The Effect of Video Gamification on Student Achievement, Learning Outcomes, and Engagement Level

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Abstract

The goal of this study was to examine the effects of gamification on the learning and engagement of middle school students. The participants in this study were 145 male and female 8th grade students (80 in the intervention group and 65 in the control group). The students' ages ranged from 13 to 15 years old and were enrolled in over six sections of 8th grade science. The study analyzed both quantitative and qualitative measures to assess student achievement, learning outcomes, and student engagement. Statistic differences emerged in academic performance, with those in the intervention group scoring higher than those in the control group on two of the unit tests. Additionally, those in the control group reported less affinity towards playing video games than did those in the intervention group. More students in the intervention group reported that playing video games did not negatively impact grades than those in the control group. Finally, data indicated that students in the intervention group demonstrated more engaged behaviors than those in the control group during the study.

In the past 30 years, the proliferation of computer technology has been astonishing. Today, computer technology is everywhere. It has infiltrated grocery stores, golf courses, our transportation system, and yes, our schools as well. Computerized planning, grade books, and teacher organizers allow teachers to work at a level of efficiency that our grandparents could have never dreamt possible. The use of technology has also become a vital teaching tool in today's classrooms as well. Today's students, sometimes called computer "natives", expect nothing less from today's teachers (computer immigrants) than to be engaged in, even swept off their feet, by high tech learning. (Wang, Hsu, Campbell, Coster& Longhurst 2014) They have grown up with it and it is now woven into the fabric of their daily lives. For many students, the use of technology is just as natural as eating and sleeping.

For today's educators, the challenge they now face is how technology can best be integrated into the classroom. As we ride this technology wave through the 21st century, we must be aware of the potential misuse of technology. Students, as well as parents, must be properly trained on intelligent use of computer technology. They must be prepared to be vigilant while on the internet. Internet filtration technology, while very good, is not foolproof. The risk of over filtration, as well as under, is always present.

Over filtration can cause useful websites to be blocked, while under filtration can allow things to slip by that should be blocked. (Megosa& Scott 2013) While these dangers are very real and pertinent in today's classrooms, perhaps the biggest danger to our schools is the over simplification of the use of technology. Many of today's teachers simply repurpose their dusty old lesson plans for use on a smartboard or projector (Bang &Luft 2013). While there is a place for powerpoint in the classroom, there are so many richer teaching techniques that can be used with technology. Teachers need to become explorers, even inventors, in search of new and innovative ways of using available technology.

Meanwhile, the youth of today are enchanted by video games. The gaming world has evolved from the days of "Asteroids" and "Pac-Man". Video games have become extremely sophisticated and realistic. Vast numbers of young people spend a big part of their lives chasing monsters or bad guys on their tv or computer screens.
They spend countless hours completely engaged in mastering the latest craze in the video game world. The questions must be asked, "Would it be possible to transplant this extremely high level of engagement to the classroom?" "Could an effective learning environment be created using these gaming platforms?" "What if a virtual environment can be created that engages students at a high level, while also socializing learning?" While these questions are beyond the scope of this study, the possibilities of the use of gaming technology are limitless. These queries would make excellent topics for future studies.

The concept of using gaming technologies in the classroom to teach is called "Gamification". This idea has also been used in industry as a marketing tool used to encourage engagement of potential customers of a product or service. Gamification has also been used in multiple fields of business with great success. For example, pilots using flight simulators and surgeons practicing surgical techniques using simulators are common place in those fields. For the purposes of this study, the "product or service" we are trying to encourage engagement in is knowledge. In the study, we pose the question, "What is the effect of gamification on student achievement, learning outcomes, and engagement level?" One of today's major challenges faced by educators is engaging students. We are exploring the idea of engaging students with instructive computer games. As middle school science teachers, the researchers will be teaching two units covering science content. In this study it is our intent to engage them with technology, through gamification. We will measure engagement level by administering an engagement assessment to our subjects. In the study the researchers will introduce two groups of 8th grade students to a game, which presents information in a gaming environment. Students will be assessed for learning level through the use of a pre and post-test following each unit.

