Using Gaming Technology to Teach Responsible Conduct of Research

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Introduction

Plagiarism and other research misconduct issues are an emerging trend at academic institutions across the country. The discipline of engineering is particularly affected.[3] Professors are seeking ways to incorporate Responsible Conduct of Research (RCR) and combating plagiarism into their classes. Frequently, librarians are being asked to fill this educational need. In this era of "point-of-need" or "just-in-time" services especially relating to instruction, it is beneficial for librarians to explore resources that utilize an online learning environment such as tutorials, guides, and games. Adoption of such an approach has advantages for large institutions where there is a high patron to librarian ratio. This paper will detail the evaluation and application of an anti-plagiarism game targeting STEM (Science, Technology, Engineering, and Mathematics) graduate students at the University of Florida and several partner institutions. A brief history of the NSF grant-funded Gaming Against Plagiarism (GAP) project[4], an update on the game's completion in August 2012, findings related to usability testing and evaluation, scalability of the project, and a demonstration of the game will be presented. Instructions for accessing and adopting this game will also be included.

Background

At the 2011 American Society for Engineering Education Annual Conference the University of Florida science librarians introduced the GAP project.[1] Details regarding the background and rationale related to this project were published in the associated paper. The goal of this grant funded project was to "...create an online, self-directed, interactive game that will provide a role-adopting environment in which Science, Technology, Engineering, and Mathematics (STEM) graduate students will learn to recognize and avoid plagiarism."[1] This project, completed in August 2012, yields three mini-games with an overarching narrative to help students recognize what constitutes data falsification, data fabrication, and plagiarism (FFP). These three topics are of great importance to learning what the NSF and many other research bodies refer to as Responsible Conduct of Research (RCR). Students who play all three games also have the ability to acquire a certificate of completion.

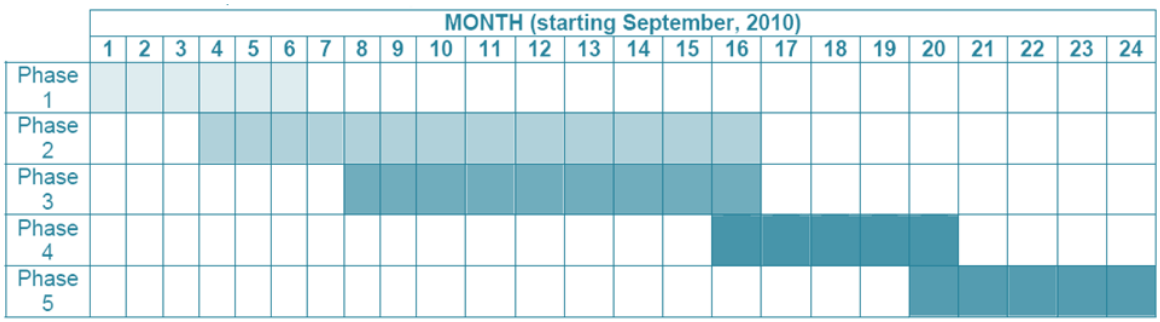
Grant Phases

This 24-month grant project ran from September 2010 to August 2012. Due to the significant workload and short funding period, the project was broken down into 5 major phases and an *initial* month by month plan (Table 1) guided progress towards project goals:

- Phase 1: Content Development (Pre-production visualization)
- Phase 2: Game Development

- Phase 3: User Testing
- Phase 4: Implementation
- Phase 5: Evaluation

Table 1: Month by Month Plan



The Content Development Phase

Librarians took the lead on the Content Development phase. As seen in the timeline above, this phase took the first six months of the project period. Buhler, et al published a detailed description of how the initial content for this project was produced .[1] In reality, this phase stretched across the entire Game Development and User Testing phases as changes were made throughout the process based on feedback from various sources (i.e. rapid prototyping).

