INVESTIGATING THE IMPACT OF GAMIFICATION ON STUDENT PERFORMANCE IN A SECONDARY SCIENCE CLASSROOM

by

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# TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND ................................................................. 1

2. CONCEPTUAL FRAMEWORK ........................................................................... 3

3. METHODOLOGY ............................................................................................... 6

4. DATA AND ANALYSIS ...................................................................................... 11

5. INTERPRETATION AND CONCLUSION ........................................................... 32

6. VALUES ............................................................................................................ 35

REFERENCES CITED ............................................................................................ 38

APPENDICES ......................................................................................................... 41

APPENDIX A Outline of Video Game ................................................................. 42
APPENDIX B Outline of PowerPoint Introduction and Rules ........................... 48
APPENDIX C Student Motivation Questionnaire II ........................................... 51
APPENDIX D Parent Observation Survey ........................................................... 53
APPENDIX E IRB Approval Letter and Exemption Forms ................................. 57
APPENDIX F Interview Transcripts ..................................................................... 60
LIST OF TABLES

1. Data Collection Matrix .................................................................10
2. Average Assessment Scores for Traditional Units ...............................12
3. Unit Style by Year ...........................................................................14
4. Average Test Scores and Standard Deviations for Treated Units ..............14
5. Example Student Responses to SMQ Free Response Questions ...............26
6. Example Parent Responses to Parent Observation Survey on Motivation ........30
LIST OF FIGURES

1. Box-and-Whisker Plot of Motion Unit Test Scores ...........................................15
2. Box-and-Whisker Plot of Forces Unit Test Scores ............................................16
3. Box-and-Whisker Plot of Energy Unit Test Scores ............................................17
4. Average Likert Scale Responses from the Modified SMQ-II ..........................20
5. Frequency of Largest Motivational Component on Treatment Surveys ..........21
6. Frequency of Smallest Motivational Component on Treatment Surveys ........22
7. Post Treatment Student Preference Teaching Style for 2015-2016 ...............24
9. Average Likert Item Responses on Parent Observation Surveys ..................29
10. Frequency of Parent Responses on Communication Regarding the Treatment ....31
INTRODUCTION AND BACKGROUND

For years, administrators, politicians, and educational researchers have been emphasizing student engagement in all levels as a significant indicator to student success. Despite my own enthusiasm for physics, as a public high school teacher, I have found it can be difficult gaining maximum engagement and enthusiasm from students. Currently, around 10% of my level two (“average college preparatory” level) 9th grade general science students do not pass for the year. My district eliminated level one general science classes in order to better prepare for the state’s standardized science test in biology. This move generated classes with a much broader spectrum of ability, creating vast differences in the amount of time needed by students to complete activities.

In an effort to reduce failing grades, increase student participation in the classroom, and provide flexibility to the pace at which students work, I decided to investigate the effects of gamification on student achievement, motivation, and parent perceptions of this new instructional strategy. Gamification is the process by which an instructional unit is presented in the format of a game or incorporates elements of gameplay. This can include students competing to earn points and gain rewards, badges or a higher status within the game. Though reformatting entire units to encompass these elements can be an enormous task, the potential increase in participation, motivation, and student overall achievement can be worth the time and effort placed in the redesign.

The purpose of my research was to determine the possible costs and benefits of developing and implementing gamified instructional units. Specifically, my research addressed the following questions:
1. What are the effects of blended model gamification on student performance on a traditional test and overall motivation in class?
   a. How do parents and students view learning through video games as opposed to a more traditional model?
   b. How does student motivation change through a gamified unit?
   c. How does creation and implementation of a gamified unit impact the teacher’s role and responsibilities?

This study was particularly of importance to my classroom for several reasons. First, we are in the process of moving to a trimester schedule where the periods will be 68 minutes long. With the extended class periods we have been encouraged to find new unique ways to engage students in the longer periods. Second, I was working to reduce student failure rates and increase student participation within the course. Finally, I noticed that many students require more time at different points within the unit, making it difficult to keep all of the students in the class moving at the same pace. With these problems in mind, I created a web-based video game using the blended model to facilitate the learning process. In the blended model, students learn through the use of technology as well as through more traditional “brick and mortar” lessons.

The goal of blended education is to increase student engagement with the content. One of the primary motivations for moving to a blended model is that it allows students the flexibility to work on the same content asynchronously. While hybrid learning still requires all students to meet the same standards and objectives, students are provided the freedom to move through a unit at their own pace. This allows students to spend more
Another goal of using a blended model is to more efficiently use teacher time. Similar to a flipped classroom philosophy, the blended model allows students to watch direct instruction videos on their own, freeing up the instructor to assist individual students. In a traditional classroom, most of the teacher’s time is spent presenting new information. If students are permitted to receive this direct instruction asynchronously through a recorded video, students are provided the freedom to play, pause, or rewind if they find they need more time to take notes or review something.

CONCEPTUAL FRAMEWORK

It is no secret that designing engaging curriculum, which meets state standards, is a challenge. From brain based teaching to flipping the classroom, educators routinely develop new models and practices in an effort to improve student performance. Regardless of the instructional strategy presented by researchers, one thing remains clear; student motivation is a key factor in student success (Deci, Koestner, & Ryan, 2001; Marzano, 2007; Sollo, 2009). Specifically, intrinsic motivation leads to higher student achievement and persistence at learning activities (Vansteenkiste, Lens, & Deci, 2006). Despite the fact that it is difficult to impart intrinsic motivation to students using extrinsic motivators (Lepper, 1973), placing students in an environment where they can play seems to encourage enthusiasm and effort (Neilhart, 2008).

In the 21st century, play for younger generations has drastically shifted from physical reality to virtual reality. In a survey conducted of 1102 American teens (ages 12-
17), 97% report playing on some sort of electronic device (Lenhart et al., 2008). Not only do almost all teens experience some form of this virtual play, but many do so extensively. According to the same study, those who play daily typically play for an hour or more and 50% of teens report playing “yesterday”. Video games of all sorts have proven to be incredibly pervasive in students’ lives and can be used as a platform to deliver already successful teaching methods (Gee, 2013).

Increasingly, teachers are turning to technology-based instructional strategies to help motivate students and get them engaged in classroom lessons. According to the Joan Ganz Cooney Center, teachers with fewer years of experience are integrating digital games into the classroom more than their more experienced colleagues (Takeuchi & Vaala, 2014). As more experienced teachers are beginning to retire, younger, more technology savvy individuals are taking their place. This survey of K-8 teachers ($N=694$) revealed that 74% of teachers indicated they use digital games for instructional purposes. As these younger professionals grow in experience, they are beginning to integrate video games into the classroom as instructional tools.

One of the more recent definitions of “gamification” is “the use of design elements characteristic for games in non-game contexts” (Deterding, Dixon, Khaled, & Nacke, 2011, p.14). In an educational context including this study, this process can include designing a lesson or lessons that utilize game elements such as rewards, challenges/missions, interactions with other players, and level advancement. Though technology need not be used to employ these elements, the use of computers and multimedia can provide a wide variety of benefits for all students (Marino et al., 2014;
The use of technology to achieve gamification also allows for flexibility of content presentation to match the needs of the learner.

The implementations of these game elements appear to have a significant impact on student behavior and performance. Students who are engaged in these educational video games report being more intrinsically motivated and less concerned with grades than those not involved in the game (Tuzun, Yılmaz-Soylu, Karakus, Inal, & Kızılkaya, 2009). Studies also show that in order to succeed in game-based instruction, the students must put forth more effort (Grimley, Green, Nilson, & Thompson, 2012; Nguyen, 2015), spending more time out of the classroom to learn the material (Plohn, 2014). Due to the fact that students need to put more effort in a video game to learn the required material, students experience less boredom (Grimley, Green, Nilsen, Thompson, & Tomes, 2011). Students also often indicate they learn more from video games and become better problem solvers (Adachi & Willoughby, 2013; Grimley et al., 2012; Plohn, 2014). Simply changing the format through which the content is delivered can increase intrinsic motivation and confidence while decreasing boredom.

Many studies also indicate that students who are placed in a gamified instructional setting show signs of significant improvement in performance or an improvement in student motivation (Adachi & Willoughby, 2013; Grimley et al., 2011; Grimley et al., 2012; Tuzun et al., 2009; Banfield & Wilkerson, 2014). Interestingly, the benefits of gamification seem to reside primarily with students who typically do not perform well in lecture style learning environments (Virvou, Katsionis, & Manos, 2005), whereas students who typically do well in lecture style learning environments show no decrease in
performance. The use of technology to implement a video game style lesson also levels the playing field between the genders (Mayer-Smith, Pedretti, & Woodrow, 2000).

Based on this research, I assumed a couple of points. First, gamification has great potential to increase student performance, particularly for those students who are not typically high achieving students in a lecture setting. This will also encourage students to spend time working on coursework outside of class, maximizing the value of time in class for activities, labs, and investigations.

