Research Questions

The following research questions were adopted in the TCP Phase II research.

1. What are the usability and feasibility issues our customers experience when playing the game?
2. What critical user interface, gameplay mechanics, and content do customers value in this and related games?
3. Are there differences in gameplay time between students with and without disabilities?
4. Are there differences in gameplay proficiency scores between students with and without disabilities?

Research Design

A cross-sectional research design was employed because of the reliance on existing group differentiation (i.e., disability vs. no disability) and the geographic diversity across research locations. This design is beneficial for measuring differences rather than causal changes, which might be found in an experimental study, and is therefore appropriate for phase II product testing.

Power Analysis

A power analysis was conducted using G*Power V3.1 (2009). A t-test with mean score differences across two groups was selected. A one-tail input parameter was established with power at 0.5 (i.e., medium effect size), error probability at 0.2, and power at 0.8. The estimated sample size for the calculation was (n=23) per group or N=46 for the total sample.

Sample Selection

During the spring semester of 2019, the final game build was formally tested in two diverse middle schools (i.e., grades 6-8) containing students with and without disabilities. All students at both schools were invited to participate. Gender and grade distribution of the participants is shown in Table 1. Demographic of the students with disabilities are shown in Table 2. Six hundred thirty-two students participated in the product evaluation.

Procedure

An implementation protocol was developed, piloted, refined, and shared with members of the research team and teachers with students participating in the study. At the beginning of the class period, students received a tutorial on the user interface (UI) features included in the simulations. Students demonstrated their ability to successfully use UI features. Students were able to choose a career simulation to play through during the evaluation period. All virtual careers were played by > 40 students. After playing each simulation, they responded to an online survey and participated in a post-simulation semi-structured interview with members of the research team. Questions addressed usability and feasibility, additional features they would like to see, and

additional careers they would be interested in playing. Students provided information about their individual perspectives on the careers.

Table 1. Sample characteristics.

Variable	Number	Percent
Male	374	59.2
Female	258	40.8
Grade Level		
6	185	29.3
7	306	48.4
8	141	22.3
Disability		
	33	5.2
Race		
Decline to State	89	14.2
White	396	63.2
Black or African American	56	8.9
American Indian or Alaska Native	11	1.8
Asian	34	5.4
Other	41	6.5

Note: The national percentage of students with high incidence disabilities in middle school is equivalent to the percentage represented in this sample.

Analysis

Qualitative analysis of RQ1 & RQ2 was based on observational data and field notes collected by the research team during student game-play. In addition, Qualtrics survey responses, post-play semi-structured interviews with students, and semi-structured interviews with their teachers served as data sources. A parent survey link was distributed using social media to parents and teachers of students with disabilities in the target audience (i.e., students with disabilities aged 12 - 17). Responses to the Qualtrics surveys were coded by categories and themes. Units of data were sorted by regularities and irregularities into tentative categories and subcategories.

Quantitative data was collected using the TCP online dashboard system. This information was compiled with data from the Qualtrics interviews and teacher reports about the types of student disabilities represented in the sample. This allowed the research team to compare students with disabilities to their peers without disabilities. Click trails (i.e., the students' virtual path through the simulations) provided time stamps for the completion of each objective in the simulation as well as an overall time-per-career simulation. Skewness (0.178) and kurtosis (-1.7) for the sample were within acceptable ranges and confirmed through visual inspection of the histogram. This data was utilized during an independent samples t-test to answer RQ3 & RQ4.

Results

RQ1: What are the usability and feasibility issues our customers experience when playing the game?

Students reported very limited usability and feasibility issues on the iPad (iOS 12.3.1) with one exception, they had difficulty manipulating the slider bar rating scale, which was meant to indicate their affinity for a given career. Teachers and parents reported the simulated environment provided opportunities for young people in their communities to access STEM careers that would be otherwise unattainable. Overall, students felt the careers in TCP represented a balance of knowledge and skills that were challenging and engaging while teaching STEM content. In order for all of the accessibility features in the simulation to be accessible to students without distracting their peers, it became apparent that headsets (or earbuds) would be required for classroom use.

