## ADDING ACHIEVEMENTS TO TUTORING APPLICATIONS

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### Abstract

The purpose of our study is to develop a way to better engage students in their learning activities. Many students in the target demographic of middle school-age children immerse themselves in video game applications, but do not apply themselves in a similar manner in the classroom environment. We found that by integrating game-like elements such as the notion of achievements into tutoring applications, students are more likely to find learning to be an enjoyable endeavor.

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### **1** Introduction

The topic of how games can be used in the classroom has been the source of speculation among teachers. Many teachers are drawn to using games as a way of presenting educational substance to their students. By structuring learning as a game, students become more engaged in learning and take initiative towards the betterment of their education. Due to the many different types of educational games on the market, it is unclear which games could be the most effective teaching tool. Also, games which contain the best educational content may not necessarily be the most entertaining to play. There are many factors which contribute to the effectiveness of games used in the classroom. However, certain game-like elements may prove to be more effective than others. Our project is aimed at exploring designs for different game-like elements and then coming up with a way of implementing our elements into a functional test model to be able to present to middle school students.

Game-like elements are the aspects which make up the structure of a game. A game typically has a set of rules or principles and is played with a goal in mind. These different elements add to a game to make it more interesting and/or challenging for the player. Some game-like elements include a scoring system, multiplayer, leveling up, and the inclusion of some sort of a story. For our project we were presented with the task to come up with one or two game-like elements which could be applied to an educational tutoring system. Our proposed game-like element(s) needed to be easy to work with and practical for the purposes of our design.

After the initial brainstorming phase, we were able to narrow down our game-like element to "achievements". In a game-related context, achievements refer to any pre-defined task that players are notified of upon completion. Achievements would be easy to focus on and

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they would give us several options in terms of being able to tailor our design to specific subjects or problems. In order to create an adequate achievement system, we had to do some research to try and figure out a way of approaching our design. We wanted to come up with a system that would be simple, but would still be meaningful to the students. Although our design is a work in progress, we felt as though it would be important for us to present the students with our best effort the first time around. Our first design would be the starting point from which we could revise and tweak aspects depending upon the students' reactions.

Once we had decided that we would be working on designing achievements for an academic purpose, we conducted a literature review for the purpose of analyzing and educating ourselves and to decide which areas we wanted to focus on for our project. The literature review was especially helpful for learning about what kind of concepts had already been tested and what had been proven to work already. We wanted to take what was learned through the literature review and apply it to our new design. While what we wanted to do with achievements had not yet been tried, we drew from other similar studies to come up with a framework from which we could build upon.

Based upon our research and suggestions we received after presenting our ideas to our peers, we then adjusted our initial design. We wanted to keep the scope of our project small in order to put us in a better position to receive feedback from the students. It was important that the students understood what we were presenting to them and that they were not distracted by any loose ends. We also wanted to keep in mind that our project would change based upon the students' interactions. After collecting feedback from the students we would be better able to take a look as to what kinds of revisions would make our design be better suited to the needs and

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interests of the students. Furthermore, we would provide a basis for any future studies to be conducted with our findings.

The main goal of our project is to come up with a living design for using game-like achievements in the classroom. We also want to collect data to support our assertion that achievements could be a viable motivation booster for students. Our motivations for using game-like elements include helping students establish good study habits and providing them with a way of practicing what they are learning in class.

### 2 Theoretical Framework

### 2.1 How Students Learn

How do students learn? Some subjects are easier to grasp for some and more difficult for others. Everyone has different study habits and procedures, but the articles we observed stated that there are some concrete learning styles that people fall under. One article we examined "The Four Learning Styles in the DVC Survey" written by Catherine Jester, described four distinct learning styles, Visual/Verbal, Visual/Nonverbal, Tactile/Kinesthetic, and Auditory/Verbal. The article also denotes learning strategies for each style.

Visual/Verbal learners retain best when "information is presented visually and in a written language format" (Jester 2000). For example, these learners benefit from lecture slides and overhead projectors in class. Small notes, paraphrases, notecards, and highlighting are great strategies for these learners to utilize. This helps them keep a "mental picture of the information" (Jester 2000). A Visual/Nonverbal learner learns best through films, charts, and clips. Pictures and diagrams in textbooks are great aids. "When trying to remember something, you can often visualize a picture of it in your mind" (Jester 2000). The best study habits for these learners are

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to have as many diagrams and boxes of sequential steps if needed. Tactile/Kinesthetic learners are hands-on, activity-based learners. They excel in lab sessions where they "handle materials to learn new information", and "benefit from instructors who encourage in-class demonstrations, hands-on student learning experiences, and field work outside the classroom" (Jester 2000). These students study best when they can make their learning tangible. Finally, Auditory/Verbal learners retain information better when they listen closely to instructors and participate in group discussions. When trying to remember things, they might think back to how they heard the information or how it was initially stated. The best way for these learners to study is to avoid distractions so they can review information aloud and verbally go through problems step by step.

We want to cover all of the styles of learning in order to reach out to as many students as we can. In more of our research, we came across four principles that are critical when it comes to learning: learning occurs in context, learning is active, learning is social, and learning is reflective (Driscoll 2006). Without the proper context, learning and comprehension are difficult. For instance, in Driscoll's article, she asks the reader to read the sentence, "The notes were sour because the seams split," then asks what it means. She argues that even though the words might be familiar to the reader, the sentence is still confusing. Not until she states that the sentence is about bagpipes does it start to make sense. Learners will try to make sense out of anything unfamiliar, just as the sentence she gave. When they do this, learners try to think back to prior lessons and experiences, but without the correct context chances are they will not construct the correct meaning. Active learning gets students mentally involved so that they can generate connections between what is known and what is being asked to be learnt, which can result in each learning experience having meaning. Group learning is imperative. It helps students to hear other perspectives, and "brings different strengths to a complex and lengthy activity" (Driscoll

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2006). It also helps build knowledge from being among more experienced peers, and can result in mentoring by a more experienced peer. Finally, reflection on what one is learning and how one is learning a last crucial principle. "Learning is facilitated when students get feedback about their thinking, whether that feedback comes from within, a teacher or a peer" (Driscoll2006). With this feedback, students can obtain deeper understandings of material rather than just doing enough to get by.

### 2.2 Competition vs. Encouragement

"Competition is a learned behavior. Humans are not born competitive. What we are born with is an instinct to survive, but the desire to win and competitiveness are learned through social interactions" (Lopes 1995). In Marilyn Lopes' article, "Competition: Is It Healthy For Children?" she describes how in competitions, the winners do not even end up having as much fun as one would think. This is due to the fact that they are focused more on beating their opponent than enjoying the fun of the process.

We do not want to build a design which would be detrimental to our objectives by increasing competition amongst the students. We cannot have a win-lose ultimatum in our design; students do not learn that way. Our primary objective is for the students to walk away with increased educational habits and skill each time they put down the game. To achieve this, we need to encourage all the students, competition-driven and effort-driven. Although we do not believe our design would benefit from adding in competition, there are some arguments which support it. From observation, the most educationally competitive societies are on top for learning. For instance, Asian societies stress education to the fullest and it shows; Asians are among the hardest workers in the country. However, increasing competition may lead to leaving less skilled students behind.

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We are not saying competition is not helpful to learning. We just do not want to turn our design into one. We want to encourage all the students to do their best. When a student spends a huge amount of effort on something and does it correctly, the student should be rewarded just as much as the next individual who completes a problem effortlessly.

"David Johnson, a professor of social psychology at the University of Minnesota, and his colleagues reviewed all the studies they could find on the subject from 1924 to 1980. Sixty-five of the studies found that children learn better when they work cooperatively as opposed to competitively, eight found the reverse, and 36 found no significant difference. The more complex the learning task, the worse children in a competitive environment fared." (Kohn 1987)

More research and studies are concluding to the fact that "children do not learn better when education is transformed into a competitive struggle" (Kohn 1987). We need to make a design that will encourage all of the students to use their talents and resources to the fullest. We want to encourage them to compete for the knowledge, not for the reward. Increased knowledge will lead to increased performance.

#### 2.3 Extrinsic and Intrinsic Motivation

Extrinsic and intrinsic motivation can be important factors in how students learn. Extrinsic motivation refers to motivation that comes from outside an individual, such as a reward or a grade. Intrinsic motivation refers to motivation that comes from within the individual. It comes from the pleasure and satisfaction one gets from the task itself. We want to implement both of these motivators into our design, but we will require the correct balance. We want the students to be intrinsically motivated to want to acquire as much knowledge as possible sequentially through the game. Yet we also want the extrinsic motivators, the achievements, to supplement their motivation.

"Turner and Paris (1995) term these the Six C's of Motivation: choice, challenge, control, collaboration, constructing meaning, and consequences" (Wang & Han 2001). In Wang & Han's

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article, "Six C's of Motivation," they describe a scenario where a teacher applies these strategies to her class.

"In a tenth grade geography classroom, Ms. Betty assigned a group project to her students. The goal of this assignment was for students to learn the geographic location and some key information about East Asian countries. After Ms. Betty described the group assignment, students formed five teams of three students each. Each team chose one of the Asian nations and wrote a five-minute news release about it. The students were to act as anchors of a news show to introduce their country to the audience. The goal of the news report was to help students learn general information about the featured country." (Wang & Han 2001)

The teacher made the students take care of all the responsibilities of their product. She remained as their facilitator and coach. Before the project started, she asked the groups what their goals and expectations were for the project, then tailoring their project and meeting with them each week to assure they stayed on track.

Choice. Having them choose what Asian country to do research on helps advance intrinsic motivation. For instance, Group A chose to introduce Japan because they liked to watch Japanese cartoons. Group B selected Taiwan because they had recently viewed a movie produced in Taiwan and were curious about the background of the movie. These feeling-related attractions can be factors that enhance the motivation of learning (Wang & Han 2001).

Challenge. Giving a task just beyond the skill level of an individual is a good approach to challenge learners (Wang & Han 2001). This way if the student is intrinsically motivated to complete the task, the student will try to the best of his or her ability to finish. Upon receiving a few drafts from groups, Ms. Betty kept pushing the groups to include more information for balanced reports. "Continuously providing proximal goals can enhance students' self-efficacy and sustain motivation toward learning" (Wang & Han 2001).

Control. Running a controlled and monitored task or project, students will be more "responsible, independent, and self-regulated learners" (Wang & Han 2001). We have to allow

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the students to claim responsibility and feel free to make choices, but we do not want to overwhelm them. This is the reason for having a facilitator. For instance, when one of the groups had issues with assigning roles, Ms. Betty gave an explanation of all the roles allowing the students to select an appropriate role through negotiation.

Collaboration. "Collaboration seems to work best when students depend on each other to reach a desired goal, when there are rewards for group performance, and when students know how to work together effectively" (Driscoll, 1994). The only issue is teachers must be aware of each student's performance. We do not want any students to remain passive while others are active. One of Ms. Betty's groups was full of students with different talents. Their unison improved their performance.

Constructing Meaning. "Students should be given the opportunity to construct meaning in text as well as to build a rationale for the meaningfulness of literacy activities" (Turner & Paris, 1995). If we can get the students to realize the great value of knowledge, their motivation to learn will increase. It will make them strive for more. Group C had a problem with balancing their report. They focused a lot more on the section that interested them the most, leaving the other sections scarce. Ms. Betty helped balance out their report. Leaving the other sections scarce would not help Group C realize the importance of the assignment. Not realizing the importance of the assignment could lead to their motivation decreasing.

Consequences. This is in the sense of the outcome. Giving channels to display work increases motivation. Some teachers do this by showcasing work at art and science fairs, or publishing work to the internet. To use this strategy, Ms. Betty taught the students how to film and asked them to film their television news release. She displayed each release to the class as a whole to compare performance and results. Then she gave each student a copy as a souvenir.

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Motivation is a key component in learning, whether it is intrinsic or extrinsic. In the educational sense, we want to spark intrinsic motivation more so the students are more inspired to learn from our design rather than only paying attention to acquiring achievements. To make sure this does not happen we will design an achievement system that we hope to inspire intrinsic motivation. In the end, as long as the student applies himself to his fullest ability to our design, we have achieved our goal.