Secondly, students will be challenged by this new strategy. Though some students may struggle at first, gamification has the potential to decrease boredom and increase intrinsic motivation. Motivation can be a very powerful tool in education (Sollo, 2009). Opening students’ minds to the idea that learning can be fun could be the most influential result of conducting this action research.

METHODOLOGY

Treatment

Designing the Game

The unit I designed is a space themed unit covering motion and forces for a 9th grade introductory course (N=124 in five sections). Before implementing the game, I created an outline of the objectives I wanted students to meet, as well as the activities that would help them meet those objectives. From this outline, I created two parallel storylines with a space theme that would bring the students through various missions to meet the objectives (Appendix A). This included writing up scripts and having friends and family record themselves acting as the characters in the storyline. It is imperative to
note that the lab activities, worksheets, and content of material were the same for both the
video game style and traditional presentation.

After I developed the storylines and found volunteer actors to record the
necessary narratives, I programmed the activities into an online learning management
system, Moodle, to create the game. This included uploading videos and material, as well
as programming the particular rules for each item. For example, each video had to be
programmed so that only the individuals on that team would see that particular video and
it would only open up to the student after they had completed a specific predetermined
set of criteria.

Structure of the Game

The students were provided class time to log into the course Moodle page to play
the game. Once inside the game, students were given the opportunity to choose a
codename and were assigned a team (the light side of the force or the dark side of the
force). Students were also placed in squads, which acted as lab groups. Students earned
experience points (XP) by completing objectives, missions, and activities. As students
earned XP, they could level up, increasing their ability to earn rewards and unlock secret
“Easter eggs” within the video game. Students were able see their live XP and level
online along side of their anonymous classmates’ scores and total team score.

Every time a student completed a mission or assignment in the course, a new
objective opened up to them. These objectives included watching videos and taking
notes, reading sections of the textbook, taking quizzes, completing labs, completing
WebQuests, participating in online forums, completing practice problems, etc. The
Moodle page allowed the instructor to control a set of rules to determine when and how the students accessed or viewed items on the page. Therefore, students did not see the next mission until they completed the previous mission, which created a sense of mystery of what was to come next.

Rules of the Game

Before administering the treatment, I felt it was very important to lay some basic ground rules for the students and thoroughly explain how the game was going to work in our classroom. I took one 42-minute class period to go over my expectations for the students. I also chose to do this in the form of a PowerPoint presentation so that the students would have the opportunity to ask questions as a group (Appendix B). Firmly establishing the rules of the game in advance allowed the classroom to function smoothly and provided students with the power to make this strategy succeed or fail.

Students were permitted and encouraged to use any resources necessary to complete the tasks provided to them, including the textbook, Internet, and one another. Students were also encouraged to use me as a last resort when trying to figure something out. While collaboration was encouraged, I also warned students that cheating (copying other students’ papers) would hurt them in the long run on the test and if discovered, could result in earning demerits for the team or (in more severe occurrences) abandonment of the game altogether.

The asynchronous nature of this game allowed students to work at their own pace, and prevented them from moving on until I was sure that they had encountered all of the necessary material. With that in mind, I told the students that they could work on this at
home (other than the labs which needed to be completed in class). However, I also told students that as long as they used class time wisely, there would be no need to complete this work at home unless they began to fall behind or were absent from class.

Research Methods

Sample Demographics

Data collection occurred at Dallastown High School in Dallastown, PA. Dallastown Area Senior High School had an enrollment of approximately 1838 students. Roughly 24.8% of students in the school were reported as economically disadvantaged and 14.25% classified as special education. The school had an overall performance profile score of 93.3 for the 2014—2015 school year as provided by the Pennsylvania Department of Education (Pennsylvania Department of Education, 2016). This score was based off of performance indicators within a variety of categories including performance on the state Keystone Exams in biology, algebra, and literature.

This study was conducted within my college preparatory general science class, which covered introductory principles of chemistry and physics (N=124 in five sections). Enrollment within the class changed at various points throughout the unit as some students came in from other districts, some students left our district, and some students left and later returned at various points throughout the unit. This sample of students was composed of 52% males and 48% females. Roughly 86% of this population were Caucasian, 7% were Black or African American, 4% were Hispanic or Latino, and less than 3% were Asian or of multiple ethnicities. Of the students taking this course, 33 were classified as economically disadvantaged (26.6%) and 21 students (16.9%) had either an
Individualized Education Plan (IEP) or 504 plan. Students who were entering the high school to take general science had just completed a year of earth science, but had not learned the basics of atoms and molecules or physics. This makes the general science course the first time many of the students had ever encountered the content.

**Instruments**

Data collection occurred in two main forms intended to verify one another. A breakdown of the different tools and the research questions they addressed is detailed in the table below.

**Table 1**

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Overall Grade</th>
<th>Parent Observation Survey</th>
<th>Interview</th>
<th>Modified SMQ-II</th>
<th>Teacher Log(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Question</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sub-question #1</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sub-question #2</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Sub-question #3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

First and foremost, grades were paramount in determining the actual impact the treatment had on student performance. With the data that I had from previous years where the treatment was not implemented, I was able to compare this group of students to those from previous years. I compared this years’ student scores to the students’ scores on previous tests earlier in the year to see if there was any significant change in overall
performance. Though the two groups were similar, this only provided an interesting comparison, which cannot be used as a control. This will be discussed later.

The second form of data collection was in the form of interviews and online surveys. Students received a modified Student Motivation Questionnaire-II (SMQ-II) to determine the source of their motivation in the classroom (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011). The SMQ-II (Appendix C) was used in a wide variety of science courses and was very robustly tested as a valid survey tool and it helped triangulate the results. I modified the survey to include a Likert scale, which probed for game play as a motivator.

Parents received an observation survey (Appendix D), which probed how their children’s behavior may have changed outside of the classroom. Interviews were also a great asset to the data analysis. I interviewed at least five students to provide some insight into motivational factors and perceived performance. The results of the interviews validated the quantitative data received from the logs and test scores. The interviews also assisted in triangulation to increase validity and reliability of the study.

The research methodology for this project received an exemption by Montana State University’s Institutional Review Board (Appendix E), and compliance for working with human subjects was maintained.

DATA AND ANALYSIS

Student responses, test results, and records from previous years were compiled and analyzed to determine if there was a distinguishable pattern with the treatment on student motivation and performance.
Student Performance

Comparison to Previous Years

In order to assess student performance, I first compiled the overall average scores for each large formal assessment in which there was no treatment over the past couple of years to assess whether comparing students from this year to previous years was appropriate. It is again important to note that though these groups were similar, they could not be used as a control in this experiment as they were different students of a different year taking slightly different unit exams. Instead, this acted simply as an interesting comparison.

Table 2
Average Assessment Scores for Traditional Units

<table>
<thead>
<tr>
<th></th>
<th>Atoms and the Periodic Table</th>
<th>Chemical Bonding and Formula Writing</th>
<th>Chemical Reactions</th>
<th>Factor Label Method</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-2016</td>
<td>73.9 (N = 118)</td>
<td>64.5 (N = 119)</td>
<td>77.5 (N = 118)</td>
<td>84.9 (N = 118)</td>
<td>69.6 (N = 116)</td>
</tr>
<tr>
<td>2014-2015</td>
<td>82.2 (N = 75)</td>
<td>65.1 (N = 74)</td>
<td>X</td>
<td>79.2 (N = 69)</td>
<td>73 (N = 75)</td>
</tr>
<tr>
<td>2013-2014</td>
<td>72.7 (N = 97)</td>
<td>61.3 (N = 96)</td>
<td>69.6 (N = 98)</td>
<td>83.5 (N = 100)</td>
<td>74.2 (N = 100)</td>
</tr>
</tbody>
</table>

Looking at Table 2, it was reasonable to conclude that the 2015-2016 students appeared to perform at a similar level to students of previous years. It is worth noting that each year, students were given a slightly different assessment (potentially of varying difficulty) as well as a different curve on each test. Unfortunately, I could not recall the exact curve provided to each year’s students to compare raw scores. However, I could say with some degree of certainty that the assessments were roughly of similar difficulty. There was no data available for the 2014-2015 chemical reactions test due to the unit
being spliced into two smaller assessments (quizzes), which would not provide an adequate comparison to the larger tests. Though these populations performed similarly on these assessments, previous years could not be used as a control as the assessments were each different and there was some variation in overall average test scores year to year.

From this data, we saw that the students in the 2015-2016 general science classes were roughly similar in score results to previous years. In every case, the 2015-2016 students performed lower than the 2014-2015 students with the exception of the Factor Label Method Quiz, on which students this year had the opportunity to earn up to 20% in bonus points. With the exception of the energy test, all of the differences in the average test scores were within one standard deviation of the previous two-year’s averages. This implied that any difference in the average test score was not significant and the student population was similar. Interestingly, the energy test did show a difference in scores. This was the only assessment after the treatment had been removed from the classroom that was analyzed. After the game unit ended, we returned to a more “traditional” teaching method.

