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An Effective Project Management Simulation for Distance Education

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PEER-reviewed Research Paper

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An Effective Project Management Simulation for Distance Education

ABSTRACT

The challenge in distance education for project management courses is how to maintain quality when team projects, traditional lectures and in-class exercises normally conducted in face-to-face courses are not practical. This research explores the desirability and effectiveness of computer-based project management simulation as a teaching tool for industrial technology students in a distance education (DE) degree program.

The purpose of using the simulation was to enhance learning outcomes related to project management processes and techniques taught in the course. A survey of approximately 100 students over four semesters was used to determine how online students responded to the use of simulation to teach specific project management concepts. Additionally, the research sought to determine which project management concepts were most enhanced through this active learning activity. The results established that the SimProject® computer-based simulation improved project management education for distance students and added value to the course by reinforcing text-based content. The data established a positive relationship between the simulation and specific project management knowledge areas for scope, time, cost, risk, human resource, communication, stakeholder, and quality management.

The simulation provided students with the challenge to execute a virtual project, allowing up to three separate attempts, each with the same defined goals for time, cost, and quality. Dynamic, simulation-induced, life-like obstacles based on student choices presented unique management decisions for each trial. A successful outcome required students to meet time, cost, and quality goals within 10 percent of target. Student motivation for this pedagogy was apparent as most used all three attempts and provided positive survey feedback.

INTRODUCTION

The 2017 Project Management Institute (PMI) *Job Growth and Talent Gap* report shows that through 2027, "the project management-oriented labor force in seven project-oriented sectors is expected to grow by 33%, or nearly 22 million new jobs." This anticipated demand for project management skills has been fueled by attrition rates in the workplace along with growth in demand for project-oriented skills in leading economies worldwide (PMI(a), 2017). Subsequently, many non-traditional students have sought technology related degrees via distance education (DE) and see project management education as a means of career placement or advancement. The challenge for DE project management courses is how to maintain quality when team projects and in-class exercises are difficult, even in virtual-meeting environments.

Succinctly put, the research sought to answer the question: "How do online students respond to the use of a simulation to enhance learning of project management concepts?" The SimProject® computerized project management simulation used for this research and presented herein was initially vetted by researchers in 2011 – 2012, using face-to-face students within an engineering management program (Jeong and Bozkurt, 2014). This paper extends that work for DE students, defines the desirability and effectiveness of SimProject® as a teaching tool, and provides in implementation structure for technology management and applied engineering programs.

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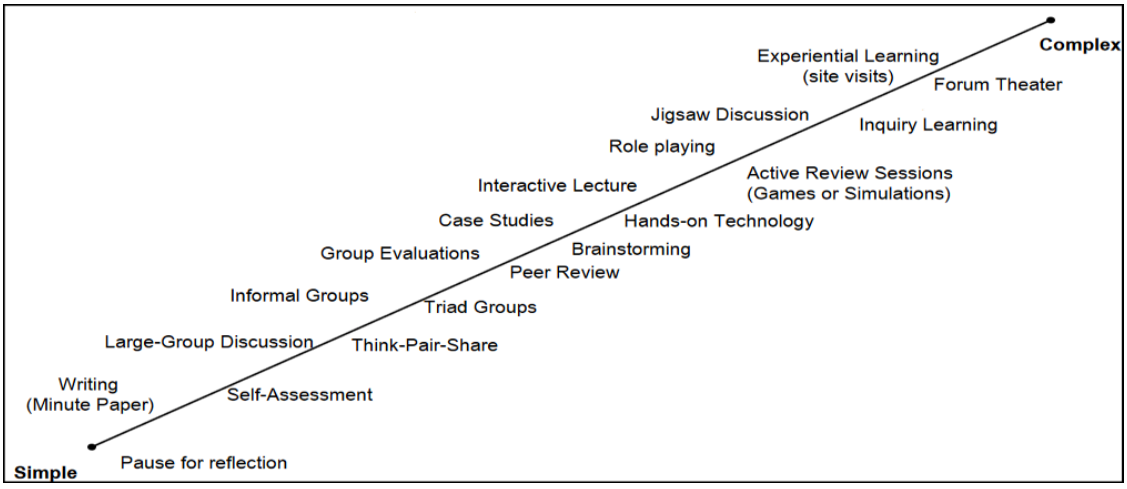
SIMULATIONS AS AN ACTIVE LEARNING PEDAGOGY

Untener et. al. (2015) stated that active learning is an important pedagogical factor in preparing students to enter the fast-paced, knowledge-worker workforce that awaits them upon graduation. Further, graduates are better positioned to enter industry through a pedagogy that provides foundational principles enhanced by active learning to apply those principles (Untener, Mott, & Jones, 2015). Meta-data research by Chernikova et. al. (2020) concluded that simulations are among the most effective means to facilitate learning of complex skills, and that scaffolding facilitates simulation-based learning.

