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TEACHING TECHNOLOGICAL LEADERSHIP IN GLOBALLY DISTRIBUTED TEAMS WORKING WITH BUILDING INFORMATION MODELS

Carrie Sturts Dossick[1], Anne Anderson[2], Nishant Bordia[3], and Laura Osburn[4]

Abstract: In this paper, the authors analyse leadership learning in distributed student teams working together on Building Information Models (BIM). This paper includes the curriculum design and learning outcomes for student teams consisting of students from Indian Institute of Technology - Madras (IIT) and the University of Washington (UW), USA. The literature on leadership suggests that with current communication technology, students who seek AEC professional careers need to include technological leadership in their learning. In this paper we explore leadership as a social process learned through experience. We conclude that technological leadership learning does occur in globally distributed student team assignments, and that with a two project approach, students can apply their learning in the second project immediately after learning from the first project.

Keywords: Building Information Modelling, Global Teams, Online collaboration, Leadership

1 INTRODUCTION

Globalization and the increasing use of Building Information Modeling (BIM) in the AEC industry require changes to AEC education. According to a 2014 SmartMarket Report, 75% of global contractors are increasingly expecting new hires to be prepared to work with BIM technologies as well as collaborate with other disciplines. Improved communication technologies allow AEC firms to collaborate in distributed teams (Harty & Whyte 2009; Nayak & Taylor 2009; Rezgui 2007). There is an increasing need to prepare AEC students for a BIM-enabled workplace where they work in collaborative environments online (Ahn et al. 2012; Zhao et al. 2015). While many engineering and construction programs have introduced technologies as tools, fewer have looked at leadership skills as they relate to technology. In this paper, we present a global team-based curriculum model for teaching technology leadership.

[1] Professor, Department of Construction Management, Executive Director, Center for Education and Research in Construction, University of Washington, Seattle, WA, USA, cdossick@uw.edu

[2] Assistant Professor, Department of Construction Management, Washington State University, Pullman, WA, USA anne.anderson@sdc.wsu.edu

[3] Masters Student, Department of Construction Management, University of Washington, Seattle, WA, USA, nbordia@uw.edu

[4] Research Scientist, Center for Education and Research in Construction, Department of Construction Management, Adjunct Professor, Department of Communication, University of Washington, Seattle, WA, USA, lbusch@uw.edu

2 Literature Review

Virtual team studies identified three styles of interaction: transactional, transformation and technological (Iorio & Taylor 2015). Transactional leadership relates to task planning, while transformational leadership relates to inspiring the team (e.g., goals and aspirations). Walvoord et al. (2008) defined the third style, technological leadership, as a leader who considers "the pressures experienced by team members due to time scarcity, numerous advanced technologies and (in)appropriateness of a particular modality for the information being exchanged" (pg. 1886). And, they go on to argue that "there is a need for e-Leaders to identify or make available to team members the most appropriate communication media for the virtual team task or process."(pg 1886).

Iorio & Taylor (2015) concluded that traditional AEC leadership training, developed for face-to-face leadership contexts, is not sufficient for distributed virtual teams, as these teams are mediated by technology. Their analysis pivoted on the concept of situational awareness: "a team member's understanding of the work environment and the degree to which members share the same interpretation of the events that occur within the environment." (section 3.2) Students gained these skills through experiencing online interactions and became aware of how technology disrupts norms of face-to-face interactions (e.g., bandwidth, voice, and presence). They found that students in their study quickly improved their technical skills through weekly interactions with globally distributed partners.

In this paper, we explore how active learning in globally distributed teams supported student learning for technological leadership. In this paper, we present a detailed description of the curriculum design and then present assessment of learning outcomes.

3 Curriculum Design

This project is a teaching and research collaboration between students and faculty from IIT and UW. The global student teams used Sococo, a 2D virtual workplace as a space for UW and IIT teams to collaborate. While both classes focused on teaching BIM, the UW course emphasized the process of BIM Execution Planning along side of construction BIM uses and included readings on the challenges of distributed team collaboration.

3.1 Project Description

For six weeks, students from IIT and UW worked together on two sequential projects where they had a chance to apply lessons learned from Project I to Project II.

Project I (2 weeks): Students designed the addition of 3 rooms to a residential house in Chennai, India, (the home of IIT). The team needed to decide where to build the rooms. In week 1 IIT modeled the 3-room addition in Revit while the UW students developed a construction schedule. In the second week, the UW team then integrated the Revit model and baseline schedule to develop a 4D model in Navisworks.

Project II (4 weeks): Building on lessons from Project I, UW student developed a BIM execution plan for the virtual team's design and construction sequence analysis of a multi-story residential building based on provided Architectural drawings. This building was for people who had lost their homes in the recent floods that ravaged Chennai. As a result, students were challenged to think about ways in which this building could be built quickly. Overall, the tasks were to develop optimized 3D and 4D models for the construction of the.

For the final assignment, students were asked to present three sections of the project: 1) Project I and II Overview 2) Challenges and Benefits for global teams, and 3) Recommendations for BIM Execution Planning.

4 Assessment Methodology

Data collected for this project consists of student project work (final presentations and classroom deliverables) and a survey distributed to UW students at the end of each of the two projects. The survey focused on meeting frequency and communication technology, a satisfaction level (1-7, 7 being very satisfactory), then long answer questions about difficulties they had with the project, communication and tools, lessons learned and suggestions for "next year".

