



An innovative Practice of Critical Thinking in an Undergraduate Construction Course Project

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Abstract

It is verified that undergraduate students learn through research. A short project was designed and performed to assist the understanding of interdisciplinary ethics, political, environmental, economic, and other disciplines in civil and construction engineering projects. It was part of a larger structural design project. The project was a simulation of real-life multidisciplinary aspects of engineering projects. Various ways were tested and developed. Individual and group projects were assigned.

An activity of theatrical role presentation was added to the previous methods that included a critical thinking debate. After an initial literature review, they were asked to play their role after the instructor introduced their role in the project. The instructor guided the students in gathering information about their enrolled position during the term. The role positions were in construction or the disciplines participating in the construction. At the end of the term, they presented their research as their role and then discussed and argued it in a town hall with their classmates. Each student explained, debated, and defended their point of view based on their research. They were suggested to manage the situation, find reasonable solutions that other parties might agree to, be ethical and rational, and follow the regulations and legislations even if the discussion results did not match their personal or group role benefits.

Each of the students presented their role section even if it was assigned as a team project. Despite the point that all the students participated in the team presentation, their involvement and participation were assessed based on their peers' feedback and the instructor's assessment.

The students showed particular interest, enthusiasm, and passion for the project, and the observation of their commitment and involvement was exceptional. This paper presents the project and the reasons for the success of this experience. The pieces of the discussion and arguments of the students are presented. This method and the students' response and feedback conclude that the approach can be adopted and used in courses in different disciplines with higher education learning environments that match the current complicated job conditions.

Introduction

The construction professionals encounter a broad range of problems that is an interdisciplinary experience in the jobs related to the construction industry. That is a result of the diverse nature of the industry. So, it is essential to cover a wide range of fields in construction education in higher education. This research investigates the efficiency of a short practice regarding the complexities of large-scale construction projects in a construction engineering technology course.

This project aims to provide an innovative method of modeling the reality for the students in construction projects and absorb their interest in the real projects at a higher level. The basics of this project are the two concepts of student network learning and roleplaying. Each student has a unique role in the project that simulates real-life challenges and projects and needs to connect and interact on the presentation days and during the term. That resulted from 6 years of short learning projects for the engineering and engineering technology courses. The students showed high interest in such a method without exception, with the highest rating.

This method can be applied to different courses. The author conducted a construction engineering technology program for reinforced concrete design II. The number of class students was between 12 to 18, but the project is flexible based on the number of students. More or fewer roles will be defined.

Background

Alexander C. Et al. (1977) list a "Network of Learning" that advised builders and town planners interested in establishing learning networks *to decentralize the process of learning and enrich it through contact with many places and people all over the city. It was the basis for what is known as network learning*, followed by network capabilities through the internet. The history and development are long, but as a recent method, academics at the CoCo Research Centre, University of Sydney, focused on the *architecture* of learning networks, aiming to identify arrangements of tasks, tools, and people that contribute to successful learning networks. (Carvalho and Goodyear, 2014)

The idea of network learning was the backbone of such a project.

Roleplaying is the other base of such a project that makes it attractive to the students. After observing a workshop on a roleplaying course in theater by DiBiasio et al. (2017) at the 2017 ASEE conference, the author decided to adopt roleplaying in this project to define a role played for the students.

This roleplaying game (RPG) puts students in the roles of actual people immersing themselves in the roles of engineers, industrialists, elected officials, workers, scientists, public health officials, inventors, and city residents. Students learn and practice engineering concepts (engineering design, stakeholder analysis, mass balance, sewage treatment, material properties, and selection, sewage properties and conveyance, statics and stress, filtration, and chemical precipitation. The idea was so brilliant, and the attendees had a chance to play the role that will be part of the presentation method by the author to collaborate and take a role (DiBiasio et al., 2017).

Roleplay exercises allow students to assume the role of a person or act out a given situation. (CITL)

Role-playing can be effectively used in the classroom to motivate and engage students, Enhance current teaching strategies, Provide real-world scenarios to help students learn, Learn skills used in real-world situations (negotiation, debate, teamwork, cooperation, persuasion) and Provide opportunities for critical observation of peers Harbour, and Connick, J. (2005).

These roles can be performed by individual students, in pairs, or in groups which can play out a more complex scenario. Role plays engage students in real-life situations or scenarios that can be "stressful, unfamiliar, complex, or controversial, " requiring them to examine personal feelings toward others and their circumstances. Role-playing can be prearranged research assignments (Bonwell & Eison, 1991, p.47).