RQ2: What critical user interface, gameplay mechanics, and content do customers value in this and related games?

Students appreciated the ability to customize their virtual characters by gender, hair, and eye color. They also appreciated the positive prompting and reinforcement from the virtual mentor. The virtual phone was considered particularly relevant due to its practicality and mechanisms for supporting executive functions such as planning, task initiation and completion, and short term memory. Students enjoyed being able to play through an entire day in the life of a career and found it useful to witness firsthand the types of tasks involved on an average day in the life. Students and teachers also appreciated the length of each simulation (i.e., 20 - 30 minutes) as it allowed for a briefing and debriefing associated with each career prior to the end of class.

Finally, students and teachers reported the decision trees within each simulation reinforced positive social aspects of the careers. For example, when a person's boss asks them what they accomplished during the course of a day, the player gains points by making eye contact, smiling, and asking the boss to come in and sit down so he or she can be shown exactly what the employee completed.

RQ3: Are there differences in game play time between students with and without disabilities?

Due to the difference in group size, a random sample of 30 students without disabilities was selected for analysis. To control for students who played various careers over multiple sessions, the average game play session time was calculated for each group of students. Average session times were used to conduct an one-tail t-test. Results of the independent samples t-test indicated a significant difference in the average session time, in seconds, between students with and without a disability when playing the simulations. Students with disabilities n=30 (M = 1021.5, SD = 533.8 seconds) participated in more simulation time than their peers without disabilities n=30 (M=606.5, SD = 254.9 seconds); $t(58) = 3.77$, $p<0.05$, $d=0.99$. Inspection of the dataset indicated students with disabilities spent significant additional time outside of the classroom in informal environments playing the simulated careers. This provides preliminary evidence the virtual environments, or at these career simulations, may be more engaging for students with disabilities than those without disabilities.

RQ4: Are there differences in game play proficiency scores between students with and without disabilities? An independent samples t test was conducted with students' overall proficiency score in the game as the dependent variable and group (disability vs. no disability) as the independent variable. When students with disabilities n=32 (M=29.7, SD=18.9) were compared to students without disabilities n=32 (M=37.3, SD=21.7) there were no statistically significant differences at the p<.05 level; t(62) = -1.38. The lack of differences implies the UDL features in the simulations provided students with flexible means to demonstrate their understanding of the STEM content in diverse ways.

Section 2. Problems encountered and methods of resolution used.

Generally, no problems took place during research implementation. The initial build was established for laptop or desktop play. This presented a problem for implementation in schools that had adopted iPADs. The simulation builds were then ported for tablet usage. The process of porting took extra time to ensure the integration was seamless. After internal usability testing to ensure the gameplay dynamics maintained on the tablet port, the research began.

Section 3. Problems remaining or unfulfilled research objectives

No problems exist, all research objectives were fulfilled.

Section 4. Unexpected or serendipitous results, information or events which may have altered the direction of the project. The impact these results may have on the potential transition into similar or related research or products.

- The integration of the tablet proved to support wide acceptance by the students and easy distribution for the schools. This research along with the on-going market research indicates there is a need to move to a fully web-based system that supports flexibility on a variety of devices. Efforts are now underway to move current simulations to a web-based platform.
- The difference in gameplay time between students with and without disabilities should be investigated further. A variety of reasons could contribute to these differences.

For instance, individual student conditions in cognitive processing associated with the interaction of the games could support these times. Or as one student discussed, "taking time to make the right decisions" indicates some students are meticulous about decision making when playing the simulations. Future research should focus on potential interactions among gameplay, student, and environmental characteristics, especially related to individual disability characteristics.

- Providing further investigation relative to the motivations for students with and without disabilities to play the simulations, unassigned, after school hours is of interest to the research team. The team found it interesting to see so many students, especially those with disabilities, play career simulations after school hours. According to the educators, none of the students were assigned to play any of the careers after the school day. The identification of moderating factors for this finding is intriguing and warrants further investigation.