A total of nine teams participated in the research related survey. We analysed each team (two UW students) to understand their experiences as a team and as individuals.

5 Analysis of Learning

We used student satisfaction to categorize the teams and then studied these teams in terms of learning outcomes. The analysis in this paper compares the difference in leadership behaviours between these two types of teams: those with negative trending satisfaction and those with consistently high or positive trending satisfaction measured after Project I and Project II. Taken together, the level of satisfaction of most of the teams was high to very high (5-6 on a 7-point Likert scale). However, satisfaction decreased from 76% with 5 or higher after project I to 64% at 5 or higher at the end of Project II. Teams with negative trends shifted from an extremely high satisfaction level (Project I) to a neutral (Project II).

Based on an analysis of long answer survey questions, the main reasons for negative shifts were late delivery of models, lack of promptness or completeness of correspondence between the universities, and frustrations with communication technology (e.g. limited bandwidth). Teams with a positive shift from high to very high level of satisfaction reported higher levels of collaboration through more frequent meetings, usage of other communication technologies and what the students perceived to be a "fair" division of work. Table 1 summarizes the coded data, and we found several paths to success.

First, some teams successfully built trust by getting to know each other socially. Second, some teams overcame the time difference challenge with transactional leadership whereby they found the best meeting times and coordinated due dates across the International Date Line. In the third path, technological leadership provided ways to work through the bandwidth challenges with different types of tools (e.g., WhatsApp and Google Hangout). Fourth, students had to learn to communicate technical specifications and develop iteration strategies for "fixing" the models that didn't meet their needs for 4D modelling. Fifth, teams reported to be excited and curious about their IIT counterparts. Sixth, students developed different technical solutions for file management such as file naming conventions for version control. Finally, the teams that overcame low engagement of team members learned to use transactional leadership as well as transformational leadership to get their teammates on the same page in terms of shared goals and mutual expectations.

Table 1: Leadership Types

Leadership Type	Definition	Tasks	Examples	Comments
Technology	Which brings up technological innovation in a workflow and technologically aids to the effort of collaborative team work	Troubleshooting, identifying tools, managing data	"Be more proactive with guiding teammates through software issues and raise awareness to underlying issues that can hinder the project in the future." "We changed the time of our meetings with IITM team to their morning when they had a faster connection speed so that meetings were not interrupted."	Connection between technological and transformational leadership
Transactional	Which allows the leader to plan and create tasks for the team members and allocate them appropriately. It also enable the leader to schedule deliverables.	Task planning, facilitating tasks, role and responsibility development, scheduling tasks and meetings	"develop dispute resolution method to resolve underlying issues, use the BIM Execution Plan to set a clear schedule, have both side prepare a meeting agenda so that all teammates are aware of topics to be discussed" " We provided the list of revisions and inquiries in advance to make the Sococo meeting more efficient and clear on the topics we were discussing"	
Transformational	Which allows a leader to uplift other team members/followers by gaining trust in order to accomplish tasks	Injecting energy and enthusiasm, boosting the team members, motivating the team members	"sometimes initiatives to take a lead/ coordinator role must be taken to make any project work[s]". "Understand that everyone is trying to learn, so commit your group towards fostering a learning environment"	

In reviewing the data for this project, we see clear evidence of leadership learning across all three types. While the task to coordinate BIM work flows across globally distributed teams required teams to use traditional leadership skills of transactional and inspirational, this project highlighted the need for technological leadership. When counting up the number of learning statements related to technology, we found that Technology leadership accounted for 47% of the leadership learning reported by students. This shows that globally distributed team curriculum does allow for technology leadership learning, particularly if there is explicity curruciulum focused on reflection on that learning objective.

6 Conclusion

For this project, we sought to cultivate leadership skills engineering and construction students need in the 21st century workplace. These leadership skills include transactional, transformational as well as technical leadership. This project emphasized the technical leadership skills as researchers have identified that it is these technical leadership skills that are needed for teams working with and through technologies (Iorio & Taylor 2015). In the global team curriculum described in this paper, students learned technological leadership in two ways. First, they worked with online collaboration technologies to communicate between students in the USA and India. Second, they worked with BIM technologies and needed to learn to create BIM execution plans to set modeling requirements where the IIT students created 3D models that were then used in the 4D models at UW. We found that transactional leadership skills (role setting, task distribution, scheduling deliverables) were tightly integrated with technological leadership (online communication troubleshooting, modeling requirements). For these student teams transformational leadership was less emphasized in these teams as their focus was on getting the technology to work and coordinating the modeling and information exchange between the two schools. The technological leadership framework for this class project was BIM execution planning, which the successful teams reported using to set goals and expectations. The less satisfied teams reported learning the importance of setting expectations through the pain of missed deadlines and miscommunication around what they expected from each other. We conclude that transactional and technological leadership skill learning was strongly supported by the global team curriculum described here. Through the process of a trial project (2- week Project I) the student learned through experience what their gaps were in terms of transactional and technological and at time transformational leadership such that they entered the second project (4-week Project II) with a greater understanding of the types of leadership needed to be successful and an opportunity to cultivate and practice this leadership.

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