The approach follows the essential goals of ABET, including ethics, environmental, global, political outcomes, sustainable construction, critical thinking, and group work for the construction engineering technology students.

Roleplaying projects and games have been experienced in engineering education in different countries. For example, a group of researchers at the University of Memphis used it in 1998 (Bartz et al., 1996). Short-term and long-term studies have been applied to investigate the efficiency of this method in different engineering fields. (Vaz & Quinn, 2015, Apelian et al., 2016, McConville et al., 2017). Harvard explains the history and development as a pioneer of the pedagogy of reacting to the roleplaying game (Heinricher et al., 2013)

Project Development before 2018

The project was planned and improved in the years that the educator taught in different universities. The purpose was to fulfill the ABET goals. The main idea was to create a condition similar to the real-world projects to widen the students' knowledge about the possible scenarios in which they would be involved in the construction industry. The possible problems lead to social and professional ideas. They can be ethical and professional, local and global problems.

This project resulted in the involvement of the students in a variety of different aspects. Before using the roleplaying game, the project required all students to investigate the scenario, search for similar case studies in the world, and provide an essay and a group presentation.

The students needed to explain, argue and defend their point of view based on their research. They were suggested to manage the situation, find reasonable professional solutions, and find solutions. Each of the teams was required to cover all the opposing arguments in the project. In this way, the groups could search for those matters and present their knowledge.

However, this project resulted in the students' understanding of controversial and opposite opinions on a construction project; there were essential lacks which they faced which are listed below:

- The students considered that an assignment and some did not enjoy the project as they could.
- Although all of the students participated in the team presentation, their involvement and preparation were not even.
- The above matter resulted in some of the aspects were not covered equally.
- The students' beliefs, motivation, and knowledge of what they presented were not equivalent and, in some cases, under question.
- Different parties, professionals, and beneficiaries have different ideas in real-life projects. As the groups were assigned to provide their conclusion in the final presentation, the results

mainly strengthened one side of the ideas and weakened or neglected the opposing parties. That limited the understanding of the possible solutions and the logic of the opposite sides. For instance, the students in one group supported the construction despite the critical environmental problems.

Methodology

Critical thinking was planned to improve the students' understanding of some contractual problems that construction professionals may confront. The short project associates understanding different points of view, including ethics, political, environment, economy, politics, global and local thinking, sustainability, and other civil, architecture, and construction engineering disciplines.

The students need to fulfill the knowledge and research for their role and play their role in class. The entire class follows parts of a larger project and roleplaying practice regarding the complexities of large-scale construction projects in a course in the construction engineering technology program.

Roleplaying project

The short roleplaying project is planned to fulfill the lacks which were listed. The students are asked to present in two simulated town hall meeting presentations. The students need to search and provide legitimate reasoning with examples from their research. Each class student is assigned an individual short project about an assigned individual role. They need to provide a short paper before each town hall and a short PowerPoint presentation for the second town hall.

They are assigned to a role in the first town hall, which is planned to be a class in the first quarter of the term. They search for this role and play it with the preliminary research. The most crucial goal of the first town hall is to make the student become familiar with their role and become interested in the project. The student feedback and related questions in the first town hall facilitate modifying the project for the following years.

The students are assigned to play the same role they had in the previous town hall in the second town hall. In the last few weeks of the term, students are assigned to do more research before the town hall to present their assigned role as a professional and present a few PowerPoint slides. Each of the students is assigned a different duty to ensure that the presentation demonstrates their work and a few case studies that clarify the problem in the other real projects and clarify their role and ideas in their assigned role. In both town hall meeting classes, the students are asked to submit a short essay, which is complete in the second town hall.

The students are warned to avoid populist presentations and ideas and stick to ethics and professional views during the final town hall debate.

Each town hall is just one class day. There are two stages in both townhalls. In the first stage, a few minutes, they present their role and provide reasoning to support their idea. The second stage

is the debate. After each person presents their reason, the town hall will allow the debate, and all of the students are obligated to collaborate in the debate. The town hall is managed by one of the students based on their related roles.

The students must be rational, ethical, and follow the regulations and laws even if the discussion results do not match their personal or group role benefits.

The roles assigned related to the construction project were including the representatives of the tourist industry, the regional elected persons, including a congressman, mayor, and commissioner, Structural Engineers, Local People, Construction Companies, native Americans, Environmental activists, Architects, Economists, Hotel and Industries and Judiciary person.

