STUDENT PERCEPTIONS ON THE USEFULNESS OF SIMULATION-BASED TRAINING

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The NASA Flight Operations Center Unified Simulation (FOCUS) lab is a high-fidelity simulation of an airline operations center. Its purpose is to train senior aerospace students to collaborate and communicate effectively with team members in a highly interdependent environment that mirrors the airline industry. Data was collected from the participants on their perceptions and the lessons learned from running the lab. These results were analyzed across eleven semesters over the last five years. Specifically, the quantitative data captured student perceptions about whether the lab was helpful in preparing them for their future job demands. The qualitative questions assessed their most important lessons learned, the problems they encountered, and their recommended changes.While there were some variances in student perceptions, teamwork and communication were repeatedly cited as being the most crucial variables to their success in running the virtual airline.

Airline operations are complex and demand multi-level coordination and communication among multiple teams to ensure safety and efficiency (Zaccaro, Marks, & DeChurch, 2012). Even as some issues are outside one's immediate control, such as hazardous weather and in-flight equipment failures, people can control how they react and take action to resolve issues. Integral to safe operations, teamwork training is woven into the airline industry for pilots, dispatchers, flight attendants, and many other entities. The NASA Flight Operations Center Unified Simulation (FOCUS) lab provides the platform for undergraduate aerospace students to improve and refine their non-technical teamwork, aeronautical decision-making, communication, and situational awarness skills. With 5 years of collected data, we felt it was appropriate to assess how the simulation lab has been helpful in improving their teamwork KSA's (knowledge, skills, and abilities) and review participant suggestions for revising or upating the simulation design.

Simulation-based training (SBT) is an excellent way to allow individuals to practice their technical and non-technical skills in a nonconsequential environment (Alinier, Hunt, Gordon, & Harwood, 2006; Beaubien & Baker, 2004; Lazzara et al., 2010; Shapiro et al., 2008). While the training efficacy of the NASA FOCUS lab has been confirmed (Littlepage, Hein, Moffett, Craig, & Georgiou, 2016), the perceptions of the participants were not formally analyzed prior to this study. As part of quality control going forward with the simulation training, it was important to analyze participant feedback after completion of the lab. As participant reactions to training can have implications for learning and transfer of training, evaluating how they felt about the simulation experiences and lessons learned is a vital educational component of the training (Morgan & Casper, 2000). According to the FAA (2005), collecting participant feedback after training has proven helpful to determine areas that can be strengthened. With the rapidly evolving technological and regulatory changes in the aviation industry, it is important to continuously monitor the realism of the simulation design, scenarios, and debriefing procedures.

Method

Participants

572 senior-level aerospace students participated in this research while enrolled in their capstone course. These students came from different aerospace majors including professional pilot, flight dispatch,

maintenance management, aerospace administration, aerospace technology, and unmanned aircraft systems. They worked together in teams comprised of approximately ten students. Each student was assigned to a position in the flight operations center simulation (described below). These positions are similar to those typically found in airline operations.

Simulation Lab

The FOCUS Lab is a high-fidelity simulation of a true flight operations center. Upon entering the lab, students are onboarded to a simulated airline, Universal E-lines, and trained in their respective positions before participating in a simulation. Positions include the Flight Operations Coordinator, Flight Operations Data, Flight Operations Scheduling, Maintenance Planning and Control, Crew Scheduling, and Weather and Forecasting. Ramp Tower Coordinator is in an adjoining room. Pseudo Pilot is in a separate, nearby location and the CRJ Pilot Crew is off-site flying a simulator connected to the lab's software. During the simulations, teams work together to release flights and solve problems as they arise during their shift. They participate in three simulations throughout the duration of the semester and review their performance in an After Action Review (AAR) following each simulation. See Littlepage, Hein, Moffett, Craig, & Georgiou, 2016, for an in-depth description of the lab.