Students must be able to apply Project Management Body of Knowledge (PMBOK) concepts in real-world situations, making simulation an advantageous active learning pedagogical approach. Prince (2004) points out that active learning intended to promote student engagement needs to be "designed around important learning outcomes" (Prince, 2004, p. 226) and is also an excellent method to break down student's pre-conceived notions and/or misconceptions (Prince, 2004). This is of particular interest when teaching DE students who may have had prior project management experience that is counter to the PMBOK principles.

With respect to types of active learning, Figure 1 summarizes research by O'Neal and Pinder-Grover that demonstrates simulations, supported with "active review sessions" for lessons learned, are a complex undertaking (O'Neal & Pinder-Grover, 2005). The active review sessions are typically post-simulation debriefings, which are necessary to reinforce learning that occurred during the simulation process (Léger et al., 2011).

Figure 1: Active learning techniques



Wood and Reiners (2012) established success factors for computer-based simulations:

1. immediate and continuous feedback
2. short cycle times to provide a sense of accomplishment
3. leaderboards and comparisons to instill a sense of motivation through competition
4. integration of simulation exercises with course content and pre-requisite knowledge

Further, Chang et. al. (2010) developed four key principles for the use of management-related simulations:

1. develop students' understanding of management process complexity and dynamics
2. utilize decision making in different, challenging situations in a time-based environment
3. allow students to experience cross-functional information sharing in a silo-based structure
4. measure performance against benchmarks and peers

Finally, Shen et al. (2015) recommend instructor-developed, simulation-related work for course-

specific conceptual learning, i.e. exercises related to student-developed simulation output that require interpretation and reflection (Neumann, 2010).

Research also recommends that instructors using computer-based simulations act as coaches rather than teachers (Bolton, 1999; Léger et al., 2011). The goal is for the instructor to help students develop critical thinking by providing only a minimum amount of information, to lead students rather than simply inform (Léger et al., 2011). The recommended approach supports the scaffolding concept. This allows for significant help in the early phases of a simulation but less and less as the game progresses, requiring students to build knowledge during game play (Léger et al., 2011; Reiser, 2004). Additional challenges are found within a DE environment as instructors must adapt to limited web-conferencing and discussion board interactions.

SIMULATION DESCRIPTION

SimProject® is a computerized simulation giving students practice in many project management knowledge areas across several project phases. The authors recognize PMI is moving away from its traditional project management knowledge areas with the (pending) 2021 release of the PMBOK 7th edition but posit the knowledge requirements for these areas remain intact.

The software simulates the creation of an internal company project to create a prototype E-commerce website within a virtual 11-week time frame. The simulation creates a variety of company executives, stakeholders, customers, and other employees with various roles and skill sets. No technical knowledge for e-commerce or website building is required since the seven project tasks are provided. The tasks come with descriptions, required number of human resources and required skill type, i.e. Software Engineer, Documentation Specialist, etc. There are specific goals for cost, time, and quality which create the balancing act required to manage the triple constraints of projects. Table 1 summarizes the simulation's project management concepts and related PMBOK phases (PMI(b), 2017).

Table 1: Project Management concepts in the simulation by project phase

Simulation Concepts and Topics	Planning	Executing	Monitoring & Controlling
Budgeting	X		
Conflict resolution		X	
Critical path analysis	X	X	X
EAC – Estimate at Completion			X
Earned Value			X
Gantt chart	X	X	X
Network Diagrams and dependencies	X	X	X
Project communication	X		
Project issues		X	X
Resource planning & allocation	X	X	X
Resource training	X	X	
Risk planning/probability & cost calculation	X		
Stakeholder Analysis	X	X	
Team productivity, motivation & recognition		X	X

Project Planning Phase

SimProject® begins with the *initiation phase,* where students are provided documents to understand the project background, stakeholders, and corporation. Next, students conduct the *planning phase* using a provided checklist to ensure they address all areas. A Gantt chart and network diagram are provided to show task order, task dependencies and the critical path.