Each student focused on their position. So the students share their knowledge and learn from other students as each student has a different role. In most of the positions, two students were given similar roles, such that they could help each other, and if one student was absent or dropped the course, the students could still listen to that side of the argument.

The town hall presentations and debates are videotaped.

The project is added as an appendix.

Virtual Townhall events

The students were asked to play their roles one week after introducing the project, hoping that they would search and prepare for such a role by the end of the project. The students were assigned to a part of the project that matched their research concentration role. They initially presented their research as their role and then discussed and argued the matter as a town hall debate with their classmates' different roles. Each student needed to explain, argue and defend their point of view based on their research. They were suggested to manage the situation, find reasonable solutions that other parties might agree to, be ethical and rational, and follow the regulations and legal aspects even if the discussion results do not match their personal or group role benefits. The students showed a magnificent interest, enthusiasm, and passion for the project, and the observation of their commitment and involvement was exceptional.

Project Definition

The project was defined as a virtual construction scheme planned to improve and develop a region. In the last two years, the projects were related to the design projects assigned to the students in the courses design of reinforced concrete I and II. The basics of the projects are the same. In Spring 2018, the project was defined as a tourist pedestrian bridge in an environmentally unique region in the Smokey mountains. In spring 2019, the project was defined as expanding and developing a town in a forest area near Mexico gulf in Central Florida. In both projects, similar conditions are assumed. The environmental condition is considered unique species, some of which are in danger of extinction. The Native Americans consider the region a sacred heritage. The related roles on

different sides, with different positions and professional backgrounds, are explained. This paper explained the experience in Spring 2018.

The outcome and conclusion of the project

The students exhibit a high interest in this activity. It is seen that the best students and the most dedicated students in the design course may not necessarily be the best debaters, and the project provides an opportunity to observe other dimensions of the student's capabilities. The debate is an excellent practice of critical thinking, which clarifies how logical the students are in reasoning and supporting their ideas and how deep they have understood and researched their roles. The improvements result from such a project in comparison to the group presentation.

- The project is still group work, but the entire class is the group. All students participated in the team presentation, but they know that their involvement and preparation can also be directly assessed.
- The students considered the class activity of the theatrical roleplaying as a game rather than an ordinary assignment or project and enjoyed the project. Based on a survey at the end of the term, there was no exception that the students liked this activity, and they suggested that this is applied in future activities. They all found this activity to be positive, and they liked the way they learned from each other while they felt like playing a game. Even some feedbacks considered this townhall the best class they have had in the college.
- The involvement of every single student in the activity, particularly at the time of the roleplaying, was beyond expectation. The students believed in what they presented and were motivated by that. The town hall covers the different topics and sides of the project, and the training in the town hall classes is better and more attractive as each student has a focus and concentration on a different matter.
- The roleplaying game allows the different parties and professionals have different ideas as in real-life projects. That also provides broad thinking and understanding of the students' rational and critical thinking and good citizenship individually and about the others.
- It also makes the students familiar with opinions and positions other than their construction work and points of view. The result is an open mind for future construction and other jobs.
- Understanding the concepts such as global thinking, environment, local and native people and policies, and authorities' responsibilities, sustainability, and resilience are viewed in such projects.
- Each student needs to talk and present slides in the final presentation and participate in the debate managed by a student with the authority job in the town hall.
- The student evaluation of such projects has been 100% positive.
- Some students said that it is a type of project they will remember forever.
- The students learn from each other, and the class is a learning network.

Conclusion

The result of the debates was positive. The students said they have learned about diversity, job positions, the construction challenges, the environment, construction-related politics, laws, and other aspects of the design and construction.

The debates were real, and the student involvements were impressive.

In the questionnaire provided about this project, all students agreed that they learned and enjoyed this project. Some students mentioned that it was their best project activity in university time.

The author, the educator, modified and used this method for several years. However, it was stopped after the covid-19 pandemic, as dealing with the online and semi-online courses for the students who used to be face-to-face in-class students elongated and decelerated the teaching. As a result, the project was not planned since spring 2020. However, It is planned for subsequent years.

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Attachment- Project Definition: Developing a town near a sea and a forest

That is not an actual project, but it is defined for getting a sense of similar projects. It is assumed to be in Florida, as shown in figure 1.