### 2.4 The Psychology of Achievements

It can be said that rewards or the use of different variations of rewards such as achievements engage students in a certain subject matter. The reason that students can relate to this system of rewards so easily is due to the psychological impact of earning those rewards. It is no secret that children in a classroom setting enjoy being rewarded for their scholastic efforts and progress. This may stem from their need for affirmation in an educational setting. Test scores and grades can be used as a way for students to receive feedback for their work. However, rewards and achievements take this feedback a step further by giving the students an extra goal to strive for when completing different tasks.

In approaching our initial design for using achievements as a game-like element, we consulted different research about achievements. Many of the articles we read about achievements discussed their use in modern gaming systems such as the Xbox's system. One such article entitled "Why Are You Addicted To Achievements?" by Rick Lane, goes into detail to explore the various motivations behind earning rewards. The article places achievements into a psychological framework and asserts that earning rewards is a part of an essential aspect of a human being's desire for accomplishment. Furthermore, achievements may be developed in a manner which promotes different types of behavior. The article references B.F. Skinner's

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experiments with animals and uses them as an example of how behavior can be taught. "These experiments were designed to teach animals to behave in a specific manner by responding to various forms of repetitive stimuli. For example, in one of Skinner's experiments a pigeon was given a piece of food every time it turned around. This positively reinforced that that particular behavior, encouraging the pigeon to turn around more" (Lane 2011). Following the same model of positive reinforcement, achievements could be adapted to encourage learning.

How achievements can be a used as a psychological motivator can be further explained through social cognitive theory. The theory details how humans behave in relation to their environment. "Social cognitive theory (Bandura 1986) addresses how performance and motivation are affected by rewards tied to achieving challenging performance standards. The emphasis in social cognitive theory is on how rewards relate to a person's perceived competence or self-efficacy (the belief that one can cope and succeed at a given level of an activity, task, or problem)" (Cameron 2005). According to the principles of this theory, a person's perception of self-sufficiency greatly affects their level of motivation. The gratification earned through achievement can satisfy a human being's struggle to attain success. Also, because successes and failures typically fluctuate, there may always be a need or a want to achieve something more.

### **3 Prior Art in Achievements**

### 3.1 Rewarding Students in the Classroom

There is quite a bit of speculation as to the effects of rewarding students for their performance and behavior in the classroom. Over the past years teachers have been trying out new methods of delivering information to students. Teachers have had to adjust their styles of teaching in order keep their students interested in school. One of these methods includes giving the students some sort of reward for their efforts in class. By giving students rewards, the teachers hope to reinforce good learning practices as well as give the students an extra incentive to perform well. However, there is some argument that this method of teaching devalues the subject matter that students are learning and may have a negative effect on their intrinsic motivation.

During our research we came across a variety of articles discussing the impacts of giving students rewards in the classroom. In conducting our research we found out there are an assortment of ideas about what kinds of rewards are the most effective. Additionally, there is a debate regarding which sets of things students should be rewarded for. A large emphasis is placed on rewards that are tangible versus rewards that are not. Tangible rewards are those which are straightforward physical objects, whereas intangible rewards do not have these qualities. Tangible rewards can be used as intangible rewards when there is a distinction between earning the reward and then exchanging it for something physical. The use of strictly tangible rewards generally achieves immediate results from students. However, those who oppose the use of tangible rewards argue that they only produce short term changes (Davies, 2008). Also, there is the problem of students losing motivation after the rewards are taken away. To remedy this loss of motivation, many teachers give intangible rewards such as tokens or points which can be exchanged for other types of rewards. In order to increase motivation for a longer period, the rewards must be placed in a context into which the students can relate.

One of the articles we read discusses different reward systems that teachers had developed and their observations of how well their methods work with their students. In one system implemented at the Greyhound Intermediate School in Eaton Rapids, Michigan, sixth grade students received point cards for good behavior. These "PAWS" cards, named in

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reference to their school mascot, could be exchanged for tangible rewards such as food or school supplies. All of the school faculty members possess the cards and are free to give them to students as they see fit. After collecting the cards, students can give them back to their teachers in exchange for points, which can then be collected and added up to purchase goods. Teacher Denise Kane remarks that although the newer students were hesitant at first, she has found that after a while they came to "enjoy it". She also remarks that the students have exhibited better behavior, some of them staying after school to help a teacher or even help the custodian clean by removing trash from the floor (Bafile, 2003).

The important thing to keep in mind while implementing a reward system is to make sure that the rewards are consistent with student behavior and performance. It is also important that the students do not expect a reward every time they do something positive. Rewards should be used sparingly in order to reinforce good behavior and effort. The more recent research conducted concerning reward use in the classroom has looked at the different kinds of rewards and how they have been implemented. Some skeptics cite the possible long-term effects, which can have detrimental consequences to the way a student learns. However, in general, it is accepted that rewards work well.

Teachers need to prepare for when rewards are taken away. Once the rewards cease, students may lose motivation for what they are doing and even stop doing a task all together. There is also the problem of rewards possibly decreasing a student's initial motivation once they are taken away. One study on this phenomenon conducted by Lepper et al. (1973) showed the effects of demotivation on children aged three to five. The children were given markers to draw with which were then taken away for a period of two weeks. After the two weeks, the researchers separated the children into three groups.

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Each Student in the first group was taken into a separate room and was told that he or she could win an attractive "Good Player" certificate by drawing a picture with markers. Each was eager to get the certificate and drew a picture. One-byone, students in a second group were also brought to a separate room, encouraged to draw, and then given a certificate, but the certificate came as a surprise; when they started drawing they didn't know they would get a certificate. A third group of students served as a control group. They had been observed in the first session but didn't draw or get a certificate in the second section. After another delay of about two weeks, the markers again appeared in the classroom, and the experimenters observed how much the children used them. (Willingham, 2008)

The researchers found that the students in the first group used the markers half as much as the students who were surprised by the player certificate (the second group). This could mean that the students who initially liked drawing did not see a point to drawing any longer since there was no prize to be earned. Those children who did not know about the certificates and simply drew because they enjoyed it were more likely to continue drawing once the reward was taken away. Even though they did not receive a prize, it did not matter because the children were intrinsically motivated to draw.

Rewards should be presented in such a way that the students do not equate learning with gaining rewards. In the workforce it is highly unrealistic that an employer will reward an employee with gifts or a paid vacation every instance that something useful is accomplished. Similarly, giving students rewards for every success in class will later lead to them having a misconstrued view of work and success. The goal then becomes finding a way to implement a reward system which can be beneficial to the students, but also not take away from their initial level of motivation. Over the past few decades, there has been a substantial amount of research that has gone into studying the effects that different types of rewards have on the motivation of students over different periods of time. Some of the most extensive research conducted in this field was conducted by psychologists Cameron and Pierce who put together a meta-analysis of different studies on the subject of classroom rewards.

Through their research, Cameron et al. observed some underlying trends within different reward implementations.

In the most recent meta-analysis of the literature, Cameron et al. (2001) reviewed 145 studies and identified several conditions under which rewards were found to decrease or increase people's performance and motivation. Negative effects of reward were detected in studies in which participants engaged in a task of high initial interest and the rewards signified failure or were loosely tied to behavior. Specifically, decreases in motivation and performance were found when rewards were not tied to meeting a specific performance standard, when the standards for receiving the reward were not clearly outlined, when participants were unable to meet the contingency required to obtain the reward, or when participants received less than maximal reward. In another review of the literature, Deci et al. (1999) found that participants' motivation and performance decreased when rewards were offered in a controlling and authoritarian manner. (Cameron 2005)

After observing how a reward system could have a negative effect on students'

motivation, Cameron and her researchers came up with some general guidelines to avoid this from happening. Some of the things discussed in her article include making the rewards challenging to attain, attaching the rewards to progress, involving students in the system, making sure the students know the criteria for each reward, and using rewards frequently at the start and then gradually fade them out over time (Cameron, 2005). In following these general guideline principles, it can be possible to implement an effective reward system in a classroom setting.

### 3.2 Existing Achievement Implementations

The idea of implementing achievements in a game to engage and motivate players is certainly not a new one. Many game publishers even dating back those on the Atari 2600 in the late 1970s would create lists of tasks for players of their game, often by printing a list on the game's manual and offering prizes to players who proved they completed the list. This was done for two reasons –players who were 'stuck' or 'lost' in the game could use these as an alternative method of playing which would keep them engaged instead of prompting them to give up, and players who had completed the game could challenge themselves by attempting to complete the

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auxiliary tasks, creating longevity for the product. In 2005, however, Microsoft took this concept to a new level with the introduction of its new gaming console, the Xbox 360. Every game for the system featured between five and fifty achievements that were worth a total score of up to 1000 points. A player could easily see a list of every achievement they had ever obtained, and a "Gamerscore" that contained a tally of the points for those corresponding achievements. This formula led to a system that was so successful, it surprised even those who implemented it. When asked about the community response to achievements, the product manager for the Microsoft Xbox stated:

"You never quite know how people are going to react to these sorts of things," observes Greenberg, the group product manager for Xbox 360 and Xbox Live. "But we were very pleasantly surprised when it took off like wildfire. The gaming community is crazy about them." (Hyman 2007)

Having an achievement system that was deeply integrated in both the console and game development helped players understand its importance. Many players wasted no time in collecting achievements, often completing obscure, difficult, and lengthy tasks to do so. Indeed, many players stayed with the Xbox platform simply because they had this achievement system that added an extra dynamic to its games that other platforms lacked. Indeed, "a study by Electronic Entertainment Design and Research (EEDAR) suggests that many and diverse achievements lead to higher review scores and more units sold" (Jakobsson 2011). The idea of achievements opened an entirely new dimension of game development that changed the industry as many tried to take advantage of this new way to engage players.

Within a few years of its implementation by Microsoft on the Xbox 360 console, the majority of the other top gaming services developed their own similar achievement systems. Microsoft quickly expanded achievements to its Games for Windows LIVE service on the PC. In 2006, less than a year after achievements were introduced with the Xbox 360, Sony announced their own system for the PlayStation 3 called 'Trophies' that functioned in a similar manner. The Trophy system was introduced in July 2008, and by January 2009 it had become mandatory for all new games on the console. In 2007, Valve Corporation added achievements to its Steam digital content distribution platform, which omitted the point association and was not mandatory for all games but was otherwise identical to the Xbox implementation. Independent game developers also saw the success of Microsoft's system and implemented it in their own games, as well. The video game industry as a whole realized how effectively this system could be used to engage and motivate players to continue playing their games, leading to its widespread use on every major platform that caters to the avid game-player.

The response by the video game community to the idea of achievements is fairly selfevident in its widespread adoption by the game industry. When they designed their implementation, Microsoft did not know how video game players would respond to the idea of earning achievements as they played game. Had players disliked it, they would have likely removed their requirement that game publishers for the Xbox 360 include achievements; other video game platforms would not have adopted it, and the achievement system would no longer exist today. The fact that the opposite is true is a testament to the success of the achievement idea in the video game community. In response to achievements, hundreds of websites such as 'Xbox360Achievements.org' have been developed with the goal of helping players get as many achievements as possible. Many players view the 'Gamerscore' associated with achievements as a high score, and attempt to best their friends by maintaining a higher score. Some players purchase or rent games with easier-to-earn achievements simply for the purpose of earning them, to the delight of the publisher. Indeed, "There are many gamers who care more about the bragging rights behind accumulating points than they do about winning the games" (Hyman

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2007). Microsoft has also stated that "We see gamers coming back to us because we give points; other platforms don't" (Jakobsson 2011). Players are so eager to earn achievements that it has completely changed the way that games are played, and why they are motivated to play. Despite being an entirely intangible award on a screen, the effect achievements have in motivating players is clear.

#### 3.3 General Design Principles

According to Lucas Blair, who is a PhD researcher and game designer, there are certain guidelines that one should follow in order to create effective achievements to "improve the player's experience and the overall quality of a game."

