EFFECTS OF GAMIFICATION: ANALYZING STUDENT ACHIEVEMENT, MASTERY, AND MOTIVATION IN SCIENCE CLASSROOMS

by

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ABSTRACT

I wanted to implement a teaching model that requires students to obtain mastery of a concept. Students typically understand the premise of games and how games are played. Gamification requires that students master a specific level or learning objective before continuing on in the course. Although gamification is a relatively new model of instruction, it incorporates elements of standards based grading and mastery learning.

The purpose of this study was to determine if gamification increased student achievement, student mastery and student motivation. Learning objectives were separated and all class activities centered on leveled learning objectives. Students were not able to test out of a set of learning goals until they had demonstrated mastery of the content. Student test and quiz scores were recorded over a 27-week period. Students took surveys, participated in interviews and discussions as part of the study as well.

Results showed there was a significant increase in scores with implementation of gamification. Particular success was shown in non-honors classes rather than honors courses. Student mastery and achievement increased with implementation because students were not allowed to move forward in content if they did not receive at least an 80% on quiz scores. I will continue to adjust and modify this learning model based on the positive outcomes of the study.

INTRODUCTION AND BACKGROUND

I have been a teacher for five years and have continually tried to assess my teaching methods. I have taught high school life science courses in anatomy and biology. Throughout my first two years I taught in a very traditional style that consisted of warm-ups, lecture, and an activity or lab. Each student was supposed to learn content at the same rate and on the same day. It did not take me long to realize I was teaching to the middle of the student population. Top achieving students were bored and I left slower learners in the dust. As an educator, I envisioned a classroom where students would have the opportunity to self-pace and learn new content as previous objectives were mastered. Students would be able to re-work assessments and master objectives. Struggling students could take their time learning objectives, while high achieving students could dive into inquiry activities. The problem I encountered was I did not have enough time in the instructional day to individualize instruction on so many levels.

Hillcrest High School (HHS) is located in Ammon, ID. Ammon is a small community with approximately 13,816 residents (U.S. Census Data, 2014). Ammon's community is supportive of education. Many parents are actively involved in school activities and they are involved in student academics as well. There are currently 1,460 students enrolled at HHS. The demographic breakdown of HHS includes 93% identified as Caucasian, 5% identified as Hispanic, and the remaining 2% identified as other (City-Data, 2014).

I researched teaching models that incorporated mastery and standards-based grading models. Mastery became something I wanted students to achieve in class daily.

However, I still needed a model that would allow the flexibility required for me to be in more than one place at a time. The next teaching model that caught my attention was the flipped classroom model. Flipped instruction occurs when students watch video lectures at home, and class time is spent doing "homework" (Bretzmann, 2013). This model appeared to free up instructional time, as I would have time in class to ensure all students were mastering objectives. It would also allow me to have meaningful conversations with students about their learning.

The next step was to blend these models into a style that increased student performance, motivation and engagement. While researching I came across the gamification teaching model. Gamification includes the addition of game elements into the classroom. Educational gamification incorporates mastery and has the potential to access not only cognitive but emotional experiences for students (Lee & Hammer, 2011). This model seemed to address all the issues I was facing in the classroom. Additionally, it offered a way to leverage my time in the classroom by providing a framework to motivate, engage and require students to master learning objectives before moving on to new content. For example, if a student did not understand the structure of a cell, they would remain at that level until they demonstrated mastery. When the student mastered the objective they would level up and begin learning about cell functions.

As I researched this model, I realized that effective implementation of this new teaching model would need to have several working parts in place. My first step towards implementation of the gamification model was to establish a fully functional learning management system (LMS) using *MyBigCampus*. I also setup a website and linked all

classroom materials, quizzes, discussion boards, etc. to the website. Next, I wrote and received a grant for twenty iPads in my classroom, including a laptop for iPad management and screen casting functions. The iPads served as a way for students to self-pace via accessing all class materials online. Additionally, I recorded all lecture material as podcasts and uploaded them to the LMS. Podcasts were also synced with iPads. Students without Internet access at home had the opportunity to check out flash drives or DVD's with all classroom materials loaded onto them.

With all of the logistics in place, I was prepared to start testing the gaming model. Gamification is a new and promising concept in education. However, more research needed to be conducted on its effectiveness. The purpose of this study was *To determine if gamification increased student achievement, student mastery and motivation.*

CONCEPTUAL FRAMEWORK

Student achievement and motivation are two factors many educators struggle with in the classroom. Finding ways to engage students and increase student achievement are an important aspect of today's education system. Many educators are evaluating the effectiveness of using game-like components in the classroom, also known as gamification (Dominguez et al., 2013). Games typically have a mastery-based system incorporated into the design and many are divided into levels or worlds (Lee & Hammer, 2011). Although gamification is a relatively new concept in education, advocates suggest gamification is a way to increase student motivation, engagement, and performance (Apostol, 2013). Another benefit the model provides is a way to have meaningful dialogue with students about content rather than grades. Preliminary research suggests

this model is motivating, engaging, and has potential to increase student achievement if implemented properly.

Computer games, videogames, and games on mobile devices are structured in a way that require mastery of a set of skills before the player is allowed to move to a new set of skills. Using *Angry Birds* as an example, players must knock down bricks and boards within three attempts. A player cannot go on to the next level until the current level is passed. Rewards are also built into *Angry Birds*. As the player gains mastery, new birds become available (Andersen, 2012). Relating this to the classroom setting, mastery implies a student will retry a set of objectives until they understand the required information (Lalley & Gentile, 2009). Gamification allows educators to encourage students to master a set of objectives, meanwhile empowering students to revise and try again in a positive, nonthreatening, and productive way. Failure within games promotes mastery. This model allows students to correct mistakes without being punished (Andersen, 2012). Once students master objectives, they are extrinsically rewarded by leveling-up to the next set of learning activities (Lee & Hammer, 2011).