Students are required to allocate resources across the project time frame by using the resource pool and task descriptions. Onboarding and offboarding rules are provided for bringing human resources into or releasing them from the project. If not planned correctly, this can create additional issues and costs.

Each activity has an associated cost, which is applied to the budget during planning and charged against the budget during execution. A pre-defined budget sheet is included with a breakdown of costs by categories. Students build their own budget as they allocate resources, schedule training, plan rewards/incentives, schedule meetings and stakeholder communication vehicles. Students will see variances between the recommended budget, their planned budget, and their actual costs. Finally, risk planning is accomplished as students identify project risks, potential monetary impact, and probability of occurrence. The total risk cost is placed in the Reserves category of the budget.

Execution Phase

The *execution phase* is a loop that occurs over the virtual 11-week time frame and a checklist is provided as a guide. It begins with work-week execution planning where students schedule appropriate human resources for tasks occurring in that week. Students must determine if the resources need training, and if so, assign to a training course on a specific day. Also, team motivational rewards/incentives and communication must be considered and scheduled on the week calendar. Stakeholder communication is identified based on stakeholder type and preferred mode for each, then scheduled on the workweek calendar. Each execution planning activity has its own cost which is charged to the project's cost accounts when they occur.

Once all execution planning is verified, the simulated workweek may be triggered by the student. During this execution, the student will be confronted with many obstacles and must consider the type of each and who is involved. Each obstacle will come with 2 or 3 potential solutions ranging from no action to a hard-nosed action. The selected solution determines the next path in the simulation. Although possible, few students successfully complete the entire simulation on the first attempt. Three simulation runs can be allowed, providing different experiences based on chosen solutions.

Monitoring and Controlling Phase

At the end of each virtual workweek, students enter the *monitoring and controlling phase* and the simulation generates multiple reports of everything that has occurred, including decisions made by the student. Reports include resource productivity, earned value graph, an estimate at completion (EAC) chart, and quality/defect graph. An updated Gantt chart indicating task progress and projected completion for each is also available. These important reports add value by providing information for students to determine if they are on track to meet their goals.

The controlling phase occurs as the student reviews the progress, compares it to the goals and determines if adjustments are needed. This is where critical thinking must be employed. Students determine which reports to check for each of the triple constraint areas and determine corrective actions if necessary. Instructors may add rules restricting actions to prevent students from "gaming" the system by abusing overtime or severely overloading the number of resources required on a task to speed up completion. After student adjustments, they may begin the next workweek and continue iterations until the project is finished.

Lessons Learned

Students submit a summary of their experience by answering specific questions such as personal lessons learned and project management insights. Then, a live, virtual meeting to review lessons

learned with the entire class is conducted with the entire class, with attendance/participation as part of the grading rubric. This has typically been a time when students really engage as they grumble about some of the simulation resources as if they were real people, and they commiserate with each other over the problems some of those resources caused. More importantly, they give tips and discuss what they learned. They are happy when they discover others ran into the same issues and overcame them the same way.

COURSE STRUCTURE USING SIMPROJECT®

The plan described below was used in four project management courses as part of a 15-week semester during fall 2017, fall 2018, spring and fall 2019, for a total of 97 participants. Table 2 presents a weekly implementation outline. The simulation itself begins in the ninth week, but the table presents preparation milestones for Weeks 5 – 8 and students were required to purchase the simulation (2019 estimated cost of $50) prior to Week 9. Also prior to the simulation kick-off, normal course content delivery included content for: 1) project planning, 2) analyzing Gantt charts (with critical path) and network diagrams, 3) resource planning, 4) risk management and cost, 5) working with teams, team motivation and conflict resolution, 6) project communication methods and frequency.

Week 9 kicked off the simulation assignment with a brief instructor review of scope, schedule, and cost management concepts. An instructor created document was provided to 1) outline specific assignment goals to finish the simulated project within 10% of time, cost, and quality, 2) a list of required documentation at completion, and 3) the grading rubric. This was supplemented with a short (~10 minute) instructor-narrated PowerPoint video regarding the assignment goals and expectations, which also explained how to get started. Finally, a pre-simulation quiz was administered to motivate students to thoroughly understand the simulation rules and the assignment intent.