The Game Development Phase

As described in the previous paper,[1] focus groups were used to gain feedback on several potential design metaphors, prototypes, and play styles. As a result, the Development team created a set of three mini-games with an overarching narrative. The games use Flash as a delivery method because it is freely available and has an easy to install plug-in for browsers. These games utilize a scaffolding approach where the concepts introduced in the first game are built upon by the subsequent games. In addition, the Development team also made it possible for each mini-game to be played individually. For example, if professors/librarians chose to use these games to augment a face-to-face course, then this will allow them to introduce concepts at their own pace and engage students in a dialogue after playing one or all of the games. Delays from the Game Development phase to the Implementation phase extended through Month 20. Listed below are the educational goals of each mini-game along with descriptions and images. Each game has its own look and feel, many of which took inspiration from the commercial gaming market.

Mini-Game 1: Cheats & Geeks

Goal: Introduce players to the concepts of Plagiarism, Data Fabrication, and Data Falsification

Description: In this board-style game (Figure 1), players race against a virtual opponent to present their research. Players are tempted by the opportunity to advance faster by committing

research misconduct including plagiarism (copying the opponent's place on the board), data falsification (moving forward without a roll of the die), and data fabrication (creating a new path on the board). However, they have to watch out for rising suspicion levels and peer reviews in the form of pop quizzes (Figure2) that test their knowledge of research misconduct. The first player to reach the convention wins, but getting caught violating the ethics code could land them in the Research Ethics Office.

Figure 1: Overall layout of Cheats & Geeks

Figure 2: Example of pop quiz in Cheats & Geeks

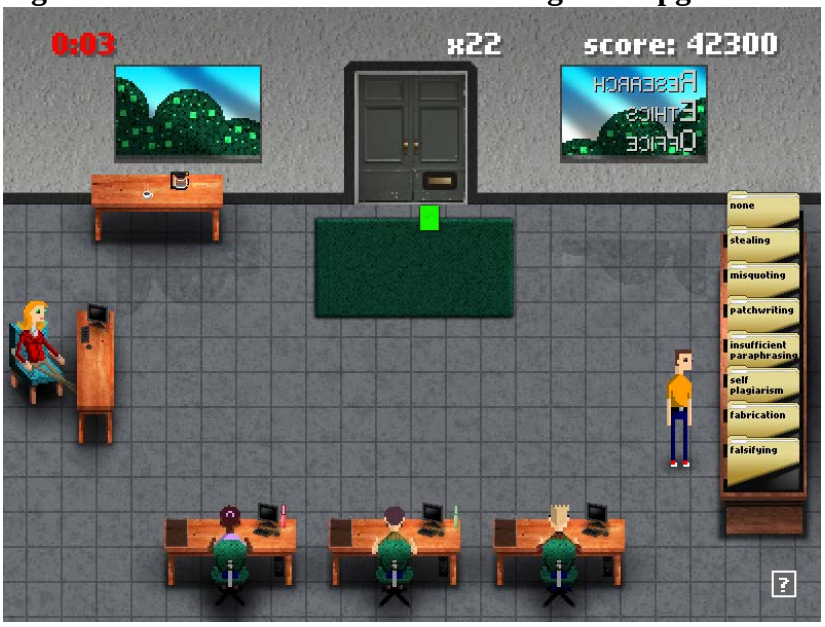
Mini-Game 2: Frenetic Filing

Goal: Identify the various types of plagiarism and correctly organize them into categories

Description: With plagiarism rampant on campus, graduate students are assigned to assist with cases in the Research Ethics Office. In this fast-paced arcade game players review cases, define the type of plagiarism, and file them according to the type of misconduct. Players begin in Training mode (Figure 3) and then advance to Arcade mode. Like "Diner Dash" this game is a race against the clock to get as many cases processed as possible before time runs out. Players earn in-game upgrades, like coffee and sneakers, to improve their speed of reviewing and filing cases (seen in Figure 4).