Schools around the country are beginning to model grading practices after mastery and standards-based grading. These grading schemes go together because standards-based grading measures student proficiency on objectives. Unfortunately, many traditional grading systems are setup in a way that students are able to successfully get through school simply because they complete homework, do as they are told, and get by with superficial learning (Scriffiny, 2008). Mastery systems do not allow students to play school but require students to learn the material and demonstrate knowledge. In

addition, mastery systems eliminate negative feedback in grading because students have unlimited opportunities to improve their understanding of a topic (Lalley & Gentile, 2009).

Leveled-up learning comes from game vocabulary. Levels are similar to military rank. For example, a person entering the Marines would begin as a private and work up to a corporal or higher (Daley, 2012). Leveled games are structured similarly. Players begin at the lowest level and move through the levels as they master skills and content. Leveling objectives ensures all students meet the prerequisite requirements before moving on, thereby decreasing gaps in content knowledge.

Videogames have had a dramatic impact on society in the past three decades. Worldwide, gamers spend over three billion hours per week playing games (McGongial, 2010). According to the *Entertainment Software Rating Program*, 68% of American households play videogames (ESNT, n.d). Game play is not a new concept in education, and many teachers currently incorporate board games, card games, computer games, or video games into their instruction (Lee & Hammer, 2009). The educational gaming philosophy is structured around the fact students are playing games. Studies show students spend more time learning content if it is delivered through a gamed approach (Peng & Alhabash, 2013).

Professors and teachers are beginning to experiment with gamification. A university in Spain developed a gamified approach as a way for students to study and revisit topics they did not understand. Preliminary results indicate that while the model is motivating, more research must be done on all aspects of gamification (Dominguez, et

al., 2013). Many universities and charter schools are interested in the cognitive aspect of games. Educators are trying to pinpoint what exactly it is about games that engage and motivate students to master material. Research suggests content must be challenging, but not to the extent that a student will want to give up. Educators who are implementing game-elements into the classroom hope to change the perspectives on learning from a have to attitude into a want to attitude (Lee & Hammer, 2011).

Another benefit to gamification is it provides a platform to have better conversations with students about progress and achievement. Currently there is considerable focus on student grades rather than learning. In this model the learning has been neglected or secondary to the grades earned. Unfortunately, many conversations about student grades include topics such as: points that were missed, what work is missing, and what work is incomplete. Many students and parents focus on the grades received, instead of the more important topic of what has been learned. Teachers, students, and parents should be discussing objectives that have been mastered, how mastery was demonstrated, and standards that still need to be mastered (Philip, 2012).

A way to shift the conversation and focus on mastery is to integrate experience points (XP) into the classroom. Experience points are similar to points that are already given out in the classroom. In a traditional classroom, students complete work in exchange for points, which are translated into percentages and letter grades. In addition, traditional models reflect effort rather than mastery. In a gamification model, students complete work in exchange for points, but these points are not immediately translated into percentages and letter grades (Daley, 2012).

Students gain XP as they move through levels of the course, but the only time a letter grade is given is at the end of the semester or unit depending on the instructor's framework. Small incremental letter grades and percentages do not always reflect the changes in learning that can occur throughout the course of a semester (Philip, 2012). Ultimately XP translate into a letter grade. For example, a student who receives the minimum eight out of ten on a lab assignment will receive eight XP, instead of it showing up in a grade book as an 80%. The way scores are received is essentially the same except for the removal of a percentage score and a letter grade. This way students focus on earning as many points as possible and not just looking at their overall percentage. Another example would be if at the end of the semester a student has 830 XP out of 1000 total, their XP would translate into a 83% or a B. It is not until the end of a semester or unit that a letter grade can be earned (Lee & Hammer, 2011).

Several grading studies have been conducted throughout the United States indicating letter grades may not be the best way to monitor student achievement because of their ambiguity (Rojstaczer & Haley, 2012). The purpose of this grading philosophy shift is to realign points received to knowledge obtained. Current grading systems do not place emphasis on mastery of standards or skills, but XP gained throughout the semester will reflect mastery of objectives and skills (Scriffiny, 2008). Instruction with game design embedded into the curriculum has the potential to shift the perspective of what grades mean and how they are calculated. Requiring mastery reinforces that all information is critical and repeating content to obtain mastery is crucial.

While implementation of game elements in the classroom has many benefits, the limitations and risks of the model must be addressed. One weakness is students could minimize what they learn in this model, because it is just like a game. Although research is not conclusive, it is possible students will not value the content knowledge if it is presented in a similar format as games (Apostol, 2013). Another shortcoming of the model is it encourages extrinsic reward systems. However, many students benefit from the extrinsic nature of the current school system. Several schools have integrated early release or extended lunches within the school day in response to A, B, and C letter grades. Many students receive rewards for good grades from their parents or other school organizations as well. Regardless of the teaching model, extrinsic motivation will likely be a part of education. The potential to increase student mastery of standards, focus on learning, engage and motivate students outweighs the negatives. To avoid these obstacles, the instructor must develop and integrate curriculum in a captivating and meaningful way (Lee & Hammer, 2011).

METHODOLOGY

The treatment of the study included the implementation of game elements into general and dual enrollment anatomy and physiology courses. Data was collected to determine if gamification increased student achievement, mastery, and motivation. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix A).

The first component of the study included leveling the content in the classes. Each level was divided based on standards and learning goals as shown in the Game Grading Setup (Appendix B). Students were not able to level-up or move past a standard until they met the learning objectives by at least 80%. All quizzes and tests were retested in an alternative format after not mastering by at least 80% or higher on the first attempt. Students had unlimited attempts at mastering objectives. In addition, students earned experience points (XP) and moved through class ranks as shown in the XP Setup (Appendix C). Each new unit began with new experience points. Students started with zero XP and as they moved through the levels of that unit earned XP.

Pretreatment data collection began third quarter of the 2013 – 2014 school year in addition to second quarter (fall 2014) in anatomy and physiology classes. In this phase students were encouraged to retake tests and quizzes if they did not master a topic, however retesting was not required. The pretreatment data collected occurred over an eighteen-week period. Treatment began third quarter of the 2014 – 2015 school year, which lasted nine weeks. The treatment included mastery of standards, student surveys, grade discussion checklists and interviews.

