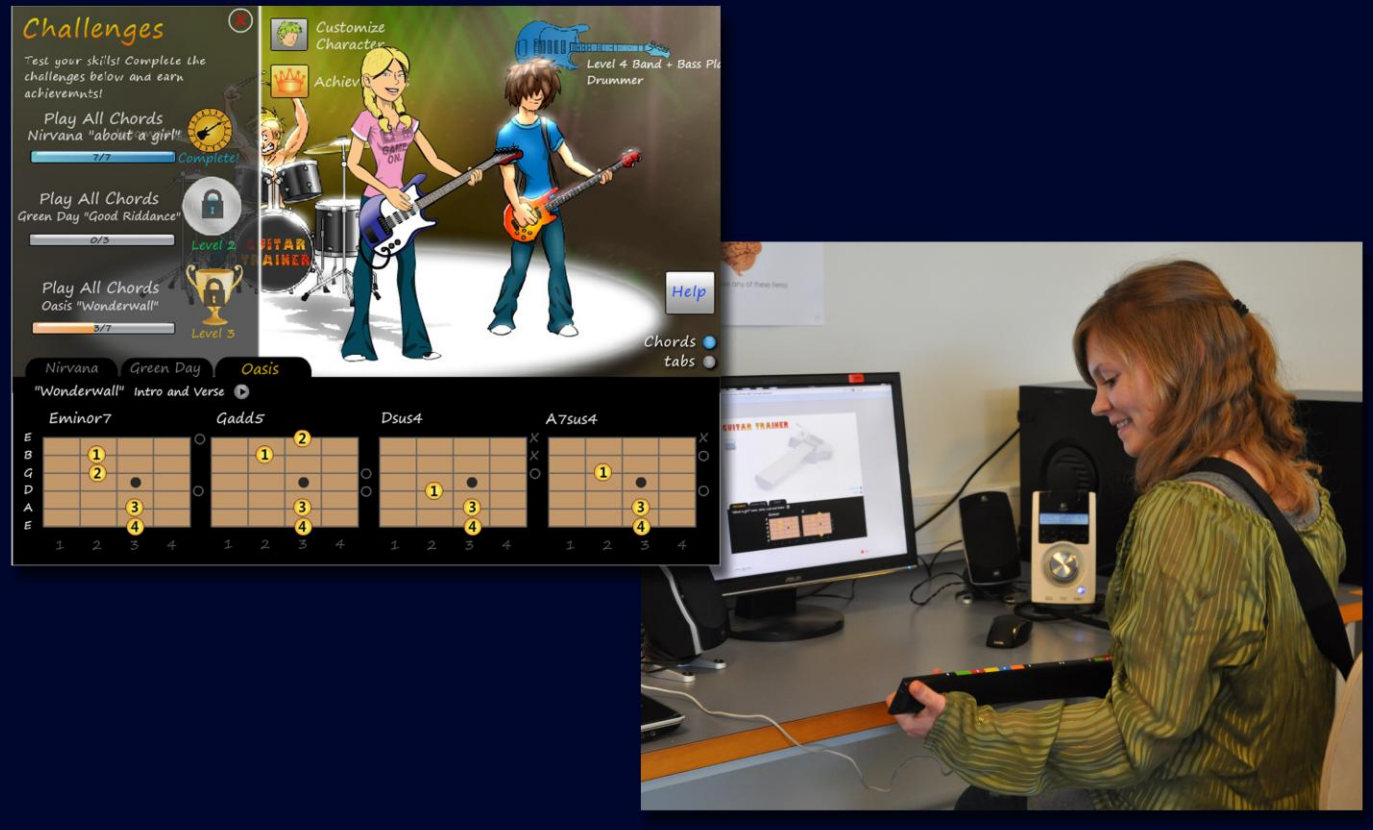
# GUITAR TRAINER

## Utalizing Game Mechcanics to Increase Motivation in an Interactive Mediated Guitar Learning Environment



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# Introduction

There is no question that games are exceptional at facilitating motivation. Millions of players across the globe feel motivated to play for hours each day simply because they enjoy doing tasks within the game. According to game designer and researcher Jane McGonigal (2010) currently online game players alone play 3 billion hours a week playing games, in the popular massive multiplayer online role playing game (MMORPG) *World of Warcraft* (WOW).

They spend an average of 22 hours a week collaborating with others and taking on quests within the game world, which is the equivalent to working a half time job.