Figure 3: Training mode of Frenetic Filing

Figure 4: Arcade mode of Frenetic Filing with upgrades



Mini-Game 3: Murky Misconduct

Goal: Analyze and evaluate complex ethics scenarios and develop a case against potential violators.

Description: In this noir detective game, players begin work as a plagiarism investigator in the Research Ethics Office (Figure 5). They evaluate suspect papers, track down evidence across campus, and compare passages for specific research misconduct violations (Figure 6). Once players identify a violation and have sufficient evidentiary support, they confront the perpetrator.

Figure 5: Murky Misconduct welcome screen

Figure 6: EthiScan 3000 used to gather evidence and evaluate sources

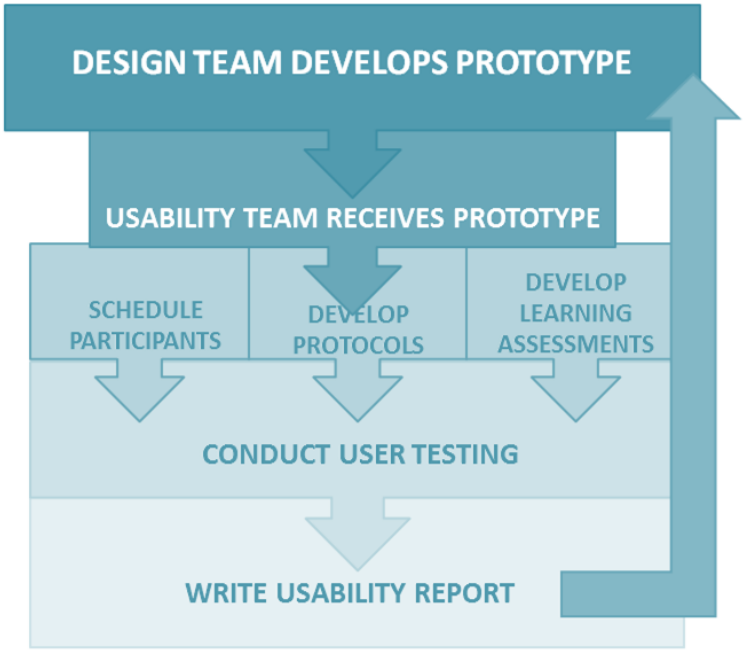
The User Testing Phase

The original goals of the User Testing phase were two-fold: 1) to ensure the user interface was intuitive, and 2) to gather STEM graduate student feedback to inform game development. It was initially thought that user testing would focus solely on game mechanics; however by the first round it was revealed that the feedback did not just benefit the game design, but also the content. Key activities outlined in the planning phase called for the team to "develop testing protocols, recruit STEM graduate students for tests, analyze testing data," and "use feedback to inform further prototypes for beta version."[1] This testing cycle was modified to include delivering feedback to the content team in addition to the development team. As the Game Development phase expanded, so did the User Testing phase. It was necessary to run the two phases concurrently.

The team met prior to the first round of user testing and discussed what each stakeholder was hoping to learn from the user testing sessions. This process was critical to cementing a shared vision of the process for librarians, game developers, and the external evaluator. Each team member had very different viewpoints of the process and upfront discussions about turnaround times, expectations, and possible outcomes made the usability process run smoothly. By the end of these discussions everyone on the team understood how the usability process worked and knew that they would be able to get useful information that would improve the game.

To evaluate the playability of the three mini-games, the team created a user testing cycle that roughly followed the diagram shown in Figure 7. During the testing, each team member had

Figure 7: The User Testing Cycle



specialized roles to expedite the process. The overall test cycle was completed in 15 working days, from the time of game delivery to the completion of the written usability report.