Challenges that the researchers face include the fact that, as popular as gaming is, there are still many students who do not enjoy video games. This variance of affinity to gaming may cause some bias in our results. Additionally, although there are games found on line, another challenge faced is the lack of a usable game in a familiar gaming platforms such as XBox, Wii, or Playstation. This lack of a familiar platform may also cause some bias. There are many games found online that are considered "educational". The content of the games may not be sufficient in covering the material needing to be covered by the science standards. This could possibly affect the results of our study. Our research will be done using the school internet. The school internet filters may become troublesome by blocking some games that are better than others. This may limit our choices to which games we can and cannot use.

Review of Literature

This generation of students have never known a time without computers, gaming systems, smartphones, or the internet. Their lives are encompassed with technology that the previous generation couldn't have dreamed possible at their age. Today's students are more adept at navigating the digital landscape than most of their teachers (Joy et al, 2014). This would be one reason why some teachers are reluctant to incorporate new technologies into their lessons. Other reasons could include a lack of training, a lack of time, a lack of resources, or a lack of support from school administration (Leary et al, 2016). Most school districts impose internet filters to block internet content that is deemed inappropriate by school policy. One problem is that filtering technology is not perfect and can either block too much content or not enough (Megosa and Scott, 2013). Many times useful software will be blocked by the school filters and its easier to leave the block in place than to change it. Some educators will use a video inside a power point presentation that is delivered on a smart board and think that they are using technology appropriately in the classroom.

There is no problem using technology tools passively when the situation calls for it. For example, using digital tools for assistive technology with special education students. There are many technologies that are commercially available that can be used to assist students that need extra help. Students can use software that supply text reading, voice-to-text, concept map, or voice recorder abilities on a computer. Educators can use video or pictorial content to assist students learning english. Students can use video recording software to give a verbal response instead of a written one (Bouck et al, 2012).

Active learning with technology is the student centered approach to learning that encompases real-world problem soving, experimentation, creation, and collaboration with peers (Herold, 2016). Active learning methodology has been shown to provide a significant increase (55%) to student success rates (Freeman et al, 2014).

The gaming industry has been under scrutiny over the last 20 years due to rising number of school mass shootings. People look for answers to why these tragedies happen. Violent video games have been placed in the crosshairs. Multiple studies have been done to show the connection between playing violent or "shooter" video games and acts of violence. A study done by Anderson and Dill in 2000, showed that children who play violent video games have an increased level of aggression. Although this study claimed a correlation, an evaluation of this study showed that there were issues with the studies design (Freedman, n.d.). Looking at multiple studies on violence and video games, there seems to be more emphasis placed on violent media as a whole than just video games. There have not been any studies that show a positive correlation between violence and violent video games by themselves. Some studies have shown that there is a negative correlation between video game play and student achievement (Weis et al, 2010). This study was done on nine and ten year old boys. The boys that played video games had lower math and reading scores than did the control group. One thing the study pointed out was that the boys that were playing video games didn't spend time doing school work. They didn't say if there was parental supervision making sure the participants were working on their school work. If the control group spent more time practicing the skills being tested on, there would be a good reason why they scored better. Most of the negative views that were found on this topic were from opinion pieces published in magazines or from blogs. When taking a closer look at the available research there were very few peer reviewed studies done on the subject that show negative correlations.

One of today's educational buzzwords is "edutainment". "Edutainment", is entertainment with an educational aspect. You do not have to be a genius to know that when students are entertained they are engaged and more motivated to learn. There have been multiple studies done over the last five decades that correlate student engagement and student achievement (Dyer, 2015). Digital tools that are currently commercially available are exceeding capable of delivering the content we need to get to our students in an engaging manner. According to an article in the Huffington Post, the leading form of entertainment in the US are video games (Taylor, 2014).

