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Game-based Learning's Effectiveness in the Middle School

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GAME-BASED LEARNING'S EFFECTIVENESS IN THE MIDDLE SCHOOL

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Abstract

This project offers an overview of GBL and an example of GBL curriculum created for middle school math students. The study explores the question: What effects do GBL practices within curriculum have on middle school (grades 5-8) students to increase student motivation and academic success? The research suggests a positive correlation between GBL and motivation. Students who are allowed to participate in GBL are more excited and motivated to learn, as well as more confident in the skills they learn. GBL allows students to be more in control over their learning, creative, empowered, and describe learning as fun. Students also demonstrate academic improvement when playing well designed games for learning. Further research is needed to gain a more comprehensive understanding of GBL. First, a study comparing the differences between standard GBL and DGBL is needed to differentiate between the two. Also, a longitudinal study on the retention of information learned using GBL is desirable for further understand of student success. Lastly, it would be beneficial to look at the relationship between students' socioeconomic status and GBL effectiveness.

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CHAPTER 1: INTRODUCTION

Pre-teens and teenagers are spending more time with media than almost any other activity on a daily basis, an average of more than seven and a half hours a day, seven days a week. Of that time, almost an hour and fifteen minutes is spent playing video games across multiple platforms (Rideout, Foehr, Kaiser, & Roberts, 2010). In addressing the students coming into the traditional middle school classroom, it is imperative to note students' previous experiences and their current engagement with media. No matter a teacher's personal view on the amount of screen time in which students engage, professionals should view this as an opportunity to leverage student interests as it pertains to game play and incorporate this knowledge into current curriculum development and instructional delivery.

Play is an important part of the human experience. Play can be described as an intense learning experience in which both children and adults voluntarily invest their own personal time, energy, and commitment, while simultaneously gleaning great enjoyment (Rieber, Noah, & Smith, 1998). The use of games and playing within the educational setting isn't a new idea. Piaget emphasized the importance of play in the student development as far back as the 1960s (Piaget, 1962). The reason that play is so important to the human experience is that it helps students' cognitive development. According to Plass, Homer, and Kinzer (2015), one way that play is seen as contributing to children's cognitive development is by developing their personal schemas that allow children to go beyond their immediate reality. For example, a child can pretend a stick is a bat or gun while fully knowing that it is neither. This development of imagination and being able to hold objects "in mind multiple, even conflicting, representations of reality underlies key later developments" (Plass et al., 2015, p. 259). Further, Game-Based

Learning (GBL) is a way to emphasize game play in a classroom and align it with specific learning outcomes (Plass et al., 2015).

However, as stated above, students' ever-increasing technology use and media consumption, along with humans' natural gravitation toward play, has created a new push for the use of games, especially digital games, within education. According to Fu-Hsing, Hsien-Sheng, and Kuang-Chao (2012), playing digital games has become the favorite form of play for students today, and when designed well, is a meaningful learning activity. In Prensky's (2007) revolutionary work on Digital Game-Based Learning (DGBL), the author asserts DGBL is not just about using games to review material anymore (i.e. Jeopardy, Bingo, etc), even though this has been and continues to be important and a useful application of DGBL. DGBL can (and is) now being used for primary learning, meaning the first and only way that a student learns new curriculum. This includes vastly different content, material, and difficulty level: everything from teaching preschoolers and kindergartners the alphabet and how to read, to teaching military trainees how to fight realistic battles in video game-like simulators. The author's experience is in agreement with Prensky's analysis: GBL can be used in any education setting to help motivate and engage all students regardless of the subject area, ability level, and/or grade level. This is what makes the research of GBL so important for our students, teachers, and schools.

Prensky (2007) states three vantage points and why it is so important to look at using GBL as a tool to educate and motivate people;

- If you are a <u>business executive, school administrator</u> or anyone involved in spending money to bring people — adults or kids — to a higher level of learning, there is a newer, better way available. While it is neither a panacea nor the only

way, it behooves you to consider it seriously and invest a significant portion of your resources in this direction.

- If you are a trainer or teacher, your students will not have short attention spans for learning if the approaches you take really engage them. It is possible to get learners of all ages totally involved in learning any subject matter, and tools are increasingly available to help you do this. Using them may, however, mean re-thinking much of what you believe about teaching and training.
- If you are a student or trainee, don't despair; relief is on the way. The days of sitting bored to tears in classrooms or in front of a boring computer or Web-based training screen are numbered. If you want to make things better faster, seek out and lobby for the approaches described in this book. You and your fellow learners will be glad you did! (p. 19)

In the author's experience, as a school administrator and as a student, all of the prior stated benefits are apparent and assist in driving home the point to see the need to explore GBL more thoroughly.

Guiding Questions

This study will explore the question: What effects do GBL practices within curriculum have on middle school (grades 5-8) students to increase student motivation and academic success? For the purposes of this study, motivation is defined as the number of tasks accomplished (i.e.- daily assignments, homework, etc) and/or time spent working with the content curriculum. Academic success will be defined as students' scores on curriculum delivered using GBL.

Rationale

The research on GBL is lacking especially as it relates to middle school students and its effects on their overall motivation and academic success. As an educator who sees value in trying to reach all students, especially our disenfranchised students, I am hopeful that GBL learning will meet some students who have or would see the current educational system as boring, unengaging, or lacking ways to meet them where they are.

The goal of this research is to increase the implementation of GBL at Sartell Middle School (SMS) in Sartell, MN. As the gradual implementation of GBL is happening, we will evaluate its efficacy at engaging students and improving their success at learning and retaining new content. My desire is for GBL to grow dramatically at SMS so that we can help our students learn in new and exciting ways!

Application

The application of this thesis will consist of the development and application of GBL curriculum for a 6th grade math interventions classroom. It is important to note that the curriculum is specifically created for students at Sartell Middle School in Sartell Minnesota that struggle with math based on the previous years MCA scores and/or teacher referrals. The students who are identified as struggling must take the traditional 6th grade math and also the pullout 6th grade math interventions. For these students, math is often a class in which they have negative attitudes, low self-confidence, lack motivation, and have little academic achievement. From this author's experience, and the current research, once students start to struggle with the curriculum and become unengaged, teachers can have a difficult time helping these students improve academically. Therefore, this GBL curriculum was specifically created to help students experience success through small clearly defined tasks, keep them engaged by using high interest

modes and means of curriculum practices, and develop their motivation through the use of an item shop that students could earn privileges during class based on the quality and quantity of work completed.

Data Gathering and Further Research

The author plans to use Minnesota Comprehensive Assessment (MCA) scores to evaluate academic achievement and growth from those students who participated in the GBL curriculum. Using this data will help us to evaluate the effectiveness of the curriculum. Further research is needed to find efficiencies in implementation, best practices in educator training, and ways to maximize the benefits of GBL.

Definition of Terms

Game-Based Learning (GBL)- a way to emphasize game play in a classroom and align it with specific learning outcomes (Plass et al., 2015).

Digital Game-Based Learning (DGBL)- The delivery of GBL digitally, through the use of electronic devices.

Academic Success- students' scores on curriculum delivered using GBL

Motivation- the number of tasks accomplished (i.e.- daily assignments, homework, etc) and/or time spent working with the content curriculum

CHAPTER 2: LITERATURE REVIEW

Literature for this thesis was located through searches of Ebscohost, JSTOR, ERIC, Educational Journals, Academic Search Complete, as well as online searches for statistics. The research was narrowed through a search of articles from 2000 through 2017 using the following key words and phrases: "Game-Based Learning," "Serious Games," "Educational Games," "GBL", "Game-Base Learning in Middle School", and "Digital Game-Based Learning". Google search engines were utilized to search definitions of unknown terms and clarification when the author's lack of knowledge hindered comprehension of research findings.

Defining and Basic Information About Game-Based Learning

What impact could play and games have on learning in an educational environment? Can Game-Based Learning be effective to educate all types of students and learning styles? How can students benefit from Game-Based Learning? A number of studies have been conducted to investigate the use of Game-Based Learning (GBL) in education. GBL is defined as a way to emphasize game play and align it with specific learning outcomes (Plass et al., 2015). There is often confusion between GBL and gamification. Filsecker and Hickey define gamification as "incorporating game elements into a non-gaming software application to increase user experience and engagement" (2014, p. 138-139). Plass, Perlin, and Nordlinger (2010) help make a clear distinction between GBL and gamification, by clarifying GBL as the design process of games for learning which involves a specific and delicate balance of the subject matter that needs to be covered with the intended desire of game play. GBL is different than gamification in that it specifically focuses on subject matter and not just the gaming elements. It should be noted that GBL and gamification often coexist in the same classroom and complement each other in achieving the learning objective.

Today's generation of school-age students not only love to consume media, on average seven hours and thirty-eight minutes consumed daily, but they enjoy playing games. In a typical day, 8- to 18-year-olds spend on average one hour and thirteen minutes playing video games. This is a considerable increase of time young people spend playing video games compared to previous findings, from an average of twenty-six minutes in 1999, to forty-nine minutes in 2004, to now one hour and thirteen minutes in 2010 (Rideout et al., 2010). This evidence indicates that schools and educators should consider how to incorporate games and GBL into the educational environment. If students are choosing to play video games during their free time, then why not use that interest to engage them with classroom curriculum?