One important tip that Blair suggests is that for parts of games when concentration is critical, the designer should delay achievement messages until after the intense part in finished. This way, the achievement notification won't distract the player and cause him or her to lose concentration (Blair 2011). For example, in a Rock Band session when there are tons of notes coming down the screen, an immediate achievement notification would only serve to distract the player from the rest of the upcoming notes. Therefore, to avoid distracting the player, it would be much better to wait until after the song is finished before displaying the achievement notification to the player.

On the other hand, for parts of games that are less intense, the designer should notify the player immediately of success in order to encourage the player. However, the achievements that have been unlocked should still be available to browse through later just in case the player doesn't want to stop at that particular moment and see which achievements have just been unlocked (Blair 2011). The benefit of this implementation is that it allows the player to feel

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immediate praise for his or her accomplishments, while still enabling the player to have the freedom to continue playing if they do not wish to stop playing at that immediate moment.

Another tip that Blair explains is that you should use "measurement achievements" rather than "completion achievements" when designing games. Measurement achievements are achievements that indicate to what degree of mastery the player completed the task. For example, in a Guitar Hero song, you could have various achievements for 3, 4, or 5 stars earned on a song on a certain difficulty. In contrast, completion achievements do the opposite. They are awarded to the player for completing vague tasks which don't really indicate how well the player mastered the content. Continuing with the Guitar Hero example, a completion achievement would be one that, for instance, rewards the player for simply completing a song. This in no way indicates how well the player did on the song, and it does not encourage the player to try and improve in order to get a better score the next time. The benefit of using measurement achievements is that they increase "intrinsic motivation through feedback" for the player (Blair 2011).

Blair also makes the important point that your achievements should not only cater towards goals focused on performance, but instead, sometimes guide the player to pursue mastery goals (Blair 2011). When players become too focused on performance, they get locked into a specific mindset of only using one particular strategy, which they think is the best way to earn the most points. For example, in a first-person shooter game, this is your stereotypical player who always chooses the machine gun because it is the weapon that will enable him to earn the most skills. However, as a result of doing this, he only gets good at using one type of weapon and strategy, while his other skillsets never improve. This is why some, but not all, achievements should focus on mastery of certain skills instead of always focusing on

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performance. Mastery achievements would include goals that encourage players to go outside of their comfort zones and try to become more efficient at skillsets that they aren't as likely to try otherwise. For example, in a first-person shooter game, mastery achievements could be earned by achieving a certain number of kills with various types of uncommon weapons, such as snipers rifles or pistols. Although the players probably won't be able to earn as many kills per game with these atypical weapons, the extra motivation of having a particular achievement specifically linked to those types of gameplay will give players the incentive to use them. This idea is very important in an educational game because it should be the designer's goal that students will be improving in all areas of a particular subject, rather than only improving at one particular thing. For example, a student who spends all of his time practicing addition problems in a math game is definitely going to become very adept at solving problems relating to addition, but his acquired skillset may not help him very much in other areas such as geometry.

In his study, Blair also looks at the issue of how much information should be viewable about a player's earned achievements by other players of the game. There are trade-offs that arise depending on how much privacy you implement. If you make everything public, so that any player can view the completed achievements of another player, you definitely increase the amount of motivation that players have to succeed because they want the approval of their peers. Players will strive to complete achievements for their own sense of pride amongst their peers. Additionally, public achievements allow players to see which achievements their peers were able to unlock, and it gives them an extra incentive to attempt those achievements. This is the "if he can do it, I can do it" mindset. A third benefit of public achievements that Blair explains is that they enable players to check and see which other players they could look to for help or advice with regards to obtaining specific achievements. However, at the same time, publicly visible

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achievements can sometimes cause players distress due to the fact that their peers will have a low opinion of them because of their less-than-average in-game abilities or accomplishments. Blair suggests that the designer can avoid this effect by creating some achievements which are earned by helping other players to accomplish certain tasks. This way, the less-skilled players aren't ignored or rejected. Blair's suggestion mainly applies to multiplayer games, but even in the development of a single-player game with public achievements, it is something to consider. Another suggestion that Blair makes is that the designer could decide to allow each player to display only a few of his or her earned achievements. This way, the player could showcase the achievements that he or she was proud of, but not have to deal with the problem of other players seeing which achievements haven't been earned yet (Blair 2011).

Yet another tip that Blair suggests is that "incremental achievements" and "metaachievements" should be used in order to guide the player. However, these types of achievements should not be used to the point where the player feels like he is being controlled. Incremental achievements are achievements which are given for completing a sequence of challenges, with each successive one increasing in difficulty or effort required. An example of this would be achievements for 10, 100, and 1000 kills in a first-person shooter game. Metaachievements are achievements which require the player to complete a variety of different tasks, all contributing to the same goal. For example, in a street car racing game, there might be an achievement for winning a race in every district of the city. As one might expect, these two types of achievements are very helpful in giving direction to the player and giving them goals that they can follow, which help them to progress in the game. However, the potential downside to using these types of achievements is that the player may end up feeling like they have too many restrictions on them. If this is the case, it will hinder the player's ability to explore in the

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game and his or her creativity will really be limited. For this reason, when designing achievements it is very important to consider both sides of the spectrum, with the ultimate goal of giving direction to the player, while at the same time not limiting them too much to the point where they feel like they are not in control of their experience (Blair 2011).

In games which have a competitive component between two or more players, the designer should hold off on making competitive achievements available until after the players have become comfortable enough with the game and are fairly skilled or competent. (Blair 2011). The reason behind this is similar to the effects of performance-based achievements. Although they do motivate students to challenge themselves in order to win, they do not necessarily promote learning and experimentation. The presence of competitive achievements will cause players to focus on the goal of winning, and this will cause them to go with the "safe bet," or their most effective skillset. They will not feel comfortable trying new things and experimenting. This is why it is so important to make sure that the players are all experienced enough in the game before exposing them to player vs. player competition that is further provoked by the presence of competition-based achievements.

Blair also makes some suggestions for what is the appropriate level of difficulty for achievements. Basically, there are two things you need to keep in mind when designing achievements. First, you need to make sure that the achievements are not impossible, but at the same time, they cannot be too easy, to the point where they aren't even fun for the player. If the achievements are too easy, the players will complete the achievements too quickly and they will not have to challenge themselves in order to improve and eventually feel a sense of pride or victory once they do complete the achievements. But on the other hand, if you make achievements too tough, the player can react to them in one of two ways. The first thing that can

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happen is the player will not feel confident enough in his or her abilities and won't even attempt to unlock the achievement. The second thing that can happen is the player will get so frustrated at their inability to succeed that their self-esteem will be ruined and they will eventually stop playing. There is a fine line between these two possible negative outcomes and there is no general rule on how to avoid them. You just have to try and look at your game from the point of view of your target audience and try to gauge what the correct level of difficulty should be. Player testing can help with this fine tuning. Another way that this can be dealt with is you can offer alternate achievements for the more advanced players who have already mastered the main goals of the game. This way, they will not get bored because they will be doing unusual things that they may not be as proficient at (Blair 2011).

The second thing that designers need to keep in mind when considering the difficulty of achievements is the player's sense of self-confidence. According to Blair, research has shown that people with a higher self-confidence are generally more committed to pursuing goals. They actually believe they can succeed, so they are more willing to put their efforts forth. If they didn't believe they could succeed, they would be a lot more hesitant to attempt to accomplish certain goals because they would feel like their efforts would be futile in the end. This sense of self-confidence can be affected by various causes. The first is the player's level of proficiency in a certain area. There need to be appropriate achievements for all skill levels that will suit each different player's proficiency level or area of expertise. For example, in Guitar Hero, there are achievements for each of the four difficulty levels: Easy, Medium, Hard, and Expert. Regardless of the player's level of expertise, they can pursue appropriate achievements with the confidence that they are proficient enough to be successful in the end. Someone playing on Medium difficulty doesn't need to worry that they won't be able to complete hard songs. There are

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achievements that specifically apply to the Medium songs, so they know that those achievements should be within their grasp (Blair 2011).

Self-confidence can also be affected by seeing other players around you experience success. This exposure to success can be achieved through public achievement lists, where players can view which achievements have been earned by other participants. When a player sees that someone they know was able to succeed, they think, "If he can do it, then so can I!" As a result, they are more motivated to work towards an achievement that they may not have otherwise pursued (Blair 2011).

Another thing that affects self-confidence is the feedback that players receive. This is why the way that achievements are written is so important. As a designer, you want the language and phrasing of achievements to portray a positive vibe to the players in order to encourage them. There is a big difference between saying, "You made it past the 3<sup>rd</sup> level," vs. "Excellent job! You saved the city! You are a hero to all!" Obviously, players who are given the second achievement description will feel a lot better about themselves and have a higher sense of confidence (Blair 2011).

### 4 Design 0

#### 4.1 Why we chose Difficulty and Achievements

When we began our search for possible game-like elements that we wanted to work with in our project, we had to consider which options were the most practical. Some of the initial ideas we came up with included adding a story to the game or to revamp the user interface to make it more appealing to students. However, as discussed earlier, we wanted to focus on something which could be accomplished fairly easily, but would still have a large impact on how the students would interact with our design. Our first thoughts were to focus on adding some sort of scoring system into the game. A scoring system would add a competitive factor to the game as well as give students a sense of accomplishment. Students would be able to track their own progress in the game by consulting their score and earn in-game points that would add up toa student's overall score. Originally, students would be able to share their score with others along with having a leaderboard which would let the students see the top scores in their class. However, we did not want to discourage those students who consistently underperformed.

We wanted to choose a game-like element that could be tailored to each student, motivating them in different ways. The game should challenge the students to some degree, but it should also be used to build better study habits and reward students who have shown improvement. Also, we wanted to use something which could be easily accessible and simple enough for the students to grasp right away. But rather than having a simple, but possibly boring, scoring system, we decided that we should incorporate the scoring element into an implementation of achievements, due to the success that implementations of achievements have been experiencing on systems such as Xbox 360. Achievements with scoring tied into them would add an extra incentive for students to perform well.

Along with a scoring system, we wanted to implement a leveling system in order to adjust difficulty according to a student's appropriate skill level. Adding a leveling system would make it so that the game is challenging for all types of students. The students could level up and earn certain rewards for their efforts in the game. Again, though, we wanted everyone to have an even playing field and not just reward the smarter students for answering questions correctly. We narrowed our game-like elements down to focusing on using a system of achievements where players could earn rewards in different categories. By using a variety of achievements,

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everyone could benefit and earn better rewards in the game. We would have achievements based upon the proficiencies of each particular student. That is to say, we wanted to scale the questions that students would be asked based on their respective academic skillset.

Based upon our ideas discussed above, we decided that our game-like elements for Design 0 would be "leveling"– later transformed into "difficulty" – and achievements. We felt that the two would work together in order get the students to enjoy their experience with our design. The reason we chose these specific elements comes from both our research and also from our observations of other existing achievement system implementations. For example, as discussed in our literature review, on the Xbox 360, players gain achievements and achievement points associated with performing certain tasks and feats in a particular game. The game developers come up with their own arbitrary achievements to which players must strive to attain while playing their game. The achievements might include anything from beating a certain level of the game on a certain difficulty, to playing the game for a certain number of hours. We found that we wanted to apply the diversity seen in the achievements for these games to our own design for achievements.

In trying to apply some of the aspects of these different achievement systems to a more educational setting it gave us something to base our design off of, but also something to learn from about what works well and what doesn't. We knew we didn't want to create an unbalanced achievement system which would cater to those students who knew more about math than others. In creating a diverse achievement system which could be based on effort as well as performance, we would be able to reach out to those students who might not perform as well with on-the-spot math problems. We saw that an achievement system could also be a way to gauge student

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performance without ostracizing students who might not otherwise be able to attain goals based on accuracy or correctness.

As for achievement use in an educational setting, there have been previous attempts to implement achievements into the classroom resulting in diverse opinions. There are those who argue that a reward or achievement system, if implemented correctly, could in fact increase intrinsic motivation to succeed in the classroom and there are others who do not believe rewards can be used as an effective means of sustaining student motivation.