Over the last 20 years studies have shown that there are many positive learning aspects to videogames (Novak and Tassell, 2015). Video games have been shown to develop high-level thinking skills such as problem solving, communication skills, strategic thinking, cooperation, resource management, and advance planning (Shi and Shih, 2015). Studies have shown that people that play action games or shooter games, have higher spatial resolution in visual processing and advanced mental rotation skills. A 25 year longitudinal study has shown that these skills are transferable to predicting achievement in STEM careers (Granic et al, 2014). The current generation of video games are complex and demanding, sometimes requiring hundreds or thousands of hours to master (Moline, 2010). Video game companies and designers spend millions of dollars and thousands of man hours in research and game design to develop the next blockbuster game. The same can be said for the genre of games developed for learning. According to a study done by Shi and Shih in 2015, designing Game Based Learning games are problematic. One problem is that game designers do not know how to maintain the integrity of the curriculum. Teachers are good with knowing the material needing to be taught, but do not know how to develop an interesting game. Playing a video game has to come secondary to the learning goals of the game to be considered an effective learning tool. Many researchers have come to the conclusion that if a game is designed properly it can be used effectively as a learning tool (Dicheva et al, 2015). Game designers and researchers have developed a model to design and test video games for their learning and entertainment potential. All games are based around in-game goals. In the genre of educational games, the goal would be the learning objectives (shi and shih, 2015).

The research done on technology and video games being used in the classroom point to one thing. The blind use of technology has little to no positive effect on learning outcomes and achievement. For technology to show positive outcomes there has to be planning behind it. Just like any lesson taught in the classroom, a good lesson is a good lesson and a bad one is a bad one. The use of technology is not a magic bullet that automatically increases learning, or turns a bad lesson good. There are times that the use of digital resources are not the right tool to be used for that lesson.

There has been little research done on the effect of video games on student achievement and learning outcomes on the age group that we propose to study. Out of that research most of it was done in computer or information technology classes not in a general science class. We will focus on using a video game that has the learning objectives at its core. We want to make sure that the game is a good tool to achieve learning outcomes.

Research Design and Methodology

Participants

The participants in this study were male and female 8th grade students. The students' ages ranged from 13 to 15 years old and were enrolled in over six sections of 8th grade science. There were two groups consisting of three sections each. Special consideration was given to make each group as equal as possible. Equality of the groups was based on numbers of both male and female students in each group. Grouping also incorporated the students most current math and language arts screener data to ensure both groups were as equal as possible in ability. Overall, the grouping of each section was determined by the staff member in charge of student scheduling, but was also scheduled with ability in mind. If a choice was made in balancing the number of male and female subjects verses the overall ability of the subjects, the grouping was hedged toward student ability.

School setting

The study took place in the 8th grade science classroom. Coincidentally, this was the same classroom that the students had last year as 7th graders. The study consisted of 145 participants (80 in the intervention group and 65 in the control group). As of 2017, the school's student body was comprised of 44% White, 25% African-American, 11% Hispanic, 9% Asian, and 11% other. The school was approximately 51% female and 49% male. As of 2017, 59% of the students came from low-income households. Less than 5% of the student body were considered English Language Learners. (www.greatschools.org)

Method

The study analyzed both quantitative and qualitative measures to assess student achievement, learning outcomes, and student engagement. The study spanned two units; a unit on basic physics, and a unit on basic chemistry. The chemistry unit covered balancing equations and lab equipment identification and purpose. The Physics unit covered Newton's laws of motion. A pretest was given prior to starting each unit. The unit pretest for balancing equations consisted of 10 equations needing to be balanced. Both tests were given in a paper pencil format. The pre and post-tests for chemistry lab equipment and Newton's Laws consisted of 20 multiple choice questions given via a program called Quizziz. Four answer options were provided for each question. Participants were placed into two groups. Both groups started the unit with a traditional lecture lesson to gain required background knowledge and learning objectives. During the lecture, students were expected to take Cornell style notes. The intervention group continued the unit using computerized video games, while those in the control group continued the unit lessons derived from traditional textbooks. A post-test was then given after the unit was complete. The post test for balancing equations contained 10 different equations of the same difficulty level. The post test for chemistry lab equipment and Newton's Laws contained the same 20 multiple choice questions as the pretest, however, the questions were arranged in a different order from the pretest. Learning objectives were derived from the 8th grade Next Generation Science Standards. All assessments and video games were administered using school purchased laptops. All participants received a survey asking about gaming preferences, time spent at home playing video games, and gaming platform preferences. Participants also received another survey after the unit to see how they felt about the games. The video games used were evaluated using the design model found in the study done by Shi and Shih in 2015. The video game platform used was developed by Teacher Gaming. The games used were Bongo balance for balancing equations, Chemcapers for lab equipment and Motion Force for Newton's laws of motion.

