Gaming Against Plagiarism (GAP): A Game-Based Approach to Illustrate Research Misconduct to Undergraduate Engineering Students

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Gaming Against Plagiarism (GAP): A Game-Based Approach to Illustrate Research Misconduct to Undergraduate Engineering Students

Rami J. Haddad and Youakim Kalaani

Abstract – In this paper, we discuss our experience using a set of games called "Gaming Against Plagiarism" to increase awareness in different types of research misconduct, and highlight the ramification of committing such misconducts among undergraduate engineering students. Gaming Against Plagiarism consists of three mini-games that address research misconduct. The types of research misconduct addressed are stealing, misquoting, patchwriting, insufficient paraphrasing, self-plagiarism, data falsification, and data fabrication. In these games, students are virtually put into situations involving research misconduct. The students either have to identify the type of misconduct or make an ethical decision by avoiding research misconduct. We assessed the impact of these games using qualitative and quantitative assessments techniques. Pre and post-surveys were conducted asking students to identify different research misconduct cases before and after they played the games. The results indicated that using this game-based approach to increase awareness of research misconduct among undergraduate students is effective. This conclusion was inferred by the statistical analysis with 98.7% confidence level. We also showed that the concepts of falsification and fabrication are somewhat confusing for students.

Keywords: game-based, research misconduct, ethics, plagiarism.

INTRODUCTION

Academic dishonesty such as Plagiarism is among the most serious offenses that could be committed by students, especially in the context of research. A broad study of 63,700 undergraduate students revealed that 62% of the undergraduate students admitted to cheating on written assignments [1]. Unfortunately, this serious problem is still growing. The highly competitive nature of the millennial students is misleading them to cheating in order to thrive, claiming that the end justifies the means [2]. Therefore, the high achieving students are also not immune to cheating. In the light of the 2012 Harvard cheating scandal, the Harvard Crimson newspaper recently conducted a survey of 1300 students of the incoming freshman class of 2017, to find that 42% admitted to cheating on assignments before joining Harvard [2]. What was considered as an academic survival skill by struggling or procrastinating students is now considered as an academic thriving skill by high achieving students.

There are many reasons that influence cheating among students. Academic struggle, procrastination, and competition among high achieving students are some of these reasons; however, what is alarming goes beyond the students’ surviving or thriving needs. The students’ ignorance of what constitute plagiarism is baffling. A study of 63,700 undergraduate students revealed that 40% of the undergraduate students didn’t consider plagiarizing written assignments as a serious offense [1]. In addition, the students’ lack of motivation to actually read the honor code or the code of conduct in their institutions makes this issue harder to solve. A study of 1037 undergraduate students at

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Yale University revealed that the majority of the students have not read the university’s undergraduate regulations on academic dishonesty [3].

Higher education institutions address this topic in various ways such as including it in their student code of conduct, and discussing it in first-year experience courses. Unfortunately, research misconduct is one of the difficult topics to teach using lecture-based conventional instruction techniques even for the most seasoned instructors.

Game-based learning (GBL) is among the most popular emerging approaches in education, problem-solving, and research due to the recent advancement in game design technologies and the increased popularity of games among young people. A recent survey conducted by the entertainment software association (ESA) indicated that 58% of all Americans (183,920,442 citizens) play video games [4]. As an example of a successful implementation of a game to solve a research problem is the game Foldit. Foldit is a game designed by the University of Washington in 2008, to help scientists solve a DNA folding problem for a protein that could play a key role in curing HIV. The game attracted around 46,000 gamers who took only 10 days of playtime to solve a problem that baffled scientist for more than 15 years [5]. Therefore, the engaging nature and the wide popularity of games can be leveraged to increase awareness in research misconduct, and help trigger attitudinal changes among students.

**GAMING AGAINST PLAGIARISM PROJECT**

Gaming Against Plagiarism (GAP) is a National Science Foundation (NSF) grant-funded project, developed by the collaboration of University of Florida Marston Science Librarians and the University of Florida Digital Worlds Institute [6,7]. The main purpose of the GAP project is to increase awareness in different types of research misconduct, and highlight the ramification of committing such misconducts among students in a very engaging and entertaining manner. Gaming Against Plagiarism consists of three mini-games that address research misconduct. The types of research misconduct addressed are stealing, misquoting, patchwriting, insufficient paraphrasing, self-plagiarism, data falsification, and data fabrication.

When played in order, the progression of the three mini-games adhere to the Bloom's revised taxonomy starting with the knowledge level up to the evaluation level [8]. Figure 1 demonstrates the correspondence between the game progression and the Bloom's revised taxonomy.