**Video Game Score Results**

Student exam scores from the units in which students used the video game were compiled and compared to previous students from previous years. The development of the video game took several years to design and implement. As such, different years of students played different portions of the video game as shown in Table 3.
Table 3  
*Unit Style by Year*

<table>
<thead>
<tr>
<th>Year</th>
<th>Motion Unit</th>
<th>Forces Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-2016</td>
<td>Video game style</td>
<td>Video game style</td>
</tr>
<tr>
<td>2014-2015</td>
<td>Video game style</td>
<td>Traditional</td>
</tr>
<tr>
<td>2013-2014</td>
<td>Traditional</td>
<td>Traditional</td>
</tr>
</tbody>
</table>

Records from previous years were analyzed to retrieve an average of student scores, shown in Table 4. These scores are shown as percentages since each test was worth a different number of points. The standard deviation of the averages for each unit was taken to help determine the spread of outliers within each assessment. A t-test was not run due to the fact that these were not comparable populations. Though the populations were similar, they were by no means an equal comparison since they were different students taking different tests.

Table 4  
*Average Test Scores and Standard Deviations for Treated Units*

<table>
<thead>
<tr>
<th>Year</th>
<th>Motion Unit</th>
<th>Forces Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-2016</td>
<td>68.4 ($N = 121, \sigma = 13.0$)</td>
<td>70.3 ($N = 123, \sigma = 16.2$)</td>
</tr>
<tr>
<td>2014-2015</td>
<td>71.7 ($N = 73, \sigma = 14.5$)</td>
<td>80.2 ($N = 75, \sigma = 13.8$)</td>
</tr>
<tr>
<td>2013-2014</td>
<td>75.6 ($N = 98, \sigma = 16.0$)</td>
<td>75 ($N = 98, \sigma = 15.3$)</td>
</tr>
</tbody>
</table>

Interestingly, the scores seem to indicate that the units in which the students used the video game to facilitate learning resulted in lower than normal test results. However, when looking at the distribution of grades for each unit (as in Figures1-2), we can see that
although the averages were lower, years without treatment had much higher maximum scores (well above 100%), which implied there was a much larger curve provided on the previous exams.

Figure 1. Box-and-Whisker Plot of Motion Unit Test Scores. The 2013-2014 year was not a treatment year, (N=97). The 2014-2015 and 2015-2016 years were treatment years, (N=73, N=121 respectively).
Figure 2. Box-and-Whisker Plot of Forces Unit Test Scores. The 2013-2014 and 2014-2015 years were not treatment years, \(N=97, N=75\) respectively. The 2015-2016 years was a treatment year, \(N=122\).

In both exams, it appeared that students in the treatment year of 2015-2016 performed lower. This lower performance could just be that the students performed lower on that particular unit. Each quartile appeared lower than the previous year’s quartile marks with the overall average in decline during treatment years. Though this initially appeared to be due to the implementation of the gamification units, we saw the same pattern immerse with a unit in physics where no gamification treatment occurred. The unit on energy was also analyzed to show any “background” trends (Figure 3).
Figure 3. Box-and-Whisker Plot of Energy Unit Test Scores. All of these were more “traditional” units with no implementation of gamification, \((N=100, N=75, N=115)\) respectively.

The same decreasing trend could be seen even without the implementation of gamification. With this “background” trend, it was impossible to conclude that the gamification was the cause of the decrease in test scores. It was, however, worth noting those years with larger numbers of students always had lower minimum scores on every assessment than the 2014-2015 school year with fewer students. Even though the test scores were lower than average on treatment years, students’ overall scores were not heavily impacted due to the students also receiving their XP as a grade.

It is also worth noting that most students performed within one standard deviation of their own test scores on the treated units compared to non-treated units throughout the
year. Only 25% of students (30 out of 119) seemed to perform outside of their own standard deviation on the treated units. Of those 30 students, 10 students performed better on the treated units by more than one standard deviation of their test scores while 20 students performed worse on the treated unit by more than one standard deviation of their own test scores. Of the 10 students who performed significantly better on the treated units, one was an English Language Learner and two were students with IEP’s. Of the 20 students who preformed significantly worse on the treated unit than non-treated units, three were diagnosed with Attention Deficit Disorder. It is also worth noting that eight of the 20 students who preformed worse on the treated unit were absent from class for 3 or more school days during the treated unit implementation (more than 10% of the unit).

This data suggested that the implementation of the video game units probably did not hurt the overall student population. Only a small portion of the students were statistically negatively impacted, and it is impossible to say whether the negative results were due to the treatment or lack of attendance.

**Motivational Factors**

Student responses to the modified SMQ-II surveys were collected and analyzed. Due to limited time in the classroom, I was unfortunately forced to reduce the number of surveys the students took throughout the video game process. I was able to have students take the survey at key points within the experiment. Students took one survey before the video game was implemented, one survey during the video game, and one last survey after the video game had concluded. As students worked through the material at their own pace, I had students complete the survey when they reached particular checkpoints
within the content, rather than all at specific times. This resulted in some students taking the SMQ-II, which was intended to be completed during the video game, only one week after the pre-survey. Other students who worked at a slower pace did not complete the survey until week two or three of the video game implementation. The final survey was completed after the video game had officially ended and students were engaged in our next unit being presented in a more traditional method.

Likert Data

Likert items were categorized into six motivational components (intrinsic, self-efficacy, self-determination, grade, career, and video game teaching style). Each student’s responses were given a corresponding quantitative score ranging from 0 (never) to 4 (always). This was in accordance to the recommended analysis by author Shawn Glynn (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011). Unlike the study conducted by Glynn, the SMQ-II I provided to my students did not have any reverse order questions or Likert items probing anxiety about assessment. Scores were analyzed by taking the total score of the Likert scale for each student. Averages for each component on the surveys can be seen in Figure 4.
Figure 4. Average Likert scale responses from the modified SMQ-II within each motivational component. Error bars are indicating one standard deviation within that scale’s responses. Pretreatment, \( N=100 \), during treatment, \( N=106 \), and post-treatment, \( N=99 \) are included, though there were no Likert items regarding the video game available before the treatment was implemented.

Students were not required to take this survey in accordance with IRB approval. Therefore, some students did not take the surveys or did not take the surveys seriously. The Pre-SMQ did not contain any Likert items probing motivation due to the video game because, though some students had been introduced to the idea, they had not experienced playing the game as of yet.

Looking at the data in Figure 4, it was easy to see there was no significant difference in motivation component values as students played the game. The number one motivator, according to the Likert scale data collected, had been and continued to be grades. The component scores for each individual were varied greatly causing a large standard deviation. This score alone also did not show how the students ranked a
particular component relative to other components. For example, a student whose component score for intrinsic motivation may only have been 10 out of 20, that may have been the highest score given by that particular student. Therefore, I sorted through the responses and tallied how many students indicated each motivational component as their most influential. For students who had a combination of two motivational components as the most influential, I counted both recognizing that motivation is complex and multifaceted. However, for students who had three or more motivational factors, I did not tally any of the categories as they were unable to distinguish one component as more influential than any of the others.

![Graph](image)

**Figure 5.** Frequency of students who indicated a particular category as the largest motivational component for pre treatment, (N=114, including 14 combination responses), during treatment, (N=123, including 19 combination responses), and post treatment, (N=118, including 22 combination responses) surveys.
Figure 5 shows the frequency of highest ranking motivational components by students in contrast to Figure 6, which shows the frequency of lowest ranking motivational components.

These data confirmed that the grade alone was the largest motivational component for these students. It was also important to note that as time continued, student interest in the game decreased. Therefore, this data did not conclusively indicate that the video game had a significant impact on student motivation.

**Free Response Data**

At the end of each SMQ, students were provided with a number of free response questions to help gain more insight into student responses. With each survey, I categorized the responses from the students to see what motivation component students
would reference when asked directly “What motivates you the most in school?” Though students were asked this question on each of the three surveys, the ranking of frequent responses remained the same in each survey. This is unsurprising due to the fact that the same students were taking the same survey multiple times, but it does provide some reliability that the rankings remained the same in each of the three timeframes regardless of the video game.

Consistent with the Likert data, students most often referenced grades as being the largest motivator. However, it was interesting to see the variety of reasons grades were cited as the largest motivator. Though the Likert data indicated that grades themselves were the motivational component, the SMQ fails to identify the underlying reasons as to why students were motivated by those grades. Even though many students simply stated “grades” as the motivational component, others went into more detail citing things such as remaining eligible for sports or activities, being punished by parents for poor grades, or being financially rewarded for good grades.

The second most frequently cited source of motivation for students was, interestingly, life or career oriented. This was in direct contrast to the Likert scale data, which identified career and intrinsic motivational components as the least influential components. 24.5% of students before the video game identified college, career readiness, or future life as the component that motivated them the most.

The third most frequently referenced motivational component in the free responses was the students’ friends. Students specifically mentioned competing with friends and the ability to see and work with their friends as a motivator. Though the
motivation due to parents and teachers closely followed this, every survey had more student responses referencing friendships as a motivator than teachers.