Week one: Team members were pre-assigned to schedule participants, develop user testing protocols that were specific to the current game iteration, or design learning assessments. As soon as a game prototype was delivered, the team sprang into action. STEM librarians contacted graduate students in the College of Engineering and the NSF-funded I-cubed program to recruit and schedule 3-5 participants. Simultaneously, a sub-section of the content team met to develop relevant user testing protocols and submit for IRB approval if the protocol differed from the original IRB approved protocol. For each iteration, all team members, including the external evaluator, received final protocols to ensure that learning assessment was addressed.

Week two: One week after the game prototype delivery, two librarians met with each of the 3-5 scheduled participants. One librarian served as the session facilitator, following the established testing protocol. The facilitator led participants through a game play experience followed by a semi-structured interview. The second librarian served in the role of observer, taking notes and carefully observing how the student interacted with the game. Many of the sessions were video recorded for the purposes of accuracy. Immediately after each session the observer typed up notes and produced a summary of important elements for the User Testing team.

Week three: In the final week of user testing the team developed a summary report that analyzed the most important feedback across users. This report always followed the same structure – an executive summary, suggestions for future iterations (ranked from high priority to low priority), and a summary of positive/ negative feedback. The reports also included appendices with the protocols and the complete notes from the usability testing sessions. This report was distributed to the Development Team, Content Team, and Evaluation Team at the completion of each test cycle.

The original *Game Development and Usability Plan* involved 8 prototype test cycles lasting from April 2011 through October 2011. In reality, the game delivery dates were delayed and involved only 4 prototype test cycles lasting from October 2011 until April 2012. Due to these delays, the Implementation and Evaluation phases needed to be rescheduled.

Findings/ Results

Through User Testing glitches/software bugs were discovered with the interface as well as confusing elements of the content. The process allowed for the revision of content and redesign of the interface to meet user needs. For example, during testing for mini-game 3, *Murky Misconduct*, it was clear that participants were having difficulties collecting evidence across campus. In fact some players opened browser windows and searched for article titles in online databases rather than staying within the game world. After user testing, the need for tutorials to walk students through the evidence collection process was apparent. This resolved an interface issue. Similarly during User Testing for mini-game 2, *Frenetic Filing*, we observed issues with

students correctly matching definitions. This appeared to be a content issue rather than a game mechanics issue. Team members used card sorting and diagraming to redesign the definitions and remedy this problem.

All the protocols included the question, "if you had to change one thing about the game, what would it be and why?" This question yielded the best results, often pointing out creative solutions for improving the game that we had not considered as designers. Elements such as character choice, help pages, and replay-ability features were all introduced by user testing participants.

Overall the games were improved by critical analysis from a diverse group of STEM graduates.

The Implementation Phase

The fourth phase focused on the implementation of the game. The goal of this phase was to distribute the game to internal (UF) and external (participating institutions) STEM departments. To support this goal, the librarians and the grant's external evaluator developed a pre-test to collect demographic information, to measure the students' knowledge of FFP, and to sample attitudes toward FFP prior to playing the game. The same questions from the pre-test were used at the end of the game as a post-test to see if any new knowledge was gained after playing the game. As mentioned earlier, the participants could log in to the game, save their games, and then receive a certificate of completion of the games.

The Evaluation Phase

Methods

A pre-test and post-test were created to collect demographic information, to test content knowledge, and solicit attitudinal data. Students from UF and the other participating institutions were given the pre-test, given access to the three games, and then given a post-test.

Findings/Results

There were a total of 76 participants who took the pre-test, 69 who took the post-test. A majority of participants (~82%) were in the 21-29 age group. Gender was split 50/50, and a majority of students came from the United States (62.3%) followed next by India (18.8%). Most of the participants were obtaining their Ph.D. (72.5%) and were studying in Engineering or in the Physical Sciences.

In the pre-/post-test, one question asked students to identify types of misconduct based on a variety of situations. This question mimics the drill in mini-game 2, *Frenetic Filing*. The charts below show the percent difference between responses from both the pre-test and post-test. These results are segmented between the participants that self-identified as engineering students (n=28) and all respondents to the pre and post-test surveys (n=76 and n=69 respectively).