Week 10 work began early with a live, virtual "introduction to SimProject®" instructor-led meeting. This included a demonstration of logging into the simulation and a short demo of its functions; the goal to reduce student anxiety. The meeting also included how to register the simulation to the course. Students then viewed an automated SimProject® overview tour provided by the software creators. A question & answer session was then conducted.

Following this, students completed their SimProject® planning steps. Afterward, students used the execution checklist and began simulation Week 1 with the software. At the end of workweek 1, students review reports, make necessary adjustments, and begin the next simulated week. This pattern is completed repetitively at their own pace until the simulated project is complete. They may stop after the first attempt if they are successful at hitting the goals on their first try. If not successful, students must complete their second and third full simulation runs by the end of course Week 11. Students are encouraged to complete at least a second full run even if the first is successful since it is possible to choose different solutions to obstacles and resource assignments to observe differences in outcomes.

At the beginning of Week 12, the simulation write-ups are submitted. After submission, a required online lessons-learned meeting is held the next day. This allows students to evaluate their own lessons-learned against what others learned.

Instructor Grading

Grading should be developed based on the specific course intended learning outcomes. The process used by the authors was based on students meeting the cost, schedule, and quality defect goals, each with a 10% overage allowance. Additional areas to be considered for grading are: 1) handling of resource issues and conflict, 2) limiting the wasting of resources due to poor onboard and offboard scheduling, and 3) abuse of overtime. Students could run the simulation up to three times and select a specific run attempt for grading. They were then required to turn in several simulation-generated documents along with a summary of how they used the earned value, EAC and quality charts to monitor and control; see Appendix A: Sample Grading Rubric.

Table 2: Semester simulation schedule in 15-week semester

Week	Topic	Student Workhours
9	Simulation preparation • SimProject® tour • Instructor overview video • Pre-simulation prep quiz	1 – 2
10	Monitoring & Controlling • Introduction to SimProject® Virtual Meeting • Begin SimProject® Planning • Run SimProject® Execution (run workweeks) • Complete first full attempt at simulation	4 – 5
11	SimProject® • Attempts 2 and 3 • Repeat planning, execution, monitoring & controlling	1 – 2
12	SimProject® Summary • Submit write-ups • Conduct lessons learned meeting	1 – 2

REPLICATION AT OTHER UNIVERSITIES

The first step would be to contact Simulation Powered Learning, https://simulationpl.com/, the company that owns SimProject® to discuss using it in a course. There is an overview tour of the simulation built into the product that an instructor can view and then use as an overview for students. It is highly recommended that the instructor completes a full simulation run on their own to understand the nuisances before assigning to students.

Supplemental resources help students enjoy the simulation more and therefore, learn more. The authors have created short videos, detailed in Appendix B: Supplemental Instructor created materials that the reader may obtain by emailing angoliam@ecu.edu. Some were created with textbook PowerPoints to keep the explanations consistent with the reading but should be valid regardless of the text used. Additionally, SimProject® contains a full manual of instruction and many help features.

Additional suggestions for dealing with student problems are: 1) have students read the help information within the simulation, 2) provide short topic-specific, pre-recorded instructor videos, i.e. a 10 minute video on ways to deal with difficult employees, 3) link textbook sections to the simulation so students can use it as a reference, 4) create short one-on-one virtual meetings with students. The software includes several pop-up help screens to guide students. For grading purposes, the instructor can see inside each student's simulation run to look at their actual planning and execution which facilitates grading.