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**Figure 1- GAP Series Progression and its correspondence with Bloom’s Revised Taxonomy**

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Game 1: Cheats and Geeks

Cheats and Geeks game is designed as a dice board game. In this game, the player is a graduate student trying to publish his work before his competition. To do so, the player has to go through peer reviews, funding opportunities, and pop quizzes addressing plagiarism, data falsification, and data fabrication. In addition, the player gets the chance to cheat his/her way to publication by plagiarizing the position of the other player ahead, falsifying his/her position in the game, or fabricating a path on the game board that does not exist. However, when the player cheats he/she jeopardizes losing his/her current position if he/she gets caught. Figure 2 illustrates the layout of the Cheats & Geeks game and demonstrates an example of a pop quiz addressing a research misconduct issue.

Figure 2 - Layout of Cheats & Geeks and an example of a pop quiz addressing a research misconduct issue

Game 2: Frenetic Filing!

In this game, the player is hired by the research ethics office to help the evaluators sort and organize the different cases of research misconduct into the correct categories. The player is given two minutes to hand as many cases as possible to the evaluators to review and provide the player with their feedback. Based on the feedback from the evaluators, the player has to classify the type of research misconduct related to each case by filing the case in the appropriate research misconduct category. This game addresses seven types of research misconduct including stealing, misquoting, patchwriting, insufficient paraphrasing, self-plagiarism, fabrication, and falsification. Figure 3 illustrates the layout of the Frenetic Filing! game and demonstrates an example of a successful filing of a research misconduct case.

Figure 3 - Layout of Frenetic Filing! and an example of a successful filing of a research misconduct case
Game 3: Murky Misconduct

In this game, the player is hired by the research ethics office as an investigator, to study cases of suspected research misconduct, track down evidence, critically analyze and evaluate the evidence using the EthiScan 3000 interface and finally accuse the suspects with the specific research misconduct offense committed. Figure 4 illustrates the Murky Misconduct game welcome screen notifying the player about the case he/she will be investigating. To the right is the EthiScan 3000 screen used in analyzing and evaluating the evidence of each case.

PROJECT IMPLEMENTATION & ASSESSMENT

In this project, we assessed the impact of introducing these games on undergraduate engineering students' perception of research misconduct. The GAP mini-games were introduced in two different courses (Advanced Engineering Analysis - EENG 5090 and Electronics & Circuit Analysis - ENGR 2131) in the Electrical Engineering Department at Georgia Southern University. A total of 24 students took the pre and post surveys. The majority of students (~58%) were juniors while the rest (~42%) were seniors. The pre and post surveys consisted of the same fourteen multiple-choice type questions. Most of the questions illustrated situations involving certain research misconducts, while few did not involve any research misconduct. We used the same set of questions used by the University of Florida in their assessment of these mini-games. The students had to identify the type of research misconduct addressed in these question by selecting one of the following multiple choice options (no misconduct, stealing, misquoting, patchwriting, insufficient paraphrasing, self-plagiarism, data falsification, and data fabrication). Figure 5 illustrates the situations discussed in the survey questions.

Figure 4 - Murky Misconduct game welcome screen and the EthiScan 3000 screen used for each case

Figure 5 - Pre/post survey questions

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The pre survey was conducted before introducing the students to the GAP mini-games while the post survey was conducted after the students have played these mini-games and earned the certificates of completion. Figure 6 shows the results of the pre and the post surveys represented by the percentages of students answering each question correctly.

![Figure 6 - Pre/post surveys per question results and the overall average](image)

The results in Figure 6 demonstrate a significant improvement in the students’ overall abilities to classify various cases based on the research misconduct associated with them. The pre-survey showed that only 59.8% of the questions were answered correctly versus 73% of the questions answered correctly in the post survey.

In general, there were improvements in answering the questions correctly with the exception of questions 8, 11, 12, & 14. Questions 8, 11, & 14 discussed situations that did not involve any research misconduct. Those questions were among the few questions answered correctly by the majority of the students in both the pre and the post surveys. It is suspected that the lack of improvement is due to the increased vigilance of the students after playing the games. As for question 12 dealing with falsification, we have noticed that the concept of falsification and fabrication can be easily confused, by observing a bimodal distribution in the answers to this question.

To statistically verify our findings, we conducted a thorough statistical analysis using the Minitab statistics software. Our null hypothesis states that there are no statistical differences in the percentage of correct answers obtained from the pre and post surveys. To test our hypothesis, we used the General Linear Model to analyze the data with probability criterion for the significance level equal to 5% ($p=0.05$). This means that if our analysis generates a p-value less than the 0.05, then we can reject the null hypothesis indicating that this proposed approach to teach students about research misconduct is in fact useful. Our response variable is the percentage of correct answers per question. Figure 7 indicates that there are two main factors in this experiment. The first factor is the treatment effect.
modeled by the difference in the pre & post survey results while the second factor is the questions effect modeled as a nuisance or blocking factor.