Procedure

Data were collected over the last five years across eleven semesters with three to six teams participating in the lab each semester. After being onboarded to Universal E-lines, students participate in three simulations that act as their "work shifts" lasting approximately two and a half hours. During the simulations, participants completed their position's job duties while coordinating with other team members to solve various problematic scenarios that arise. The overall goal is to release flights safely and efficiently. A week after each simulation, participants engage in an AAR (After Action Review) to discuss their performance in the lab including what went well, what did not go well, and what behaviors led to various outcomes. Following the third simulation and associated AAR, all students completed an evaluation of the lab wherein they were asked quantitative and qualitative questions regarding what they learned, problems they encountered, and what they would change about their experience.

Two researchers separately content coded the qualitative comments. The first rater content coded the comments and developed the overarching categories for each qualitative question. Then, these overarching categories were given to the second rater and the second rater content coded the comments according to those categories. Inter-rater reliability was assessed using Cohen's Kappa to adjust for chance agreement. Then, a third researcher assessed all of the comments for which coders disagreed and made an expert judgment as to the final codes for frequency calculations.

Measures

Although participants take many measures throughout the duration of their participation in the FOCUS Lab, the measure of interest for this study is the FOCUS Lab Evaluation. This measure consisted of five quantitative items and four qualitative questions. The five quantitative questions were rated on a scale from 1 (Strongly Disagree) to 6 (Strongly Agree) and were as follows: "The FOCUS Lab experience helped me learn how my aerospace specialization relates to other specializations," "The FOCUS Lab experience helped me understand the work of other specializations," "The FOCUS Lab experience helped me understand the need for good communication among specializations," "The FOCUS Lab experience helped me understand the need for coordination among specializations," and "The FOCUS Lab experience will help me with the job demands as I start my professional career." The qualitative questions were, "What is the most important thing you learned in the FOCUS Lab this semester," "What were some of the problems you encountered in the FOCUS Lab that prevented smooth operations,"

"What would you change about the FOCUS Lab and your experiences in the lab to help future students," and "Is there anything that should have been included in the previous classes that would have made you better prepared to work in the FOCUS Lab." As described above, the qualitative questions were coded for content and then recoded by a second coder to assess inter-rater reliability.

Results

Inter-rater agreement was .78 and Cohen's Kappa was .75. The average rating of each of the five quantitative items assessing the understanding of specialization relationships, the work of specializations, the need for communication, the need for coordination, and the perception that the lab prepared them for job demands were all relatively high (M = 5.16, M = 5.18, M = 5.47, M = 5.45, M = 4.96, respectively). See Table 1 for the breakdown of these average ratings across semesters. Overall, ratings were stable across time.

Table 1.

Average Ratings of Quantitative Items across Semesters.

Semester	How Specializations Relate	Understand Specializations	Communication	Coordination	Job Demands
Fall 2011	5.28	5.38	5.69	5.67	5.11
Spring 2012	5.04	5.02	5.36	5.33	4.78
Fall 2012	5.16	5.26	5.53	5.42	5.32
Spring 2013	5.21	5.30	5.51	5.49	5.10
Fall 2013	5.14	5.16	5.55	5.43	4.84
Spring 2014	4.96	5.12	5.24	5.23	4.96
Fall 2014	5.11	5.11	5.44	5.39	4.94
Spring 2015	5.34	5.28	5.45	5.45	5.15
Fall 2015	5.13	4.82	5.50	5.53	4.69
Spring 2016	5.37	5.46	5.54	5.63	4.89
Fall 2016	4.58	4.58	5.13	5.08	4.58

In order from highest to lowest frequencies, the categories derived for each question and examples of qualitative comments are described in Table 2. The frequency of responses in each category for each question are in Table 3. Results indicate that for question one, the two most frequently listed responses for the lessons learned were in relation to communication/coordination (N = 189) and teamwork (N = 129). For question two, encountering problems, many students indicated that miscommunication was an issue (N = 124); this result clearly mirrors the results in question one with the emphasis on communication. Other problems encountered during the simulation included the scenarios (N = 92) and lack of knowledge or deficit in training (N = 80). The most frequent comment for question three, recommended changes for the lab, was a request for more training (N = 112). Finally, in question four, which asks about whether they would include previous classes before the lab, most individuals indicated that no additional classes were needed (N = 160).