The final survey also included a question that asked students which teaching method they preferred, having experienced both a more traditional style and the video game. Despite a drop in student test scores, 42% of students said they preferred the video game over a more traditional teaching style and another 30% of students claimed they did not care one way or the other (Figure 7).

![Pie chart showing student preferences](image)

*Figure 7. Post treatment student preference teaching style for 2015-2016, (N=104).*

Only 27% of students preferred the “old-school” teaching style. This was in drastic contrast to 2014-2015 students (Figure 8) of whom 82% preferred the video game style at the end of the video game.
This statistic is skewed, as students from the 2014-2015 school year were not provided an ‘either’ or ‘no preference’ option as the 2015-2016 students were. However, even without the “don’t care” option, far fewer students in the 2014-2015 year preferred the more traditional method than students in the 2015-2016 year. This implied that the video game had a limited impression on students. A smaller percentage of students from the 2015-2016 school year ended up preferring the video game, but they also spent two consecutive units playing the game.

Students were also asked to type a free response style answer to the question, “Are you motivated by the video game style? Explain.” Students submitted their answer along with the final SMQ data. Though many students responded with one-word answers or vague responses, some students provided great positive and negative feedback into their views on the video game.
Table 5  
*Example Student Responses to SMQ Free Response Question*

| Example of Positive Responses | “Yes, it gave me the chance to work on my work at my own pace. I feel like there was a lot of repetition in the videos and labs, so I learned it easier. One thing that I would change is to have a little more time and for the solving equations or any math problems, maybe you give us videos to watch but then after we watch them you go over an example or two to make sure we are all on the same page.”  
“...I get way to tired after lunch when just sitting in the classroom and taking notes. Also you are competing against others. And I like to learn at my own pace and individually. The video game helped me with that.” |
| Example of Negative Response | “This is not a video game. This is an independent course using moodle. Gaining "XP" never motivated me, because it is entirely arbitrary. The "easter eggs" might have been entertaining if there were more of them, if they worked all the time, and if we were given time in class to use them. It really annoyed me when Mr. Cohen said he "programmed" any of this because, to me knowledge, no coding was involved throughout, except for the really cool excel sheet he made. In conclusion, I liked it, but it was in no way a "video game".”  
“No not really i can't teach myself out of a book and be expected to do good on tests” |

**Interviews**

After analyzing the quantitative data, I called for volunteer interviewees from my general science classes. Eight students offered their time to be interviewed by me. As students were questioned, I transcribed the conversation as best as possible (Appendix F). Two of the students interviewed preferred the video game style, two students preferred a more traditional style, two students had no preference, and two students did not respond on the last survey to indicate if there was a preference or not. This provided a broad set of views. Though the same set of core questions were asked to each student, some questions required elaboration or more specific questioning.
Of the eight students interviewed, six students cited their future or college as the motivation for their desire to do well in school. Students also mentioned grades, being in a class with students who had a positive attitude, financial compensation, parents and siblings as other sources of motivation. Students were varied in their responses as to what motivated them the least. According to the interviewees, lectures, being randomly picked on, group reading activities, confusion, or being treated like a younger student did not motivate them to try their best in a particular subject.

In the interviews, students were also asked what they liked and disliked about the video game. Almost every student interviewed cited the ability to work at his or her own pace as a huge advantage. In other classes, students sometimes felt as though they were being rushed or as though the lesson was dragging on and wasting time. Students also commonly mentioned the ability to work with friends as a positive component of the game. Ironically, students also mentioned that they did not like that some of their friends were holding their group back or slacking off and it became frustrating. One student commented, “It was really frustrating when we were forced to work in our squads because some of our squad members would just be hanging out and not really doing anything and then I would have to wait for them before I could move on [in the game].”

One of the most commonly mentioned dislikes about the video game was an apparent lack of time to complete the game materials. Despite this, students also indicated that they did not really spend time working on the video game from home. Only one of the eight students interviewed said they logged on to Moodle from home more than twice. This particular student also mentioned she had no problem completing the
video game material in time for the test. Other students admitted they did not log on from home regularly as directed in class. When asked why this was, one student commented, “I wasn’t really super motivated. I was out of it. In class I liked it. I really should have put more into it.” It would seem that the vast majority students were not willing to spend time working on the video game outside of the classroom despite it being one of the expectations in order to complete the material by the test day if they did not complete it in class. Though a good number of students were able to stay focused during class and were able to complete the work on time, many students became distracted by the social element of the video game during the class period or put off working on the video game in order to complete work that was due for their next class.

I also inquired about student study habits since students both in the interviews and in the free responses from the SMQ mentioned the difficulty of the tests and the low scores. None of the students I interviewed indicated they studied more than two days before the test itself and a number of students indicated that they typically did not study at all for science. When I asked why one student had not gone online to look at the study guides posted one student responded, “I never looked at study guides. I’m too lazy to go online and print them out.”

Parent Survey

The parent survey was not administered as often as intended due to the incredibly low response rate. Though the survey was sent out to both parents of each student, only 20 parents responded to the first call for responses and only 16 parents responded to the second survey. Nine of the parents were “repeat responders” who responded to both the
initial survey and the survey administered during the gamified unit. Responses were scaled using the same method as the SMQ. Average responses from before the video game implementation did not vary significantly during the video game (Figure 9).

Figure 9. Average Likert item responses on the parent observation survey before, \((N=20)\) and during, \((N=16)\) the video game treatment.

Though it appeared in some places that there was an increase in the response for each question, it was important to keep in mind the very low sample sizes. It was also worth noting that the standard deviation of responses within each question was around one full response value, making any appeared difference within the standard deviation. Thus, the Likert responses provided by the parents do not confirm or deny any changes in student behavior at home.
Parent free response questions on the survey also yielded some very interesting data. While some parents provided no elaboration on their responses to the Likert items, others made sure to add comments when asked if they had any other comments regarding their child’s motivation in school. Some parents reported very positive outcomes viewed from home. Other parents had strong opinions on the use of technology in the classroom, which they were willing to share (Table 6).

Table 6
Example Parent Responses to Parent Observation Survey on Motivation

| Example of Positive Responses | “[My son] is actually enjoying the video game lessons. He did come home excited the other day. He said he was in first place at that time. We have an extremely hard time finding anything that motivates [my son]. We are constantly trying to find new things to introduce to him.”

“[My daughter] really seems to enjoy her science class this year. She seems confident in the class....this is not something I used to see!” |
| --- | --- |
| Example of Negative Response | “As a more experienced teacher I would offer you some advice... That perception is everything and it is many students’ perception that playing these videos or recordings of yourself teaching while you are at your desk (not working with students one on one or in small groups) that the perception is you aren't "really teaching" or really helping students... This is not a good perception out in the community in an anti-teacher climate especially when [your district’s] teachers are the highest paid in the county. You might want everyone to think you work really hard and are worth the money versus the perception that is going around currently. If you feel a video is all the kids need to watch why don't we just video the best Science teacher in the department and show all the sections that teacher??? Do you see how this could be a problem? I recommend use those videos sparingly.

PS Heads Up...you might want to check on IEP & 504’s with speech & hearing. These videos are not good for Those students.”

“She thinks the class is boring and she doesn't understand some of the material.” |
Though some parents had very intense views of the video game, it was worth noting the level of understanding these parents had about the video game. On the survey provided during the video game implementation, when asked, “Has your son/daughter explained the video game being played in class?” only two parents responded that their children had explained the classroom activity in detail (Figure 10) and only one parent had seen the video game.

![Frequency of parent responses when asked if their children had talked to them about the video game in the class, (N=16).](image)

This implies that the parents were not as well informed regarding class as I had believed them to be. By the parents’ own admission, the vast majority of parents who were willing to take the time to respond to the survey either had no clue about the video game or did not receive any real in depth explanation of what the activity was. Due to the lack of responses from parents and appearance of low communication between students and parents, I did not interview any parents. However, in my interviews with students I inquired about the level of communication with parents and what their parents’ responses
were to the idea of the video game. All of the students interviewed indicated they had
told their parents about the video game. However, students mentioned that the responses
were varied, even within their own family. In some cases the father disliked the idea and
was wondering why I wasn’t teaching whereas the mother liked the idea and though it
was something unique. Some of the students also indicated that their parents did not
understand the premise of the game or the parents “weren’t really listening.” The
interviews, parent surveys, student scores, and student survey responses all worked
together to provide a larger picture of the impact of gamification on the students.

INTERPRETATION AND CONCLUSION

The goal of this study was to investigate the impact of gamification on student
scores, student motivation, parent and student perception, and teacher responsibilities
within a secondary science classroom. This study was inconclusive in finding support for
gamification improving student test scores, as all average test scores were not that
different from those of previous years’ data. The vast majority of students also performed
within one standard deviation of their traditional test scores. Of the few students who did
perform significantly worse on the gamified unit, almost half were absent from school a
significant amount of time (10% or more of the unit).

This study also showed that the gamification process was unsuccessful in
changing the overall average of student motivational components. Students responded to
Likert items with minimal change throughout the units and expressed similar views both
before and after the video game was concluded. Student interest in the video game was
promising in the first week of game play, but dwindled as the unit progressed as indicated
by the number of students who identified the video game as the largest motivator decreased.