Game Design & Implementation, Perspectives, and the Shifting Role of Teachers

This research indicates the need to incorporate well-designed games and GBL within the educational setting. It is wise to design game-based learning environments that scaffold student motivation and engagement. As Eseryel, Ge, Ifenthaler, Law, and Miller (2014) argued, it is important for GBL to be designed in such a way that students can complete complex, but realistically attainable tasks, which move them closer to the intended learning target, while at the same time allowing students enough autonomy and personal choice. It is clear that designing a game that has a clearly defined goal as players' complete specific tasks and provides feedback within the gameplay, makes for a game worth playing. However, for a game to be of educational value, it has to include an engaging educational experience that also provides scaffolds for student learning (Anderson & Barnett, 2013). For example, Anderson and Barnett (2013) argue that educational video game designers should embed metacognitive activities, such as open-ended reflective questions, into gameplay and also avoid presenting new terminology in new level introductions or cut-away scenes, which most students skip or ignore, and most often aren't

instrumental to the success of the game. If an educational game is designed so that students must demonstrate their understanding and knowledge of the intended learning goals to successfully complete and win the game, then it will help remove the negative correlation of students' playing motivation (students' desire to play the game only) and their learning motivation (Fu-Hsing et al., 2012). Fu-Hsing et al.'s (2012) study was consistent with previous findings which have shown that students can be distracted by game-playing in the classroom due to the fact that they want to win and not learn the new curriculum; therefore, the students skip the intended reading which is often poorly built into the game and guess on the practice questions . If an educational game is well designed, whereas the reading and learning objective is paramount to the success of the player within the game, it would significantly reduce the tendency for students to skip or not engage with the curriculum.

There is a common belief that in order to compete with the commercial multiplayer games students play outside of school, sophisticated graphics, sound effects, and immersive storylines need to be incorporated into educational games. However, based on Papastergiou's (2009) study of a digital game in a high school Computer Science class, this may not be necessary. The author found that a rather simply designed game had positive effects on knowledge acquisition and student motivation. Also, a simply designed game could perhaps even reduce distraction from the learning objective. This again demonstrates that designing a game that is focused on a clear learning objective that students can articulate along with student choice and autonomy is more important than the intricate graphic, sound effects, and complex storylines. It also makes the application and implementation of GBL much more obtainable for educators who may not possess the proper skills or have available technology to incorporate the sophisticated games.

When implementing GBL into an educational environment, many factors can dramatically affect whether it will be successful or not. One factor that educators often express concerns with when implementing GBL is the amount of time required to properly setup, prepare lessons, and deliver instruction through the use of games (Webb, Bunch, & Wallace, 2015). Teachers' school year schedules do not offer much opportunity to explore new curriculum and delivery methods, necessitating the need to use personal time to properly install GBL. In Webb et al.'s (2015) case study, one teacher articulated the struggles that teachers face in an exit interview by stating, "For me to have time to sit down and develop [lesson plans for the unit], I don't have time. I've got too many other obligations to take care of. Too many" (p. 892). Teachers must take time to lesson plan, explain, and demonstrate how to properly play the game, anticipate and troubleshoot any issues that students might encounter during gameplay, monitor student progress and learning, and oversee pacing of curriculum when implementing GBL; in addition to the other obligations that are required of them, both on a professional and personal level. Webb et al. (2015) noticed that teachers seemed to account for and overcome these time constraints by reflecting on how they would implement GBL in the future and changing the pacing of units to give themselves and students more time, but they also stated a strong desire to obtain more ongoing professional development as it pertains to GBL.

Factors that can impact the successful implementation of GBL are the perspectives that both teachers and students have about using games as a learning tool, especially when focusing on Digital Game-Based Learning (DGBL). There is a clear generational divide between the elder generation teachers and the students they are educating as it pertains to the digital game experiences and in-depth video game knowledge (Alyaz & Genc, 2016). This finding is not surprising since the exposure to video games for elder generation teachers is far less, but what is

surprising is Karadag's (2015) research that suggests that it is actually not critical for teachers to have a comprehensive understating of digital games to design lessons that use video games to develop literacy activities. Another exciting finding by Alyaz and Genc (2016) is that all "teachers can effectively create learning opportunities by using videogames as both the core unit and supplemental piece in lessons…" (p. 142). Some teachers may not have experience with digital games but this should not be used as a valid reason not to explore GBL opportunities for the students they educate. It is also encouraging to see that research being completed with pre-service teachers indicates that they believe that GBL will make it easier and more effective to evaluate primary school students' ability to learn to read and write (Karadag, 2015). It is clear that teachers' opinions on GBL are starting to change and will continue as the new generations of teachers move through the ranks of the teaching profession.

As teachers' professional perspectives change about GBL, there is still a significant difference in value that students believe is offered by using instructional time during school for GBL in comparison to their parents. Sáez-López, Domínguez-Garrido, Miller, and Vázquez-Cano (2015) conducted research using MinecraftEDU (the educational version of the commercial video game Minecraft, which has sold over 26 million copies of the game worldwide ("Minecraft Sale Statistics", n.d.) to compare opinions about GBL between students, parents, and teachers. The most significant finding was that over 70 percent of students thought that employing GBL, and more specifically MinecraftEDU, in the classroom was appropriate for learning, whereas almost 80 percent of parents thought MinecraftEDU was a waste of instructional time. Sáez-López et al. (2015) research indicates an increase in academic achievement, though not significant, when using MinecraftEDU to teach new curriculum this isn't the only benefit to students. Nebel, Rey, and Schneider (2016) point to several other

important benefits that students learn because of the social effect of gameplay during Minecraft that empower to display their learning and become teachers themselves.

Fostered by the lack of guidelines and information and the freedom of creation, players engaged in long interactions with the game and its mechanics, creating hours of tutorial videos on YouTube and countless wikis. Thus, Minecraft paradigmatically shows a progression of learning that lasts longer than a one-time play: learning through playing (e.g., learning history with a game of hide-and-seek in virtual ancient Rome), learning through creating (e.g., expanding the city of Rome after searching for historically accurate information), and learning through teaching others (e.g., showing others the new version of Rome) (Nebel et al, 2016, p. 362).

As GBL and especially DGBL becomes more present within educational institutions and as the research continues to demonstrate its value, parents will start to change their perspective on the value of GBL learning, however it should be noted that when implementing GBL into curriculum there could be some negative views about the use of instruction time by parents of your students.

As educational professionals decide that they want to implement GBL learning, they will need to decide if DGBL learning is the right fit for them and their available technology. When considering DGBL, teachers must make sure that inappropriate and inadequate hardware, software, networks, and infrastructure will not constrain proper implementation of GBL. A teacher in Webb and colleagues' study summarized this notion with the statement, "I think a big challenge with any game is trying to find the right technology and enough of it to integrate into the classroom" (Webb et al., 2015, p. 892). As technology is becoming more available within public education, this constraint will continue to become less and less of an issue. Educators will

want to make sure that they have adequate technology and support before starting any DGBL and plan accordingly for any issues. Marklund and Taylor (2016) state that technical issues are overcome by leveraging the students that are technologically proficient within the classroom and empowering them to assist when problems arise. Marklund and Taylor (2016) also state proper preparation is necessary to make sure educators have infrastructure that supports GBL, procure lacking resources, and seek any outside assistance needed otherwise "without a solid foundation of well-maintained technology, games can quickly become unruly to use, and technical difficulties can quickly start piling up" (p. 133).

As the education environment changes and we see more wide implementation of GBL, there will be a need for the role of the teacher to shift as well. The teacher's role will transition from the gatekeeper, which all information must pass through and then is disseminated to the student, to a facilitator that assists students with more individualized needs as the game delivers the content (Webb et al., 2015). GBL and the games that students play will never replace teachers and their instruction, "but should be used to support inquiry teaching in the classroom" (Anderson & Barnett, 2013, p. 922). It is clear based on the findings of multiple studies (Anderson & Barnett, 2013; Webb et al., 2015; Karadag, 2015; Fu-Hsing et al., 2012) that the design of GBL and its implementation can support learning but that it won't ever replace proper instruction by an educator.

Student Engagement and Motivation

That games motivate and engage students is often seen as one of the biggest overall benefits of GBL and why many educators gravitate toward its use in the classroom. "The argument is that games for entertainment have been shown to be able to motivate learners to stay engaged over long periods through a series of game features that are of a motivational nature"

(Plass et al., 2015, p. 260). One of the game features that GBL uses is the influence of competition. When competition is structured such that students are competing against their classmates but also their own limitations, it can have significant positive effects. In their study, one of Webb et al.'s (2015) participants noted, "I think [the competition] just kind of helped the morale of the group. You know, wanting to learn and wanting to do better with [the game]" (p. 895). Not only can it improve the morale and class culture but Burguillo (2010) and Cheng, Kuo, Lou, and Shih (2012) found that friendly competition among classmates and against one's self in DGBL provides students with a strong motivation to increase their performance and motivates students to want to continue learning.

As students engage with GBL they often describe the learning rich environment and games as fun (Karadag, 2015). As Tüzün, İnal, Karakuş, Kızılkaya, and Yılmaz-Soylu's (2009) study compared a traditional school environment with that of a GBL environment, it showed middle school students had statistically significant higher intrinsic motivations and statistically significant lower extrinsic motivations while learning. The students demonstrated a decrease focus on overall grades and exhibited independence while participating in the game-based activities. Tüzün et al. (2009) attributed the increase in student motivation due to the fact that GBL offered "exploration, interaction, and collaboration affordances, and anchored them in meaningful real-world events" (p. 74). When students' attentions shift from their grades to that of discovery, engagement, and interacting with practical problems within GBL, they have more 'fun' because they can see how the learning is significant and important to them and their education. This is best captured in the results of a study that described students in a DGBL environment as becoming absorbed into the game. The author describes the scene in the classroom studied as follows:

> There was relative quiet during the intervention, broken by exclamations of satisfaction from students who had managed to get a flag, by exclamations of disappointment from students who had come across obstacles and by short dialogues regarding the exchange of procedural information and tips about the game. (Papastergiou, 2009, p. 8)

The depiction of the classroom and the environment GBL establishes is a clear indication of how GBL engages and motivates students.