When the total amount of hours players spent playing WOW are combined it totals roughly 5.93 million years. In comparison, currently the estimated average amount of time young people play games, in a country where gaming is popular, is 10,000 hours by the time they are 21 years old. This is the same amount of time a U.S. student will spend in classrooms from 5$^{th}$ grade until the end of 12$^{th}$ grade, if their attendance is perfect (McGonigal, 2010). These students are learning as much about being good gamers as they are about any other subject in school. Yet the problem is that all this time invested in playing games most often results in learning that can only be applicable within the virtual game world.

The realization that games have the power to create an intense desire to want and continue to play has led to the development of what is referred to as pervasive or serious games designed to be

harness the motivation games create and utilize it in the form of educational tools. Many serious games have been designed to teach the player about various real-world related topics such as history, mathematics and music. Companies such as Microsoft in collaboration with MIT created a "Games-to-teach (2001)" project to teach physics through playing games on the XBOX. Lucas Arts (2011) has also done a similar project creating a website designed to aid teachers in teaching critical thinking through their online games. These are just a few of the companies interested in creating games for learning purposes. Researcher in the subject of games for learning, Marc Prensky, has dedicated a website to keeping an updated list of games that provide real life learning experiences here http://www.socialimpactgames.com/ (Prensky, 2011).

Of many of the existing serious games, many have been developed to teach music. Music Games, such as *Opera Fatal* (1996), were designed to teach elements of music including music theory, history and instrumentology through an engaging game narrative, which could be explored in a three-dimensional (3D) space. *Loom* (1990) also was developed to teach the player to read a progression of musical notation as the player advanced in the fantasy story, and was developed with Tchaikovsky's "Swan Lake" in mind (Mamen, 2009). Since many games that teach musical notation can be easily accessible on the web for multiple types of instruments a collection of music games can be found at flashmusicgames.com. However, many of these games suffer from the same problem. Because of the hardware required, such as connecting an actual instrument digitally to a computer, they lack the ability to learn how to play the actual instrument itself. Due to these limitations, perhaps games such as *Opera Fatal* (1996) focused more on teaching the theory of music, rather than teaching a specific instrument.

From the opposing standpoint there are, however, games that incorporate the technology of a digital reader with an instrument. This allows individuals to learn accurately at their own speed, as the computer program for these specific instruments is designed to

measure the accuracy, correct amount of notes among others. Specifically, this includes instrumental learning games such as for the piano including: *Mozart 3.1, Music Teacher's Secretary, Muzika, NoteWorthy Composer, Piano Professor, Melodic Ear Trainer 1.3* among many others (Zeigler, 2011). Many of these games suited for the Keyboard include a device that can turn the notes played on the instrument until digital data called a MIDI (Musical Instrument Digital Interface) device. In the past, obtaining MIDI data from a guitar often requires more advanced and expensive MIDI devices and therefore the list of guitar learning games that incorporate this technology is much smaller. Conversely, recent advancements in gaming technology have begun to close the gap between playing a real guitar instrument and playing a game.

In the past year devices such as the *Fender Mustang Pro Guitar Controller* (2010), a guitar controller hybrid has allowed players to combine the feeling of playing a tangible instrument with a game. *RockBand 3* (2010), *Powergig* (2010) and the latest *GuitarHero* (2005) can all be combined with guitar controllers. Although the technology exists to combine learning to play guitar with the fun of a game, there is a fine line that exists between designing a game that is an effective learning experience that is also fun to play. Some of these games tend to focus more on the gaming aspect and less on the learning, creating games that are suitable for players who already have knowledge of guitar that want play a game in addition to their practice session instead of guitar beginners who might need more instruction.

Currently, combining learning experiences and entertainment in gaming, is still a research topic in need of further development as although many musically related learning games are continually being produced, little research has been done to show if the game mechanics are truly affecting the gamer's motivation and performance when compared to other methods of learning music. This study will focus on effectively incorporating game mechanics into learning games to see if the individuals' levels of motivation to

learn can be increased through game mechanics. Specifically, this study focuses on how specific game mechanics can effectively be utilized to enhance a player's motivation when applied to a learning game. These topics will be the focus of this dissertation and will be discussed in the following chapters.

# Personal Motivation

The idea for this dissertation was conceived while the author was attempting to self-learn the guitar for the second time. Like most true beginners have experienced, training the guitar can be frustrating. Playing scales, having painful fingertips and trying to play the chords like they sound in an actual song seemed near impossible. With a great degree of failure and preferring to conduct other activities rather than picking up the guitar, such as playing video games, namely StarCraft II, the practicing ceased.