As indicated by the interviews, student surveys, and the parent observation survey, there seemed to be mixed feelings about the video game. One parent even commented in their survey, “[Student] is up in the air as to whether he likes the new approach. He has mentioned a frustration in finding information on the web. I think he wants to "like" the new approach but is hung up on something ...just not sure what it is.”

Students also reported in interviews that parents were even unsure or took opposing opinions about the new technique. This may have been a symptom of a larger problem; lack of communication between the students and parents. It was my presumption that the students would explain the game to their parents at home and any parents who had questions about the video game would respond to the multiple email surveys I sent out inquiring for more details.

While there was no direct evidence to support gamification as a “silver bullet” within this study, there were many positive and surprising outcomes. Despite the lack of measurable changes in motivational components, more students preferred the video game style to a more traditional teaching method even though, on average, test scores were lower (though still within the standard deviation). Students and parents also reported that students, some who had not been previously engaged, found new excitement with the video game.

As with much educational research, there was a large degree of inaccuracy due to the depth and complexity of the issues being investigated. There were a large number of
reasons the results of this investigation were not as positive as was hoped. First and foremost, the second unit of the video game was not created with nearly as much detail as the first unit. I believe this caused a significant loss of interest in the video game during the second unit. This assumption was supported both by the fact that students reporting the game as the largest motivator in the SMQ-II decreased significantly and the fact that students last year who only completed one unit of the game preferred the video game in the end more frequently than those who had completed both units.

Another source of inaccuracy in this experiment was the fact that many students felt as though they did not have enough time to complete the video game. Student absences are an issue in our district. For a variety of reasons (educational field trips, illness, assemblies, family vacations, etc.), it was a rare occurrence to have every student present. In the 29 school days that the treatment was occurring, there were 229 absences (not including absences due to assemblies, clubs, and other school related obligations), with only 33 out of the 122 students being present each day. Despite the understanding that if students were absent or were falling behind, they should work on it at home to catch up, the students interviewed indicated that they did not log in to work on the video game at home.

At the end of the unit on forces, many students told me they had not completed the video game and needed more time. I told them that if 60% of the students could log in and do something at home to show me they really needed more time in the two nights before the test, I would postpone the test. That evening, approximately 5% of the students logged on from home. This could have been due to a cultural issue in the district where
students were not willing to work or study at home. As a result, not completing the material on the video game in time for the assessment probably led to lower than usual test scores.

The video game was introduced with the intent of helping students engage the material in a unique way that increased motivation. Through talking with students and interacting with parents, it was clear to see that many of the students did enjoy the game, even if only temporarily. Despite a lack of changes in the motivational components as indicated from the SMQ, the activity itself required that students be engaged in the material in order to accomplish specific objectives set forth within the game. From my own observations, most students were very engaged in the video game during the class period on most days. This increased engagement is critical for increasing student motivation and is a step in the right direction.

VALUES

Though this research does not directly support gamification in the classroom, it also does not condemn it. Average test scores were within one standard deviation of one another (year to year) and overall student scores were not heavily impacted due to the addition of the XP grade. Last year during the video game, I had a student walk up to me about to ask a question and pause before asking. She stopped dead in her tracks and said to herself as much to me “Wait. Never mind. I can figure this out on my own.” For the first time in my career, I had my students begin to independently problem solve and actively refuse assistance in an effort to figure out a solution. If the gamification philosophy can promote student independence, temporarily increase motivation, and help
students develop problem-solving skills, it is well worth the time and energy put into the creation and implementation of the unit. To learn science is to learn how to investigate and problem solve. If our students do not learn how to solve problems independently, but can spew back all of the nuanced rote memorization in science we teach them, I believe we have failed as educators.

As a teacher, the gamification process radically changed my role both within the classroom and as a planner outside of the classroom. Outside of the classroom, the gamification process required a substantial amount of planning and designing. The first unit on motion took roughly a year to piece together. I worked in my spare time and on vacation to plan, organize, and program the video game. I was no longer planning for just one lesson or activity at a time, but was planning for a variety of pathways through which students could encounter the content and reach the objectives with proper scaffolding. Though the second unit took less time to construct, I do not believe it was as well planned as the first unit on motion. Even though this required a huge initial time investment, I believe it was well worth it for the students. I was also able to use the same game each year with making only minor adjustments. The second year I ran the unit on motion, preparation for the entire unit was very minimal and did not require a lot of work to implement.

Within the classroom, my role took an even more drastic change. Instead of the majority of my time being spent on presenting new material and repeating answers, I was able to spend the vast majority of my time working with the students in small groups or one-on-one. My role shifted from a more presentation heavy model to a largely assistive
model. In a typical gamified unit class, I would spend time updating the scoreboard, helping students with technology issues or helping students better understand the content. The video game provided me the freedom to help those students who needed my attention the most, and allowed those students who were meeting the objectives delve deeper into the content than I normally would have in a traditional classroom. The gamified units also allowed students the opportunity to learn with freedom and not be constrained by their peers and encouraged students to seek out new information on their own or problem solve for themselves when they encountered an obstacle.

As we are moving to a trimester schedule, we will have 68 minute periods beginning next year. My hope is that the longer periods will provide students with more time working on the video game and reduce the amount of transition time to maximize effectiveness. I plan to continue this study with honors level general science students to see if a higher level of intrinsic motivation will yield better results within the gamification unit. It will also be interesting to see how honors students view the video game as compared to level two students. I will be revising or eliminating the second unit to reduce the redundancy of the unit and expanding the video game to potentially involve other units in chemistry as well. I also plan to include a letter home to parents identifying what the gamification unit is and why it is being implemented.


text heighten engagement and learning for students with learning disabilities?  


APPENDIX A

OUTLINE OF VIDEO GAME
Ranks – Cadet: 0-19  2nd Lieutenant 20-39  Lieutenant 40-59  Captain 60-79  Major  Lieutenant Colonel  Colonel  Brigadier  Major-General…

INTRODUCTION VIDEO
Welcome! I’m glad to see you’ve chosen to join the Alliance. I know you must be eager to get to the battle. Don’t worry we’ll have plenty of time for that later. Besides, we can’t have new recruits on the battlefield before they’ve had the proper training! For now, you are going to start out as a Cadet, our lowest rank. Don’t worry, you’ll be given the opportunity to prove your knowledge and skills in order to earn more Experience Points (XP) and promotions. You are in a group of highly motivated recruits so don’t waste time and allow your friends to out rank you! Also keep in mind that you CAN be demoted or lose experience points by being off task, not completing your work, or being disruptive to other Cadets. You can always check to see where you rank on the rankings board on the moodle page. If you earn enough experience points new challenges, missions, and rewards will open up for you. Any paper worksheets or experiments you conduct will be turned in at the end of the unit in your packet with your unit exam. All papers you need will be in the crate by Master Cohen’s desk. You can acquire them as you need them. If you ever have any questions, you can immediately contact your superior officer, Master Cohen. Talk about a guy that knows the Force inside and out! He’ll help you with any problems you might have, but try to figure things out on your own first before going to him. Remember that you are in complete control of your own progress and you will have to investigate some stuff on your own. Feel free to use the internet to search for tutorials, explanations, or any information you need at any time.

Before we give you your credentials to get in and out of the base, we have to give you an entrance exam to see where we should place you in the Alliance. Good luck and may the force be with you! (5)

Quiz (10)

Great job on that entrance exam! You ready for your first assignment? Good! Ever since the attack on our base in Alderan, we’ve been short on people to help out with radar detection. We need to know if and when the Imperial forces are coming so that we can be prepared for battle when they arrive. You have a lot to learn about motion before we can get you out in the field fixing equipment and detecting Imperial ships, but I’m sure you can handle it. The first thing you want to do is learn some of the terminology relating to motion. I would recommend you take a second before your mission to read over pages 38-42 of your Field Manual. You can stop when the Field Manual stats talking about graphing motion; you aren’t ready for that yet. Remember, you are going to want to keep a record of notes in your notebook to help you out later. This includes all of the fancy words and vocabulary you learn.

https://www.youtube.com/watch?v=Lha8SgQ_4fE (5)
https://www.youtube.com/watch?v=V8hJhTE3bUk (5)
Quiz (15)

Complete the Displacement Lab Activity (PACKET)

VELOCITY VIDEO
Well, hey there! Congratulations kiddo! Looks like you are moving up in the Alliance pretty fast. Time for your first lesson on SPEED and VELOCITY. You are going to need to understand speed and velocity so that you will be able to determine how long it is going to take the Imperial forces to get to our front door. That information will help us prioritize and get the necessary supplies ready. Your knowledge of speed will also help determine what forces they’ve deployed.