Not only does GBL help with student motivation and engagement, but it aids in students' self-confidence with the content. Ku, Andrew, Chan, Chen, and Denise (2014) suggested that low confidence hinders students' ability to learn. Their research draws out two significant findings. First, as students got older, they continued to lose confidence in learning if they were not given additional supports to help them improve, and second, both high-ability and low-ability students gained significant improvement in their confidence toward mathematics when GBL was used in their classroom. There is a direct relationship between a student's confidence in the things they are learning and their self-efficacy, or the ability for a student to complete a task. Eseryel et al. (2014) found a significant positive influence of students' self-efficacy on their engagement. "The results indicated that the increase of self-efficacy led to the increased student engagement putting forth more effort in solving the problem scenarios …" (Eseryel et al., 2014, p. 49). As students complete tasks inside of the gameplay in a GBL environment and experience success, their self-efficacy increases which equips the students to put forth more effort when tasks become more challenging. As students' confidence and self-efficacy builds, their satisfaction with learning grows. Shah and Foster's (2014) findings suggest student satisfaction is important in supporting student interest and knowledge acquisition. When students find satisfaction simply in learning new things for the joy of learning through GBL (or any delivery

means) what an exciting learning environment that is. This exciting learning environment was also found in Sáez-López, et al.'s (2015) research when almost one-hundred percent of students reported that MinecraftEDU enhances creativity (96.1%), is fun (98.5 %), and enables discovery (96.6%).

Academic Success

GBL provides opportunities for students to improve their confidence, develop self-efficacy, be creative, have fun, enable authentic discovery, and acquire new knowledge. Not only do students acquire these new "soft" skills, but there is also research to show students' test scores on new curriculum delivered using GBL improve. One study by Lin, Chang, Chen, Liou, Liu, and Yuan (2013) that used GBL for remediation with 6th grade students in an after-school program had significant findings. The study incorporated instructional videos into a digital version of Monopoly to enhance the performance of sixth-grade students' math skills. Throughout the game, whenever students were unable to answer fill-in the blank questions correctly, they received immediate remedial instruction specifically for that question. The results of the study demonstrated that GBL is more effective than traditional instruction or the instructional videos themselves at leveraging the benefits of mastery learning in a math classroom. Using GBL to deliver instant feedback and in conjunction with other educational strategies, such as mastery learning, has significant student academic benefits. Papastergiou's (2009) study of a high school Computer Science class in Greece is in agreement with Lin et al.'s (2013) findings. The study determined that students who learned the Computer Science curriculum through the DGBL method showed significantly greater achievement of the embedded subject matter on the post-test than their classmates not using DGBL. As the findings

from these different studies suggest, "DGBL can be effective in a variety of subjects…" (Papastergiou, 2009, p. 10) and can help students with vast differences.

Often research finds and suggests instructional practices that work for only high-achieving or low-achieving students but rarely both. Ku et al.'s (2014) research shows that GBL significantly improves student performance for both high and low-achieving students in mathematics in comparison to their peers' learning in a traditional paper-based setting. They have found GBL to be most effective because all students need specific goals, instant feedback, and various levels of challenges. Ku et al. (2014) goes on to state:

> Immediate feedback of students' performance plays a supporting role, which lets students grasp their progress and directs them to move forward, especially for low-ability students. Various levels of challenge let students with diverse levels of ability enter the flow state. (p. 75)

The state of flow that the researchers are talking about is from Csíkszentmihályi's (1975) work *Beyond Boredom and Anxiety* in which the author referred to flow as "the satisfying, exhilarating feeling of creative accomplishment and heightened functioning" (p. xiii). GBL allows students to receive immediate feedback to assess their progress, move forward, and helps remove the sting of failure which enables the state of flow. Also, as the various levels of challenges changes for each student, it is easy to see how GBL (especially DGBL, which automates the leveling process) can individually determine the student's ability level and encourage them to become satisfied and accomplished in their work.

There are many factors that have a collective influence on how effective student knowledge acquisition is in GBL, so much that it led Fu-Hsing et al. (2012) to describe the complicated process as a mystery to many. Fu-Hsing et al. (2012) research suggested that

knowledge acquisition through the use of DGBL is because "a student simultaneously possesses learning motivation to learn new knowledge in the game, learning ability to successfully understand new knowledge in the game, and playing skill to successfully complete the game's task" (p. 248). As more is learned about student knowledge acquisition in GBL it is becoming clear that students' academic success can be greatly increased across many curriculum areas. Shah and Foster (2014) report that both 5th and 6th grade students made statistically significant gains in post-test and interviews about their understanding of systems. In another study, Tüzün et al. (2009) found that by utilizing a computer game to support student learning in a Geography class, and "students achieved statistically significant learning gains when learning about world continents and countries…" (pg. 74). Two more studies referenced earlier in this chapter, Lin et al.'s (2013) study of after-school GBL math remediation and Papastergiou's (2009) study of a high school Computer Science class, show statistically significant gains in student knowledge acquisition when GBL is implemented. These findings of GBL student academic success across various curriculum areas, grade levels, and settings are a strong indication of GBL effectiveness.

Conclusion

"The use of play in an educational context and for purposes of learning and development is by no means a new phenomenon" (Plass et al., 2015, p. 258). GBL is a way for teachers to combine academic content with games, so playing games can be used as an implement in the educator's toolkit to engage students. Further research is still necessary within GBL, but the research suggests a positive correlation between GBL and motivation. Students who are allowed to participate in GBL are more excited and motivated to learn, as well as more confident in the skills they learn. GBL allows students to be more in control over their learning, creative, empowered, and describe learning as fun. Students also show academic improvement when

playing well designed games for learning. The research offered to this point is intended to provide a basis for implementing GBL into a middle school curriculum.

CHAPTER 3: APPLICATION

Introduction

The chapter presents the development and application of GBL curriculum for a 6th grade math interventions classroom. It is important to note that the curriculum is specifically created for students at Sartell Middle School in Sartell, Minnesota that struggle with math based on the previous years MCA scores and/or teacher referrals. The students who are identified as struggling must take the traditional 6th grade math and also the pullout 6th grade math interventions. For these students, math is often a class in which they have negative attitudes, low self-confidence, lack motivation, and have little academic achievement. From the author's experience, and the current research, once students start to struggle with the curriculum and become disengaged, teachers can have a difficult time helping these students improve academically. Therefore, this GBL curriculum was specifically created to help students experience success through small clearly defined tasks, keep them engaged by using high interest modes and means of curriculum practices, and develop their motivation through the use of an item shop that students could earn privileges during class based on the quality and quantity of work completed.

Process for Developing Curriculum

Step #1: Determine Learning Objective and Overall Goal. When modifying or implementing new curriculum, teachers must first determine learning objectives and their overall goals for their students. With objectives and learning goals established, teachers can create curriculum to meet the desired outcome. Teaching to the target is paramount to good pedagogy. The learning objective for this class and the game-based curriculum was to focus on two intentions: (1)

increase students basic math skills and (2) increase student engagement due to the interactive nature of the material.

Step #2- Identify Students and Needs. After the learning objective is determined and the overall goal is stated, the teacher must come to know their student population and the specific educational needs of the students that will present in their classroom. Knowing the students' interests and experiences will determine the types of games that will be most effective in educating and engaging them. Also, knowing the specific educational needs of students in the classroom will make it so the GBL curriculum is specifically targeted at their current comprehension level. This again is to make sure that the objective is the learning and not the game! The author identified students for this class based on state test scores. All students were identified as "Does Not Meet" or "Partially Meets" grade level math standards. After these students were identify by their test score, the list of students is given to the previous year math teachers. The previous year math teachers are asked to make referrals from the list of students based on the students' lack of engagement and/or need for more individual attention. Once all this information is gathered and processed, students are selected and enrolled into the 6th grade math interventions class. If there are still available spots in the class, the previous year math teachers are again asked for referrals of students that aren't currently in the class that would benefit from a math interventions class.

Step #3- Take Inventory of Available Resources. Educators must evaluate available resources to use when implementing GBL within their school setting. Knowing the amount of equipment, financial resources, staff support, and one's own teaching style will help decide which specific types of GBL can be used and aid in the success of GBL curriculum and its sustainability. Educators with limited availability to computers would want to avoid DGBL for obvious

reasons. A school with very little financial resources would want to focus on GBL resources that have little to no cost such as using playing cards, various forms of Bingo, teacher created games (see Appendix B for example of "I Have, Who Has" teacher created math game).

All students at Sartell Middle School have iPads available to them, financial resources have been earmarked for new curriculum creation, support staff are available to help develop and implement GBL, and the implementing teacher is an innovator/early adopter of new teaching practices. After assessing the available resources, it was determined that using a wide swiping variety of GBL (both DGBL and low-tech GBL) learning was accessible and desired. The curriculum will include teacher created physical games, BreakoutEDU boxes, technology tools (Spheros, Ozobots, littleBits, etc.), and DGBL platforms/websites.

Step #4- Development of Curriculum. Curriculum development is the craft of creating material to engage students in the learning process. Materials were developed for Sartell Middle School Math Interventions class and are meant to be adaptable by teachers to fit their individual needs. All units were created in the same framework, within our Learning Management System (LMS), Schoology (Appendix C). Units began with a pre-assessment, known to students as "Assess This" that evaluates students comprehension of the unit to be taught. Based on student scores on the pre-assessment, they are assigned a group that determines the level and type of instruction they will receive, known as "Get Smarter" to students.