"From the humanist perspective, structured environments, interventions by teachers, and reward systems are seen as forms of external control that limit individual expression and freedom. Specifically, the concern is that rewards may entice students to perform an activity but, once the rewards are no longer available, students' intrinsic motivation to engage in activities is undermined. Researchers on the other side of the debate argue that negative effects of reward are limited and that the appropriate use of rewards can boost performance and lead to a personal sense of intrinsic motivation." (Cameron2005)

Our group felt as though motivation heavily depended upon the level of interest of each student. If we could attain a good balance between difficulty and achievement/rewards then students might be better motivated to succeed. Through our literature search we hoped to come up with a set of guidelines for making our achievements as effective as possible. This meant looking at what things have worked and what things have not worked well in studies which are similar to our own as can be seen by our literature review.

### 4.2 *Considerations of Difficulty*

When considering how to incorporate difficulty in our system we had to make sure we were not jeopardizing the positive effect we want the game to have on the students. When adding difficulty to a game, we have to make sure of few things. We can't make the below average kids feel discouraged, the average kids feel too stimulated, and the above average kids feel disinterested. We have to make sure that the game is well balanced so we keep the drive of the

player at its peak. We do not want to bring down anyone's self-esteem. We have to create the sense of challenge yet stipulation to increase motivation to continue the game. By the time they've went through the game we want the player to be gratified in their persistence and their new knowledge, instead of just victory.

Another factor to consider is competition. In the atmosphere that our game will be played in competition is alive whether we admit it or not. Academics are a competitive area and our audience is starting to enter that stage of competitiveness. We cannot forget that we have to keep it as clean of a competition as possible. Competition is only fun for those who win, not the other side. Lopes also brings up that with the goal of winning in mind, the winner puts his or her focal point on the prize not the joy of the process. We have to make sure that the players do not make their greatest priority winning over the educational purpose. We have to make sure that the game keeps the difficulty opaque to the player.

Competition can help us still though. We have to gauge it correctly. As stated before, more stipulation for more motivation. "Competition can offer ways to gain insights about one's capacity to develop physical and intellectual skills."(Lopes 1994). Children do succeed when under pressure, but it has to be the right pressure. We can't undermine it, or overdo it. It augments skill-building and strategy-building, essentials that we want the players to take away from the game. Yet this is most positive only when all participants feel they have equal chances of succeeding.

So we have to construct a system that does not intimidate the below average, stress the average, or bore the above average. We need to find the right gauge of competition, and make sure all participants feel confident from start to finish.

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### 4.3 Implementation of Difficulty

We decided to make the difficulty a back end feature of our system. The player will never see what difficulty they are playing during the game. It's activity-based progression – progression based on increasing individual statistics. This way, players will not feel too challenged or too underestimated, and it will also keep the game intrinsic. As shown in Figure 4-1, the very first level of the game is a survey level. This level has various questions in all levels to see where the player falls. From there, the system places the player in the right level for the next stage. Each player goes through a difficulty check after each level promoting or demoting them.

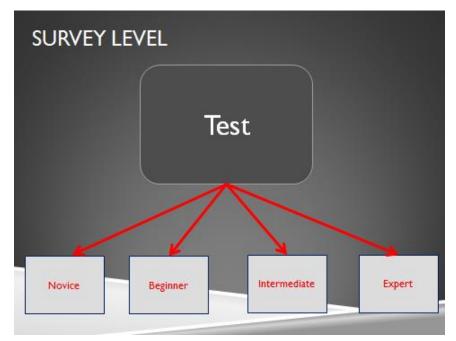


Figure 4-1. Diagram of the survey level functionality.

We chose to use monkey size to indicate difficulty. When the monkey grows the player is improving, and the opposite for when it shrinks. We hope that seeing the monkey grow or shrink will act as motivation for the player.

#### 4.4 Achievement Considerations

The other game-like element that was considered for improving education was that of achievements. Achievements are a system of pre-set goals that are in place that will notify and possibly reward the player when his objective has been attained. When looking at the use of achievements for any type of game, there are a few things that need to be considered. For example, what makes a good achievement? What makes an achievement compelling, and worth working towards? How do we ensure that achievements require skill to obtain, while also ensuring that those who are less talented aren't ignored by the system? These are all questions that must be considered when looking into the implementation of achievements, especially when trying to apply them to an educational game.

Another question that one might ask is: why add achievements in the first place? Achievements can help enhance a player's experience in a few different ways. They offer defined goals that the player can use to gauge their progress and strive to attain. The notification that one has earned an achievement and a possible reward that may go along with it are both forms of positive reinforcement that will draw in a player and help him/her keep playing. People enjoy acquiring things, and that action is associated with positive emotions such as pleasure and excitement. Individuals who experience these emotions while acquiring something will continue to perform that action, which in the case of achievements as a game-like element means they will keep playing and learning. Achievements also increase competitiveness by allowing players to compare which achievements they have unlocked. Regardless of the achievement system implementation and if students compare via a centralized leaderboard or via word of mouth, those students who have unlocked certain achievements can point others in the right direction, and the desire to improve relative to their peers will keep students playing and learning. An

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added advantage is that although achievements add an element of competition, it is indirect and thus does not put students directly against each other; less competitive students could ignore the progress of their peers and merely focus on improving themselves if they choose. Finally, achievements can be either intrinsic or extrinsic motivators based on how the individual achievement is designed, which is something that will need to be considered for the implementation.

One final area to consider with regards to the implementation of achievements is the question of achievement type. As stated in 3.3, there are certain general principles that are involved in designing effective achievements that will engage students. In order to keep students interested and to make them functional for gauging a student's progress, we decided to develop achievements based on the three principal categories of Speed, Accuracy, and Effort. Speed achievements are awarded to students who are able to answer questions under a time constraint. Achievements in the accuracy category are given to students who can consistently provide the correct answer to each problem. That way, while the skill to find the solution quickly is encouraged, those students who always answer quickly but are only occasionally correct miss the accuracy achievements and must try a new tactic to obtain them. In addition, students who spend a lot of time ensuring that they have the correct answer are rewarded for their diligence. The final category of Effort comprises achievements that are awarded for showing improvement and not giving up. Although there is no way to be sure that a student is putting in their best effort, improvement and a large amount of time spent are signs of effort that can be tracked and rewarded and are the focus of this category. Effort achievements are also important because they allow less skilled students who many not be able to obtain some Speed or Accuracy achievements a way to be recognized for being engaged and putting in the effort required to learn

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the material. The combination of these three categories accomplish our goal of rewarding the most skilled students most often, while still ensuring that other students aren't far behind and that all students have a way to earn difficult achievements that they can be proud of.

#### 4.5 Achievement Implementation

The actual implementation of achievements can be done in a number of ways. Three primary categories of achievements that we identified were those of Speed, Accuracy, and Effort. By combining the three, the achievements cater to many different kinds of students. A student who consistently gets answers correct but has to think long and hard about them will come across accuracy achievements easily, and will be pushed to become faster at answering problems to obtain speed achievements. In contrast, students who answer questions very quickly may be occasionally incorrect, so they will have to work harder in order to get achievements in the accuracy category. Effort achievements allow anyone to get them provided they simply put in the requisite amount of time and don't give up. These allow all students to have the chance to get some achievements, and push students to focus on areas that they may not be as proficient in.

There are a few possibilities available when it comes to rewarding the player for earning an achievement. The program can simply notify the student which achievement was attained, essentially telling them "Good job!" The system could also attach a point value to achievements with harder ones dispensing a greater number of points, allowing players to easily see their progress at a glance. This would also have the effect of promoting some indirect competition between students, providing an additional potential source of motivation. A player could be given some type of collectible or medal as a result of obtaining an achievement which could be shown either in a listing of that player's accomplishments or used aesthetically within games. A

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final option is to attach achievements to some sort of power-up or game modifier; obtaining an achievement will give them a reward that is usable within the game. All of these are possible and will be considered as future designs are discussed. Each possible implementation of achievements affords different rewards and ways to engage the player, which is important when determining how students can best be entertained by an educational game.

#### 4.6 Lessons Learned

After we had all of this planned out, we realized that our design was kind of disconnected. It did not really make sense to consider the topics of difficulty and achievements, so we decided that we needed to limit our design to just one topic. We had to make the choice of disregarding either achievements or difficulty, and to us, it made the most sense to eliminate difficulty. In practice, difficulty is very much of a standalone element, whereas achievements have to take into account many different considerations (including difficulty).

Therefore, we decided that by dismissing the topic of difficulty, we weren't truly abandoning it, as it still goes into the planning of achievements. However, unlike difficulty as a sole-standing element in games, the incorporation of difficulty into achievements is much more encouraging for the players. If there is an achievement which requires the student to accomplish a task of a certain difficulty and that student is unable to do so, the student can still continue playing the game and just not pursue that particular achievement. There will be plenty of other achievements that the student can focus on and still continue advancing in the game. The students can always set certain achievements aside that are too difficult, and then go back later and try to tackle those achievements once their skills have improved if they wish.

In the scenario of the most basic difficulty implementation, which is a static difficulty implementation, there is no room for skill-based flexibility. For example, if the player gets stuck

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at a particular challenge in the game that he or she cannot currently succeed at, the player may get discouraged and stop playing. The difficulty of the game would then be preventing the student from moving on and gaining more experience. Being able to move on past an overly difficult challenge will allow the students to improve and eventually have the necessary skills to attempt whatever it was that they were struggling with at a later time.

And even if difficulty was done in such a way that it was hidden from the player and was dynamically changed, there would likely be at least one or two students who would catch on to the fact that their progress was not coinciding with their performance. This discrepancy between progress and performance would actually give the opposite effect of what we were intending to achieve. In the case of those few very alert and metacognitive students, they would feel like they were being dragged through the game regardless of their actions and performance instead of feeling motivated because their adjusted difficulties were more appropriate for them, This eventual realization is similar to the familiar example of a young child playing sports with his dad. Hoping to encourage his son and make him feel like "a winner," the dad intentionally loses to his son every time they play (oftentimes with a dramatic comeback at the end). At first, the child thinks that he is really good and loves playing with his dad. But in the case of some psychologically advanced children, once they find out that they basically can't fail, they lose interest and question any of the praises that they had been told in the past. This future discovery of the hidden difficulty mechanism by some students is the problem with having a hidden dynamically changing difficulty in educational video games (or more generally, in any type of game). No matter how hard you try, some players are eventually going to find out the truth that they are being guided by an invisible hand through the game, and this has the potential to tragically diminish any positive self-image that they had previously developed. This likely won't

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be the case for all students, but even if it applies to just a small sample of the students who are attentive enough to sense the inner workings of the game, it is a consequence that we as designers did not want to accept.

## 5 Design 1

#### 5.1 What we changed and why

For Design 1 we chose to narrow down the scope of our game-like elements. Some of the changes that were made reflected our review of different literature, but it also reflected the work that our peer groups were doing in their designs for other game-like elements. We felt as though our best option was to focus on one thing for which we had the strongest ideas. For us this meant taking a step away from implementing a difficulty system and turning our attention towards coming up with an adequate and interesting achievement system that we could demonstrate to middle school students. We knew that we would only have a limited amount of time with the students, so it was important to present achievements in a manner which would be easier for the students to comprehend. As a result, they could get a better sense of the scope of our design. It would not have been productive for neither us nor the students to have come up with a design that was intended to analyze multiple aspects of the design. We felt as though difficulty was a much bigger subject than we had originally anticipated and we chose to reorganize our efforts into our achievement system. If our design had too many variables, the students might have had mixed feelings about the design depending upon what caught their attention. By having just one or two things for the students to interact with, we would have a better chance of judging the students' reactions.