Data Analysis

To assess student achievement, the post and pre tests scores were compared to assess student growth. To assess learned outcomes, scores were taken and averaged. To assess student engagement, an engagement survey was given randomly during both gaming and traditional lessons. The engagement survey tool is from the book *Coaching Classroom Management* by Sprick and Reinke (2010). It is comprised of a 5 by 12 grid making up 5 minutes of time broken down into five second increments. The survey was administered by watching each student for five seconds. If the student was engaged in the task for the entire five seconds a check was placed in a box.
If they were not engaged in the task for the entire five seconds the box was left blank. The surveyor started in one row and moved through the class watching each student for five seconds. When all students had been observed, the surveyor started over and followed the same pattern until the five minute time limit was reached.

The engagement score was calculated by dividing the total number of checkmarks by 60 and then converting to a percentage. The engagement survey was administered by administration or by another staff member depending on availability. The participants were also given a questionnaire to determine gaming interest prior to starting the units. They were also surveyed at the end of the units to determine what they thought about the material and the games chosen. The surveys were given through Google forms.

Results

To determine how the use of video games can enhance or diminish student achievement, engagement, and learning outcomes, several analyses were completed. First, descriptive statistics are reported in Tables 1-2 for student scores on the pretest and posttest measures completed after each unit of instruction (i.e., Balancing, Chemistry, and Motion). Data are reported by group (Intervention vs. Control).

Table 1: Descriptive Statistics: Students in the Intervention Group

Variable	Mean	SD
Balancing Pretest	2.0	2.0
Balancing Posttest	2.8	3.2
Chemistry Pretest	11.0	3.9
Chemistry Posttest	14.3	3.3
Motion Pretest	9.3	3.7
Motion Posttest	13.5	3.5

Note. N=80

Table 2: Descriptive Statistics: Students in the Control Group

Variable	Mean	SD
Balancing Pretest	1.9	1.7
Balancing Posttest	0.9	1.2
Chemistry Pretest	11.3	3.4
Chemistry Posttest	12.9	3.5
Motion Pretest	8.7	3.3
Motion Posttest	11.6	4.5

Note. N=65

To examine gains made on these unit tests, gain scores were computed for each student. Table 3 provides the descriptive statistics for the gain scores, by group.

Table 3: Descriptive Statistics: Gain Scores by Group

Variable	Mean	SD
Balancing Gain Intervention	1.0	3.3
Balancing Gain Control	-1.0	1.8
Chemistry Gain Intervention	3.2	3.8
Chemistry Gain Control	2.0	3.5
Motion Gain Intervention	4.2	3.4
Motion Gain Control	2.8	4.9

Note. N=145

Academic Performance

To determine if the intervention statistically improved academic performance, as measured by three different unit tests, Independent Samples *t* tests were computed. Results from the *t* test using the Balancing equations unit test data indicated that students in the intervention group had scores on the posttest administration that were statistically significantly higher (M=1.0, SD=3.3, $t(93) = 3.13$, $p<.01$) than the control group.

Results from the *t* test using the Chemistry unit test data indicated that students in the intervention group had scores on the posttest administration that did not differ statistically (M=3.2, SD=3.8, $t(121) = 1.75$) from the control group.