Within the "Get Smart" section, students are placed in one of three, leveled groups based on their performance on the pre-assessment. Curriculum is differentiated among the groups to meet the needs of the three levels. The first group is called the "Hang Glider Party;" this group received the lowest scores (less than 65%) on the pre-assessment and need the most support to understand the concepts; therefore, they will receive small group direct instruction with the

classroom teacher. The second group is called the "Solo Ninja Work," this group scored well on the pre-assessment (between 65 and 85%) but didn't show complete mastery; therefore, they receive instruction through teacher created video explaining concepts and working through example problems (See Appendix D, a screenshot of instruction video). The third group is called the "Hacker Challenge", this group scored well (above 85%) on the pre-assessment, showing competence of content, so they are given an extension/enrichment challenge that allows them to apply their understanding of the concept in a new and engaging way (Appendix E contains an example of a Hacker Challenge). Once students have received the instruction on the content within the "Get Smarter" section, they transition to practicing and demonstrating their understanding of their new skills within a section known to the students as "Do Work" (Appendix F contains an example of a Do Work).

The "Do Work" section allows students to have multiple opportunities and various types of ways to practice new skills and displaying their learning. Additionally, the "Do Work" section has an added incentive for students by adding a 'cash' value to the completion of the activities that can be used to purchase from an in class item shop (See Appendix G, available options from the item shop). The item shop is used as a means to motivate students and help them understand the difficulty level of activities based on their 'cash' value.

materials and structure. The materials and structure of the course were created to teach four units of study: Basic Math (Adding, Subtracting, and Multiplying Multi-Digit Numbers and Long Division), Decimals (Place Value/Rounding, Adding and Subtracting, Multiplying, and Dividing), Fraction Prep (Divisibility Rules/Prime Numbers, Greatest Common Factors and Least Common Multiples) and Fraction Operations (Adding, Subtracting, Multiplying, and Dividing Fractions).

basic math unit. Students in need of remediation are in need of basic math foundational skills interventions. The author's intent was to create curriculum that helped develop foundational basic math skills. The foundation skills included adding/subtracting/multiplying multi-digit numbers and long division. Students need to acquire these fundamental skills to be able to scaffold other learning such as multiplying fractions. Materials developed or adapted for the basic math unit "Do Work" section focus on two components: (1) ready-made web applications of DGBL that allow for a quick feedback loop for students and are able to be engaging enough to hold the students interests, (i.e.: Batter's Up Baseball, www.prongo.com/math/multiplication.html), and (2) physical in-class partner games created to encourage students to collaborate, communicate, and compete, resulting in overall accountability of their learning (see Appendix H, partner game, Monkeying Around with Multiplication).

decimals unit. Students build off the foundation of the basic math unit with instruction and practice of understanding place value and rounding of decimals, and adding, subtracting, multiplying, and dividing decimals. In the development of this unit, the author's intent was to add another layer of GBL to the curriculum. The unit's "Do Work" section was very similar in nature to the Basic Math unit, in that it used already created web applications of DGBL and collaborative games, but it also added an element of role playing. Students were presented with "Who Done It/Crime" Scenarios and "Suspect Profiles" (Appendix I) and as they completed activities, they would receive clues that got them closer to solving the mystery. These clues include: books that have a cutout with a USB drive containing secret information hidden inside (Appendix J), QR Codes that link to text files which eliminate specific suspects, and deciphering clues (Appendix K). The intent in adding a role playing component in addition to the curriculum was to motivate students to complete more "Do Work" practice activities and increase student

engagement. This type of theme or role playing is meant to be adapted by other teachers in any curriculum or grade level as the content wasn't affected.

fraction prep. In preparation for students to work with fractions they must learn several concepts such as divisibility rules, prime numbers, greatest common factors, and least common multiples. This unit is intended to challenge the students by using a BreakoutEDU box (Appendix L). Students are told that they will need to work collaboratively within a team of students to complete all the "Do Work" challenges. Each "Do Work" challenge will gain them access to unlock one of the locks attached to the box. If they break into the box, they will be rewarded ($20 extra item shop cash) for their efforts. The author used this type of GBL (BreakoutEDU) to promote collaboration and incent students to complete more practice activities.

fraction operations. In the author's experience, the unit of fraction operations is the most difficult for students to comprehend. As the difficulty of the task is increased, so must the commitment and motivation level of the students. It was the intent of the author to make this unit highly engaging with the use of STEM (Science, Technology, Engineering, and Math) gadgets (Ozobots, littleBits, MakeyMakeys, and Spheros) and high-touch tools (LEGOs kits and Giant Jenga set). This type of equipment grabs attention because of the novelty of it. The novelty of the equipment is used to help student engage with the curriculum. We also used all the equipment to allow students to self assess their learning. This can be seen in the littleBits o'Math Worksheet (Appendix M) that students solve equations in which they subtract fractions and receive the proper snap circuit, or in a Sphero Maze Course (Appendix N) in which students must navigate their robot through the maze based on their answers on the fraction subtraction worksheet.

Once a unit is complete, students complete a post-assessment with the "Assess This" section to validate and verify student academic success in the new knowledge taught.

Step #5- Access Effectiveness and Modify. Educators use the data available through assessments, observations, and interactions with students to access the effectiveness of the curriculum. Using the data, educators can make modifications to curriculum to ensure learning objectives are being met and students are engaged.

CHAPTER 4: CONCLUSION

Summary

> Play is an activity enjoyed for its own sake. It is our brain's favorite way of learning and maneuvering... Play may have different strengths, not all of them mystical and soul-stealing. But even in its least intoxicating forms, play feels satisfying, absorbing, and has rules and a life of its own, while offering rare challenges. It gives us the opportunity to perfect ourselves. It's organic to who and what we are, a process as instinctive as breathing. Much of human life unfolds as play. (Ackerman, 1999 p. 6)

Ackerman's articulation of play and how it is the brain's favorite way of learning speaks to the importance of incorporating GBL into curriculum and schools. GBL is a way for educators to combine academic content with games, therefore the games can be used as an educational tool and not just as a means of entertainment. The research shows a positive correlation between GBL and student motivation, whereas motivation is defined as the number of tasks accomplished (i.e.-daily assignments, homework, etc) and/or time spent working with the content curriculum (Tüzün et al., 2009). Students who participate in GBL are more engaged and motivated to learn new curriculum. Also, students who participate in GBL develop increased confidence levels when learning new curriculum. GBL allows educators to use many educational strategies simultaneously, such as: shortened feedback loop, positive reinforcement, mastery, multiple learning styles, and more, which in turn have positively influenced student academic success.

Professional Application

As educators and schools look at ways to improve their current curriculum with GBL, several areas of research need to be examined. The first is the needs for students to be engaged differently with the school setting. Research shows this generation of students is vastly different

than prior generations (Rideout et al., 2010). They are spending more time engaging with technology, finding more and novel avenues to be entertained, and have several more options available to them for learning. Within all of this information, students still love to play games! Playing games is a way we can leverage the human desire to want to play with our obligation as educators to teach our students. If educators use more play and games within their curriculum, students will be more motivated within their classroom regardless of the grade level, content area, and ability levels.

Educators should seriously consider what resources are available to them when developing and implementing GBL curriculum. GBL can be delivered either digitally or by more traditional means. This decision should be based on adequate technology and sufficient support as technology related issues can build up and make the learning much less effective. Technology requirements don't need to be very robust, since a game that is focused on a clear learning objective is more important than the intricate graphic, sound effects, and complex storylines that is present in many commercial games. Educators should not base DGBL on whether they possess the proper skills or if they are comfortable with digital games. Research shows no correlation between an educator's past experience with digital games and student success. If an educator comes to the conclusion that they have inadequate technology and support for DGBL, they should explore the use of other means of GBL such as BreakoutEDU boxes, teacher created games, repurposed commercial board games, and more.

The implementation of GBL may seem daunting for some educators as it causes them to step outside their comfort zone and try something new. Even so, the implementation of GBL has shown increased student engagement and academic achievement. GBL students' attention shifts from that of grades to that of discovery and engagement, while improving their confidence, self-

efficacy, and enjoyment. This causes an increasing interaction with content and improvement of overall student academic success, defined as students' scores on curriculum delivered using GBL.

Limitations of Study

The purpose of this study was to evaluate the effectiveness of GBL on middle school (grades 5-8) students to increase student motivation and academic success. The findings from this study would be used to implement GBL in the 2017-2018 school year for a 6th grade math interventions class at Sartell Middle School. GBL is still a new concept in the field of education, especially in the middle school setting, therefore the amount of research isn't exhaustive. As the implementation of GBL increases, I believe we will learn more about its effectiveness in educating our students.

The second limitation of this study is how very little research is present on the differences between traditional GBL and DGBL. It would be very interesting to see findings on student engagement and achievement for the same curriculum delivered using GBL versus DBGL. The findings on the difference between the two would be helpful for educators deciding on how to implement their curriculum most effectively.

The third limitation of this study is the long-term implications of GBL have yet to be fully studied. A longitudinal study needs to be conducted on the lasting effects of GBL on student learning so it can be better implemented.

Implications for Further Research

This study has offered an overview of GBL and an example of GBL curriculum created for middle school math students. Further research is needed to gain a more comprehensive understanding of GBL. First, a study comparing the differences between standard GBL and

DGBL. Also, a longitudinal study on the retention of information learned using GBL is needed. Lastly, the implications of students' socioeconomic and GBL effectiveness.

Conclusion

It is clear from the research and the author's experience that play is an important part of the human experience and students' favorite way of learning. Knowing this, schools across the country have an opportunity to engage students in new and different ways. GBL, whether it is low-tech, minimal cost options or DGBL, can be a game changer for educators and students. GBL is a way for teachers to combine academic content with games, so curriculum can be more exciting and motivating. GBL allows students to be more in control over their learning, creative, empowered, and describe learning as fun. Students also show academic improvement when playing well designed games for learning. With the information provided by this study, it is time for educators and schools to look towards improving curriculum and student performance with GBL.