Along with abandoning our plan to add a difficulty system, we also decided to against the idea of having a survey level at the beginning of our quiz. The survey level would have proven to be problematic in the sense that it might distract the students from the ultimate focus of our project, which was the achievement system. The students may have also viewed the survey level from a competitive perspective. Even though the difficulty levels would not have been apparent from the students' point of view, the students might have become aware about what the survey level was for and their corresponding placement into difficulty levels. They might have also become aware of the varying degrees of difficulty questions amongst their peers, which could have created inconsistency in their opinions. For instance, if a student found out they were getting harder questions than another student, they might not like our design because they might think of it as unfair.

Even though we are not using a scaled difficulty system, we still want to vary the difficulty of obtaining the achievements we implemented. We decided that we would simply create some achievements which were difficult to attain and some which were easier to attain. By having the difficulty integrated into our achievements, we would be able to see which students excelled above expectations and which did not. In this system, difficulty would not be apparent to the students while they played. The students would have the opportunity to perform well by earning harder-to-attain achievements, but they would not be penalized if they fell short. There would be no set of rules that state a student must get a certain number of difficult achievements. It would be completely arbitrary as to whether or not the students obtain every achievement available to them.

Another change from our Design 0 was that we wanted to make our achievements goaloriented. Goal-oriented achievements simply refer to achievements which are structured in a

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particular manner that gives them a purpose in their educational context. From our literature review, we read that it is important for students to be able to connect what they are doing to what they are learning. For us this meant paying attention to what sort of achievements we created. Achievements should make sense to the students and they should be integrated in manner that coincides with the type of work they are doing. Although achievements themselves are limitless in the number, they should provide a means to an end. Ultimately, we wanted the achievements to be able to keep the students interested in the problems they were working on but also make them feel like they were gaining knowledge along the way.

Our design also changed according to what our peers were working on as far as their specific game-like elements. Originally, we wanted to reward the students with in-game rewards such as clothing for a monkey avatar. However, we recognized that another group was already working on such a system. Instead of competing with them directly, we decided to offer the students other kinds of rewards which would be used to help them solve test problems.

#### 5.2 Implementation of Design

For Design 1, we had the opportunity to have advanced urban middle-school students test our design and provide feedback based on their experiences and their feelings about adding the game-like elements of achievements and rewards to the classroom environment. The primary focus for the design 1 implementation was not the game itself – rather, it was an attempt to gauge how successful achievements would be when students were presented with them. As a result, a fully functional game was not developed for design 1. Instead, we chose to implement our test using Microsoft PowerPoint, using a math quiz. Students were presented with ten multiplechoice questions, delivered through slides (see Figure 5-1), and had ten minutes to complete it. For each question, they were presented with four possible answers that they could choose from,

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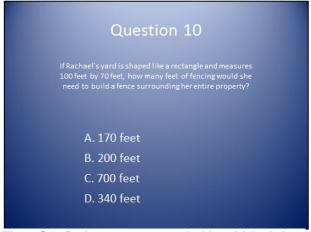


Figure 5-1. Students were presented with multiple choice questions delivered by Microsoft PowerPoint. The possible solutions were clickable, and produced a red X if incorrect or a green check if correct. Students could continue trying until they were successful, at which point an arrow would appear in the bottom right to advance to the next question.

and were instructed to click the answer that they believed was correct. If it was, the system showed them a green checkmark and an arrow that they could click to advance to the next question. If not, a red 'X' appeared and the student had to try again until they had the correct answer. After the tenth question, a 'STOP' sign was displayed and the test ended. Due to the visual nature of feedback from this system, there existed the possibility that students would try and look at their classmates' progress for assistance. In addition, the test only consisted of ten questions, making it likely that two adjacent students would be working on the same question simultaneously. As a result, it would have been possible for students that were having difficulty with a question to simply look over at their classmate's quiz, see the correct answer, and adjust their response accordingly. To eliminate this source of error in our design, two versions of the test were developed in the same manner that simply had different questions. A listing of all slides and associated questions and answers that were shown to the students are available in Appendix A.

In order to test our design, we also needed to develop a list of achievements that the students could earn while playing. This resulting list, shown in Appendix B, attempted to

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contain implementations of Speed, Effort, and Accuracy-style achievements. We felt that promoting the ability to answer questions correctly was most important, and as a result many of our achievements are focused on the accuracy category such as 'Perfectionist,' for completing all questions correctly, 'On a Roll'/'On Fire' for getting many questions correct in a row, and 'Attention to Detail'/'Super-Star'/'Man or Machine?' for simply getting a percentage of the test correct. The 'Speed Demon' achievement was developed to reward players who could correctly answer a question very quickly, to provide an example of a Speed achievement. Finally, some achievements were rewarded simply for completing the test, or completing certain questions, as well as 'Quality over Quantity' that rewarded students for spending time to think about a question to ensure that they would be correct, giving an example of Effort achievements. However, one question that needed to be answered was whether or not knowing what achievements were available and how to attain them in advance would affect students' strategies, so the achievement list was only provided to half of the students that took the quiz and the students were asked afterwards whether they felt that having the list available was helpful or not.

Implementing a system to automatically distribute achievements to students as they played via PowerPoint would have been extremely difficult, if not impossible. As a result, a separate system was developed using notecards, as can be seen in Figure 5-2. When students completed the task associated with an achievement, the instructor administering their test would inform them that they have received an achievement, and give them the Achievement Card and the accompanying Reward Card (see Figure 5-3). Due to the short nature of the test, all of the Reward Cards all provided assistance to their player with future problems, in the event that they were having difficulty and needed help. The presentation of the achievement allowed the student to feel a sense of accomplishment as they played, as they could easily see how many tasks they

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Figure 5-2. Achievement Cards such as this one were distributed to students after they performed the task listed.

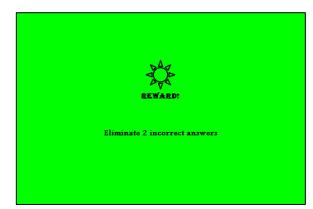


Figure 5-3. Reward Cards, given to students for acquiring achievements, could be used for assistance with difficult questions.

had accomplished. A student could lay out all of the achievements that they had earned in front of them, allowing them to easily see what they had accomplished. In addition, if they wanted students could see how many achievements other students had earned, promoting indirect competition. The 'Effort'-style achievements described earlier prevent less-talented children from being discouraged when comparing themselves to a more skilled student, while those who are better at math could still feel accomplished by earning many achievements. The students could see all of the achievements they had acquired by looking through their Achievement Cards, and if they were having difficulty with a question they could exchange a Reward Card for assistance.

The most important part of our implementation for this design, however, was the feedback the students could provide after completing the quiz. This feedback was a vital part of Design 1, as it would allow us to determine whether or not the ideas presented were valid and would be useful and exciting to students. The goal of adding achievements to the classroom environment was to make learning more fun and engaging, but it would be useless if it did not accomplish this goal. As a result, after completing the quiz, students were given forms to fill out asking them questions about their thoughts on our design (see Appendix C for a blank version of

this form). The first half of the feedback form consisted of six questions, with circles to fill in allowing students to respond in a quantifiable way. Students were asked to rate the difficulty of the questions asked and how difficult they felt it was to earn achievements, as this could affect their responses to subsequent questions. The next two questions asked if achievements made what would otherwise be an ordinary math quiz more fun, as well as if it made them more interested in math, the primary goal of this project. The remaining questions on part one simply requested feedback on various ideas that we could use to improve our design. The second half of the feedback form was more subjective, as the questions were styled in an open-response way. In this part of the feedback form, students were given the opportunity to describe exactly what they liked and didn't like about the achievement system, show their feelings about individual achievement ideas that they liked or didn't like, and finally provide any additional comments they had about our design. The information requested in these feedback forms would be vital moving forward with the next design.

#### 5.3 *Feedback – Data Collected on Student Performance*

Eight urban middle school students tested Design 1. As stated in the previous section, each student was allowed provide an alternate answer if their initial solution was wrong. As a result, a perfect score would only require 10 total attempts, and the worst-case scenario would require 30. On average, the students took 11.9 tries to complete the test. Figure 5-4 shows the number of questions each student got correct and the number of incorrect attempts they made. All students finished the test in the allotted time, but some used rewards to skip questions which explain the few missing correct answers.

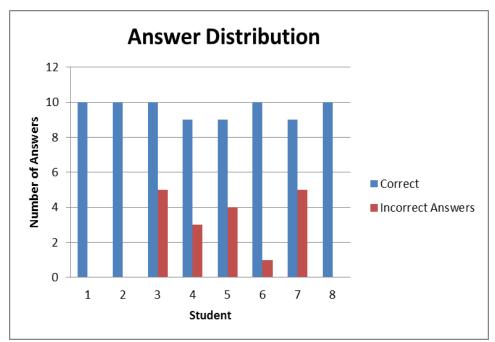


Figure 5-4. The number of corrent and incorrect answers that each student provided. The students who tested our design were advanced students in math, which was

demonstrated by the four students attaining perfect scores and the rest with only a few wrong answers away. In addition, the students self-selected their groups, which could have affected the data as it is unknown whether the smartest students grouped together or if the groups were selected randomly.

Further analyzing the results, we measured how many tries and skips (a reward after answering 5 and 8 questions correct consecutively) were committed collectively for each question on both tests. We split our group, four students for each test. Figures 5-5 and 5-6 show the distribution for each test. Every student who had skips used them for one of the last three questions. This result was anticipated due to the last three questions of both tests being the most time consuming, not technically the most difficult.

Comparing figure 5-5 and 5-6, the students taking Test 2 consistently answered more questions correctly. Most likely Test 2 students were more relaxed. For instance, one of the students taking Test 1 started off nervous. She had a few failed attempts at the beginning of the

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test, but soon after she started getting the rest of the questions correct on the first try, except the last one. Her situation is a cause of the first bell curve in figure 5-5. Also, we noticed that the students taking Test 1 spent more attempts than expected on question 2. We did not expect this because we designed the test to get more difficult towards the end. However, Test 2 students performed closer to what we had expected, committing more attempts towards the end.

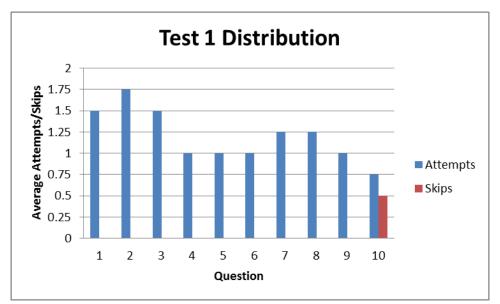


Figure 5-6. The average number of attempts (or skips) used per question by the students taking Test 1.

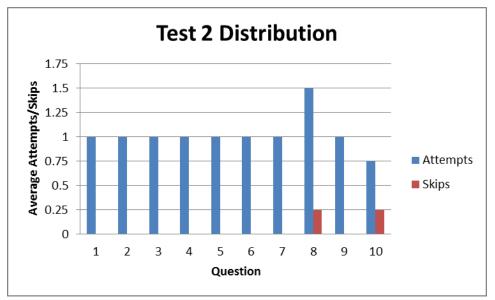


Figure 5-5. The average number of attempts (or skips) used per question by the students taking Test 2.

We decided as a group to run a controlled experiment and only show one out of our two students the list of all the achievements. We wanted to test our theory of having prior knowledge of all the achievements would result in more acquirements of them. Figures 5-7 and 5-8 below show the frequency for each achievement acquired during our study.

From Figure 5-7 we see that with prior knowledge of the achievements, the students seemed to attain the achievements that rewarded free passes or eliminated wrong answers. The "Speed Demon" achievement, which was obtained by answering a question correctly in less than 5 seconds, had the highest frequency. This result is likely due the combination of its reward of eliminating a wrong answer and the ease through which it was attained by the advanced math students.

The students who did not have prior knowledge of the possible achievements had very different results, as shown in Figure 5-8. These four students obtained more achievements in a more equal distribution. It seems that having knowledge of what achievements were attainable might have impaired the focus of a student, while not having any knowledge of the achievements

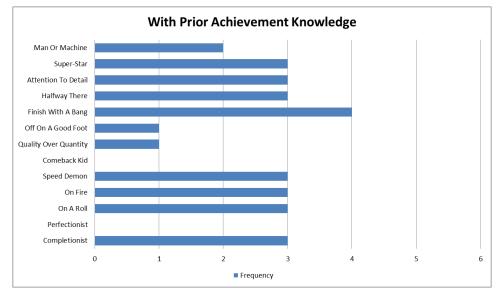


Figure 5-7. The number of students who acquired each achievement while knowing about them beforehand.

and focusing only on the material aided another student. On the other hand, the small sample size and the self-selecting nature of the groups could simply mean that the second group had stronger math skills.