DATA ANALYSIS AND DISCUSSION

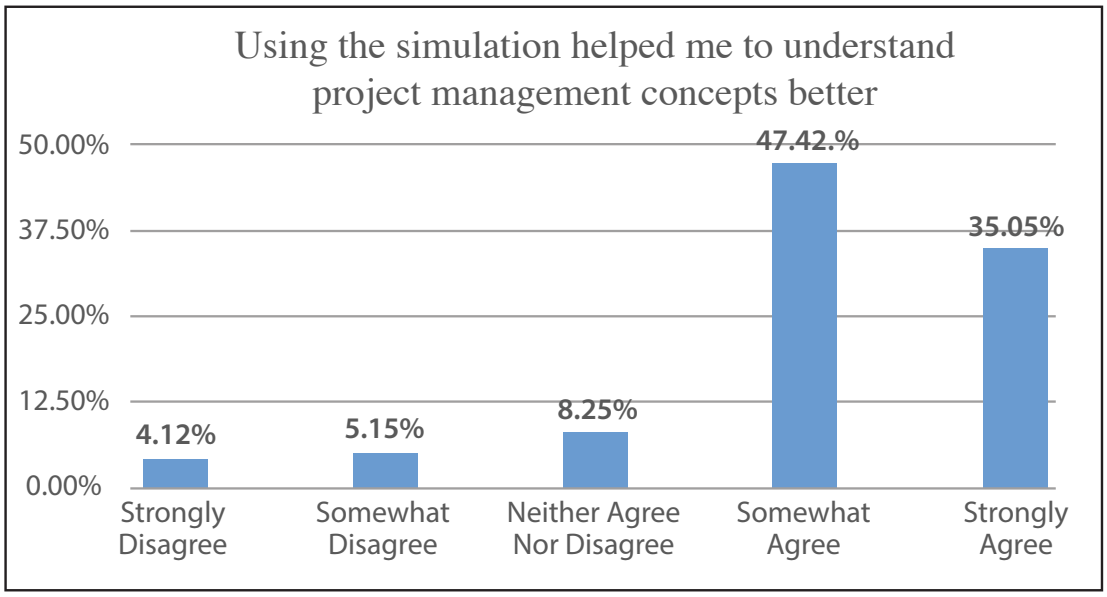
The primary goal of this research was to determine if the simulation added value to the process of learning project management in an online course. Secondary was determining which project management concepts were most successful. Each student completed an anonymous survey after turning in the simulation assignment but before receiving a grade. The charts and analysis that follows are based on the survey results. A total of 97 students used the simulation over four semesters. The majority were working, non-traditional students, and approximately half had some type of experience as a project leader\manager. For those with experience, the years of experience ranged from 6

months to 20 years. Since this research spanned four semesters, the researchers calculated results at various points across the three years when participant counts were lower and at the current total of 97 participants. Some differences were seen in the results and it became evident the results from 97 participants were more reliable than when results were calculated with 30 or 40 students.

The survey began with engagement-related questions since literature indicated an advantage of active learning is increased by student engagement (Prince, 2004). Only 2% of students did not find it engaging, while 88% found it engaging to some degree which is an extremely high percentage and enough to continue to include the simulation in the course.

Figure 2 shows results from a question that gets to the heart of this study, which is the impact of the simulation on learning. This question asked if the simulation helped provide a better understanding of project management concepts. The results were positive, with 82% of the participants agreeing the simulation helped with understanding, 8% neutral and 9% felt the simulation wasn't helpful.

Figure 2: Simulation learning impacts on Project Management concepts



One student commented: "I was not super familiar with Gantt charts, network diagrams, or the concept of earned value. This simulation helped me understand the functionality of these more fully. I have been able to understand and use these concepts more effectively in my other work as a result." Of those who saw no advantage, one commented on "gaming the system" to perform well while likely not understanding the concepts well.

Several questions were used to further explore the impact of the simulation on other course learning objectives, including some of the 10 Knowledge Areas from PMBOK 6th edition and project management tools such as Work Breakdown Structure (WBS), Gantt Charts, Network Diagrams and Earned Value. Students rated their perceived proficiency with concepts pre- and post-simulation, with results shown in Figures 3 – 6. When reviewing the charts, the first two columns which show ratings of "no knowledge" and "not proficient" are higher for the pre-simulation than the post-simulation indicating the number of students who felt they were not proficient decreased dramatically after the simulation. In the last two columns, which show ratings for "somewhat proficient" and "very proficient", are higher for post-simulation than pre-simulation indicating the number of students who felt they improved their proficiency level increased dramatically after the simulation.

It should be noted for each of the charts, the number of participants indicating they had "no knowledge" dropped to zero after the simulation. This was expected and validates the participant

responses were thoughtful. Additionally, the number of participants indicating they were "not proficient" decreased between pre- and post-simulation as was expected. Even though a few students still felt they were not proficient, the vast majority improved their knowledge and/or skill level after the simulation. These are impressive improvements; however, the authors acknowledge that other factors may have had some influence on the results.