I collected data from the spring of 2014 and spring of 2015 and compared scores. Quiz and tests remained the same between each of the groups although the students were different between groups. I also collected data from the fall of 2014 and compared it to the spring of 2015 to determine the score differences between the same students although content was different. Data was collected and an ANOVA non-parametric test

determined the variance, standard deviations, and p and F values between each of the three quarters for both quiz and test scores.

The gamification model suggests that students should master learning objectives by at least 80%. Therefore, data was collected to determine the number of times a student attempted mastery between the previous school year (spring 2014) and the spring of 2015. I analyzed the scores and averaged the number of mastery attempts between the spring quarters, as well as the pretreatment and treatment phases. Additionally, data was collected to compare the number of students that reattempted tests and quizzes when mastery was not required, and when mastery was required. Frequencies were collected and I determined the significance of the variance between pretreatment and treatment.

In addition to recording and emphasizing student mastery, I wanted to determine if conversations with students about their performance changed with the implementation of gamified learning. During the pretreatment quarter, I recorded what I discussed with each student using field notes. During the treatment I kept a Discussion Checklist which focused on student mastery rather than incomplete, missing or other miscellaneous items (Appendix D). The checklist was analyzed for themes and used to support evidence for the differences in student grade conversations. When implementation began students completed the Likert Grade Survey at the beginning and end of the quarter (Appendix E). Students responded by using *Strongly Disagree*, *Disagree, Neutral, Agree,* or *Strongly Agree* attitude scale. In this section students were asked if their instructor discusses grades with them, if they know how they are doing in class, and if the instructor provides opportunities to discuss student learning both in and outside of class. Data was analyzed

by looking at the variance between the beginning and end of treatment. Additionally, Chi-square hypothesis testing was conducted to determine if there was a statistical difference between the pretreatment and treatment. Student interviews were conducted to gage how students interpreted the effectiveness of the gamification model as shown in Student Interviews (Appendix G). Interview data was analyzed for themes and used to support evidence for conversation changes.

To determine whether the gamification model was motivating, I distributed a student Likert Motivation Survey (Appendix F). Students responded to the attitude scales using *Strongly Disagree* signified -2, *Disagree* signified -1, *Neutral* signified 0, *Agree* signified 1, or *Strongly Agree* signified 2. Students were asked if they were interested in anatomy and physiology, whether they were motivated to learn, how often they studied at home, and what their confidence in A&P was. To analyze the data from the Likert Motivation Survey I averaged the responses of the whole group. I was then able to identify positive or negative changes in the averages reflected as a percent. Additionally, a Chi-square test was completed to determine if there was a statistical difference between student attitude toward anatomy and physiology during pretreatment and treatment.

A data triangulation matrix has been included to show the variety of data collection instruments that were used throughout the study. Additionally, the focus and sub focus questions are listed and paired with the data collection techniques (Table 1).

Table 1
Data Triangulation Matrix

	Data Source		
Research Questions	1	2	3
1. How does gamification affect student achievement?	Compare quiz scores between spring 2014 and spring 2015	Compare test scores between spring 2014 and spring 2015	Compare student growth pre-treatment and treatment
2. How does gamification affect student mastery of standards and objectives?	Compare the number of student attempts at mastery between spring 2014 and spring 2015	Compare student growth pre-treatment and treatment	Compare number of attempts at mastery using pre-treatment and treatment
3. How does the shift in grading provide a platform to have meaningful conversations with students about grades?	Student interviews	Checklist of what was discussed pre-treatment and post-treatment	Student surveys
4. Is gamification motivating and engaging for students?	Field notes, tally sheets to keep track of number of attempts at mastery	Student surveys	Student interviews

DATA AND ANALYSIS

Student quiz and test scores increased during the treatment in both non-honors and honors anatomy and physiology courses throughout the 27-week data collection period (Figure 1).

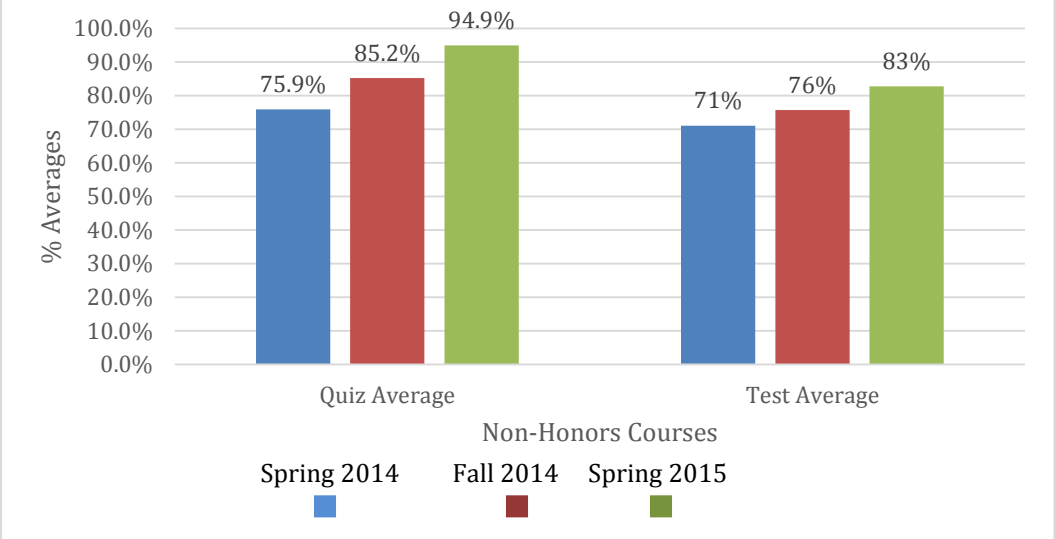

Figure 1. Averages non-honors, (*N*=1,880 scores). *Note*. Spring 2014 = 496 scores, Fall 2014 = 504 scores, Spring 2015 = 552 scores, Spring 2014 = 124 scores, Fall 2014 = 112 scores, Spring 2015 = 92 scores.