Realizing the authors own intense motivation to play video games, instead of practicing the guitar, led to the desire to analyze what it was about video games that motivated the author, specifically, and in general gamers. Moreover, what was the motivation to play them for extended hours without breaks and what was it that motivated individuals to come back again and again, until the game had been mastered. Furthermore, the big question was whether this intense motivation to play video games could be transferred to a learning experience that would give the player a skill that could be employed beyond the videogame world.

Supplementary motivation to create a physically interactive learning game by coupling the use of a guitar with a learning experience was also influenced by current technological abilities of new generation consoles. Devices such as the *Wii Fit Balance board*, Playstation *Move*, Xbox 360's *Kinect* and games for mobile devices have been used to engage users through the advancement of Natural Human Interaction (NHI), which implements the users' body movements with the videogame. Since the Nintendo Wii's release in 2006, it has also proven to be useful in medical rehabilitation therapy, helping

patients recover from dieses and injuries such as regaining motor functions after a stroke (Minor, 2010).

Being intrigued to further investigate how to combine games with educational and physically active experiences, lead to the decision to conduct a study, exploring how to increase human motivation in learning experiences through the implementation of game mechanics. By developing a greater comprehension of how to increase motivation to spend time on educational games, it would contribute to the understanding and consequently the development of educational games that could and possibly would be played as much as other non-educational videogames such as *World of Warcraft* and *StarCraft II,* because of the same quality of entertainment.

# Literature Review

Many theorists, psychologists, game designers among many other individuals spend much time defining what particular words within the study of game design mean. Because the definitions of the following words are different between researchers, the following vocabulary needed to be briefly and clearly stated on how these terms will be utilized in this dissertation. A few definitions outside of the game design field have been included as they also relate to the study and for that reason alone needed to be operationally defined.

Following the definitions section will be the remainder of the literature review. The sub-sections of this category are divided into challenges, competition & cooperation, recognition, curiosity and control and narrative, fantasy and creating emotion. The major focus of this section is devoted to answering questions surrounding motivation. This is done through utilizing current and past literature

dedicated to this topic, and what the relevance is to learning games, specifically.

# Definitions:

## Motivation

The first definition in this project is *motivation,* as increased motivation is one of the overall defining goals of this experiment. A motive by dictionary definition is: "something (as a need or desire) that causes a person to act (dictionary.com)." Further definitions of motivation given by Huitt (2001) studying the field include:

- *Internal state or condition that activates behavior and gives it direction.*
- *Desire or want that energizes and directs goal-oriented behavior.*
- *Influence of needs and desires on the intensity and direction of behavior.*

These definitions all contain a similar message using terms such as want and desire when describing the feeling of motivation, yet because the topic of this dissertation involves learning, motivation will be defined according to Disessa (2000 cited by Gee, 2003 pp. 3), as: "a learners willingness to make an extended commitment to engage in a new area of learning."

Sources of motivation can be broken down into two categories: intrinsic and extrinsic motivation. Intrinsic motivation refers to personal desires that make them engage in certain behaviors for shear interest, enjoyment, challenge or pleasure of doing so (Berlyne, 1960; Hunt, 1965; White, 1959 cited in Lepper, Corpus & Iyengar, 2005). An example of this is a person doing homework because they possess interest in the topic rather than completing the task because they were asked to. Extrinsic motivation, in contrast, is created outside the person such as someone doing their homework because the teacher told them it was due.

## *Engagement*

Another term that is frequently utilized and deeply analyzed in digital game research is engagement. There are many theories on the causes of engagement but for the sake of this dissertation, engagement will be defined more simply as to occupy ones attention. It is hypothesized, by the current author that engagement is important to this project as when the participant is engaged they will have a higher level of interest in the learning process.

## *Self-mediated guitar learning environment*

A more traditional method of learning an instrument would involve a tutor, giving the trainee personal instruction. There are many modern ways to learn to play guitar if someone has the desire to do so, they can simply go online and research musical notation or watch a video of a guitar trainer, and learn to play themselves. There are multiple ways to learn guitar and any guitar learning method that involves media and the users own personal desire to learn to play, can be referred to as a self-mediated guitar learning environment.