Our two-level treatment factor was the effect of playing the mini-games on the students’ perception of the research misconduct situations which was measured using the pre and post surveys. We considered the different types of questions as a blocking factor to eliminate the induced variability to the response variable. Our analysis, as shown below, generated a p-value equal to 0.013 which is smaller than the 0.05 criterion for significance. Therefore, we can reject the null hypothesis with a confidence level of 98.7% and conclude that there is a statistically significant difference between the pre and the post survey results. This means that the proposed approach is in fact useful. To further investigate this conclusion, we conducted a Tukey's comparison with 95% confidence. The outcome of the Tukey's comparison also supported our conclusion that the results obtained from the pre and the post surveys are statistically different due to the students' exposure to the GAP mini-games.

Statistical Analysis of the Data

General Linear Model: Percentage versus Questions, Treatments

<table>
<thead>
<tr>
<th>Factor</th>
<th>Type</th>
<th>Levels</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td>fixed</td>
<td>2</td>
<td>Post, Pre</td>
</tr>
<tr>
<td>Questions</td>
<td>random</td>
<td>14</td>
<td>2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15</td>
</tr>
</tbody>
</table>

Analysis of Variance for Percentage, using Adjusted SS for Tests

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Seq SS</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td>1</td>
<td>0.12070</td>
<td>0.12070</td>
<td>0.12070</td>
<td>8.33</td>
<td>0.013</td>
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<tr>
<td>Questions</td>
<td>13</td>
<td>1.00188</td>
<td>1.00188</td>
<td>0.07707</td>
<td>5.32</td>
<td>0.002</td>
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<tr>
<td>Error</td>
<td>13</td>
<td>0.18834</td>
<td>0.18834</td>
<td>0.01449</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>1.31092</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S = 0.120366  R-Sq = 85.63%  R-Sq(adj) = 70.16%

Grouping Information Using Tukey Method and 95.0% Confidence

<table>
<thead>
<tr>
<th>Treatments</th>
<th>N</th>
<th>Mean</th>
<th>Grouping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td>14</td>
<td>0.7295</td>
<td>A</td>
</tr>
<tr>
<td>Pre</td>
<td>14</td>
<td>0.5982</td>
<td>B</td>
</tr>
</tbody>
</table>

Means that do not share a letter are significantly different.

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Percentage
All Pairwise Comparisons among Levels of Treatments
Treatments = Post subtracted from:

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Lower</th>
<th>Center</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td>-0.2296</td>
<td>-0.1313</td>
<td>-0.03303</td>
</tr>
</tbody>
</table>
To backup the hypothesis observed in question 12 (there is confusion between the falsification and fabrication misconduct concepts), we generated the interaction plot for question 12 pre and post surveys results. The interaction between Falsification and Fabrication is demonstrated by the intersection of the pre and post lines shown in figure 8.

For the qualitative part of the assessment, some students’ comments are included here:

- "There are quite a few research misconducts that I didn't know they are research misconducts"
- "Playing these games helped me understand plagiarism"
- "The first two games were easier to play compared to the last one, still very interesting way to introduce plagiarism"
Pedagogically, game-based learning is one of the most current trends in education. Its engaging nature helps the students learn faster adding the fun factor. This paper presented a game-based learning approach using a set of games called "Gaming Against Plagiarism" to illustrate research misconducts and highlight their ramifications to undergraduate students. We conducted a pre and post test surveys to measure the effectiveness of this approach. We concluded that this approach is effective, which was also inferred by the statistical analysis with 98.7% confidence level. We also showed that the concepts of falsification and fabrication are somewhat confusing for students; therefore we recommend that when using this tool, an extra instruction to delineate between these two concepts will be helpful in the future.

REFERENCES


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Rami J. Haddad is an Assistant Professor of Electrical Engineering in the Department of Electrical Engineering at Georgia Southern University. Dr. Haddad received his B.S. degree in Electronics and Telecommunication Engineering from the Applied Sciences University, Amman, Jordan. He received his M.S. in Electrical and Computer Engineering from the University of Minnesota Duluth, Duluth, MN. He received his Ph.D. degree from the University of Akron, Akron, OH. Dr. Haddad is a member in IEEE, OSA, CUR, and ASEE professional organizations. His research interests include various aspects of optical fiber communication/networks, broadband networks, multimedia communications, multimedia bandwidth forecasting, STEM education and engineering pedagogy.

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Youakim Kalaani is an Associate Professor of Electrical Engineering in the Department of Electrical Engineering at Georgia Southern University. Dr. Kalaani received his B.S. degree in Electrical Engineering from Cleveland State University (CSU). He graduated from CSU with M.S. and Doctoral degrees in Electrical Engineering with concentration in power systems. Dr. Kalaani is a licensed Professional Engineer (PE) and an ABET Program Evaluator (PA). He is a member of IEEE and has research interests in distributed power generations, optimization, and engineering education.