Looking at the pretreatment phase, the quiz averages for spring 2014 were based on 496 quizzes for non-honors students. The standard deviation in this group was 34%. The fall 2014 quiz scores were based on 504 quizzes and the standard deviation dropped to 25%. In the treatment phase (spring 2015) results were based on 552 quiz scores and the standard deviation was 10%. When looking at quiz results the F value compared to the F-critical value was a ratio of 78 to 1.6, which means the results were statistically different. Anova tests were run at 95% confidence levels. P values for the non-honors course quiz and test scores were 4.09×10^{-7}.

Test results for non-honors anatomy and physiology students showed a smaller standard deviation in all groups. The spring 2014, fall 2014 and spring 2015 standard deviations were 17%, 15%, and 12% respectively. Similar to the quiz results, the F value ratio for non-honors test scores was 15 to 1.6.

The non-honors expected low scores were also calculated. The expected lows and highs were calculated to determine where 68% of student scores were expected to score (Figure 2).

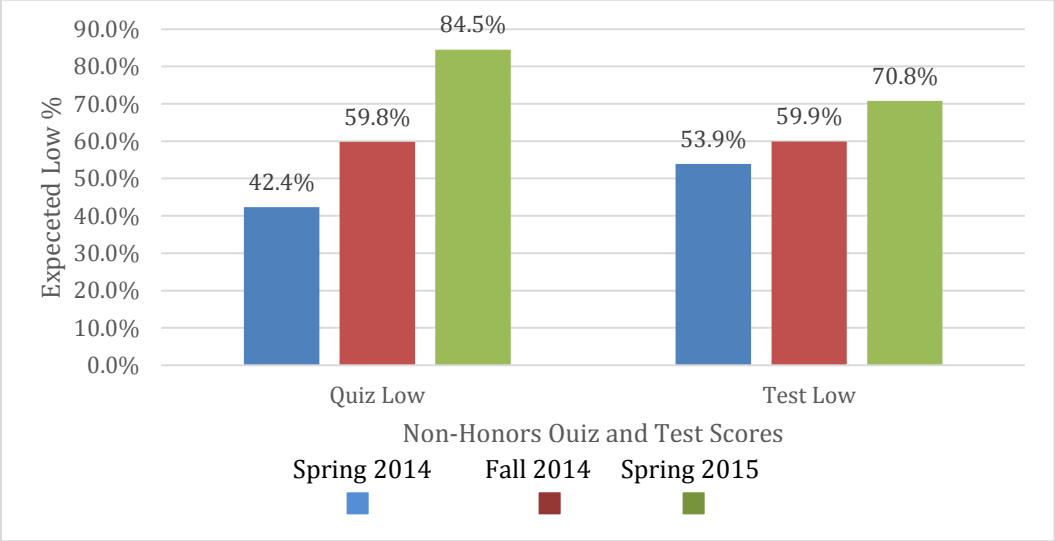

Figure 2. Expected low ranges non-honors, (*N*=1,880). *Note*. Spring 2014 = 496 scores, Fall 2014 = 504 scores, Spring 2015 = 552 scores, Spring 2014 = 124 scores, Fall 2014 = 112 scores, Spring 2015 = 92 scores.

For the spring 2014 quiz group, the expected low was 42.4% and the high was 100%. Similarly, for the fall 2014 group the low was 59.8% and the expected high was 100%. For the treatment group, the spring 2015 expected low was an 84.5% and the high was 100%. The test score range did not show as significant improvement as the quiz scores did. The expected low and high ranges for spring 2014 test scores was 53.9% -

88%, fall 2014 was 59.9% - 91%, and lastly the treatment group was expected to be between 70.8% - 95%.

Honors anatomy and physiology scores also showed improvement but gains were not as significant as the improvement for non-honors courses (Figure 3).

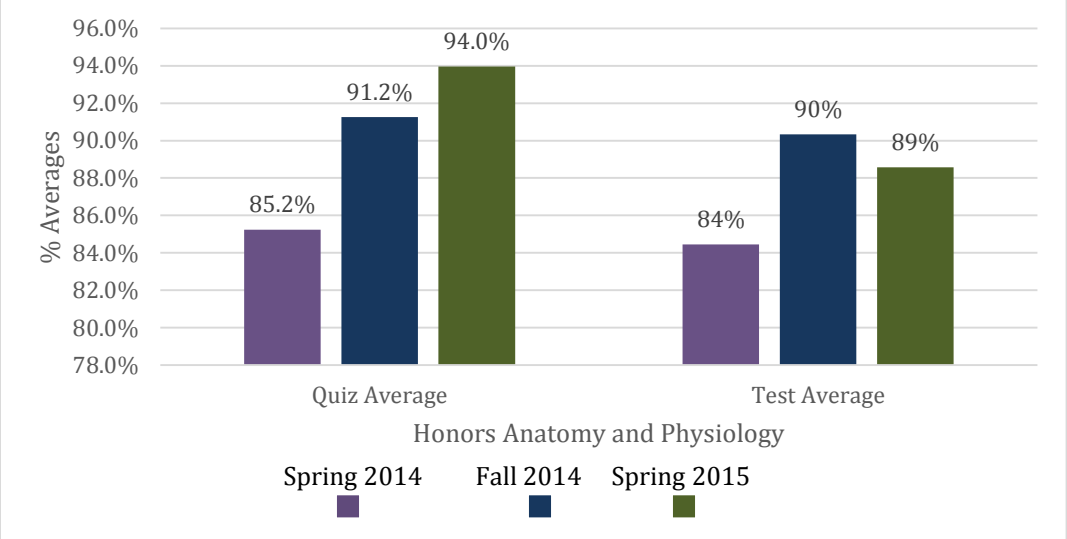

Figure 3. Averages honors, (*N*=1,923 scores). *Note*. Spring 2014 = 215 scores, Fall 2014 = 594 scores, Spring 2015 = 768 scores, Spring 2014 = 86 scores, Fall 2014 = 132 scores, Spring 2015 = 128 scores.