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APPENDIX A

Literature Review Search Explanation

Literature for this thesis was located through searches of Ebscohost, JSTOR, ERIC, Educational Journals, Academic Search Complete, as well as online searches for statistics. The research was narrowed through a search of articles from 2000 through 2017 using the following key words and phrases: “Game-Based Learning,” “Serious Games,” “Educational Games,” “GBL”, “Game-Base Learning in Middle School”, and “Digital Game-Based Learning”. Google search engines were utilized to search definitions of unknown terms and clarification when the author’s lack of knowledge hindered comprehension of research findings.

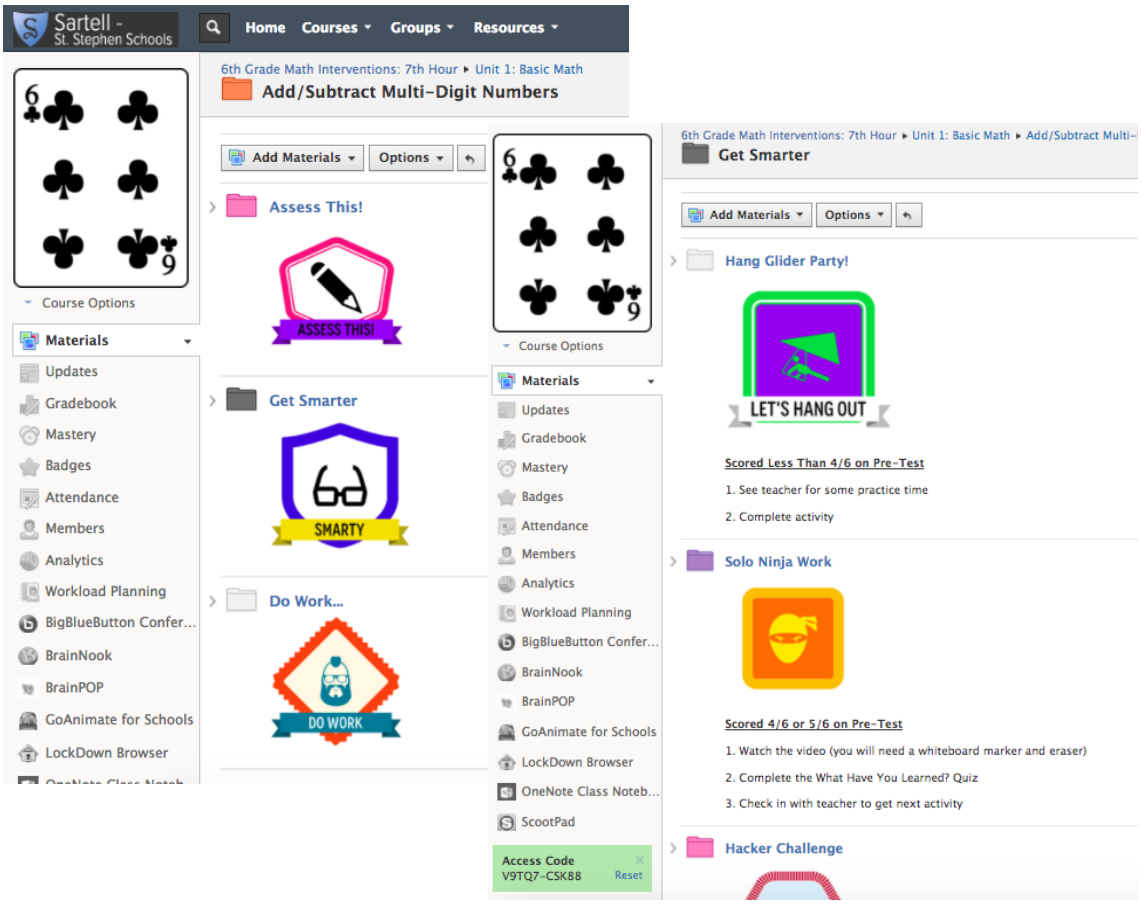
APPENDIX B

"I Have, Who Has" Game

I have 1. **Who has 2^2?**	**I have 4.** **Who has 3^3?**
I have 27. **Who has 4^2?**	**I have 16.** **Who has $(-2)^3$?**
I have -8. **Who has 10^2?**	**I have 100.** **Who has 5^3?**
I have 125. **Who has 12^2?**	**I have 144.** **Who has $(-2)^5$?**