Results from the *t* test using the Motion unit test data indicated that students in the intervention group had scores on the posttest administration that were statistically significantly higher (M=4.2, SD=3.4, $t(128) = 2.83$, $p<.05$) than the control group.

Student Survey Data

To determine if there were differences in student responses on the survey administered, several frequency distributions were computed (see Figures 1-6). Figure 1 indicates that students in Group 2 (i.e., control group) reported less affinity towards playing video games than those in Group 1 (i.e., intervention group).

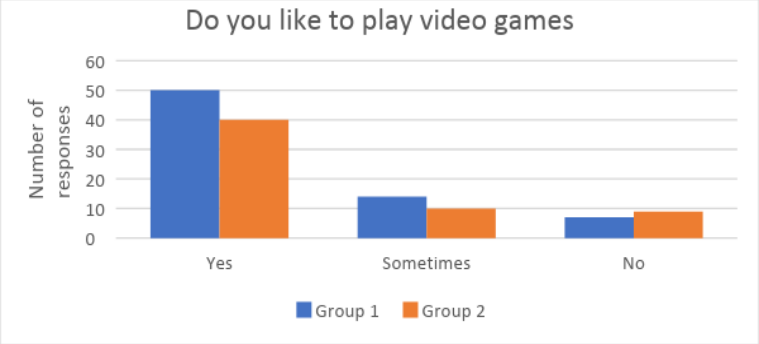

Figure 1. Video game enjoyment

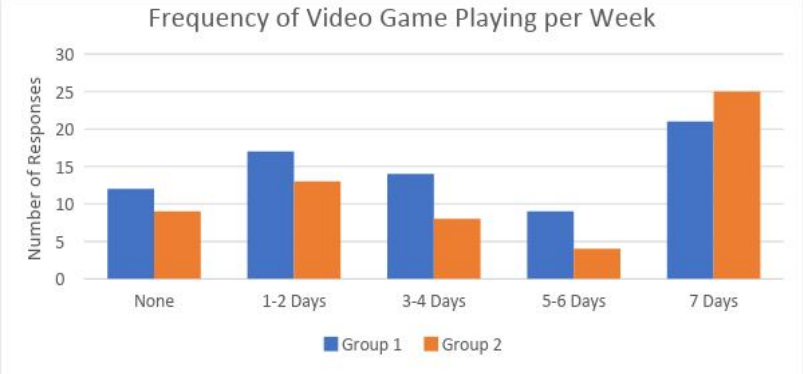

Figure 2. Frequency Per Week

Figure 2 illustrates the distribution of frequency of video gaming throughout a week. Data indicate that more students in Group 1 played less than seven days a week than those in Group 2.

Figure 3. Number of Hours a Day Spent Playing Video Games

Figure 3 data indicate that more students in Group 2 spend six or more hours a day playing video games than those in Group 1.

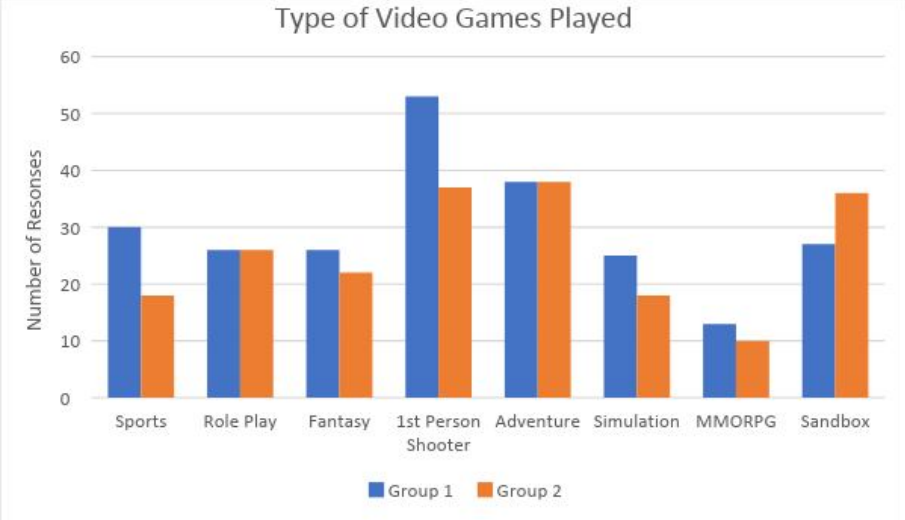

Figure 4. Type of Video Games Played

Figure 4 illustrates the variety of video games the students reported playing. Data indicate that more students in Group 1 play first person shooter games than those in Group 2 while more in Group 2 play Sandbox games over those in Group 1.