In the honors group the quiz averages for spring 2014 were based on 420 quiz scores for honors students. The quiz average was 85.2% and the standard deviation in this group was 25%. The fall 2014 quiz scores were based on 594 quiz scores and the average was 91.2% and the standard deviation dropped to 16%. The spring 2015 results were based on 768 quiz scores. The average for the treatment group was 94% and the standard deviation yielded 9%. When looking at quiz results the F value compared to the F-critical value was a ratio of 26 to 1.6, and the test score ratio was 7.9 to 1.6 which represents a significant change. Anova tests were run at 95% confidence levels. P values for the honors course quiz and test scores were 4.09×10^{-8}.

Test score averages for students showed an improvement from 84% to 90% between the spring 2014 and fall 2014 groups. However, results also indicated a drop in test score average for the treatment group to 89%.

The expected high and low values were calculated to determine where 68% of the students in honors anatomy and physiology courses were expected to score (Figure 4).

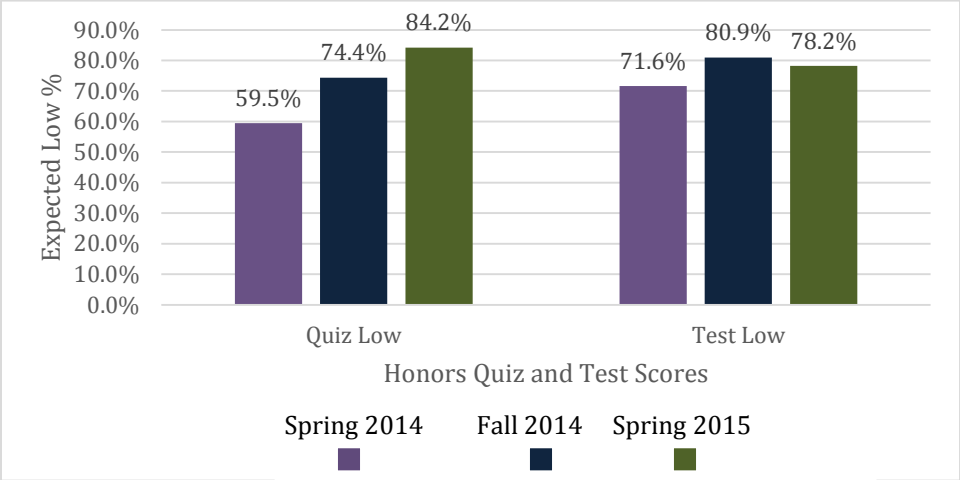

Figure 4. Expected low range honors, (*N*=1,923). *Note*. Spring 2014 = 215 scores, Fall 2014 = 594 scores, Spring 2015 = 768 scores, Spring 2014 = 86 scores, Fall 2014 = 132 scores, Spring 2015 = 128 scores.

For the spring 2014 quiz group, the expected low was 59.5% and the high was 100%. In the fall 2014 group the low was 74.4% and the expected high was 100%. For the treatment group, spring 2015, the expected low was 84.2% whereas the high was still at 100%. Test score low and high ranges showed improvement but the treatment group showed a decrease in scores. The expected range for the spring 2014 group was between 71.6 – 97.3%. The fall 2014 group range was between 80.9 – 99.8%. Lastly, the treatment group range was between 78.2 – 98.9%.

When asked about student motivation to learn anatomy and physiology topics students reported they were more motivated post treatment from pretreatment data (Figure 5).

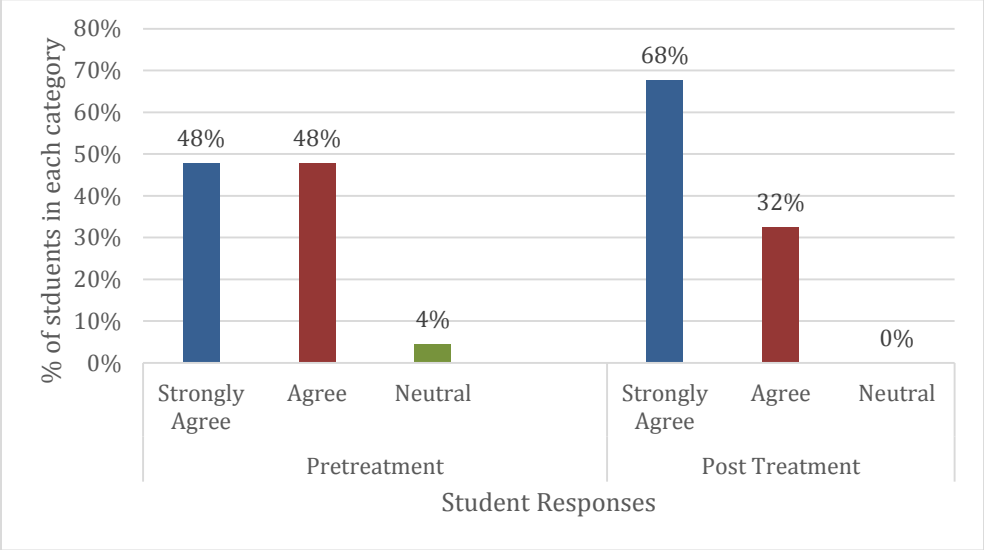

Figure 5. Student motivation non-honors, (*N*=60).

One student responded by saying, "I am more motivated to learn when I know I have to get at least an 80%, and if I don't, you'll make me do it again." Students in honors classes reported higher motivation levels when compared to non-honors students. The percentage of students that strongly agreed that they were more motivated increased after treatment with a gain of 20% and based on the Chi-square analysis the results were significantly different between pre and post treatment surveys. All survey data was calculated with 95% confidence. Another student said, "First semester was easier, but I didn't do anything. Now that you make me retest I feel more of a reason to pay attention in class." During the pretreatment survey 96% of students felt motivated towards learning anatomy and physiology. After treatment 100% of students reported motivation. In the pretreatment interview one student responded, "I want a career in the medical field,

but some days it's hard to stay focused." In the final interview the same student said, "I would rather learn things in class so I don't have to worry about forgetting them at home."

