurat of Ur,
3. What do you know about cuneiform writing?
4. How happened the fall of the Ur city?
5. Describe the Ishtar Gate, Babylon.

Also using Oculus Go to ‘travel’ to Pompeii through virtual reality, the students toured the city and then answered:

1. Describe Pompeii locations, its urban, streets and living characteristics,
2. Describe Pompeii Forum from a physical and a day-to-day point of view,
3. Describe the two types of house living,
4. Describe public locations for collective entertainment of the Pompeii inhabitants,
5. How was the fall of Pompeii?

While the first team of students moved to the station to travel to present-day cities, a second team began their virtual trip to the station of past civilizations. The station to travel to present-day cities used Oculus Go to have immersive experiences. The 360° videos allowed students to visit the cities of Buenos Aires and Hong Kong in one ‘trip’ and São Paulo and Bangkok in a second trip. After each tour the students filled a comparative table identifying the following aspects of urban life:

1. Urban Equipment (streets, parks, sidewalks, street furniture),
2. Mobility (transportation means),
3. Green areas,
4. Precariousness/Prosperity,
5. Pollution,
6. Daily life.

After finishing the fourth worksheet, each team of students ‘travelled’ to the European Green Capitals at the third station. The use of HTC VIVE Pro headsets and controllers along with 360° videos provided by Google Earth allowed students to have a street-level view. Each team was able to selected from a menu of zip codes to cities they could visit.

When all the teams of students finished going through the stations, the whole class played a Jeopardy-type game related to the visit of past civilizations, present-day cities, and future cities. The students could choose between six different categories, five difficult levels and the quantity of points. The game allowed the students to review course concepts, reflect on the importance of urban sustainability, and to think about the urgency of implementing this type of strategies.

As a final step of the immersive activity, the students answered a voluntary, anonymous survey. The rating scale of the survey was one to five, being five the highest value and one the lowest one. The results showed that in a sample of 24 opinions, 91% of the students rated the immersive experience with a 4.5, while 87% of the students rated the usability aspect with a 4.5. The best-rated criterion was navigation, which means that the students were able to access and navigate the resource easily.

Meanwhile, the motivation criteria got a 4.5 rating from 96% of the students, and the learning perception aspect got a 4.5 rating from 91% of the results, which means that the students could actually learn from the immersive experience.

The results of the survey got several final reflections. Some of these reflections can be shown as follows:

*“At the start of the experience I felt intrigued and excited because I have never had the chance to participate in a virtual reality activity. I enjoyed the activity and learned new stuff; it was quite interesting because it got me focused at all times. At the end I got a little bit confused when returning to reality.”*

*“I learned a lot about the past. Even though we have already reviewed those topics in class, it helped me to understand more about how was the first ever-created city. It was an awesome experience, and I liked it because it got me fully into it and provided me a lot of information.”*

*“Sincerely, I was delighted with this activity because all three stages got me amazed, I was watching and learning. I liked to visualize an ancient civilization I’ve heard a lot of, that got me amazed. Historical data of this civilization was beyond interesting, as well as visualize it in a 360-degree view. I got quite interested about the comparison of both metropolitan cities and the differences that exist between them.”*

*“I felt really amazed with what I was watching, it was exactly as I recalled from my trip to Copenhagen, and it was a beautiful experience. This time I focused on analysing certain inclusive aspects of the city, when I went there, I did not really put attention into that. In general, I found the activity dynamic, funny and enriching.”*

*“At the end of the dynamic I felt really happy because this technology provided me a really immersive experience of how were ancient cities. It also showed me how are some cities that are hard to reach for me, exceptional cities that must be an example for my home town.”*

## CONCLUSIONS

An outlook of the past, present and future was explored thanks to the virtual reality resources, as well as the 360° video. This immersive activity allowed students to get a wide look of the urban sustainability and its implications. The ‘trip’ to the past was able to cover the origin of urban problems, as well as the consequences of not facing them with a sustainable vision. The ‘trip’ to the present allowed comparing how some urban strategies are currently being implemented. While the European Green Capital ‘trip’ took the students to a representation of the future.

The last virtual tour served as an inspiration for changing the current conditions of cities. Even though contents were directly obtained from what has been seen through the course, the designer team was able to integrate all three temporal lines within one activity. This helped the professors to close the gap of reviewing each timeline by its own and merge them. Therefore, this dynamic served as a conclusion of the course “Sustainable Cities and Communities,” and it was a huge success given the integrated vision that students could get from it.

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