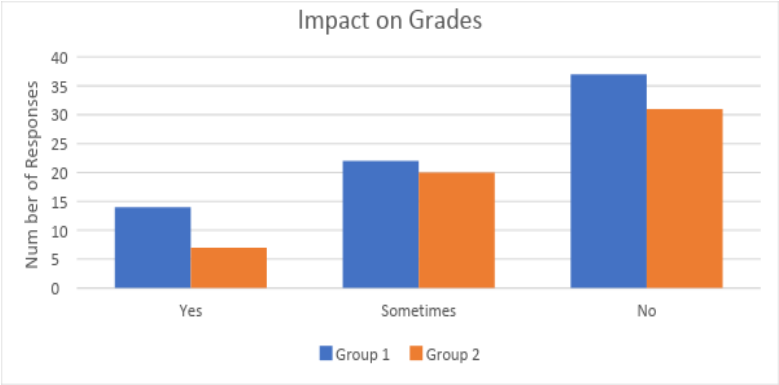

Figure 5. Student Perception of Video Game Playing on Grades

Figure 5 represents student perceptions on whether playing video games negatively impacts their grades. Data indicate that more students in Group 1 report that playing video games does not negatively impact their grades over those in Group 2.

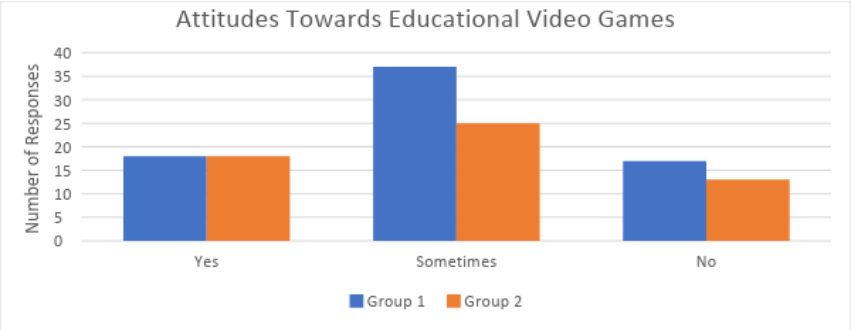

Figure 6. Attitudes Towards Educational Video Games at School

Figure 6 illustrates students' attitudes towards playing educational video games at school. Data indicate that more students in Group 1 indicated that they sometimes like to play educational video games at school over those in Group 2. Similarly, while fewer students overall indicated "no," more in Group 1 did than in Group 2.