When asked 89% of students responded in the pretreatment phase that their teacher discusses grades with them. In the post treatment survey 97% of students *agreed* or *strongly agreed* that the instructor discusses grades with students in class (Figure 6).

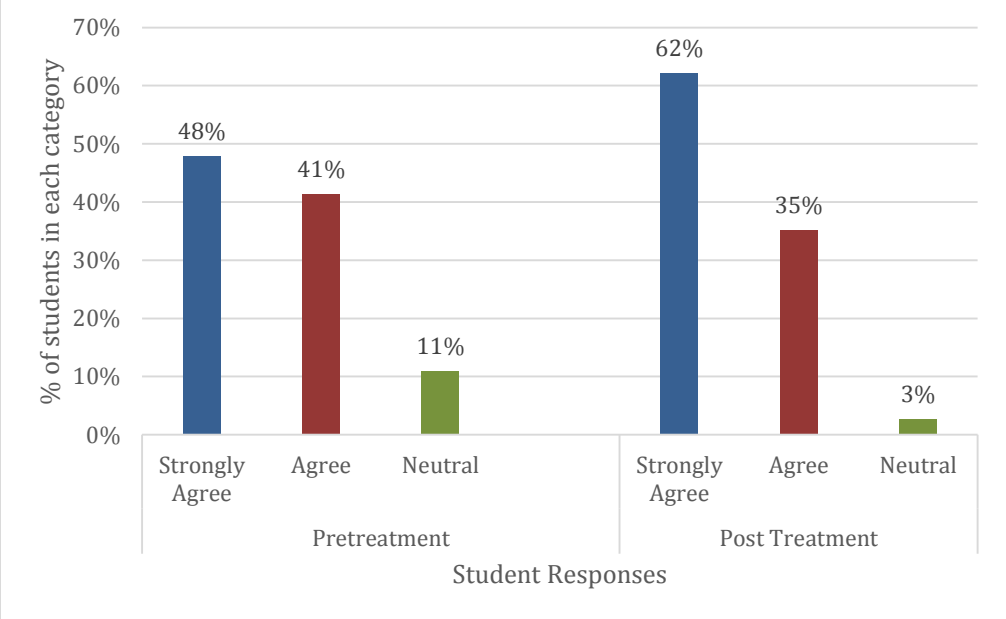

Figure 6. Instructor discusses grades non-honors, (*N*=60).

One student responded to the grade interview with, "You always said what my grade was, but now you tell me what learning objectives I need to work on for the test." Another student stated, "I know exactly what objectives I don't know yet."

Many survey responses were the same between pretreatment and post treatment results. Pre and post treatment data showed that student willingness to participate and study in class did not change significantly. Additionally, student confidence levels did

not show a significant change. While 74% of students reported confidence in their A&P knowledge during pretreatment, 78% felt confidence in the treatment phase (Table 2).

Table 2
Student Survey Responses

Non-honors A&P	Pretreatment			Post Treatment		
	Strongly Agree	Agree	Neutral	Strongly Agree	Agree	Neutral
I am willing to study and participate in class	57%	39%	4%	59%	38%	3%
80% higher encourage me to keep grades up	67%	30%	3%	78%	19%	3%
I am willing to retake quizzes	50%	37%	13%	70%	27%	3%
I am interested in A&P	63%	33%	4%	73%	24%	3%
I enjoy A&P	61%	30%	9%	81%	19%	0%
I am confident in A&P knowledge	20%	54%	26%	29%	49%	22%

Note. (*N*=60).

At the end of the treatment phase, students answered survey questions regarding their earned icons in the grade book. According to the survey responses, the icons encouraged students to retest poor learning objective scores. In the pretreatment data, 5% of students in non-honors classes *strongly disagreed* that icons encouraged them to retake scores. During post treatment the 5% of students moved from *strongly disagree* to *disagree*. Additionally, 30% of students felt neutral about the icons during pretreatment, whereas post treatment that number dropped to 19%, and the students shifted into agreement or strong agreement with the statement (Figure 7).

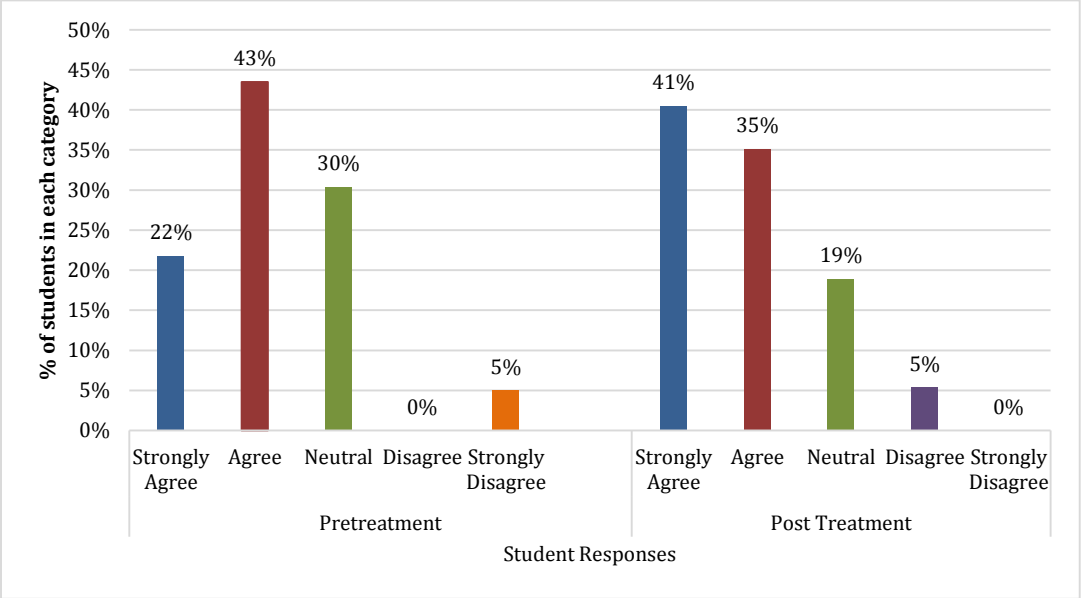

Figure 7. Non-honors response to icons, (*N*=60).