The results for the self-identified engineering students demonstrate an increase in knowledge between pre and post-test for 89% of the example situations where misconduct occurred (Table 2). However, all participants, including engineering students, perceived misconduct in situations where there was no misconduct (Table 3). The GAP Team hypothesizes that this could be attributed to hyper vigilance that resulted from playing the series of games.

When comparing the pre and post-test responses between engineering students to the total, there are some measurable differences across pre- and post-test scores. Although the project's external evaluator states that there are no significant differences between the pre and post-test scores, overall there is a slight gain of knowledge after playing the games based on these scores.[2] The external evaluator validates that for the overall pre and post-test results "*there was a significant difference in test scores between users based on their country of origin*. Students from the United States scored significantly higher in the pre- and post-test scores than their international counterparts. US students scored 84% in the pre and post-tests while non-US students scored 72% in the pre-test and 69% in the post-test. The difference between pre- and post-test was not significant within the groups but it was significant between the groups at both tests".[2]

Table 2

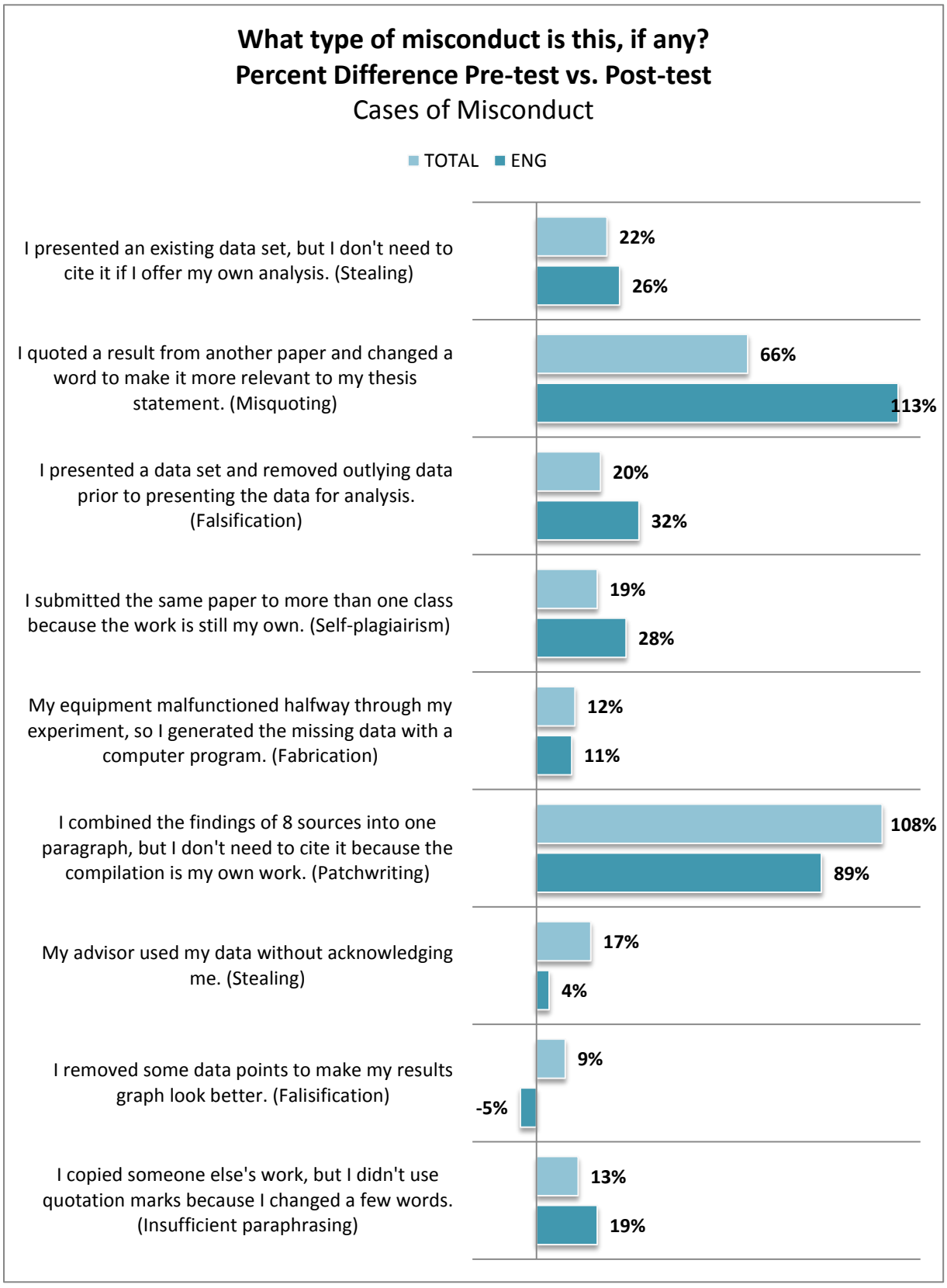
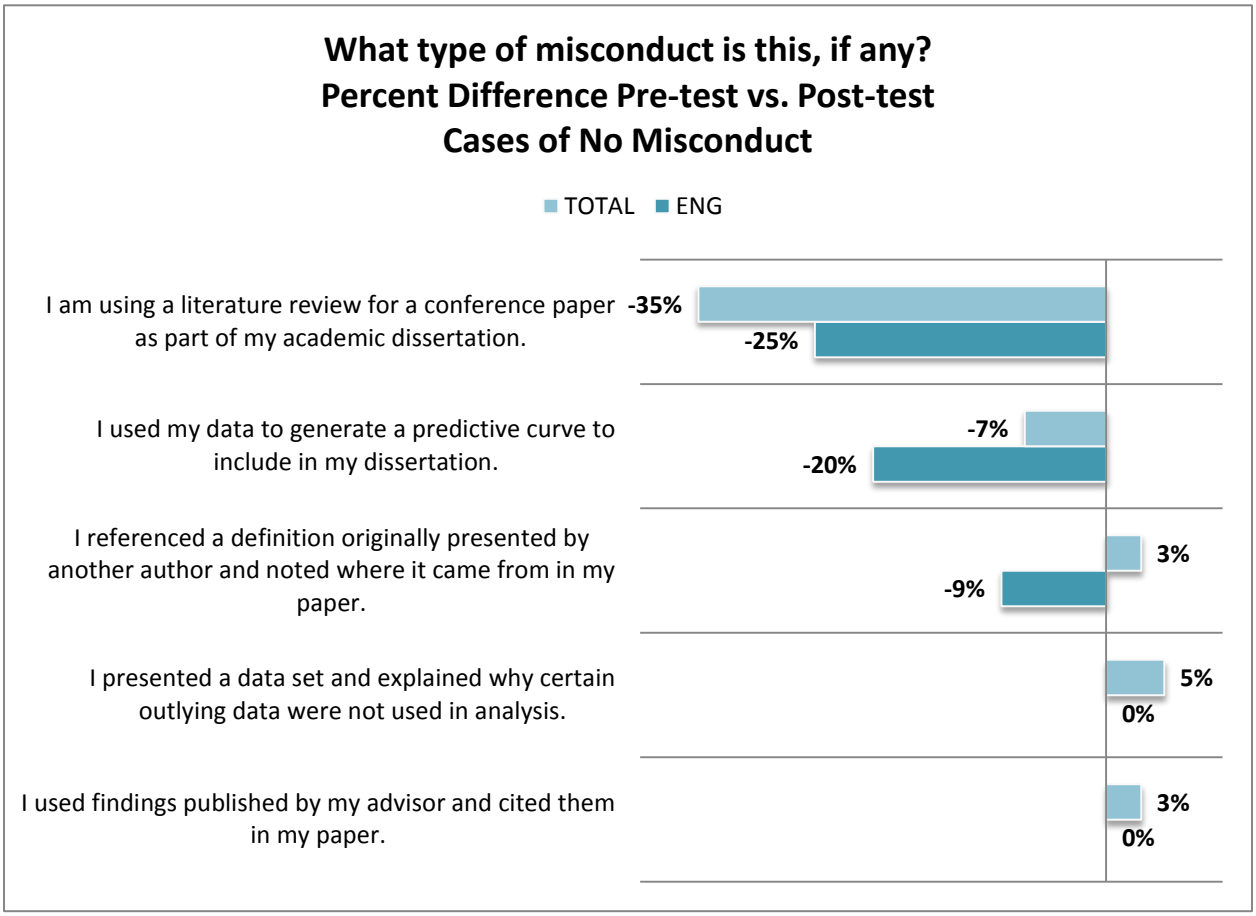