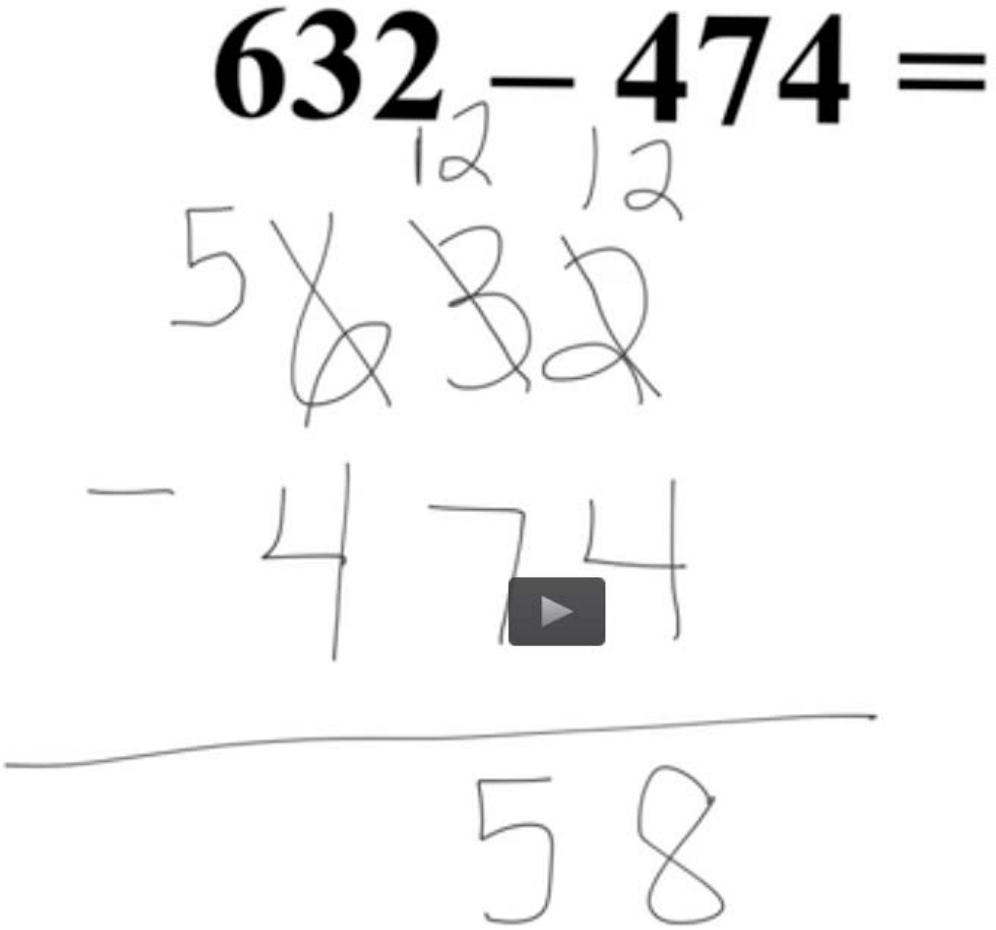
APPENDIX C

Schoology Course Screenshot



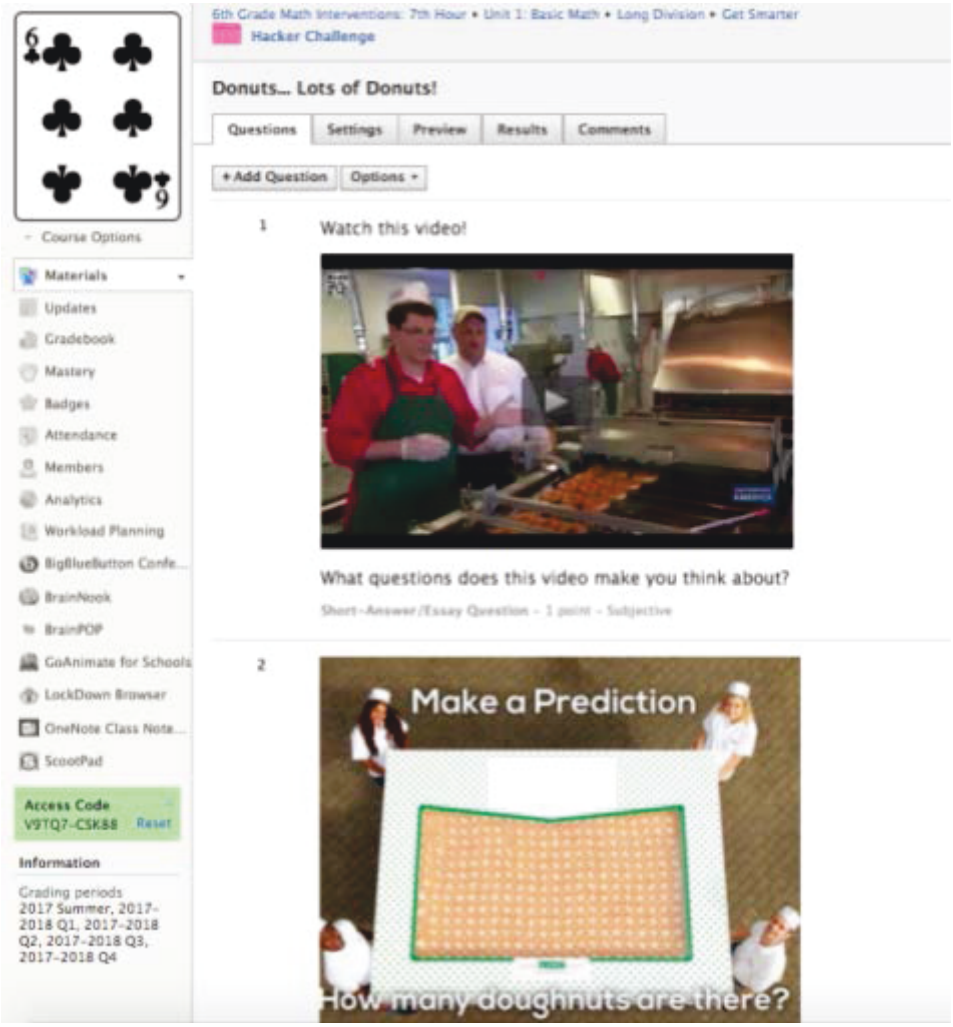
APPENDIX D

Solo Ninja Instructional Video Example



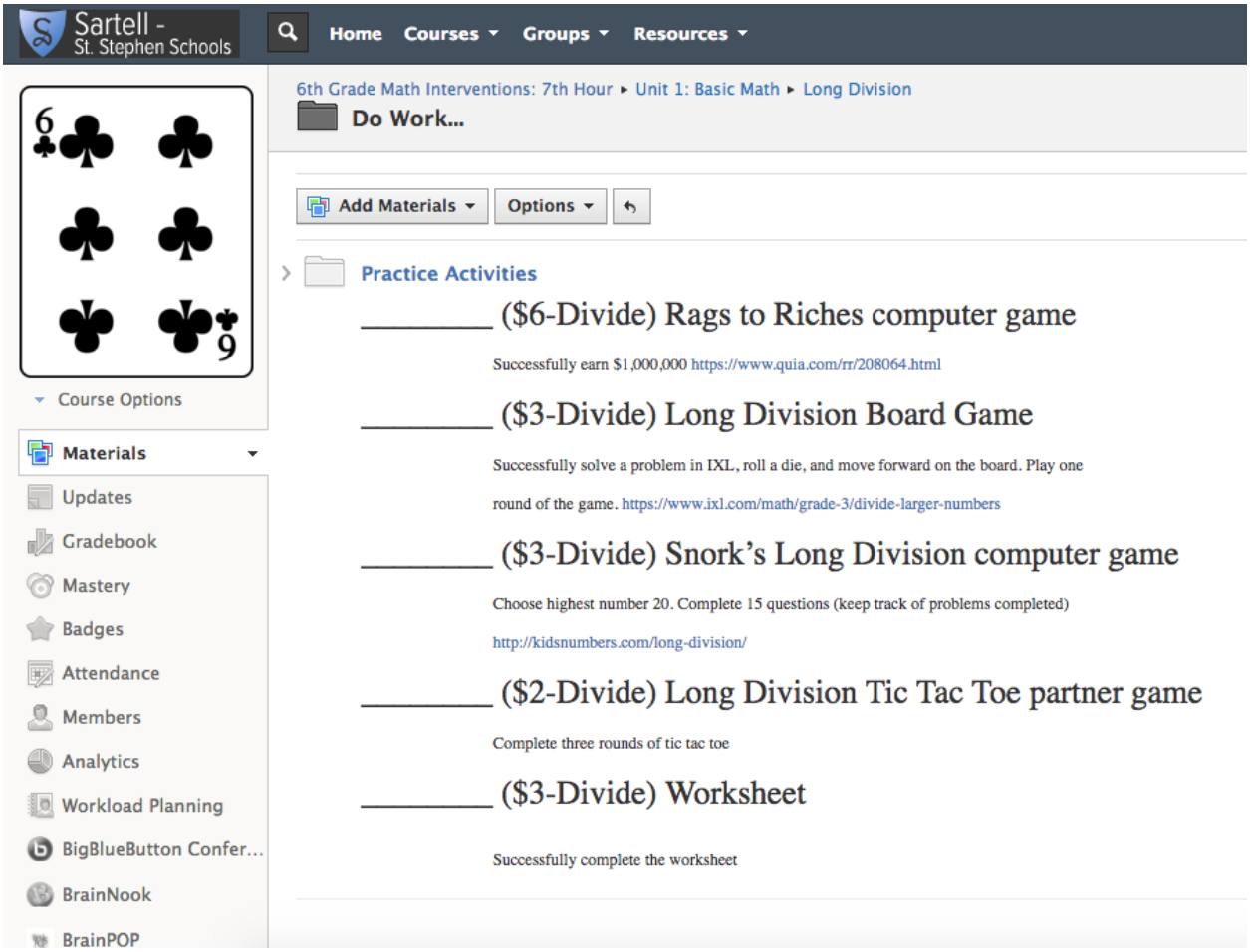
APPENDIX E

Example of Hacker Challenge



APPENDIX F

"Do Work" Example



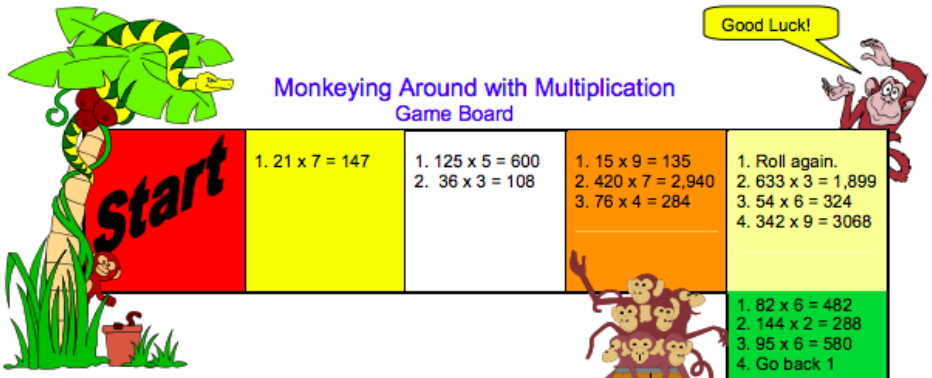
APPENDIX G

Item Shop Menu Poster

Item	Cost
Listen to music during activities	$20
Teacher's chair	$12
Leave 2 minutes early	$70
Pick class seat for the day	$45
Water break	$10
Pick your partner	$20
Bring in outside food	$18
Wear hat in class	$18
Window art	$22
Choose "Get Smarter" group	$30
Change "Get Smarter" group	$30
Get a pencil from teacher	$15
Bathroom break	$14
Charge iPad	$15

APPENDIX H

Monkeying Around with Multiplication



Start	1. 21 x 7 = 147	1. 125 x 5 = 600 2. 36 x 3 = 108	1. 15 x 9 = 135 2. 420 x 7 = 2,940 3. 76 x 4 = 284	1. Roll again. 2. 633 x 3 = 1,899 3. 54 x 6 = 324 4. 342 x 9 = 3068
1. 82 x 6 = 482 2. 144 x 2 = 288 3. 95 x 6 = 580 4. Go back 1 space. 5. 300 x 5 = 1,500 6. 37 x 2 = 74				
1. 25 x 4 = 100 2. 205 x 5 = 1,020 3. 12 x 9 = 108 4. 68 x 6 = 406 5. Roll again. 6. 511 x 9 = 4,599	1. 252 x 4 = 808 2. 19 x 9 = 171 3. Lose your next turn. 4. 707 x 3 = 2,121 5. 88 x 4 = 352 6. 60 x 9 = 450	1. 93 x 6 = 548 2. 121 x 8 = 968 3. 48 x 8 = 386 4. 52 x 7 = 364 5. 624 x 3 = 1,872 6. Move ahead 2 spaces.	1. Trade places with the person in last place. 2. 97 x 2 = 184 3. 160 x 8 = 1,280 4. 49 x 8 = 392 5. 736 x 2 = 1,462 6. 75 x 9 = 675	1. 70 x 9 = 630 2. Go back to START. 3. 44 x 9 = 386 4. 720 x 8 = 5,660 5. 17 x 6 = 102 6. 81 x 4 = 321
1. Move back 3 spaces. 2. 36 x 7 = 252 3. 58 x 3 = 164 4. 802 x 6 = 4902 5. 28 x 8 = 204 6. 450 x 9 = 4,050				
1. 62 x 5 = 310 2. 399 x 2 = 788 3. 36 x 6 = 216 4. Trade places with anyone. 5. 571 x 2 = 1,042 6. 831 x 3 = 2,493	1. 247 x 5 = 1,235 2. Roll again. 3. 79 x 7 = 563 4. 903 x 4 = 3,612 5. 403 x 7 = 2,821 6. 18 x 4 = 82	1. Lose your next turn. 2. 35 x 8 = 260 3. 52 x 9 =468 4. 531 x 4 = 2,124 5. 64 x 5 = 320 6. 46 x 3 = 138	1. 12 x 8 = 98 2. 27 x 4 = 108 3. Move ahead 1 space. 4. 811 x 7 = 5877 5. 400 x 9 = 3,600 6. 96 x 2 = 182	1. 53 x 3 = 159 2. 87 x 5 = 435 3. 600 x 8 = 4,600 4. 909 x 3 = 2,727 5. 16 x 6 = 96 6. Move back 2 spaces.
1. 90 x 5 = 4,500 2. 74 x 3 = 222 3. 321 x 3 = 961 4. 611 x 6 = 3,666 5. Lose your next turn. 6. 63 x 3 = 189				
End	1. 200 x 7 = 1,400 2. 604 x 3 = 1,212 3. Move to END! 4. 22 x 5 = 110 5. 81 x 7 = 567 6. 804 x 6 = 4,824	1. 33 x 3 = 66 2. Lose your next turn. 3. 66 x 6 = 396 4. 215 x 3 = 645 5. 72 x 4 = 288 6. 908 x 8 = 7262	1. Move ahead 2 spaces. 2. 86 x 4 = 344 3. 700 x 7 = 4,900 4. 61 x 7 = 431 5. 711 x 4 = 2814 6. 12 x 7 = 86	1. 505 x 4 = 2,200 2. 713 x 6 = 4,278 3. Move back 4 spaces. 4. 56 x 2 = 112 5. 28 x 3 = 84 6. 900 x 8 = 7,200

APPENDIX I

"Who Done It/Crime" Scenarios and "Suspect Profiles"

#1- The Phantom of the Theater *(Place Value/Rounding)*
It was an exciting night for the social-climbing Mrs. Patricia Peacock: she had called all of her wealthiest acquaintances together at the Hampshire Theatre, for a fundraiser to restore the aging facility.