INTERPRETATION AND CONCLUSION

I was very pleased with the improvement in success that anatomy and physiology students showed throughout the study. I am impressed with the increase in scores among the non-honors students. Non-honors quiz averages increased by 20% when mastery was enforced. Non-honors test scores increased by 12% over the course of the study. This indicates that if students master learning objectives along the way, they are more likely to perform better on tests and exams. While honors students showed improvement as well, the results were not as dramatic. Honors quiz scores increased by 10% from spring 2014 to spring 2015. Test scores for honors students increased 5% overall, however the test average actually dropped from 90% to 89% between fall 2014 and spring 2015. This indicates that although the model increases achievement for honors and non-honors

students, non-honors benefited from implementation more than honors students. I feel this may be due to the fact that my honors students are typically more self-motivated.

When interpreting student growth from one assessment to another, the results were statistically insignificant. Once the instructional model was in place very few students were in a situation where they needed to retake tests and quizzes. There was no change in the retake data between pretreatment and treatment. I think part of this was because students were able to pace themselves and choose when they wanted to take a quiz. This allowed for flexibility in their learning so they did not take a quiz before they felt ready to take it.

When interpreting student motivation there was a significant change in pretreatment to post treatment survey results. I was pleased that the model was setup in a way that allowed students to be both intrinsically and extrinsically motivated. After students experienced success with material they appeared to be more engaged. They had more control of their learning, and were able to move as quickly or slowly through material. I think allowing more flexibility impacted their intrinsic motivation. Additionally, there were some external structures in place that required students to succeed at a minimum level. I found that after I explained to students and parents the new expectations, it did not become a mandate but a class culture.

The framework around the gamification teaching model suggested that the instructor would be able to have more meaningful conversations with students about grades. Data supported this concept. Instead of telling students what work was missing, I was asking them which learning objectives they were working with that day. I was able

to transition from late work, missing work, and absentee work to focusing on mastered or not mastered content. Students during the pretreatment were in 89% agreement that I discussed grades with them, but it increased to 97% at the conclusion of the study.

I did not realize before the treatment how important it was to have dependable technology in the classroom. Having a website with all instructional materials, video lectures, notes, handouts and case studies was instrumental in the success of my implementation. I was rarely teaching an entire class at once instead I was having small group discussions with students about learning objectives. Through this model more students were actively involved with me each day. I found that because everything was online students were able to self-pace through the content. The only students that were behind at the conclusion of the study were those that were habitually absent. Generally students that were in class and participating were within 90 minutes of each other. The extra time for some made the difference in their performance, while students who knew the material were able to move at a quicker pace.

VALUE

The implementation of gamification into my classroom emphasized a mastery based learning model. I noticed throughout implementation that most students did not need multiple tries at learning objectives. Once the parameters and rules were established, students seemed to interpret those as part of the new class culture. Beginning implementation I was not sure how I would enforce the rule that students must earn at least an 80% on all learning objectives. However, once I established an expectation and followed through with the retesting, students rose to the new expectation. At the

conclusion of the study the only students that were not able to meet all objectives at 80% were those that were absent for extended periods of time.

This study has made me an advocate for standards and mastery based learning models. The positive results I obtained over the 27-week data collection period is an indication of how successful these models can be if implemented correctly. Over 5000 quizzes and test data points were recorded and analyzed to determine the changes that occurred each quarter. The non-honors course improvements were of most interest. I have often heard that honors students will do well regardless of what the teacher does, but average students have much to gain by alternative learning models. I found this was true in my study. Non-honors students rose to my new expectations and their gains were much higher than I had anticipated. The research on mastery-based learning was based on the philosophy that if a student learns something at 80% they would likely remember at 75%. Although this may be accurate, my results determined that if students were required to get 80% on a quiz they would remember at approximately the same value for the end of unit test.

I am hopeful that the continuation of this learning model will provide students more opportunities to be motivated when learning difficult and complex topics. I feel that requiring students to master material allowed them to learn at a deeper level. At the conclusion of the treatment I was confident that each student in my class could have a meaningful conversation about the topic that was learned that day.

Although student perceptions of confidence did not increase significantly in the treatment period, I think requiring 80% on each quiz will lead to confidence in learning

over a longer period of time. Unfortunately, by the time students enter my classroom at the general anatomy level, many students have decided that they are not good at school. I believe if this model was carried out over an entire year students may feel that they are talented in anatomy and physiology. Additionally, if this model was carried out K-12 I think students would feel more confident in their learning and learn at very high levels.

I am excited about the possibility of expanding the gamification and mastery based learning approach to more educators as well as the other content areas I teach. I believe the model truly catches students that can fall through the cracks in a classroom and in a school. This model requires a lot of frontloaded teacher work, but it also allows the teacher to have time within a unit to retest material during class. It also allows the teacher to feel success by seeing their students. I feel this is the ultimate goal of a teacher.

This teaching model helped me to align standards with assignments, quizzes, tests, and all other class activities. This model allowed me to accurately gage which standards students mastered and which students needed more work in specific areas. It also required me to provide intervention and conduct retakes within the same class period as a low score was received. While implementing this model I felt more urgency with student learning, and I felt that students felt urgency to learn material as well.

Current trends in education are advocating standards based learning, but many educational consultant companies are not providing teachers with a how-to guide to change current grading practices. The leveled approach to gamification provides a connection for teachers between traditional grading practices and standards based

practices. This model has altered my teaching style as well as philosophy. Hopefully as I share my enthusiasm and success stories I have experienced with this model, other educators will feel inspired to implement it as well.

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APPENDICES

APPENDIX A

IRB APPROVAL

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

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MEMORANDUM

TO: Annie Reichelt and John Graves

FROM: Mark Quinn, Chair Mark Quinn CMJ

DATE: October 6, 2014

RE: "*Effects of Gamification: Analyzing Student Achievement, Mastery, and Motivation in Science Classrooms*" [AR100614-EX]

The above research, described in your submission of October 6, 2014, 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(s) 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.