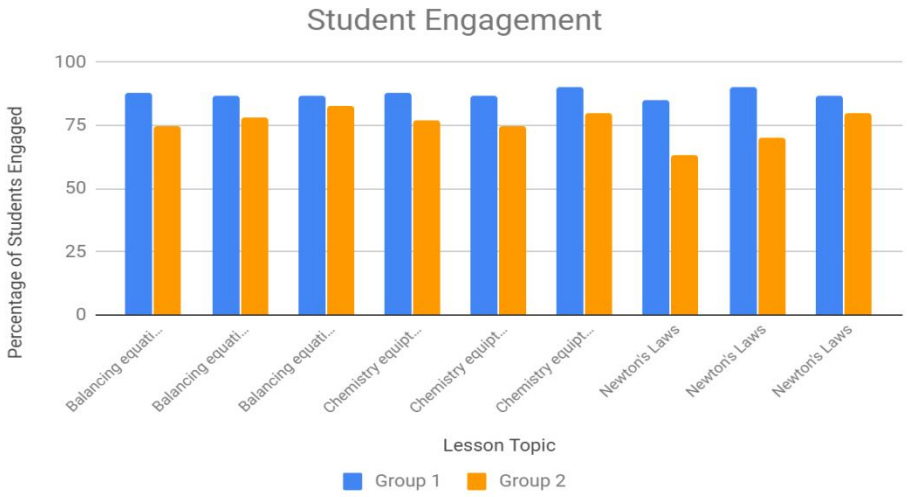

Figure 7. Student Engagement

Figure 7 illustrates the percentage of students that were engaged in the lesson. Data indicate that students in group 1 were more engaged than in the lesson than students in group 2.

Summary of results

Today's students have never known a time without the internet or smartphones. They have grown up being entertained by computer technologies. If you ask a student about the war of 1812 or to explain the principles of an electric motor, you will most likely be met with blank stares. If you ask them how to tame a horse in minecraft, you will probably get an answer from a large majority of them. When students are entertained and engaged they retain information. This leads us to the hypothesis that the use of educational video games to learn prescribed curriculum will increase engagement, learning outcomes, and student achievement. Through our research we have found that there is evidence to support our hypothesis. We have also found that the more closely the game is related to the curriculum the better the learned outcome. On two of the three games selected, increased student engagement was observed, as well as improved learning outcomes. Our research shows that the use of gaming technology can have an important role in today's classroom.

The research that has been done in the past on this subject is centered around gamification without using video games or has been done with subjects that are at the collegiate level. During our research we did not find any studies that focused on using video gamification with students that were in the age group that we focused on. However, studies done by Shi and Shih and by Dicheva in 2015, showed evidence that proper game design is imperative for a video game to be used as an effective learning tool.

Our research supports those findings. Our data showed that learning outcomes and achievement were positive on two of the three games. The two games that showed a positive effect were both closer tied to the curriculum being taught.

Our data shows that in two of the three games tested, statistical evidence demonstrated improved learning outcomes. The third game did not show improved learning outcome, most likely because the game content was not as closely tied to the curriculum being taught. Overall, our data supported our hypotheses that student engagement and learning outcomes were improved by use video gamification.

Limitations of the study

Although a great majority of today's students are enchanted by video games, many are not and/or do not have an aptitude for them. This discrepancy limited the accuracy of our study. In addition, our study group consisted of middle school age students, many of whom demonstrate day to day inconsistency in mindset and attitude. This factor was also limiting, as far as the accuracy of our study. Finally, the current selection of educational video games is extremely limited. There are few games out there that are truly curriculum based, and those that are available are extremely expensive.

Ideas for future research

In order to correct for our study limitations, future research could be expanded by varying our subject groups based on affinity level for gaming. Varying test subject demographics pertaining to age, socioeconomics, and school would add relevancy to this study topic. Testing in other disciplines in the future would be valuable to future research as well. Finally, partnering video game developers and the curriculum industry to develop content specific games would be valuable to our study.

Practical implications of our findings

Finding ways to integrate pop-culture into the classroom is a vital component for connecting to today's student. Video gamification is an emerging area in education, and there are limitless possibilities for the use of video games in the classroom. As our study shows, the use of video games on learning can increase student engagement and learning outcomes. In addition to education applications, the use of video gamification in corporate training programs to better suit the employees of tomorrow could prove invaluable.

Final conclusions

In conclusion, as our study shows, video gamification can be an effective component of a teacher's arsenal in today's classroom. The student of today has grown up in a world that is interwoven with technology and video games are a huge part of that world. The use of video games in the classroom can be an integral part of engaging students, and an effective learning curriculum. While the future of video gamification has yet to be written, it is clear that there is a future. For today's educators and curriculum industry, the challenge is finding ways to integrate the limitless possibilities into the learning process. It is a challenge that must be accepted, and mastered, if we are to continue to keep the education process on the cutting edge of technology.

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