As Mrs. Peacock took the stage to make her plea for donations, the audience gasped as the huge crystal chandelier above her suddenly gave way and came crashing down onto the stage, narrowly missing her! ***Who caused this catastrophe, and where could the culprit be found?***

#2- The Tabloid Attack *(Adding/Subtracting Decimals)*
Miss Scarlet was shocked to see the tabloid's blazing headline: "The Secrets of Josephine Scarlet". The article revealed, in embarrassing detail, the seasons that she had been expelled from the prestigious Madame Puce School for Girls.

Among the juiciest: she had cheated on at least three exams, had played vicious practical jokes on several of her classmates, and had tried to blackmail an instructor in return for a passing grade. ***Who had given out these secrets from Scarlet's past and where was the tattletale hiding out?***

#3- The Catnap Caper *(Multiplying Decimals)*
Rusty Nayler, Mr. Boddy's gardener, had formed a special bond with one of the barn cats at Tudor Mansion. The cat was an odd-looking creature, but he had lots of personality, and was great company for Rusty while he carried out some of his less exciting duties like weeding the flowerbeds.

One day the cat failed to bother Rusty for his daily bowl of milk. Rusty soon grew concerned, and searched the barn and its surroundings. The cat was mysteriously missing! Trusting a hunch that there might have been foul play involved, Rusty asked Inspector Brown if anyone had been seen near the barn with his favorite four-legged friend. ***Who stole the barn cat and where was this person now?***

#4- The Poisoned Prince *(Dividing Decimals)*
Prince Azure had a bad feeling about this party. Colonel Mustard was hosting it for Professor Plum, to celebrate his magazine article on the treasures of King Tut's tomb. Azure and the colonel had a falling out over the sale of an antique gun collection years ago, so the prince was surprised to have been invited. Maybe the Colonel was finally willing to let bygones be bygones.

At the party, Prince Azure suddenly felt nauseous and short of breath. An ambulance was summoned, and the prince lay on a chaise as he waited. "I've been poisoned," he groaned to the crowd of anxious guests hovering above him. "Who did this? Was it you, Colonel?" Detectives questioned the guests. Someone had been seen in the kitchen, doctoring up one of the hors d'oeuvres. ***Who poisoned the prince and where was the culprit?***

#1-The Phantom of the Theater		**#2-The Tabloid Attack**	
Professor Plum	Miss Scarlet	Professor Plum	Miss Scarlet
Miss Peach	Rusty Nayler	Miss Peach	Rusty Nayler
Colonel Mustard	Mrs. Peacock	Colonel Mustard	Mrs. Peacock
Lord Gray	Mrs. White	Lord Gray	Mrs. White
Reverend Green	Mrs. Meadow-Brook	Reverend Green	Mrs. Meadow-Brook
Prince Azure	Lady Lavender	Prince Azure	Lady Lavender
Who Done It?! _____		Who Done It?! _____	
#3-The Catnap Caper		**#4-The Poisoned Prince**	
Professor Plum	Miss Scarlet	Professor Plum	Miss Scarlet
Miss Peach	Rusty Nayler	Miss Peach	Rusty Nayler
Colonel Mustard	Mrs. Peacock	Colonel Mustard	Mrs. Peacock
Lord Gray	Mrs. White	Lord Gray	Mrs. White
Reverend Green	Mrs. Meadow-Brook	Reverend Green	Mrs. Meadow-Brook
Prince Azure	Lady Lavender	Prince Azure	Lady Lavender
Who Done It?! _____		Who Done It?! _____	

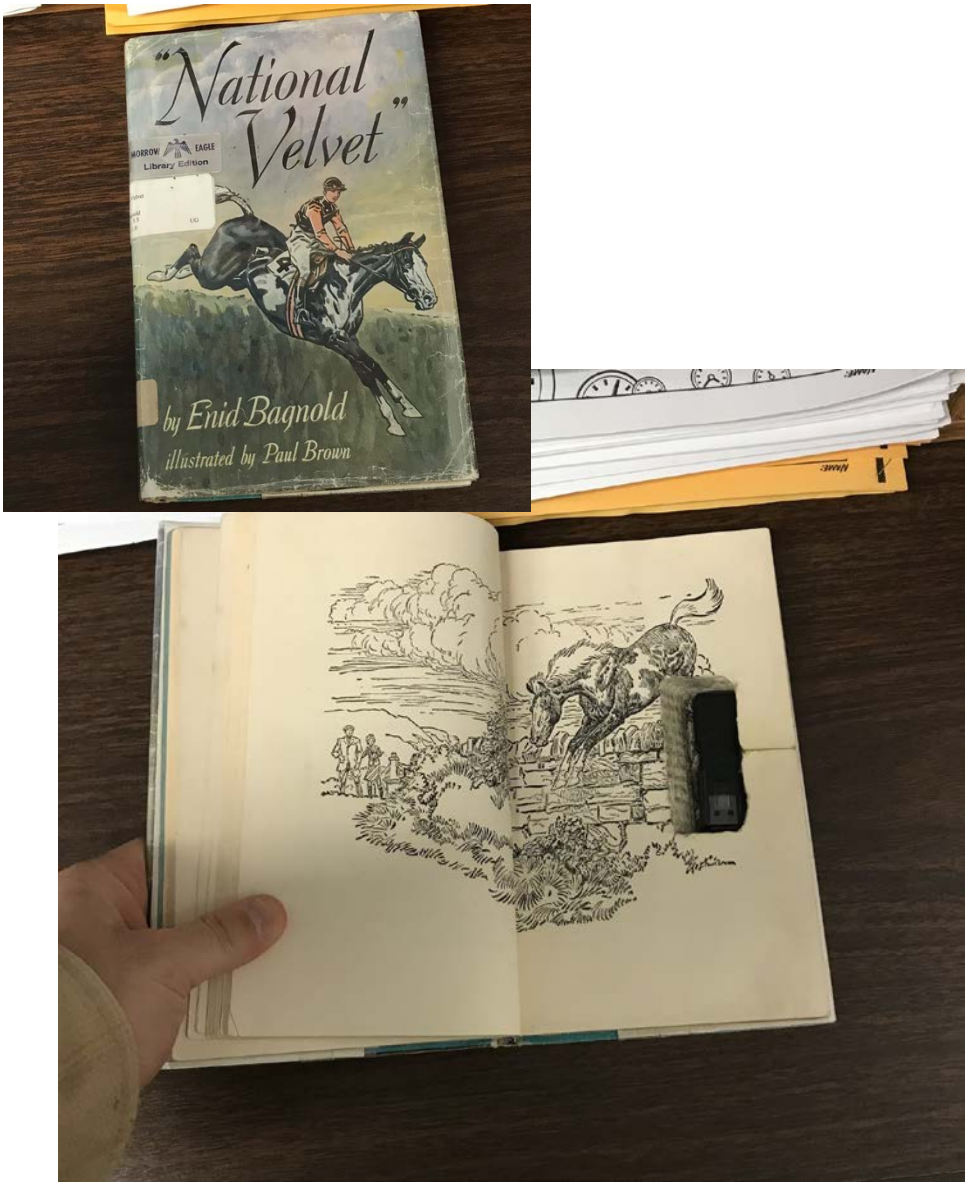
Suspects Profiles

Use the information below about each suspect to be a good detective and discover who committed each crime! As you narrow down the suspects, cross off their names on the list and once you know who committed the crime, write 'Who Done It' in the space on the other side of this sheet! You will be reward if you find the right suspect!


THE SUSPECTS
PROFESSOR PETER PLUM
Age: 37
Formerly a professor of Ancient Mid-Eastern Culture, Plum made several trips to Egypt—all funded by Sir Hugh Black—in search of ancient artifacts. Will he find the secret map that leads to a tomb full of hidden treasure?
MISS JOSEPHINE SCARLET
Age: 25
An aspiring actress with a history of unflattering reviews, wealthy escorts and estrangement from her mother, Mrs. Patricia Peacock. Would she accidentally uncover a well-guarded family secret?
RUSTY NAYLER
Age: 61
Rusty served in the military under Sir Hugh Black, and later became his groundskeeper. Crusty, cynical, short on funds and soon to retire, he's desperate for cash. Who is he blackmailing to keep an old secret?
MISS AMELIA PEACH
Age: 22
After a happy childhood in America, fun turned to tragedy for Miss Peach: her father went broke, she left law school, and her fiancé left her. Bitter, lonely and miserable, she wants someone to pay—but who?
COLONEL MICHAEL MUSTARD
Age: 41
After a mediocre military career in England, he served with some distinction in Africa. Now penniless and hounded by creditors, he's struggling to pen his memoirs. What dark secret from his past is haunting him?
MRS. PATRICIA PEACOCK
Age: 48
This socialite and three-time widow is running low on youth and inheritance. What is she hiding from her daughter Josephine? And what juicy tidbits can be found in her diary?
LORD ALFRED GRAY
Age: 44
Charming, artistic and temperamental, Lord Gray served as a cartographer in World War I, and now designs water gardens for wealthy clients. With whom is he feuding, and how far will he go to get the upper hand?
MRS. BLANCHE WHITE
Age: 62
She was Sir Hugh's cook, housekeeper, and nanny to his young nephew John Boddy. With little to show for decades of dedicated service, she now wants compensation. What delicious scheme is she cooking up to get it?
REVEREND JOHN GREEN
Age: 53
A pastor with a shady past, the charismatic "Reverend" had several run-ins with the law in America. Escaping to England, he quickly began courting wealthy patrons. By what unholy schemes will he fleece his new flock?
MRS. JANE MEADOW-BROOK
Age: 44
She's the town busybody and the wife of Boddy's attorney, Miles Meadow-Brook. What dirt will she dig up on her neighbors? And what mischief will she make during her husband's final days?
PRINCE PHILIPPE AZURE
Age: 33
Handsome, worldly and well educated, the "royal" Azure has both an elusive lineage and a knack for cashing in on it. Will his long-standing feud with fellow gun collector Colonel Mustard come to a nasty end?
LADY SU SIAN LAVENDER
Age: 29
Social-climbing herbalist Lady Lavender was widowed when her husband was mysteriously poisoned. Her clients keep her wealthy and entertained, but she wants more. What plan is she concocting to spice up her life?
PARKER BROTHERS
Some parts stored below.