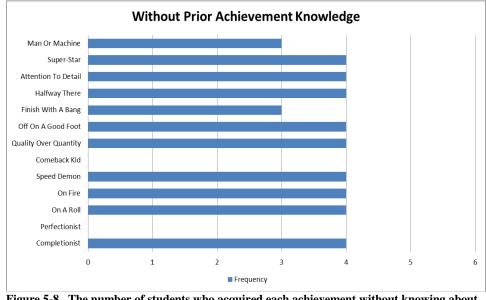


Figure 5-8. The number of students who acquired each achievement without knowing about them beforehand.

#### 5.4 *Feedback – Student Response*

As stated in section 5.2, after each student finished taking one of the two tests they were given a form to provide feedback on the idea of achievements and our design. The questions on these forms were constructed in two parts, ratings and short answers. For a blank version of the form that was given to the students, please see Appendix C. Figures 5-9 through 5-15 show the distribution of the seven questions we asked them to rate.

The first question asked the students how difficult they thought the questions were. As can be seen in figure 5-9, the majority of the students felt that the test was a little easy. Almost all our students did not take as much time as expected on the tests. This was likely caused by our lack of prior knowledge about the students to whom we would be demonstrating our design. We were not informed that the students were advanced math students, and had tailored the algebra

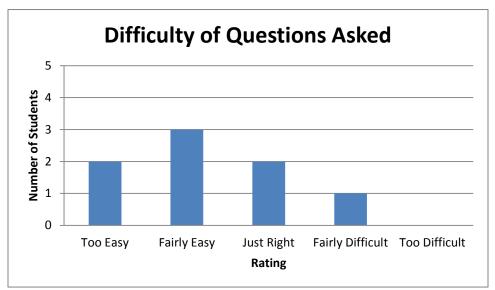


Figure 5-9. Question 1. How would you rank the difficulty of the questions asked?

and geometry questions to coincide with the average seventh grade math class. Although it would have been preferable for the distribution to center around 'Just Right,' this slight offset shouldn't affect the rest of the data too strongly.

Question two asked students if they felt it was too easy to obtain achievements. Figure 5-10 shows that the students overwhelmingly felt that the achievements were easy to obtain, but this was likely caused by the easy questions and their strong math abilities. In addition, most of



Figure 5-10. Question 2. How difficult was it to earn achievements?

the achievements from this design are acquired from speed and consistent correct answers. Many students finished the tests quickly and without many mistakes, which gave them a majority of the possible achievements. Lastly, we wanted the students to earn a majority of the possible achievements as we had a number of achievement ideas we wanted to try out. We felt that students would be able to give better feedback on achievements they had earned, and as a result they were made to be fairly easy to obtain. Since achievements were easier to obtain, the feedback they gave us was somewhat expected.

The third question asked students if they felt achievements made the experience of taking a math quiz more fun. As shown in Figure 5-11, the students showed overwhelming support for the achievement idea. Every student agreed that the achievement system made the test more fun. Taking a plain test is more of an objective than an experience. By making learning more fun, we will be able to better engage the students and thus achieve our primary goal of enhancing learning. This feedback shows that the achievement system is a significant step toward that goal.

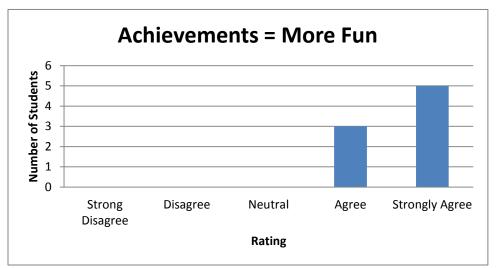
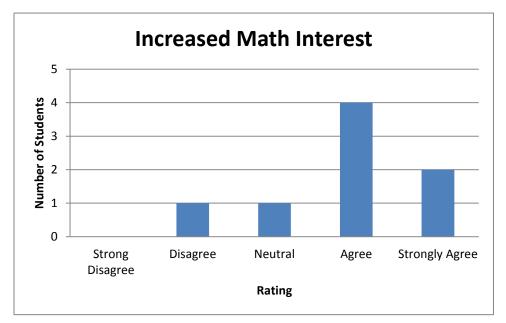
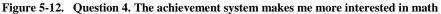


Figure 5-11. Question 3. Having an achievement system made the experience more fun

Question four was similar, but specifically asked if achievements made the students more interested in math. Figure 5-12 shows that the majority of students agreed that achievements increased their interest in math, which along with question three shows that our design and

achievement idea are having the effect we are looking for. Although one student did disagree, in hindsight the wording of the question may have prompted the student to answer negatively simply because achievements had no effect on his interest in math, rather than making him less interested. Regardless, the significant number of positive responses strongly supports our argument that achievements help engage students in learning.





The fifth question asked the students if they would like to be able to view the achievements they attain over time. As shown in Figure 5-13, none of the students disagreed to having this as a feature. It helps the students see personal progress over time. In the existing achievement implementations described in section 3.2, the system allows players to view collected achievements and see an overview of the progress they have made. Such a system would translate well to educational software as it would allow students to see how they have progressed – at first only obtaining "easier" achievements then later earning harder ones as their skills develop.

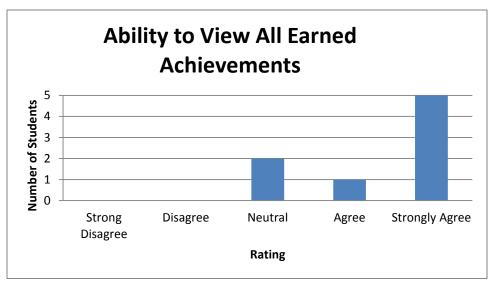


Figure 5-14. Question 5. I would like to see a record of all the achievements that I earn over time.

Question six asked students if they would also want to know what achievements their fellow classmates had attained. The distribution of answers in Figure 5-14 shows a lot of mixed feelings. Some students might be very conscious about their work and would not want others to know how they are doing, while others might want to compare their work with their peers. One student reported that he strongly agrees with this feature because "he wants to beat everyone."

Finally, there are also a few students for whom this feature does not change anything.

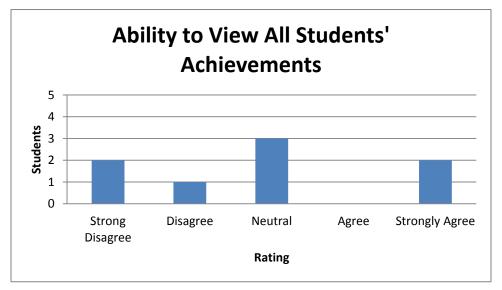


Figure 5-13. Ouestion 6. I would like to know what achievements my classmates have earned

The final question of the rating section asked the students if they would prefer to discover achievements during gameplay than prior to gameplay. The results in Figure 5-15 show that all the students would rather not have prior knowledge of the achievements, which is understandable because it would change their mindset before starting the game. The student will most likely change his playing style to attempt to attain desired achievements. As we saw from figure 5-7 in the previous section, that strategy resulted in a less consistent distribution of achievements as compared to the students who did not have prior knowledge of the achievements.

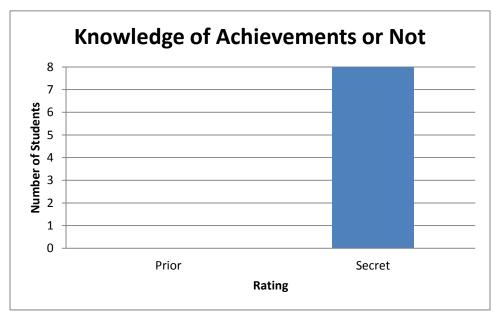


Figure 5-15. Question 7. Would you prefer if achievements were known if advance, or if they were kept secret until you earned them.

In the written response section of the feedback form, students were asked what they thought about the achievement system, what achievements they liked/didn't like, any achievement ideas they had, and if they would be interested in having an achievement score. Overwhelmingly, students thought that it was a good way to be motived and made answering math questions more fun. The primary complaints with our implementation were with the notecard system to present achievements to the students, and with achievements that didn't require much effort to obtain (such as the one for finishing the fifth question). Finally, nearly all

of the students liked the idea of having an achievement "score" for all of the achievements they had earned.

#### 5.5 Feedback – Our Observations

In addition to the feedback provided by the students at the conclusion of our Design 1 demonstration, we also made our own observations on the effectiveness of our implementation. One thing that was quickly apparent was the success of the achievement system. The students generally seemed excited when they earned an achievement, and many tried to collect as many as they could. A few students had actually seen the previous achievement system implementations outlined in section 3.2, and immediately made comparisons between those systems and our design. Many seemed positive about the idea, with one student saying "I love achievements! That'd be so awesome if I could get achievements for doing math!"

Some students did initially seem nervous, but this was likely simply a result of the fact that we, unknown older students, were standing right next to them as they took the test. That being said, the majority of students quickly adapted and became very comfortable with answering questions and earning achievements.

One of the primary problems with our implementation was with the system of using notecards to represent achievements and rewards. Every time a student earned an achievement we had to stop them so we could find and present the achievement and reward cards, which interrupted their play. This disorganization made some students ignore the achievements, as they simply wanted to answer the questions quickly. Many students also didn't use as many rewards as we had anticipated, likely due to a combination of the disorganization, and the ease of the questions (which meant that they didn't need the rewards). In addition, the short nature of the

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test mean that the demonstration ended before many students had the opportunity to use their rewards.

Despite these shortcomings, however, the Design 1 demonstration was a success. Many of the issues we observed were with the specific implementation we used, rather than with the achievement idea itself. The students were very comfortable with the idea of earning achievements, and were excited about the implications of implementing the ideas in their classroom environment.

#### 5.6 Lessons Learned

When all was said and done with Design 1, the most important thing that we learned was that the use of achievements does in fact make learning more fun for students and makes them more interested in what they are learning. The great majority of students tested either agreed or strongly agreed that having an achievement system made the experience more fun and that it made math more interesting for them. This is really important to know because it shows that in our next design we should continue with the consideration of achievements. That is not to say that everything in our Design 1 implementation was perfect, but overall it was pretty well received by the students and it showed a lot of promise in terms of concept. Certainly, there are a lot of adjustments that need to be made and issues that need to be addressed in our next design as well.

One aspect of our design that was not too successful was the difficulty of the test questions. For the most part, the students said that the questions were too easy. Some of this shortcoming can be attributed to the fact that we were not expecting to be doing the study on a group of students who were distinguished among their peers as being exceptional math students. More likely than not, if an average student had taken our quiz, the difficulty level would have

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been a lot more appropriate and challenging for them. Unfortunately for us, though, most of the students blew through the majority of our test questions with very little time or effort spent. Certainly, in future designs, the issue of difficulty appropriateness is something that needs to be addressed. As with any scientific study, one of the most important components is knowing who your sample population actually consists of. For example, if you are running a study on the exercising and health habits of grown adults in the United States, it may not be the best idea to only pull participants from a sample of professional sports players. Clearly, this population is going to have much better exercise and health habits in comparison to the average United States citizen. Not to mention, questions that are appropriate for an average citizen probably won't be very appropriate for a professional sports player. Questions like "Do you exercise at all during the week?" or "Do you properly hydrate yourself daily?" probably aren't very helpful questions to ask of a professional sports player. Surely, there might be some exceptions to the rule, but for the most part, athletes would all have very predictable answers to these seemingly obvious questions. In future work, we need to be certain that we know who we are creating a system for in order to test so that we can be confident in the fact that whatever we create will be appropriate for the particular demographic that we are targeting.