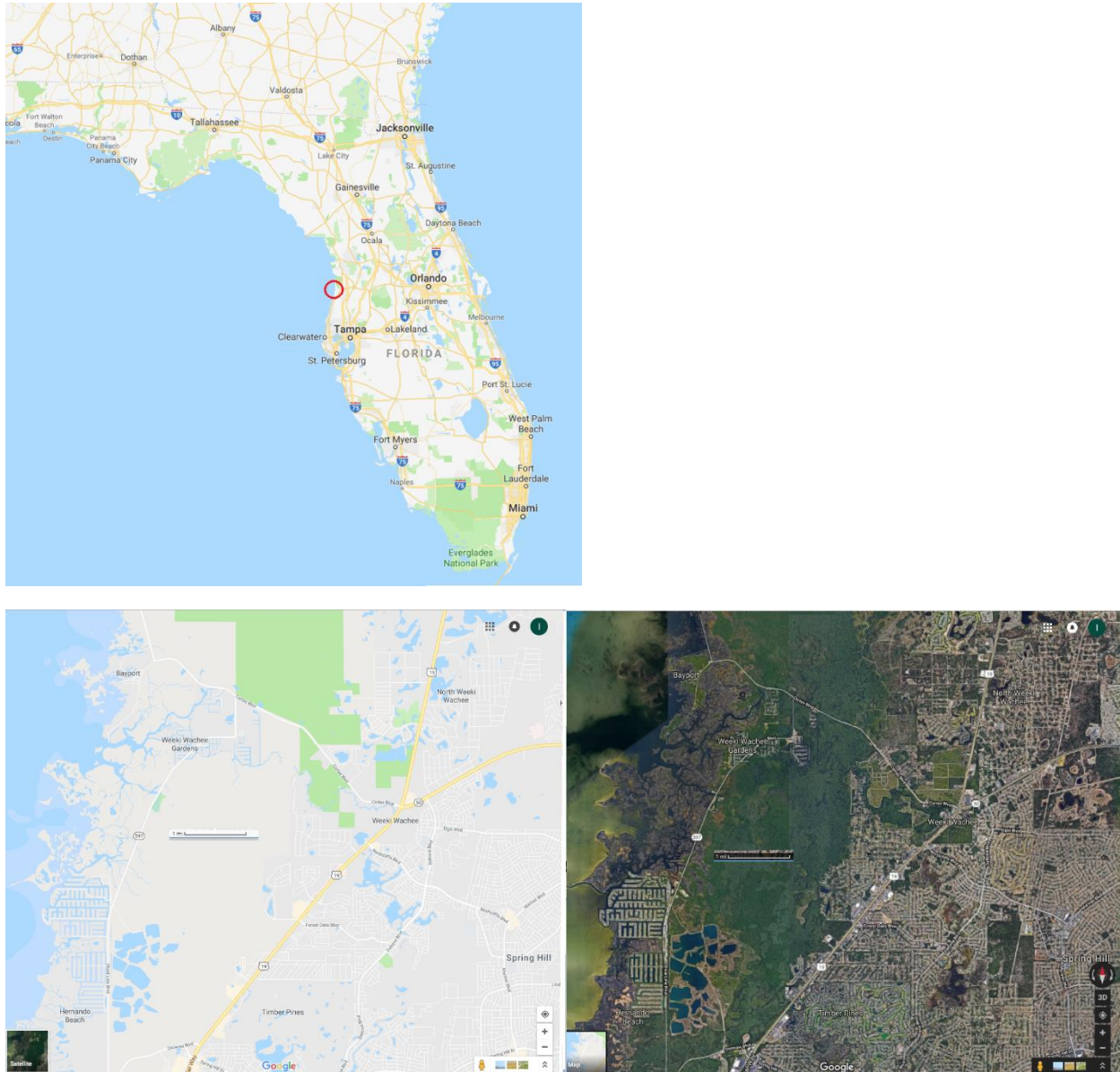


Figure 1. The assumed area of this project (a) the location of the project in the Florida State, (b) the project location on google map, and (c) the project location in google satellite map view

A town is proposed to be developed. The town is close to a forest and close to the sea beach. A group of professionals is consulted, including the tourist, industrial, and economic professionals, to investigate the possibility of progress in this area. They suggested that about 60% of the adjacent forest and the connected beaches are added to the town. The result would be more construction,

attracting more tourists, and retirement residential buildings. Hotels, residential houses and apartments, malls, hospitals, parks, and other related services and infrastructure will be needed in this area. Also, the beaches will be improved for swimming and fishing, boating and water sports and water-related entertainment is expected to be improved and schools at different levels will be needed. A long artificial island will be built with a length of more than one mile for other clean beaches, reducing the surge of water and protecting the waves close to the city. It will be possible for the tourists and the hikers to pass the remained forest area. The related trails need to be configured and built.