Figure 3 documents if students developed proficiency, which is significant because managing time on a project involves balancing the commitment and skills of other people on a team. According to *An Introduction to Project Management, 6th edition,* risk management knowledge and skill levels are among the lowest of all project management skills utilized in practice, with risk being frequently completely overlooked (Schwalbe, 2017). Those that do practice risk management tend not to practice it well. One study indicates even experienced project managers often do not create a risk management plan (Reed and Angolia, 2018). In the simulation, cost management is practiced by staying within budget and using resources wisely. Figure 4's Risk Management chart shows student proficiency levels with a higher increase (39%) for "somewhat proficient" than any of the other Knowledge Areas. The benefit here is that many students learned to use a new skill through practice.

Figure 3: Scope and Time Management Proficiency

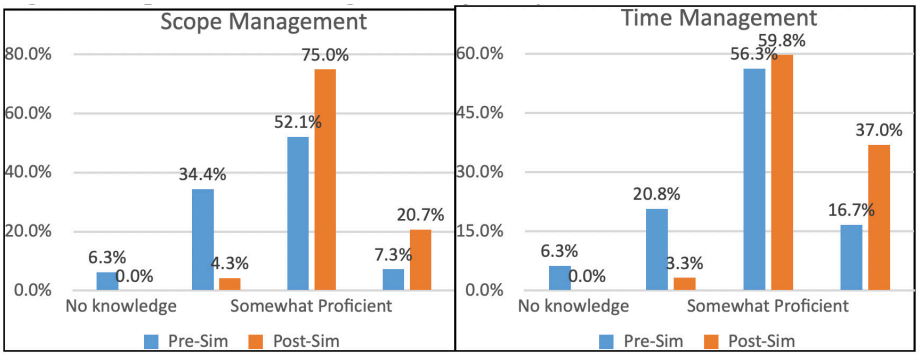


Figure 4: Cost and Risk Management Proficiency

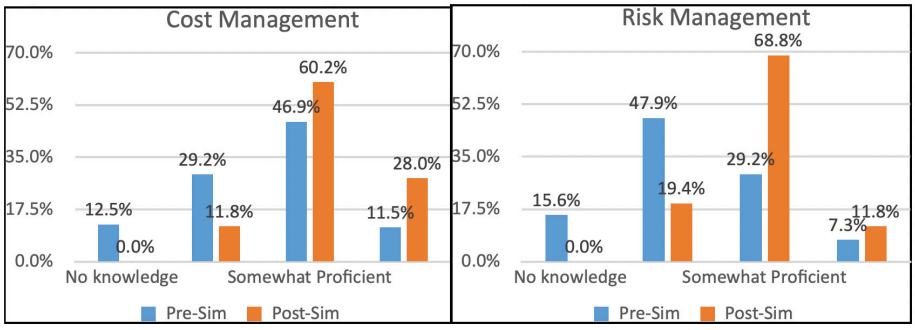


Figure 5 details the analysis for Human Resource Management and Communication Management. In the simulation, Human Resource skills are practiced by selecting the right resource for the task and working with individual resources when there are issues. These results likely occurred because topics on hiring and staffing issues had not yet been covered in the course, although experienced students might have some knowledge of these areas.

The Communication Management Knowledge Area results likely occurred because topics on communication had not yet been covered in the course, however, students with work experience were likely to have some knowledge of communication. The difference in communication on projects is the need to plan stakeholder communication based on the stakeholder's role, influence and personality and then carrying it out. In the simulation, communication is practiced by creating a communication plan before beginning the simulation and understanding the impact of not providing project status to stakeholders.