We also learned that in future implementations, the students would prefer to be able to see records of their own earned achievements. Almost all students answered positively to the question of whether or not they would wish to see a record of all their earned achievements. This makes a lot of sense because as students are playing the game, they might be too focused on the problems they are working on, and this will prevent them from watching which achievements they have been awarded. Being able to go back later will enable them to see which achievements they were awarded with, without having to break their concentration at the instant that they

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earned those achievements. Reviewable achievement histories also seem beneficial to the students because being able to go back later and view all of their accomplishments will make the students feel really proud of the success that they experienced in the game. Achievement lists are something digitally tangible that will always be there as a monument to each student's success. Achievement lists could be compared to, for example, trophies that are awarded to sports teams for winning tournaments. Seeing the trophy or plaque sitting on the shelf helps to remind the players of their success and it reassures their past victories in their minds.

We were surprised to learn that many students said that they would not want to be able to see which achievements their peers had earned. We had originally anticipated the opposite response due to the assumption that students would want to outdo each other, and knowledge of each other's achievements would give students something to compare themselves with. The students' feedback does make sense, though, because not everyone is competitive. There are many people who are very shy, reserved, or modest, and these types of people definitely would not want their achievement lists to be displayed to everyone. However, the opinions of these shy students should be taken with a grain of salt. As was discussed in section 3.3, Blair weighs the pros and cons of publicly visible achievement lists. Although some students may feel inferior having their achievements displayed, there are also many potential benefits to such an implementation. The first benefit of public achievement lists is the competition that it evokes. Knowing that your peers can look at how well you are doing in the game will certainly be a powerful motivator for making students do their best. Of course, there is a potential danger caused by the implied competition as well. For some students, the competition may end up leading towards too much pressure on them, to the point where they can no longer focus properly or otherwise get discouraged. This could be addressed in one of two ways. First, we as

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designers could make sure that there are enough different types of achievements for students of all skillsets, that way regardless of how smart a student is they won't feel inferior because they are getting far less achievements. However, if we take this approach, it is important to make sure that we don't allow the underachievers to get too comfortable with their unsatisfactory performance by encouraging them with endless praises in the form of achievements. Instead, these achievements should be aimed towards helping the less successful students to improve. The second option that we could take is to create an implementation in which the students will have the ability to only display a few, say four, of their achievements to be publicly viewable. This way, the students can all show off the achievements that they are particularly proud of, while not exposing the fact that they may not have unlocked some of the other achievements that their friends may have unlocked. This would eliminate much of the anxiety of being measured directly against their peers. But at the same time, this method should preserve enough of the implied competition in order to motivate students to do their best in order to earn more difficult or unique achievements that they can take pride in displaying in their public achievement showcase slots. Another benefit of still keeping a few public achievements slots (as opposed to abandoning public achievements entirely) is that students will be have the potential to come across achievements that their friends have unlocked that they, themselves, have not yet unlocked. Firstly, seeing these achievements could motivate the students to pursue those same achievements because they will have more confidence in approaching certain tasks if they know that their classmate was able to do so successfully. The other benefit of being able to view classmates' achievement showcase slots is the fact that students may be able to ask each other for help in unlocking a particular achievement if they see that their classmate has already done so.

Another area that could have been improved upon in our implementation was the fact that we had far too many achievements. The quiz took the students around 10 or 15 minutes for each student to complete, and most students were getting around one achievement per minute. With so many achievements within such a short time span, the significance of getting an achievement and its corresponding reward was greatly watered down. After a while, it seemed like the students didn't even divert their attention away from the game in order to look at the achievement and reward cards due to the sheer volume of cards that were coming at them. The acquisition of achievements was certainly encouraging to the students, but our implementation would have been more successful if we had created fewer achievements, or simply came up with achievements such that such a large volume could not be earned within such a small amount of time. There were cases where certain students were awarded with three or four achievements all at once for answering one single question. Instead of making the acquisition of an achievement seem special, the opposite occurred where the acquisition of achievements seemed almost meaningless. Many of the students were probably thinking "If I am earning four achievements for answering a simple question like 'x + 13 = 9,' then achievements are clearly too easy to attain." In a future implementation, we hope to turn these feelings around so that the students will be excited and enthusiastic when they earn an achievement.

Another shortcoming that was painfully apparent to us was the use of index cards in order represent the achievements and rewards. Our implementation involved us (the experimenters) tracking the students' correct and incorrect answers on paper tally sheets, and physically handing the notecards to the students once they had earned them. In theory, this didn't seem like it would be much of a problem. In fact, we thought this was a great idea due the fact that we would be able to test out our concept of achievements without having to code a computer game from

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scratch before knowing what would and wouldn't work in practice. However, we were soon reminded how much more efficient computers are than humans when it comes to processing data. If we could choose one word to describe the achievement tracking and distribution process, it would be chaotic! We were simultaneously trying to watch what the students were doing, mark their progress on our tracking sheets, fumble through the notecards in order to find the correct ones, and hand the students the notecards before they started on the next test question, which was pretty much impossible. There were many cases where a student was two or three questions past the question that they had earned an achievement on by the time we were finally able to hand them the necessary notecards. Similarly, there were other achievement notecards that students earned that were never even handed to them due to all of the confusion. Additionally, we were running the tests with one experimenter assigned to each student. If instead we had assigned two or three experimenters to each student, maybe our chaos would have been significantly reduced. Regardless, one thing is certain; this process would have run infinitely smoother if it was handled by a computer instead of by humans.

## 6 Design 2

#### 6.1 Design Considerations

In order for us to address some of the problems we faced in our Design 1 implementation, we had to devise some new plans for how we could make it better. While we did realize some successes based upon the feedback we obtained from the students, we want to focus on reworking our ideas into an improved implementation. As stated in section 5.6, the students generally enjoyed interacting with our Design. It was important for us that they had a connection with the achievement system and that they were able to make suggestions to help us re-work

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some of its traits. Knowing that they liked the idea of earning achievements while they did schoolwork was a vital point for the continuation of our work. Based upon this knowledge we were able to keep most of our implementations in place and simply look at the parts which did not work as well.

One of the main problem areas discussed for Design 1 was the implementation of notecard achievements. For our next design, we would like to come up with some sort of automated version of our notecard achievement system. This system would ease the burden on the testers as well as provide consistency and focus for the students. Also, it would make the test process go much smoother and make the overall design more effective. An automated achievement system might consist of a type of pop-up which is triggered when a student fulfills the requirements for a certain achievement. The pop-up should be something noticeable yet subtle enough that it does not distract the student from their test. The pop-up also needs to contain information relevant to the particular achievement earned and also any information about rewards that a student has earned.

Something we also want to look into for our consideration for Design 2 is student feedback. We received a lot of important feedback from students about what they thought of achievements. Also, because we collected data about who earned what and how well each student performed, we would be able to construct changes to test questions or achievements fairly easily. The students we tested were very vocal and eager to give their opinions as to how we might improve upon what we had shown them. The changes we make should reflect not only our own thoughts and ideas, but also incorporate the ideas and comments of the students.

Another thing to consider for our next design would be to provide a leveling system of achievements. For instance there could be a "bronze", "silver", and "gold" level of the same

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achievement. An adaptive leveling system might solve the issue of spreading out the difficulty of all the achievements. Instead, there would be a way of replaying a certain portion of the test and try and earn the highest degree or level of achievement. Not all of the students would be able to earn the highest level of achievement, but they would have a chance at performing well in areas in which they excel. As an example, a student might not earn the top ranking for the achievements based upon speed, but they might earn the ranking for achievements based upon accuracy. However, adding in a difficulty factor back into our design might prove to be problematic for the purpose of collecting information strictly for an achievement system.

Lastly, we would like to look at making the game itself longer. A longer test which is structured more like a game would have provided a better atmosphere for observing the students' interactions with our design. Although we were able to collect enough information from the students to help us revisit our design plans, having them complete a longer test would have been ideal. Our Design 1 had only 10 questions in each test, which, under the circumstances, was reasonable for the amount of time we had with each student. However, if we accurately want to gauge how the students would interact with the design over time, then a longer test must be considered. With a longer test, we would be able to see if the students' attitudes towards earning achievements changes. For instance, perhaps they might get bored of earning achievements after a short time. If they do view the achievements differently, then our newest design should compensate for students becoming disinterested. There are many factors which could be attributed to the replay-ability of our design. Some of those factors could be addressed with implementations such as the difficulty system discussed above.

#### 6.2 Proposed Design Implementations

From the lessons we learned in Design 1 and the considerations outlined above, our proposal for Design 2 implements a few changes. The demonstration of Design 1 and associated feedback show that the achievements are effective in the classroom, and do help interest and engage students in learning. However, the next step to be taken involves implementing a full prototype that could be used in a classroom environment. The next iteration of our design would require a much larger team, more time, and/or more resources in order to have a working prototype that can be tested with students. As a result, Design 2 is a proposed implementation that would improve the project and address the issues and concerns that were present after the conclusion of Design 1.

In order to implement the changes required for Design 2, a more advanced platform would be required. Microsoft PowerPoint was useful for quickly getting a prototype ready quickly so that we could focus on the achievements and the feedback from students, rather than spending a disproportionate amount of time coding a game. However, in order to incorporate some of the considerations outlined above, PowerPoint is no longer adequate. As a result, Design 2 would instead be implemented as a game using Adobe Flash. Flash was chosen because it would still be fairly easy to get a design prototype up and running – fair easier than, for example, using a framework such as XNA or Blender. In addition, the flexibility of the ActionScript language would allow us to implement features that are not possible with PowerPoint.

One of the first changes would be to extend the length of the game. Design 1 aimed to be approximately 8-10 minutes long, to coincide with the amount of time we anticipated we had to demonstrate our ideas to the students. However, this shortened version made some ideas, such as

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effort achievements (for improvement and amount of time played) or an achievement tracking system to trace progress over time irrelevant. By lengthening the game and comparing a student's ability to their past scores, rewarding students for improving would be very easy to implement. Similarly, a game that was meant to be played over a long span of time could easily track how much time a student had invested, and reward them accordingly with achievements to recognize their efforts. Finally, one of the biggest complaints in the Feedback of Design 1 was that the students simply received *too many* achievements. On some questions, their progress would line up to give them three or more achievements at the same time, devaluing each individual accomplishment and making them less exciting. In section 3.1 it was noted that students should not expect to be rewarded every time they do something positive, but that rewards should be used more sparingly in order to give them more meaning. As a side-effect to our desire to get feedback on a plethora of achievement ideas, the short length of the Design 1 implementation caused those achievements to be given in rapid succession. A longer version of the game would alleviate this problem by spreading achievement acquisition over time.

A second problem that was noted by both us and the students was that the implementation of achievement through notecards, while a clever way to avoid programming an entire achievement system, was still inadequate. With a large number of achievements, finding the correct achievement and associated reward card after a student earned them was a lengthy process, and also required a 1:1 ratio of test-givers to students, an impossibility in a modern classroom setting. The worst part about the notecard achievement system implementation was that when a student earned one, they either had to stop and wait for the notecard to be given to them, or they kept playing and ignored the achievement entirely. This made achievements have a negative effect, as it interrupted the students' focus and took their attention away from

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learning. As noted in section 3.3, an important part of achievement design is to ensure that the notification does not disrupt the player. Unfortunately, the notecard system failed to adhere to this standard. As stated in section 6.1, an automated system would resolve all of these problems that were presented by the implementation in Design 1, and would incorporate some of the feedback from the students. In addition, it would make our entire prototype much more similar to a design that could actually be implemented in a classroom.

After seeing Design 1, many of the students indicated that they would be interested in a way to see their achievement progress over time. The longer nature of Design 2 as described above would allow for this possibility. Achievements in Design 2 are part of a quiz or game system that students could keep coming back to over a long period of time. Over the course of their experience with this achievement system, they would receive many achievements that they may want to show to their friends or parents to demonstrate their progress. As a result, a system would be put into place to allow students to see a listing of all of the achievements they had earned and the date that they had been acquired. Achievement lists would allow students to easily see how they had improved over time, and also let them see what achievements they could still earn. In addition, an achievement tracking system would also be beneficial to the teacher as well, who could easily see which students were excelling and which were struggling. However, students would not be able to see the achievements of their classmates. Competition as motivation would already be provided by the simple fact that students can compare achievements with their classmates. As a result, a centralized "leaderboard" system would not be implemented because it would promote competition to the point of distracting students from learning, and was also discouraged by the feedback from Design 1. However, all achievement progress would be

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available to the teacher, which he could use to modify his classroom curriculum. As an aid to both students and teachers, functionality for tracking achievements is a vital part of this design.