The arguments about the project

The students must prepare a research document supporting and criticizing this construction and development project. There are different arguments about the construction of this bridge. Examples are provided here. You need to complete the arguments with the role that you will be assigned. Provide related arguments and case studies about the following arguments and complete them with the possible arguments which are not presented. Discuss your conclusion based on your research for each of them. You will have two presentations as town hall meetings, the first one on the 11th of February and the second one will be two weeks before the end of the term.

Each student must study, research her role, and provide one-page text, with an additional page for the references in the first town hall presentation time. For the second presentation, each student will provide a minimum of two pages of text, an additional page for the references, and two to five slides for the final townhall presentation that need to be mixed in the same category as other students' slides. The student needs to provide and present ideas that support her entitled position.

The supportive argument:

The tourist industry supports the project. They consider the project as an opening to an unknown region. They expect considerable benefits. They have several assumptions about the possibilities of more projects for exploring the region by the tourists in the future. New beaches, restaurants, museums, festivals, hotels, and outdoor entertainment are parts of the suggested project.

The regional elective representatives, most local people, and companies, particularly the construction-related companies and individuals in the town, support the project. They believe that the project will result in economic development in a town where most youth move to other locations due to a lack of jobs, and the region is suffering from a brain drain and lack of jobs. They believe that a list of new jobs will be offered for local people in the tourist industry, construction, housing, healthcare, etc.

After the tourists recognize the region, other projects are expected to be added to the tourist area that will progress the region. Construction companies and local industries will be progressed. The town has the capability of attracting retired people to reside. They expect more development, including economy, construction, tourism, and even more political power due to the expected

progress and population growth. The congressman has promised to follow the permission for the projects from the environmental and governmental organizations.

Opposing Arguments

The Environmental activists: They claim that the natural environment of the sea, the freshwater, underground water, and the valuable forest will be affected by the construction of this development project. The region is a unique home for several rare animal species endangered by extinction. The activists claim that the revival of those species will be endangered when people and tourists have access to the region. Also, the environment will be polluted by garbage and sound, and will affect its natural condition and ecology. The people and cars will badly affect the ecology, the forest, and the trees and plants, which are the nest of several species. The possibility of fire is also increased.

The Indian Americans: The local Indian Americans claim it is a holy region. Their ancestors have been buried in the region. They believe that their spirits will be bothered if there is access for people in this region. They consider the region a heritage area and do not tolerate disrespect.

Construction Related Arguments

A group of local engineers, including construction engineers, architects, structural, geotechnical engineers, and civil engineers, are consulted about the possible methods of developing the town. They have different ideas about the progress areas for different reasons. They have different suggestions for the buildings. Some of them believe in the usage of modern methods of fast construction. Some architects believe in the priority of aesthetic design and suggest beautiful buildings. They suggest aesthetic designs, including arcs or slopes. Some have good suggestions for the design of the buildings to be environment friendly and sustainable.

They have different ideas about the region's residential, commercial, hotel, and office buildings. The size, the number of floors, and the material are also argued. Different structural materials are suggested for the buildings, including wood, steel, reinforced concrete, and other options.

The fire and hurricane resilience of the buildings and communities is also a significant concern.

Some believe that the buildings should follow similar materials and designs and others believe in the freedom of design in every aspect.

For the second presentation time, two weeks before the end of the term, the students need to search and provide legitimate reasoning with examples from their research. Each of the students in the class is assigned to an individual short project. They need to provide a short paper of two pages (800 to 1200 words) and a page of references, and a minimum of 2 slides to 4 slides about the following arguments. The due date for the presentation and slides is class time, but the text can be presented in their portfolio on exam day. The students who have a similar task need to communicate to provide different reasoning or sides.

The students are assigned to play the same role as they had in the previous town hall playing the first of the term, and they will explain their reasons using the slides. After each person presents their reason, the town hall will allow the discussion.

A student who had the judiciary role managed the town hall of this project. The students needed to primarily present the related background, literature review, and examples related to their assigned role first. They were allowed to make teams of similar roles to make a presentation, but they needed to present their work in that PowerPoint presentation.

After the presentations, the discussion and debate were open, and the students presented and defended their views and position role title. Each student was required to reflect on their opinion in the debate. The students were asked to present their knowledge, be ethical and moral, and know the regulations and bylaws related to such roles and conditions. They were asked to find the ordinary resolution and solutions as professionals.

The students needed to prepare a short report about their presentation. They also evaluated each other with a rubric provided by the professor.