Figure 5: Human Resource and Communication Management Proficiency

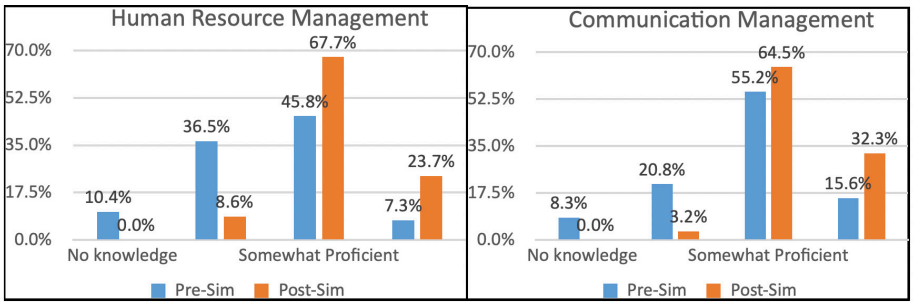
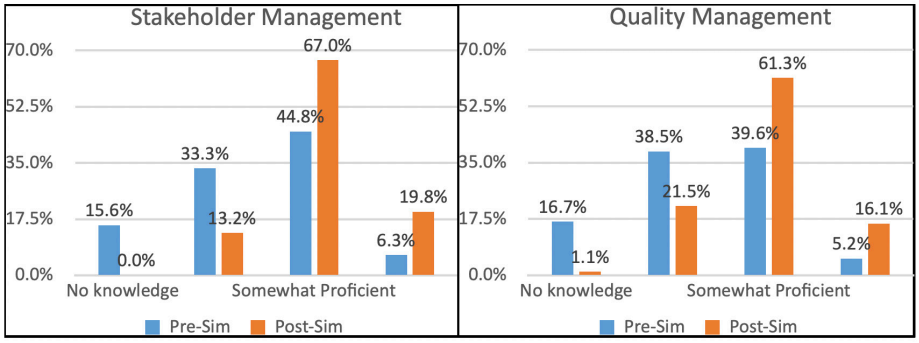


Figure 6 describes the final two knowledge areas researched. The Stakeholder Management Knowledge Area results likely occurred because advanced topics on stakeholders had not yet been covered in the course. Even students with work experience might be unfamiliar with managing stakeholders based on their roles and influence. In the simulation, the proper level of stakeholder management is documented by the communication plan, and stakeholders interject obstacles during the simulation which must be properly managed by the student.

The Quality Management Knowledge Area results likely occurred because topics on quality had not yet been covered in the course, and even students with work experience might be unfamiliar with quality topics. In the simulation, quality must be managed by maintaining a level of defects below a given threshold, which is one of the measures of success for the assignment. The textbook was available as a reference for both of the above topics.

Figure 6: Stakeholder and Quality Management Proficiency



The final step in the research was a lessons-learned meeting in which students were asked:

1. What went well?
2. What didn't go well?
3. What did you learn from the simulation?
4. What would you do differently next time?

These questions brought the learning full circle by having students reflect on their experiences and learn from one another. The greatest benefit seemed to occur during these online meetings as several commented this was an eye-opening experience. This was an essential part of the results because students often learned something additional from the reflections.

CONCLUSION

This research sought to determine the effectiveness of using a computer-based project simulation in a DE environment, and to determine which areas of project management were improved through the simulation pedagogy. The course included textbook readings to learn concepts as a prelude to the simulation active learning.

Overall, students found the simulation engaging, and in most cases felt the simulation improved learning, either on its' own or in combination with the textbook. Survey questions showed the simulation helped students to better understand project management concepts in general. Specific results indicated proficiency levels for "somewhat proficient" and "very proficient" rose impressively after the simulation for several Knowledge Areas: Scope (23% and 13%), Time (3.5% and 20%), Risk (39% and 4%), Human resources (22% and 16%), and Stakeholder (22% and 13%). One particularly striking student comment was on the ability of the simulation to make the project manager bring many aspects of project management together to be successful, "…it was challenging because it forces the user to integrate theory, application, and experience to strategically plan, execute the decisions, and manage unexpected events".

A crucial, yet expected per literature, result was the value lessons-learned activities, with several students indicating they learned better by doing than just reading, as demonstrated by the student comment: "I learn from doing not from reading, so for me, I learn more from completing this simulation than reading a textbook." Of course, the authors acknowledge there were a minority of students who did not like the simulation. One student, particularly frustrated by the limited response options for obstacles provided by the simulation, expressed frustration by saying: "This simulation was interactive, and it is easy to stay engaged and interesting. However, I found it to be unrealistic and frustrating in several matters."

That said, the results determined this simulation improved the learning of project management concepts and added value to the course for most of the students. By drilling down deeper into specific knowledge areas, it was possible to establish a positive relationship between simulation and learning outcomes for distance students, thus addressing the challenge project management instructors face in moving content into an on-line format.

Future research in this area may involve other types of project management simulations or other kinds of project management methodologies such as Agile. Additionally, the authors plan to revise the survey questionnaire to conform to 2021 PMBOK 7th (pending) and replicate the study.

REFERENCES

Bolton, M K. 1999. "The role of coaching in student teams: A "just-in-time" approach to learning." *Journal of Management Education* 23 (3): 233-250.