You are probably already familiar with speed. Speed is simply the rate of distance traveled or how far an object is travelling in a certain amount of time. Velocity is the same thing as speed with two minor changes. Velocity is looking at DISPLACEMENT over time and it includes a direction. Imperial forces moving at 10 miles per hour toward us is a lot different than imperial forces moving 10 miles per hour AWAY from us! One tells us we need to prepare for battle and the other tells us we need to bunker down and shut up in the hopes they won’t notice we are here. Read over page 44 of your field manual to get a better idea of what I’m talking about.

COMPLETE SW DISPLACEMENT WS (PACKET)

READ QUIZ

Ok. I’m glad you’ve got a good handle on speed and velocity. We’ve developed a new speeder for our informants in Naboo to get around and escape if necessary. There are three main hills going out of the city in Naboo and we need you to find the average velocity down each of these hills so we will know how far our informants can get before an attack. We’ve created a simulation in 228 to help you in your investigation. Instructions can be found with Master Cohen. May the force be with you!

AVERAGE RACECAR SPEED LAB (PACKET)

Quiz (15)

Well hey there! I’ve been instructed to go over a couple of examples of problems you might encounter on the job. Remember that it is VITAL you take the time to show all of your work with units. If you get knocked out, we want your replacement to be able to pick up right where you left off. We don’t want that to happen of course, but those Imperial scumbags are ruthless and every second counts! To help keep things organized, we use the GUFSS system. Given, Unknown, Formula, Substitute, Solve.

Let’s say a sand speeder takes 15 minutes to get from the water farm to town which is 18 km away. How fast is the sand speeder?

Let’s say out X wing fighter can travel an average speed of 100 m/s out in space. If it takes the fighter 5 minutes to arrive at the enemy starship, how far away is the starship?

One last problem: Let’s say you notice an object moving 20 m/s and it is 450 m away. How long do we have before it arrives?

Try some of these problems on your own now. Enter in your answers from the worksheet to the database to check your work, but you still must show all work and GUFSS on the worksheet to hand in for the packet. Good luck!

VELOCITY WS (PACKET)

Quiz (10)

CHECKPOINT! Check in with Master Cohen before moving on.
Greetings! I’m Admiral Ackbar. I hear you are moving up quickly in your class. We need your help. We’ve acquired intel that the Imperial forces have designed a new droid for infiltrating our outposts and cutting communication before they strike. We’ve been able to acquire one of these drones in the hope that we can determine the motion signature of the drone and detect them before they infiltrate the outposts. We need you to graph the motion of this droid on a Velocity vs. Time graph manually so that our detectors know what to look for. I would recommend recording the droid’s position every 0.5 meters. You might need some help on this one so feel free to recruit some help. Just remember that every individual must have their own papers and work. I’ve also put together some information to help guide you in your investigation. May the force be with you!

**VELOCITY MISSION DUNE BUGGY GRAPH (PACKET)**

**Quiz (20)**

Congratulations! Looks like you did a fine job. The data you provided our defense team with is incredibly valuable. Thank you for your hard work! We have another task for you. The Empire has developed a new hyperdrive system for their starships which can provide them with incredible amounts of acceleration. Again, we need to know the motion signature of the starships so we can know when they are jumping into hyperdrive. First, you’ll need to get a firm grasp of what acceleration is. Read pages 47-51 of your field manual before proceeding. Once you have completed this we have modified the speed racer setup to provide you with a simulation of the acceleration so you can perform your experiment. The location of this setup is top secret and will only be revealed to you once you are ready. May the force be with you!

**ACCELERATION TUTORIAL VIDEO**

**Quiz**

**ACCELERATION WORKSHEET (PACKET)**

**ACCELERATION MISSION**

Pst. PSSST! Hey YOU! Listen up. I need you to be hush hush about this ok? Master Cohen said you were moving up the ranks fast and that I could trust you. This is a big task, but we have to keep this under wraps so you may choose one and only one partner to join you in this endeavor. You can’t let anyone outside of your team know about this so we don’t start a panic. Our defense radar motion detectors are offline! Someone has sabotaged them. I need you to grab a spare radar motion detector and test it out to make sure that it is working the way it should. Master Cohen has a packet of information that will help guide you. He WANTED to just let the force guide you, but I said that was total hogwash so we made some clear instructions to help you out. The safety of the base depends on your success. May the force be with you.

**Quiz**

https://www.youtube.com/watch?v=DRb5PsxJerM

**MOTION DETECTOR MISSION**

HAHA! YOU’VE SAVED US ALL! Thank you so much for your hard work. Don’t worry, we’ll let Master Cohen know how hard you worked on this. You’ve helped the Alliance survive yet another battle against the evil Empire. We salute you. We know you have a big test coming up for the academy so we’ll let you get studying. Feel free to use any of the resources on the moodle to review.
Test
TSWBAT
… define and identify forces … describe how forces affect an object’s motion …
define and identify Newton’s 3 laws of motion … apply Newton’s 3 Laws to explain
RWE … Describe the motion of a falling object/projectile … Identify and explain the
factors affecting the frictional force acting on an object
FORCES!!!
Congratulations on your recent graduation from the Academy! Now your real training
begins. Before we send you on your first mission, we need you to figure out what exactly
the force is! This way, you will know it when you encounter it. We’ve put together some
materials to help you out in your field manual. Read pages 52-53 to get a grasp on what
the force is and what it looks like. Don’t forget to take notes on this material. I guarantee
you will need to refer to it later.

What is a Force? (a push or pull on an object) NET FORCE Pages 52-53

READING QUIZ I

You have progressed quite far in your training. To further your training, we have a
special mission for you. Our spies has provided us with intelligence that there is an old
Jedi Physics master who has the knowledge and understanding of the force to not only
describe all motion, but predict it as well. Once you find enough information about this
master, you must seek out this individual and learn his teachings of motion and the force.
His name is Newton.

Find Newton! – Internet Search
Find ONE NEW fact about Newton and post it... it cannot be a repeated fact!

Hello, young one. I have sensed you would seek me out. Strong with the ways you are,
but much to learn. Yes, much to learn indeed. I know you have been sent to find me and
learn the ways of the force. Become a master you will? Become smart you will? Mmmm
with training, perhaps. Not what it seems, they way of physics is. mmmMMmm No. Not
what it seems. Teach you, I cannot. Learn yourself, you must. To the forest of 228, you
must go. There in the lab, find what you seek. Caution learner. Patience, you will need.
Detailed notes of every experiment you do, must you have. Fail, you must not.

• First Law: (Cup and Penny, Spiral chute, eggs, mass and string, poker chips?)
  PAGES 54-56, 19 I
• Car accident video
• Mythbusters Car and Ramp
• http://www.physicsclassroom.com/class/newtlaws/Lesson-1/Newton-s-First-Law
• Chapstick fall SEE MASTER FOR MAGIC
• Falling Meter Stick Video FORUM (Post 1 example)
Welcome back. Completed your quest, have you? Good. Know the Laws you must to proceed.

ID the Law and Units QUIZ

OH. So YOU’RE the one who understands the force? Great. We’ve been in need of a force expert for some of our engineering projects. What’s that? You AREN’T a master yet? Oh, brother. Great, just GREAT. We ask for a specialist and we get a kid! I mean, uh, no offense and all. Hey you’ve gotta be pretty smart to have gotten this far so young. Maybe you’ll turn out ok. We’ll see what you can handle. First you’ll need to learn some of the different types of forces that exist. I don’t know much about them, but you can probably go down to control room 228 and find some information. Good luck!

What types of forces are there?
- Friction (mu of Hoth vs. degobah) 70-72
- Gravity (Reaction time, weight on planets) 75-79
APPENDIX B

OUTLINE OF POWERPOINT INTRODUCTION AND RULES
1. This class is now a VIDEO GAME
   a. … but there are rules if this is going to work
2. PARTICIPATION
   a. This is at YOUR OWN PACE… but this is a race. You have ~10 class periods to complete all of your missions. Plenty of time… if you stay on task.
   b. Is graded and expected
3. EARN XP as you progress to earn promotions, access to games, passes, awards, etc.
4. DIMERITS will hurt your ranking AND your class score (not staying on task, being disruptive, destructive, disrespectful, NOT PLUGGING IN COMPUTER)
   a. XP/Grading
   b. XP and ranking will be posted on the Moodle page SCOREBOARD. You are on a team AND on an individual squad. Think of your squad as your lab group.
5. HELP EACHOTHER OUT… WITHOUT CHEATING
6. WATCH the FULL videos
7. PACKETS WILL BE TURNED IN AS USUAL for credit
8. COMPUTER USE
   a. Stay on task
   b. If you are off task consistently, we will go back to the original plans
   c. The internet is your playground… keep it appropriate and remember I (and the district) will be able to see what you are doing and what you do IS recorded on your account
9. PLUG IT IN!
10. ISSUES
    a. Having trouble? Follow the order of operations:
        i. TRY to figure it out!
           1. Textbook
           2. Internet (Uh… Google?)
           3. Moodle Videos
        ii. Ask a friend
        iii. Master/Emperor Cohen IS here during class (LAST RESORT) and before/after school
           1. Wildcat Academy
    b. Will there be tech issues?
        i. YUP! Be patient and work with me on this.
    c. Use Firefox for the moodle!
    d. Refresh page if next task didn’t open up right away AND write it down or email it to me to fix
    e. “Low on resources” means “restart the computer”
11. CAN I work from home?
    a. Technically, yes! I cannot stop you
b. I will not REQUIRE you to do work at home UNLESS YOU FALL BEHIND
12. ALL labs and activities will be done here at school
13. Get ahead and the moodle will unlock fun games and rewards:
   a. Mr. Cohen’s favorite computer game growing up
   b. Oldschool DOS games
   c. Puzzles
14. YOU are the champions on the Road to Awesome and I’ve got your back!
15. YOU have the power to make this experiment succeed or fail.
16. Succeed and I will format more units like this with new themes
17. Fail and the video game world WILL FALL
18. The fate of this game world lies in your hands
19. This IS an experiment
20. Not everything will be perfect.
21. Not all of you will prefer this…
22. But it is worth a shot.
23. Questions?
24. IF ALL GOES WELL:
   END PRIZE
25. PRIZES FOR:
   a. Highest individual score
   b. Highest Squad Score
   c. Class with highest test score average
APPENDIX C

STUDENT MOTIVATION QUESTIONNAIRE II
In order to better understand what you think and how you feel about your science courses, please respond to each of the following statements from the perspective of “When we are in science class...”