Table 2.
Comment Coding Categories and Example Comments for Each Qualitative Question.

Question 1: Most Important Lesson Learned *Categories 1-7*	Example Comment
1. Communication/Coordination	Communication is essential to a positive outcome
2. Teamwork	How to better my teamwork skills….
3. Airline Functions	I learned valuable information about flight operations…
4. Other	The operation system
5. Knowledge of Team Member Roles	The understanding of the work in other job areas
6. Staying Calm/Positive Atittude	Stay calm, trust your FOC, talk to someone when you need help
7. Attitude to Detail/Thinking Ahead	You have to pay close attention to every detail

Question 2: Problems Encountered *Categories 1-8*	Example Comment
1. Miscommunication / Lack of Communication	Lack of good communication. Some information was never received…
2. Scenarios / Workload	Weather delays and closures and emergencies during flight
3. Knowledge/Deficit Training	Lots of inexperience
4. Technical Difficulties	Glitches in the system, technology difficulties
5. Other	Poor planning from FOC
6. Attitudes / Stress	People becoming stressed and losing situational awareness
7. Lack of Resources/ Absences	Missing team members, people not arriving early
8. Situational Awareness/ Anticipating Problems	Not everyone was ahead of the SIM

Question 3: Changes That Could Improve the Lab *Categories 1-9*	Example Comment
1. Training	Maybe allow extra time to learn how each position works
2. Nothing	I would change nothing
3. Time in the Lab	More labs if time permitted
4. Resources	Warning lights when approaching deadlines
5. Other labs	Get students to interact with each other between labs
6. Position Specific	I would have the FOC and FOD sit beside one another
7. Communication	Standard way of communication will help
8. Pilot/Ramp More Involved	Allow pilots to preview another team's sim session
9. Technical	More reliable communication devices

Table 2. Continued
Comment Coding Categories and Example Comments for Each Qualitative Question.

Question 4: Anything That Should Have Been Provided in Previous Classes to Prepare for the Simulations *Categories 1-5*	Example Comment
1. No	No. Classes prepared me pretty well
2. Other	Some time to get to know everyone in the group
3. More Training	More training time and a longer intro sim
4. More Classes	Maybe a communication class…
5. Learning About Other Positions	A overview of each position

The frequencies of these comments were also analyzed across time, indicating that there were not substantial changes across semesters. Students consistently valued communication, coordination, and teamwork as important lessons and consistently reported miscommunication as a major problem. They also consistently highlighted the contribution of training in the lab and reported that no additional classes are needed for preparation. Although these are the most frequently occuring comments, the particpants made a variety of other significant comments that underscore other learning experiences including the value of staying calm, the necessity for adequate resources, and situational awareness.

Table 3.
Frequency of Comments for Each Qualitative Question.

Content Category	Q1Freq	Q2Freq	Q3Freq	Q4Freq
Category1	189	124	112	160
Category2	129	92	51	80
Category3	35	80	50	41
Category4	30	62	40	28
Category5	21	36	36	27
Category6	18	28	28	
Category7	15	24	27	
Category8		14	24	
Category9			23	

Conclusion

Overall, this research highlights students' perceptions of the lab's value in teaching them how to communicate, coordinate, and work as a team. In their future careers, they will need to break out of their educational silos to effectively work as a team and develop creative solutions to abnormal problems. Participants clearly see the value in the lab and its ability to prepare them for the workplace. Based on their feedback, the most important lessons learned were the criticality of teamwork, communication, and coordination. Further, the most frequent change request was for more training. In direct response to this

qualitative feedback, job aids, Captivate training, and PowerPoint training modules were developed for individual positions. A downstream consequences training was also developed for students to better understand the larger impact of decisions made in response to an immediate problem. Overall, based on their quantitative and qualitative feedback, participants seem to value the lab along with its immediate educational benefits and its contribution toward students' future careers.

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