APPENDIX B

GAME GRADING SETUP

Game Grading Setup

Nervous System

Level 1	1.1	Microscopic nervous system lab
Standard 6 Goal A, B, C	1.2	CNS, PNS, Support cell quiz
Level 2	2.1	Nervous system lab
Standard 6 Goal D, E	2.2	Nerve quiz
Level 3	3.1	Impulse class activity
Standard 6 Goal F	3.2	Nerve impulse quiz
Level 4	4.1	Reflex lab
Standard 6 Goal G	4.2	Reflex quiz
Level 5	5.1	Brain board activity
Standard 6 Goal H	5.2	Brain video
	5.3	Brain quiz
Level 6	6.1	Brain board activity
Standard 6 Goal I	6.2	Brain protection quiz
Level 7	7.1	Eye dissection
Standard 7 Goal A, B, C	7.2	Senses quiz
Level 8	8.1	Study guide
	8.2	Vocabulary review
	8.3	Objective writing
	8.4	Test Chapter 7/8

Cardiovascular, Lymphatic, Respiratory Systems

Level 1	1.1	Heart model
Standard 9 Goal 2 A, B	1.2	Microscopic heart lab
	1.3	Heart dissection
	1.4	Heart anatomy quiz
Level 2	2.1	Heart boards
Standard 9 Goal 2 C, D	2.2	Circulation board
	2.3	BP lab
	2.4	Goldfish circulation lab
	2.5	Circulation quiz
Level 3	3.1	Lymphatic case study
Standard 10 Goal 1 A, B	3.2	Lymphatic quiz
Level 4	4.1	Respiration lab
Standard 11 Goal 1 A, B	4.2	Respiration quiz
Level 5	5.1	Study guide
	5.2	Vocabulary
	5.3	Objectives written
	5.4	Test

APPENDIX C

XP SETUP

XP Setup

	Nervous System	XP
1.1	Microscopic nervous system lab	5
1.2	CNS, PNS, Support cell quiz	7
2.1	Nervous system lab	5
2.2	Nerve quiz	7
3.1	Impulse class activity	2.8
3.2	Nerve impulse quiz	7
4.1	Reflex lab	5
4.2	Reflex quiz	7
5.1	Brain board activity	2.8
5.2	Brain video	2.8
5.3	Brain quiz	7
6.1	Brain protection board activity	2.8
6.2	Brain protection quiz	7
7.1	Eye dissection lab	5
7.2	Senses quiz	7
8.1	Study guide	2.8
8.2	Vocabulary review	2.8
8.3	Objective writing	2.8
8.4	Test Chapter 7/8	111

	Cardiovascular, Lymphatic, Respiratory	XP
1.1	Heart model	2.8
1.2	Microscopic heart lab	4
1.3	Heart dissection	4
1.4	Heart anatomy quiz	12
2.1	Heart boards	2.8
2.2	Circulation board	2.8
2.3	BP lab	4
2.4	Goldfish circulation lab	4
2.5	Circulation quiz	12
3.1	Lymphatic case study	2.8
3.2	Lymphatic quiz	12
4.1	Respiration lab	4
4.2	Respiration quiz	12
5.1	Study guide	2.8
5.2	Vocabulary	2.8
5.3	Objectives written	2.8
5.4	Test	111

Each chapter has 200 allotted points. 40% based on tests and 25% based on quiz scores.

APPENDIX D

GRADE DISCUSSIONS

Grade Discussions

1. What do you feel you are currently doing well on?
2. What objectives have you met at 80% as of now?
3. What objectives have you not met at 80% as of now?
4. What do you plan to redo?
5. When do you plan to redo the test or quiz?
6. Did you make an appointment in or outside of class to rectify the score?
7. Is there anything else you would like me to know?

APPENDIX E

LIKERT GRADE SURVEY

Likert Grade Survey

Participation in this research survey is voluntary and participation or non-participation will not affect student's grades or class standing in any way.

Directions: Check the box that most reflects your feelings

	Strongly Disagree	Disagree	Agree	Strongly Agree
My instructor discusses my grades with me				
I know how I'm doing in class				
My instructor cares about my grade in A&P				
My instructor provides opportunities to discuss my grade in class				
My instructor is willing to discuss my grade outside of class				

Is there anything else you'd like me to know?

_____

_____

APPENDIX F

STUDENT INTERVIEW

Interview Questions

Participation or non-participation in this interview will in no way affect your progress or grade in the class.

1. What types of situations cause you to be motivated in A&P class?
2. When you receive an 80% or higher on a quiz or test, does that impact your attitude towards anatomy? If so, how?
3. In what ways does your A&P instructor discuss your quiz scores, test scores, or performance in class?
4. Is there anything you could do to improve your learning of A&P?
5. Is there anything your instructor could do to improve your learning of A&P?
6. Is there anything else you'd like me to know?

APPENDIX G

LIKERT MOTIVATION SURVEY

Likert Motivation Survey

Participation in this research survey is voluntary and participation or non-participation will not affect student's grades or class standing in any way.

Directions: Check the box that most reflects your feelings

	Strongly Disagree	Disagree	Agree	Strongly Agree
I am interested in A&P				
I am willing to study in class by completing vocabulary, study guides, labs, case studies, etc.				
I am willing to participate in class				
Scores of 80% or higher encourage me to keep my grades up in A&P				
I am motivated to learn independently				
DNM and MET standards in Power School encourage me to score higher and retake tests or quizzes				
I work on vocabulary, objectives, study guides and case studies frequently at home (at least 3X per week)				

	Strongly Disagree	Disagree	Agree	Strongly Agree
If necessary I will retake a quiz or test on my own time				
I am motivated to learn A&P				
I will retake a test or quiz in class if there is an option				
I am interested in learning A&P				
I enjoy A&P				
I am confident in my A&P knowledge				
I spend at least 80% of A&P class focused and working to learn material				