01. The science I learn is relevant to my life.
02. I like to do better than other students on science tests.
03. Learning science is interesting.
04. Getting a good science grade is important to me.
05. I put enough effort into learning science.
06. I use strategies to learn science well.
07. I enjoy earning XP in the game
08. It is important that I get an “A” in science.
09. I am confident I will do well on science tests.
10. I like being good at this game.
11. I spend a lot of time learning science.
12. Learning science makes my life more meaningful.
13. I work hard to beat other students’ scores.
14. I am confident I will do well on science labs and projects.
15. I believe I can master science knowledge and skills.
16. I prepare well for science tests and labs.
17. I am curious about discoveries in science.
18. I believe I can earn a grade of “A” in science.
19. I enjoy learning science.
20. I think about the grade I will get in science.
21. I am sure I can understand science.
22. I study hard to learn science.
23. It is important that I earn a high score in the game.
24. Scoring high on science tests and labs matters to me.
25. I think about my score on the game outside of class.

This survey was provided online and gave the students the option of Never, Rarely, Sometimes, Often, or Always for each question. In the during and post treatment surveys, five questions were also included randomly throughout the survey.

A. I enjoy earning XP in the game
B. I think about my score on the video game outside of class.
C. I like being good at the video game used in class
D. I work hard to beat other students’ scores on the video game
E. It is important that I earn a high score in the game.
APPENDIX D

PARENT OBSERVATION SURVEY
Parent Observation Survey 2

This survey is confidential and completely voluntary. Only the teacher will know your identity and the identity of the student. The information you provide will be used in research on student motivation. Students will not see the results of this survey and will not receive credit for the completion of this survey.

In order to better understand what you think and how you feel about your son/daughter’s motivation, please respond to each of the following statements from the perspective of “Over the past week....”

*Required

1. What is your name? *

   

2. What is your son/daughter’s first name? *

   

2. What is your son/daughter’s last name? *

   


3. What period does your son/daughter have science? *
   - Period 1
   - Period 3
   - Period 4
   - Period 5
   - Period 6

4. My son/daughter talks about science class. *
   
   1 2 3 4 5
   
   Never □ □ □ □ □ Often

5. My son/daughter is the one to bring up a discussion on science class at home. *
   
   1 2 3 4 5
   
   Never □ □ □ □ □ Always

6. My son/daughter studies for science class more than other classes. *
   
   1 2 3 4 5
   
   Never □ □ □ □ □ Always

7. My son/daughter can describe to me what they have learned in class. *
   
   1 2 3 4 5
   
   Never □ □ □ □ □ Always
8. My son/daughter can explain to me what they have learned in class. *

1 2 3 4 5

Never ○ ○ ○ ○ ○ Always

9. My son/daughter speaks confidently about what they have learned in science. *

1 2 3 4 5

Never ○ ○ ○ ○ ○ Always

10. My son/daughter is confident they understand the material covered in science. *

1 2 3 4 5

Never ○ ○ ○ ○ ○ Always

11. I have seen a recent change in my child's confidence in the material covered in science. *

○ Yes, they are more confident
○ Yes, they are less confident
○ No.

12. Has your son/daughter explained the video game being played in class? *

○ They have not mentioned anything
○ They have mentioned it, but not explained it
○ They have explained it in detail.
○ They have showed it to me
○ They have tried to explain it, but it was confusing

Do you have any other comments regarding your son/daughters motivation in science class?

Submit

Never submit passwords through Google Forms.
APPENDIX E

IRB APPROVAL LETTER AND EXEMPTION FORMS
MEMORANDUM

TO: Samuel Cohen and Walter Woolbaugh

FROM: Mark Quinn, Chair

DATE: December 7, 2015

RE: “Investigating the Impact of Gamification on Student Performance in a Secondary Science Classroom” [SC120715-EX]

The above research, described in your submission of December 7, 2015, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

X (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

X (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects’ responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects’ financial standing, employability, or reputation.

(b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

(b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

(b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

(b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.
Administrator Approval

I, Kevin Duckworth, Principal of Dallastown Area Senior High School, verify that I approve of the classroom research conducted by Samuel Cohen.

(Signed Name, Title of Position)

Kevin C. Duckworth

(Printed Name)

11/17/15

Administrator Exemption Regarding Informed Consent

I, Kevin Duckworth, Principal of Dallastown Area Senior High School, verify that the classroom research conducted by Samuel Cohen is in accordance with established or commonly accepted educational settings involving normal educational practices and that I approve the project.

To maintain the established culture of our school and not cause disruption to our school climate, I have granted an exemption to Samuel Cohen regarding informed consent.

(Signed Name, Title of Position)

Kevin C. Duckworth

(Printed Name)

11/17/15

(Date)
APPENDIX F

INTERVIEW TRANSCRIPT

11th grader: RM
1. What motivates you in school?
   a. Brighter future.
      i. Have you always felt that way?
         1. Yes
      ii. Is there anything others can do to make you more motivated?
         1. Good attitude helps!
         2. Teachers who don’t sit there and look like death!

2. What motivates you least?
   a. Little games that waste your time.
      i. 5th grader treatment

3. What helps you understand material best?
   a. Reviews
   b. 1 day to go over stuff
      i. First time to understand?
         1. Better understanding
      ii. Labs
         1. Seeing how things work out?
         2. Hands on.
         3. Anyone can tell you something works, but if you don’t try it you don’t really buy it.

4. What did you like?
   a. Fun
   b. Own pace
      i. Do you feel that working as a group impedes you?
         1. Yeah.
      ii. Too slow/too fast?
         1. Sometimes drags on a little, but that’s ok since sometimes you don’t understand it right away

5. What did you dislike?
   a. Some of videos were missing information
   b. Had trouble finding answers

6. Do you discuss school with your parents?
   a. Once a weekish

7. Have you told them about science class?
   a. Yes
   b. Talked about the game
      i. Parents said it was a cool/creative idea

8. What math are you in?
   a. Algebra 2

9. Physics/Chemistry?
   a. Prefer physics
i. Reason? Less formulas
b. Easier
   i. Chemistry
   ii. If you know the formulas it becomes really easy

10. What do you do when you get home?
   a. Eat
   b. Work - make pizza!
   c. Watch TV
   d. Work on car

11. Did you spend any time at home on this?
   a. A little (one day)
   b. Opportunity to work on it is there if you miss school
   c. Compared to other subjects?
      i. More on other subjects

12. What do other classes use online?
   a. One note
   b. Word/Turnitin

13. What would make it better?
   a. Class – Congested when sitting
   b. Video Game – date to finish something by Students dragged stuff out
      i. Try to finish the material by a certain date

14. Do you feel like you’ve learned a good amount
   a. Yes
   b. Challenged?
      i. Yeah
      ii. More/Less

1. Keep it the way it is. Kids on either side.

LT and CK
1. What motivates you in school?
   a. Future – Have good education (x2)
   b. Good college
      i. College for Nursing
      ii. Law or medicine
   c. Is there anything others can do to make you more motivated?
      i. L – Explain in different ways
      ii. Comforting environment – mentally/both
      iii. Positive attitudes