What type of misconduct is this, if any?
Percent Difference Pre-test vs. Post-test
Cases of Misconduct
TOTAL
ENG
I presented an existing data set, but I don't need to cite it if I offer my own analysis. (Stealing)
22%
26%
I quoted a result from another paper and changed a word to make it more relevant to my thesis statement. (Misquoting)
66%
113%
I presented a data set and removed outlying data prior to presenting the data for analysis. (Falsification)
20%
32%
I submitted the same paper to more than one class because the work is still my own. (Self-plagiairism)
19%
28%
My equipment malfunctioned halfway through my experiment, so I generated the missing data with a computer program. (Fabrication)
12%
11%
I combined the findings of 8 sources into one paragraph, but I don't need to cite it because the compilation is my own work. (Patchwriting)
108%
89%
My advisor used my data without acknowledging me. (Stealing)
17%
4%
I removed some data points to make my results graph look better. (Falisification)
9%
-5%
I copied someone else's work, but I didn't use quotation marks because I changed a few words. (Insufficient paraphrasing)
13%
19%

Table 2



Discussion

While overall, online games-based learning is an innovative approach with several benefits it also comes with drawbacks. Benefits of an online gaming approach included student engagement, an adaptable learning environment, and scalability for large or distance courses. Some of the disadvantages for libraries could include: technical expertise, cost, and development time. In the case of the GAP grant, the unforeseen extension of the Development phase impacted the team's ability to implement the game at multiple institutions as well as evaluate the game's educational potential during the grant period. This delay caused the Implementation phase to take place during the summer semester when 9-month STEM faculty members at other universities were unavailable to distribute the game. Consequently, these compounded issues lead to fewer participants and a smaller sample size of engineering students.

Future research will focus on the following goals: expanding implementation to a wider range of universities, refining the testing instrument, conducting pre- and post-tests with a larger number of STEM graduate students, and evaluating the game in different learning environments. Disseminating the game beyond partnering institutions will allow for more robust feedback. Refining the test instrument will allow the team to determine if incorrect answers are due to

question phrasing or student misunderstanding. More significant sample size will allow for more generalization of results as well as examination of perceived trends in subgroups such as engineering students or international students. Another avenue of interest is to compare learning gains in a traditional face-to-face presentation of the information with learning gains after playing the game. Finally, the team would like to explore the potential of a blended approach, using both face-to-face and the game in FFP sessions.

Conclusion

As cases of research misconduct increase on college campuses, so do the requests for libraries to help curtail these issues. How can this type of awareness training take place in an efficient, yet effective manner? Online learning environment tools like tutorials, guides and games offer a way for libraries to serve their faculty and students in this "point-of-need" or "just-in-time" nature. These types of resources are especially appealing to the librarian who is assigned to serve thousands of on-campus students or distance learners who are scattered across the globe. The game presented here offers is an option for easily scalable, anywhere, anytime instruction in RCR and avoiding FFP.

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