A final change for this design would be in adjusting the difficulty level of the application. In our design 1 test, many students felt that the questions were too easy which in turn caused them to finish extremely quickly, not require rewards, and not challenge them or help them learn. This was counterproductive to our goals but wasn't actually a problem presented by the achievement system; instead it was brought about by the medium we were using to demonstrate how achievements worked. This was caused by our lack of prior knowledge as to the students' capabilities, and is resolved by tailoring the questions to more adequately match the students' skill levels.

Through these changes, the implementation of Design 2 incorporates the feedback provided by the students who saw Design 1 as well as fixing problems that we saw with the that implementation. The result is a prototype that could actually be used in the classroom as a learning tool, as opposed to the simple demonstration of the last design. The feedback we received shows that achievements do indeed help to motivate students and make them excited and interested in learning, and as a result this prototype would actually put this into practice and would help students learn.

### 7 Future Work

#### 7.1 Difficulty

If we had more time, we would have liked to incorporate difficulty in our achievements. From our student feedback, we concluded that all of experimental unit agreed that attaining achievements was easy. So we would like to implement an observational feature to keep track of

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how each individual student progresses or regresses. One of our students suggested this option as well.

For our observational feature, the system would run through a set of assessments after each completed level. These assessments would then be sent to our difficulty setting unit which would decipher the correct questions and achievements to prepare for the next level that student will encounter.

If we gave each achievement levels, such as bronze, silver, and gold, it would add more complexity to our design. The levels would be scaled by speed, accuracy and effort. Here we could implement a timer to keep track of total time per question, per level, and overall. This way we could incorporate more achievements into our design.

#### 7.2 Integrating Achievements in the Classroom

One of the factors to consider for future implementations of our design is to fully integrate the achievement system into the classroom. Although the achievement system itself is designed for a test-like implementation, we feel as though achievements have the potential to become something more. Instead of students simply completing tasks with built-in achievements, teachers could use the achievements as a way of measuring the successes and failures of their students. It is one point to have students complete a test, but to have them make connections between our design and what they are learning during class is key to the test's effectiveness. As students' progress through our design they should be able to connect their progression within the achievement system to progress that they make in class. The main goal here is to provide students with consistency between their performance in class and their performance in our achievement system. For instance, a student who is doing well on all his work in class should be doing fairly well with earning achievements. It is counterproductive for

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a student to become frustrated with our design and feel like they are not be rewarded enough because they are doing well in the class as respect to their grade.

Adapting our achievement system into the classroom could be done in many ways. Teachers could use numerous methods and buy multiple amounts of tangible rewards for their classrooms. Yet, these methods have to be done with some some sort of finesse to not turn the students into reward-craving scavengers, but into knowledge-hungry students. Teachers need to not over use giving out rewards to avoid bribing students. The only success that can occur with this system in a classroom is through careful planning. Teachers have to decide which in class behaviors deserve or qualify for rewards. For instance, students who attain either "On a Roll" or "On Fire," or "Quality over Quantity" or "Attention to Detail" are students who excel and show great effort.

For teachers who want to tailor achievements to their classroom, they should choose achievements that are reachable for all the students in the classroom that apply reasonable effort. Perfect score achievements are only good for students that are amazing at math. Teachers should try to have alternative achievements so no student feels left out. Teachers need to make sizeable achievements so they do not get rewarded for minimal effort. They have to keep the students motivated to do their best work, whether they are receiving a reward or not. Teachers need to choose rewards the whole class values. The age group usually affects what the students are interested in. In our case, the 7<sup>th</sup> graders might enjoy tangible rewards like fake money to maybe purchase supplies from the teacher's supply closet.

Another way for achievements to be integrated into the classroom is for teachers to take an active role in the design's implementation. Teachers could use the design in order to determine which academic areas students understand and which areas they might need extra help

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in. In Design 2 we propose plans for an achievement tracking system where students could see what they earn over time. Not only could this be useful for students, but it would also be useful for teachers. With the ability to track which types of rewards students are earning or what achievements they are attaining, teachers could adjust their lesson plans accordingly. For example, if there is an achievement for answering 10 geometry questions correctly on the first attempt, and only a few students are able to reach that benchmark, then perhaps the teacher might review and address appropriate strategies for completing geometry problems in class. Or similarly, if a teacher notices students are utilizing their rewards to help them complete a certain problem, then the teacher might address this issue in class. Furthermore, teachers could come up with some type of spreadsheet to show the students achievements earned over time in order to visually see in which areas students have improved. Ideally, a "teacher version" of the tracking system could be implemented into our initial design so that teachers could have quick access to all of their students and how well they are doing.

Taking our design a step further, offering a teacher a way of adjusting the kinds of achievements available to students would give them an extra level of control. Presently, our design entails a built-in reward system. If teachers could swap in different achievements or change the rewards offered for accomplishing specific parts, then they could tailor the design to meet the immediate needs of their students. In terms of implementing such a system one needs to think more along the lines of providing a pool of set achievements and rewards. Teachers could pick whatever achievements they want and then pick a reward that they feel is appropriate. This way of controlling what the students earn might prove to be useful when trying to reinforce different skills in the classroom. For instance, if students are taking too long on quizzes in class, then their teacher could adjust the achievement set to include more time-based achievements and

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rewards. The adjustment could give the students good practice with time management and give them an additional incentive for their efforts.

Along with showing teachers how the class is performing as a whole, a tracking system could also show individual student effort. If a teacher sees that a particular student is consistently not attaining any achievements, then they might want to approach that student or offer them some sort of additional help. Of course, one would not need our design to recognize which students are doing poorly and which are not. One could simply look at the grades which a student has earned on their tests to see how they have been performing. However, because our achievement system is built to assess different disciplines of performance (speed, accuracy, and effort), it would make it much easier to pick out problem areas a student might have. If a teacher can recognize the problem earlier, then they might have a better chance at getting the student the kind of individualized help that they need.

Another idea to consider would be to give out real world rewards for earning achievements. The use of tangible rewards, as discussed in our literature, can see immediate results. However, it is important to choose appropriate types of rewards to give to the students. Although giving students tangible rewards could motivate them to do well, it could also become detrimental. Teachers need to be careful that they choose low-stakes rewards to give to students who excel. Using rewards that students care about, but will not affect them much if taken away, will be the best option. Rewards could be anything ranging from five-bonus points on the next test or giving the students small gifts of school supplies such pens or notebooks. Also, it would be important to give rewards for different kinds of behavior, not just giving the rewards to students who perform the best, i.e. "accuracy". Students should be able to earn rewards by showing effort such as completing the most problems or by completing them the fastest. Even if

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students are being rewarded for different kinds of skills, the teacher must remain consistent in determining which type of achievements earns which kinds of rewards.

## 8 Conclusions

The goal of this project was to find a way to better engage students in their classrooms. If a student is interested in learning, they will put more effort towards the endeavor and as a result their instruction will be much more effective. One of the primary problems that educators face is engaging and motivating students. While conveying educational information through mediums such as games is a significant step toward this goal, the simple fact that it is a game does not automatically make students interested. Many educational games are simple, and lack many elements found in successful video games. While this is primarily done by design to keep the focus of the activity on learning, some game-like elements can be introduced to the classroom environment without impacting the learning experience.

Based on research and testing, we have found that achievements accomplish this goal. In addition to the game itself, achievements add an additional objective that provides positive feedback to students when they pass various milestones, encouraging them to continue. They do not fundamentally alter the way educational games integrate with the class curriculum, how students learn, or the primary goal of the game they are added to – adding achievements is more subtle and could be implemented in many educational games without any negative effects. Achievements do not change the way a game works, and a result would not change how the learning experience works either, making them much more easily adapted to existing games or a teacher's existing classroom structure. However, they *do* fulfill the purpose of motivating and engaging students. They can make children more excited about continuing to play the educational games that are already available, which translates to them being excited about

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learning more material. Feedback from students confirmed that adding achievements made educational games much more fun, and also made the students more interested in the subject matter as well. Many children learn in different ways, and some simply don't respond to traditional teaching methods. Through educational games and the notion of achievements, a much larger percentage of students will find learning to be exciting, rather than a chore.

The primary hurdle to using achievements to promote learning is simply integrating it into the classroom and getting students to use the system. However, with the increased popularity of video games among children, games are becoming more prevalent in the classroom as well. From there, incorporating achievements is the next logical step, as discussed in section 7.3. By adding achievements to existing tutoring software, those programs become more interesting to students and will increase the effectiveness of the curricula that implement it.

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## **10** Appendices

10.1 Appendix A – Design 1 – Achievement List

# Achievement List

**COMPLETIONIST** Complete all the questions

**PERFECTIONIST** Get all questions correct on first try

**ON A ROLL** Get 3 questions correct in a row (on first try)

**ON FIRE** Get 5 questions correct in a row (on first try)

**SPEED DEMON** Answer a question correctly in under 5 seconds

**COMEBACK KID** Get 2 questions correct in a row on the second try

**QUALITY OVER QUANTITY** Get a question correct on the first try after 40 seconds

**OFF ON A GOOD FOOT** Get the first question of the test correct on the first try

**FINISH WITH A BANG** Answer the last question correctly on the first try

HALFWAY THERE Finish the fifth question

**ATTENTION TO DETAIL** Answer 3 questions correctly on the first try

SUPER-STAR Answer 5 questions correctly on the first try

MAN OR MACHINE? Answer 8 questions correctly on the first try

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## 10.2 Appendix B – Design 1 – Math Quiz Slides

#### The following slides were shown as a math quiz as part of Design 1.



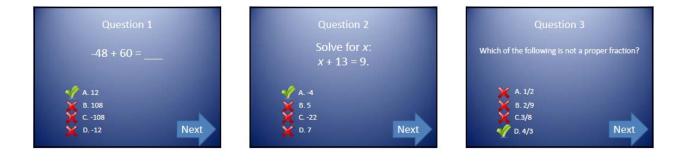




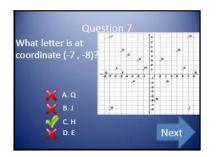


What are the	balloon's c	oordina	tes?
🗙 A. (-5, 2)		-	
B. (3, 5) C. (1, 4)			



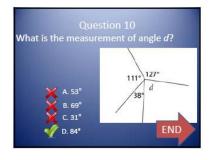














# 10.3 Appendix C – Design 1 – Student Feedback Forms

Page 1

		Feed	back		
How would rank the	difficulty of the	questions asked	?		
Too easy	Fairly easy	Just right	Fairly Difficult	Too Difficult	
0	0	0	0	0	
How difficult was it to	o earn achievem	ients?			
Too easy	Fairly easy	Just right	Fairly Difficult	Too Difficult	
0	0	0	0	0	
Having an achieveme	nt system made	e the experience	more fun:		
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
0	0	0	0	0	
The achievement sys	tem makes me i	more interested	in math:		
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
0	0	0	0	0	
I would like to see a r	ecord of all the	achievements t	hat I earn over tir	ne:	
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
0	0	0	0	0	
I would like to know v	what achieveme	ents my classma	tes have earned:		
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
0	0	0	0	0	
Would you prefer if a them?	chievements w	ere known if adv	vance, or if they v	vere kept secret until you earned	
Reveal achievements at beginning		g Only reve	Only reveal achievements once you have earned them		
0			C	)	

# Page 2

What did you think about the achievement system? Which achievements did you like? Which achievements did you not like? Do you have any ideas for better achievements (if yes, please explain or give examples)? Would you be interested in getting a score/pts for achievements? Additional comments?