2. What motivates you least?
   a. Don’t know/confused
   b. Negative attitude
   c. Better with paper in front of you
i. Lecture
ii. Opposite with L
3. What helps you understand material best?
   a. Worksheets/something to work on and try
   b. Sitting in a presentation
      i. Remember things better as you write them down
      ii. What about presentations do you like?
         1. Reading was hard to find or having to put in your own words
4. What did you like?
   a. Own pace
   b. Rewarding (grades)
   c. How the worksheets helped us learn
      i. Is there one activity that was
         1. All made sense
   d. Work with others
      i. Explain things in different ways
      ii. Own pace
5. What did you dislike?
   a. Felt short. Went fast and would get behind.
   b. 2-3 days more time would have made it a better experience.
   c. I didn’t do well on any of the test.
6. Do you discuss school with your parents?
   a. L – Yes
   b. C – No. Show them grades every once in a while.
7. Have you told them about science class?
   a. C/L – Told them about video game
      i. What was parents reaction to video game
         1. Oh cool
         2. Don’t understand
8. What math are you in?
   a. Alg 1b
9. Physics/Chemistry?
   a. Chem (both)
      i. Don’t like physics because you have to know Newton’s Laws can be confusing
      ii. Liked working with hands on labs to see what happens
      iii. Chemistry is more unpredictable/Physics is more common sense
      iv. Periodic table was boring
      v. Nothing cool happens in physics
1. Took simple things and made them more complicated. “Like when the wall was pushing back on you was really confusing”
  vi. Certain things we learn we are not going to use

10. What do you do when you get home?
   a. Eat/HW/Lacrosse
   b. Bed/Outside or Netflix

11. Did you spend any time at home on this?
   a. No – C
   b. Yes (1 day) L
   c. How long did you study?
      i. Both – nope
      ii. Do you typically study for science
          1. Nope
          2. Why do you think that is?
             a. Pretty good grade. I know I can do better if I study.
             b. Pretty much comprehension. The math questions trip me up.
             c. Don’t want to go home and do math problems
      iii. Never looked at study guides. I’m too lazy to go online and print them out.
   d. Compared to other units?
      i. Study less

12. What would make it better?
   a. Corny (first part/both)
   b. More time
   c. Make progress XP dependent
   d. Assigned squad was irritating
      i. Enforcing with the squads

13. Why are you against computers?
   a. People will abuse the computers
   b. Taking tests online is uncomfortable.
   c. Just give up and click on random things (regarding test answers)

MS, PB, and AC
1. What motivates you in school?
   a. P – Good job/college
   b. M – Happy future
   c. A – Good future
   d. Is there anything others can do to make you more motivated?
i. P - Sister motivates me because the college I want to go to is near her.
ii. A - $20 for straight B’s $40-$50 for A’s
iii. P – Dad pays $10 for A’s for main subject: Motivates just a little
iv. Making your parents proud

2. What motivates you least?
   a. M – Lectures
   b. P – group activities in English because I don’t like reading as a group (get anxiety if someone picks on me)
   c. A – Lectures
   d. M – Teachers randomly picking on you?

3. What helps you understand material best?
   a. M- interactive things like labs or hands on activities.
   b. P – Compare to things we know, providing visuals
   c. A – When the teacher demonstrates things

4. What did you like?
   a. P – Freedom to work with friends
      i. Was it distracting?
         1. Sometimes, but we got stuff done in the end.
   b. M – Working at your own pace.
   c. A – Freedom to work with partners/groups

5. What did you dislike?
   a. P – Being rushed, limited amount of time
   b. M – Having to wait to do labs because you can’t do them at home.
      i. Second video game was restrictive because you had to work with your group
   c. P – Some people didn’t do anything in their groups.
   d. A – Having to wait on your partners.
   e. M – computer problems.
      i. Were there a lot?
         1. A few at home. Had to download some of the programs. Sometimes it would freeze the computer. (1 year old computer PC)

6. Do you discuss school with your parents?
   a. All 3 – Yes (M – every day, P – Mostly every day. Parents check HAC, A – Every 2 weeks)

7. Have you told them about science class?
   a. M – Yes
   b. P – Sometimes
   c. A – Sometimes if we do something cool in class.

8. Did you tell them about the VG?
a. Yes (3)
b. Responses
   i. P – Yes, but they weren’t really listening
   ii. M – Dad didn’t like the idea (why isn’t the teacher teaching) Mom thought it was cool.
   iii. A – Mom said it sounded cool.
9. What math are you in?
   a. P – Alg 1B (all)
10. Physics/Chemistry?
    a. P – Physics (It’s cool! Everything happens for a reason) Science project was really cool.
    b. M – Chemistry (Physics is boring.)
    c. A – IDK
11. What do you do when you get home?
    a. P – Swim practice, snack, procrastinate, pretend to do HW
    b. M – Most days I do it right away to get it over with.
    c. A – Eat dinner, Outside with friends or at mom’s house.
12. Did you spend any time at home on this?
    a. P – Meant to spend time (didn’t until last two days)
    b. M – Did when I could. If you could.
       i. I had enough time to finish the game.
    c. A – Nope
13. How often do you study for science?
    a. P - 2 days before
    b. M – when we have a test
    c. A – Day before the test (at home)
    d. Compared to other units?
       i. A – Same
       ii. M – More
       iii. P – I don’t really know High grade is motivating.
14. Packet idea
    a. A, M – Yes
    b. P – Sometimes I lose things
15. What would make it better?
16. What would make the VG better?
    a. M – Videos of me teaching on the board with examples. BETTER as a video because you can replay it.
    b. P – I like the in person more because then I feel like I have to take notes
    c. P – More time. Felt rushed on the second part
17. Favorite class?
    a. P – Chorus – releaving (Math…. But not the math part of math)
b. M – Intro to Business (Freedom to learn – a few examples and then the opportunity to practice it)
c. A – English (Teacher’s cool more free time. End of period allowed to work or just talk Mr. Mohar)
d. How is it different?
i. P – It might just be the people you are around?

18. Least Favorite?
   a. A, M – Spanish (too much talking… we have to get up and do stuff like a lot of random partner stuff) Mr. Rohjan.
   b. P – French and English (don’t have any friends in English)

19. M – Tests are really different from the content taught. Such as the midterm.
20. P – That midterm was difficult. Review packet didn’t work for me.

TM
1. What motivates you in school?
   a. Nothing Probably
   b. Is there anything others can do to make you more motivated?
      i. Not really
2. What motivates you least?
   a. Not sure
3. What helps you understand material best?
   a. Teachers – if they are in a good mood I can understand them better
4. What did you like?
   a. You can work at your own pace
   b. Got to work with friends
5. What did you dislike?
6. Do you discuss school with your parents?
   a. All the time
7. Have you told them about science class?
   a. Yes – Response Thought it was pretty cool
8. What math are you in?
   a. Alg 1 B
9. Physics/Chemistry?
   a. Second half Physics
10. VG or Traditional way
    a. Video game
    i. Why? Own pace.
11. What do you do when you get home?
    a. Play on computer, chores, HW, play with animals
12. Did you spend any time at home on this?
   a. Yes – A little about an hour
   b. Compared to other units?
      i. Less Why? Try to even out the amount that I study for each class.
13. What would make it better?
   a. Nothing really.

JB
1. What motivates you in school?
   a. Baseball because I want to go play college baseball and to get there you need the grades
   b. Is there anything others can do to make you more motivated?
      i. When I see people around me working hard it makes me get in a more serious mood.
2. What motivates you least?
   a. Handout after handout no real explaining doesn’t help.
   b. When there are no activities just lecture/note.
3. What helps you understand material best?
   a. Description and then a hands on activity.
      i. Struggle is good. I might not understand it right away, but then I think “Oh. All I had to do was this…”
4. What did you like?
   a. Freedom to almost do it the way you like it. Communicate with other people
   b. It was more hands on and I didn’t get bored.
5. What did you dislike?
   a. Sometimes it was confusing
   b. First video game was a little fast.
   c. Second Video game was nice how we went over things on the board
   d. Some of the labs, I felt the videos didn’t describe the lab that well. I had to figure out what to do.
   e.
6. Do you discuss school with your parents?
   a. Sometimes. Especially about grades, but not HW and stuff.
7. Have you told them about science class?
   a. Depending on if I miss an assignment. Other than that not much
      i. Video game?
      ii. It sounded cool and different from what you normally do. Maybe I have to make a game out of it myself.
8. What math are you in?
   a. Alg 1 B
9. Physics/Chemistry?
   a. I like physics
      i. What about it? I get more interested. Just thinking about that there
         are just different versions of it.
10. What do you do when you get home?
    a. Usually I get home after BB practice, sit down, do HW, shower, Eat, some
       nights I leave HW to the morning.
11. Did you spend any time at home on this?
    a. Not very much… and I probably should have.
       i. Why?
          1. I wasn’t really super motivated. I was out of it.
          2. In class I liked it.
    b. Compared to other units?
       i. Probably about the same amount for each subject.
12. What would make it better?
    a. VG
       i. Have the meeting every couple of days
       ii. Easter eggs/games that you can sneak in more.
    b. Class?
       i. I like doing the labs and I think I learn better by doing more hands
          on.
13. Favorite Class? WC
    a. History
       i. Cool learning about (McKenzie)
14. Least Favorite
    a. English
       i. Just listening and taking notes. We don’t get to do anything with it.
       (French)
15. VG/TRAD
    a. 2nd video game Mix of the two.
16. Learned a good amount in class/vg
    a. Yeah
       i. Challenged
          1. Class YES
          2. VG sometimes it was challenging. Other times it was not too hard.