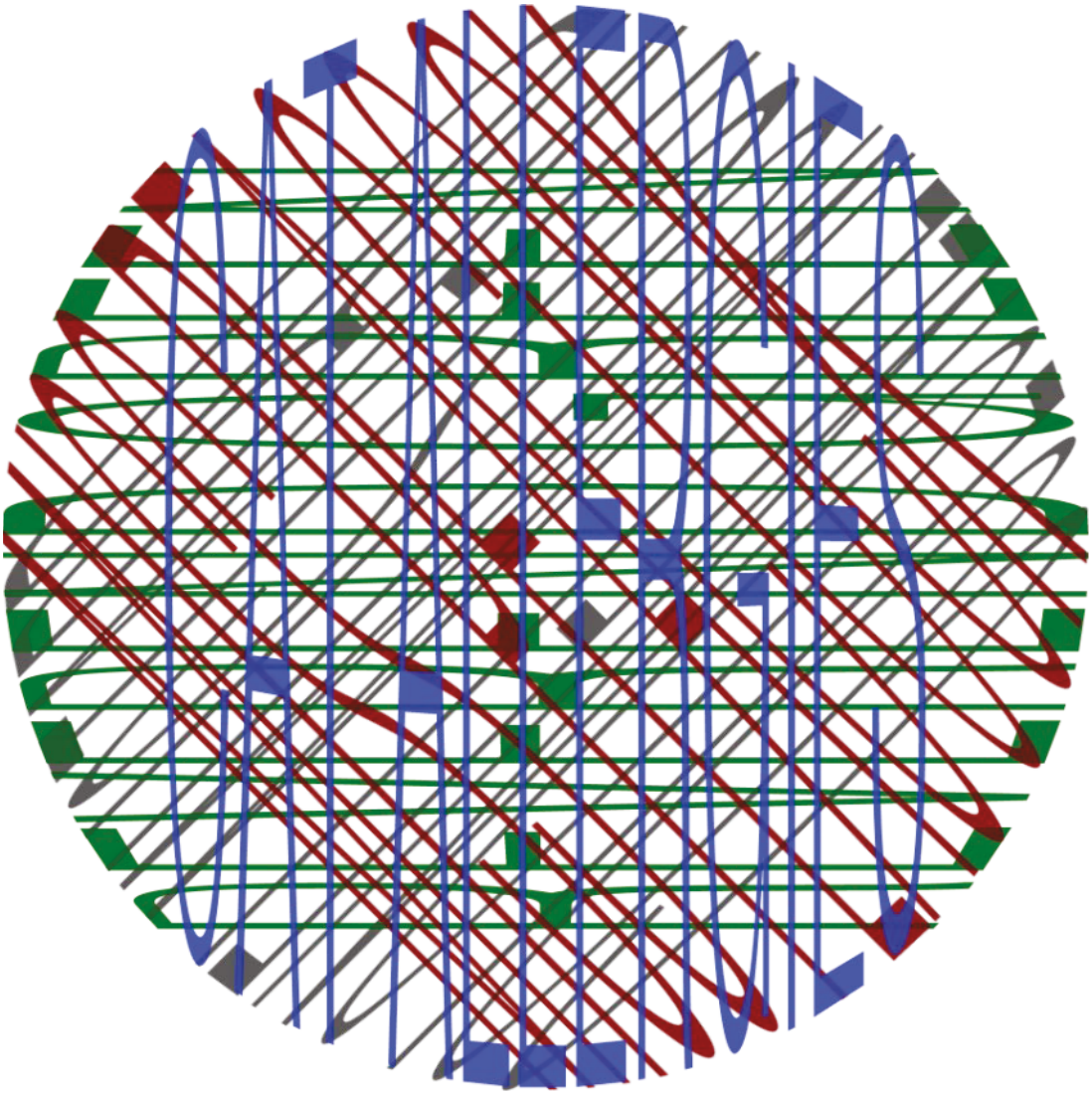
APPENDIX J

Picture of Book Cutout Clue With a USB Drive



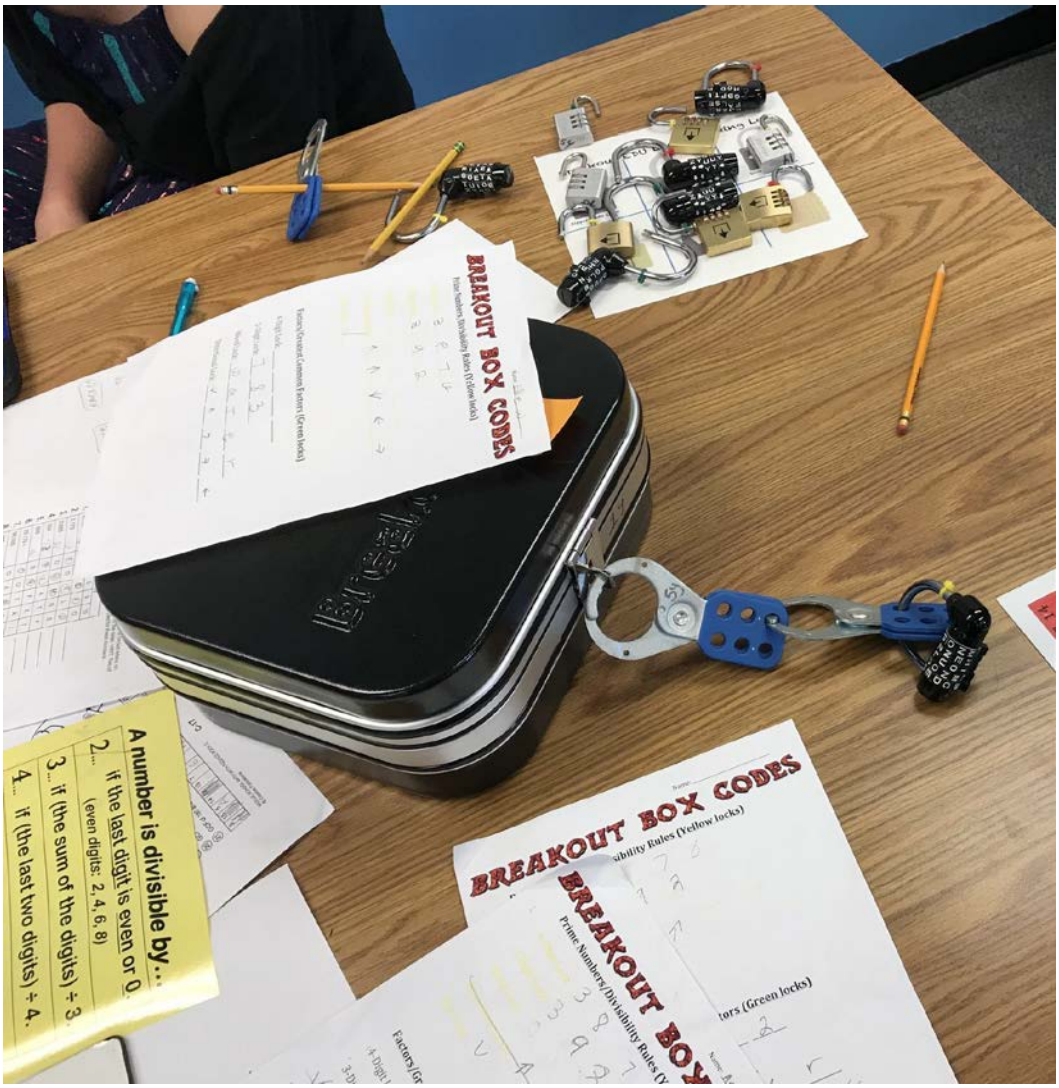
APPENDIX K

Deciphering Code Hint



APPENDIX L

BreakoutEDU Box



APPENDIX M

littleBits O'Math Worksheet

#1

littleBits o' Math

1. $\frac{4}{8} - \frac{1}{3} =$ _____
2. $\frac{4}{5} - \frac{3}{4} =$ _____
3. $\frac{7}{9} - \frac{4}{6} =$ _____
4. $\frac{6}{8} - \frac{3}{6} =$ _____
5. $\frac{6}{8} - \frac{4}{12} =$ _____
6. $\frac{4}{6} - \frac{3}{8} =$ _____

#1

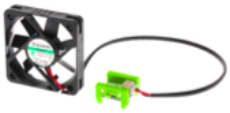
$\frac{1}{6} =$ 

$\frac{1}{20} =$ 

$\frac{1}{9} =$ 

$\frac{1}{4} =$ 

$\frac{5}{12} =$ 

$\frac{7}{24} =$ 

Circuit Sequence

Line up the ⊗ on the littleBits

1/6 → 1/20 → 1/9 → 1/4 → 5/12 → 7/24

APPENDIX N

Sphero Math Maze Course