Chang, Y C, H Y Peng, and H C Chao. 2010. "Examining the effects of learning motivation and of course design in an instructional simulation game." *Interactive Learning Environments* 18 (4): 319-339.

Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. 2020. Simulation-Based Learning in Higher Education: A Meta-Analysis. *Review of Educational Research, 90*(4), 499–541.

Jeong, Ki-Young, and Ipek Bozkurt. 2014. "Evaluating a Project Management Simulation Training Exercise." *Simulation & Gaming* (Sage Publications) 45 (2): 183-203.

Leger, Charland P, H.D. Feldstein, J Robert, G Babin, and D Lyle. 2011. "Business simulation training in information technology education: Guidelines for new approaches in IT training." *Journal of Information Technology Education: Research* 10 (1): 39-53.

Neumann, D L. 2010. "Using interactive simulations in assessment: The use of computer-based interactive simulations in the assessment of statistical concepts." *International Journal for Technology in Mathematics Education* 17 (1): 43-51.

O'Neal, C, and T Pinder-Grover. 2005. "How can you incorporate active learning into your classroom?" *Active Learning Ideas and Tips.* Center for Research on Learning and Teaching, University of Michigan. Accessed 02 24, 2018. www.crlt.umich.edu/sites/default/files/resource_files/Active%20Learning%20Continuum.pdf.

PMI (a). 2017. "Project management Job Growth and Talent Gap 2017-2027." https://www.pmi.org/-/media/pmi/documents/public/pdf/learning/job-growth-report.pdf?v=c304efd3-8c2a-48dc-9489-a945a8a07614&sc_lang_temp=en.

PMI (b). 2017. *A Guide to the Project Management Body of Knowledge (PMBOK Guide).* Sixth Edition. Project Management Institute (PMI).

Prince, Michael. 2004. "Does active learning work? A review of the research." *Journal of Engineering Education* 93 (3): 223-231.

Reed, April H, and Mark Angolia. 2018. "Risk Management Usage and Impact on Information Systems Project Success." *International Journal of Information Technology Project Management* 9 (2): 1-13.

Reiser, B J. 2004. "Scaffolding complex learning: The mechanisms of structuring and problematizing student work." 13 (3): 273-304.

Schwalbe, Kathy. 2017. *An Introduction to Project Management, 6th Edition.* Minneapolis, MN: Schwalbe Publishing.

Shen, Y., Nicholson, J., & Nicholson, D. 2015. Using a group role-play exercise to engage students in learning business processes and ERP. *Journal of Information Systems Education, 26*(4), 265-280.

SimProject®. 2011. *Simulation powered learning.* http://www.fissure.com.

Untener, J. A., Mott, R. L., & Jones, B. Preparing students for industry by integrating commercial software into coursework. Paper presented at the *122nd ASEE Annual Conference & Exposition,* Seattle, WA. 1-13.

Wood, L C, and T Reiners. 2012. "Gamification in logistics and supply chain education: Extending active learning." *IADIS International Conference on Internet Technologies and Society.* Perth, Australia. 102-108.

Appendix A: Sample SimProject® Grading Rubric (100 points)

Project Completion Goals: within 10% of time (11 weeks), cost ($50,000) and defects (12)	
10	Final Cost
10	Final Duration
10	Final Defects Count
Planning Documents	
5	Budget (final version from planning)
5	Risk identification & estimate
10	Resource planning & allocation
Monitoring & Controlling: Weekly Execution Reports	
5	Response to Issues and conflict
5	Team motivation & happiness
5	Efficient use of resource time and availability; team productivity
Post-Project Documents, Charts and Graphs	
1	Final Gantt Chart
1	Quality Chart
1	Earned Value Chart
1	Estimate at Completion (EAC)
Required Meetings	
5	Attended SimProject® Introduction Online Session
5	Attended & Participated in Lessons Learned Online Session
Summary Report (Word Doc)	
5	Summary of Earned Value Results
10	Summary of use of charts, i.e. EAC, Quality, Gantt chart to monitor
6	Lessons-learned: insights, tips or warnings you would pass on about the simulation.

Appendix B: Supplemental Instructor created materials

Type	Description
Meeting Agenda	SimProject® Introduction with Demo and Q&A
Meeting Agenda	Lessons-learned
Quiz	Pre-simulation
Video	Overview of the assignment
Video	How to plan and allocate resources
Video	How to deal with conflict and issues
Video	How to identify and estimate project risks