## *Games and Game Mechanics*

Game designer, Amy Joe Kim, best explains these definitions. In a presentation Kim (2009) analyzed how games effect players' behavior and the fun, compelling and addictive elements of game mechanics. In this presentation Kim defines a game mechanics as "… a collection of tools and systems that an interactive designer can use to make an experience more fun and compelling," which are "… sticky and viral by incentivizing certain behaviors." Nevertheless, game mechanics, as Kim states, are not set in stone. To be effective, the mechanics need to relate to the experience.

# *Motivation and Games*

As Gee (2003) stated:

*"Motivation is the most important factor that drives learning. When motivation dies, learning dies… Since good games are highly motivating to a great many people, we can learn from them how motivation is created and sustained."*

This section will be divided into a synthesis of five different components that will define intrinsic motivation in games: *Challenge and Rewards, Competition and Cooperation, Recognition, Curiosity and Control, and Narrative, Fantasy and creating Emotion.*

Much of this theory is based on the work by Malone (1981) who over 30 years developed seven different components create motivation including: *Competition, Recognition, Cooperation, Curiosity, Control, and Fantasy.* Rouse (2000) also outlines several fundamental gaming components in concurrence with Malone's seven components that motivate the user to play, such as socialization, competition, and creating emotion. Possibly the most fundamental component listed in this book is that players seek challenges.

## Challenges

*"A game should be easy to learn, but difficult to master."* - (Bates, 2004)

Malone (1981, pp 333) states that a challenge "is hypothesized to depend on goals with uncertain outcomes." Challenges are present in the everyday nature of our lives and are believed that the source for our need to conquer challenges is derived from human, animal evolution becoming efficient at overcoming the various difficulties presented by the environment (White 1959 cited in Malone 1981). By overcoming the difficulty of the challenge and achieving a goal, the challenger will feel, intrinsically, rewarded. However, the level of intrinsic rewards felt is dependent on the difficulty of the challenge and studies have shown that learning is optimized when Pursuing goals meaningful to the user that takes a certain level of effort to achieve. Csikszentmihalyi (1988 cited in Carl, 1994)

developed the theory of *flow*, designed to give an understanding on how to create the optimum intrinsically motivational experience by providing the user a challenge that is correctly balanced with the user's skill level.

Csikszentmihalyi began his research on flow theory when he noticed those who displayed strong levels of intrinsic motivation in certain activities such as rock climbers, painters and chess players were more engaged and found the activity pleasurable while performing the act than after they had successfully completed it (Csikszentmihalyi, 1988 cited in Carl, 1994). Csikszentmihalyi observed that there is a feeling of self-optimization when people are in the midst of completing a difficult challenge but they feel less engaged if the challenge is either too easy or too difficult. According to *flow theory,* if the challenge is to easy then the challenger will feel less motivated to complete the task and lose interest what Csikszentmihalyi (1997 cited in Shernoff, Csikszentimihalyi, Schneider & Shernoff, 2003) refers to as "apathy." In contrast if the challenge is too difficult then the challenger will get frustrated by the lack of success leading them to discontinue perusing the challenge, falling into a state of "anxiety." Therefore the challenge must be achievable in comparison to the learner's skill level but at the right level of difficulty in order to keep the learner engaged. As the learner continues to accomplish challenges they will get more efficient at completing them thus making the challenges that were once difficult to them now easier to accomplish. To avoid creating a state of boredom the next challenge the learner faces must increase in difficulty to keep the learner engaged. When the user is faced with a continual level of difficult yet achievable challenges that are of interest to them then they are in "flow" (Malone, 1981).

Being in a state of flow means being in a deep level of absorption and performance is at its best. Artists and scholars have claimed to be engaged in their best work while in a state of flow (Csikszentmihalyi, 1996 cited in Shernoff et al., 2003).For this reason flow theory has been researched in educational institutions. In a

study conducted on 526 high school students across the US showed that students were more engaged in the learning process when the challenge and their skill levels were in balance, and the students were in control of the learning environment (Shernoff et al., 2003). In a study of children's playground games it was found that the most popular games that were played year round were games in which children could adjust the level of difficulty (Eifferman, 1974 cited in Malone, 1981). Even with the current research of flow theory used to create intrinsically motivational experiences there is still a lack of understanding of how to apply flow in many learning environments.

Games have found ways to keep players in a constant state of flow each time they play. For this reason game designers and educational researchers have attempted to couple games with learning experiences. Rouse (2000) stated:

> *"Many players thrive on and long for the challenges games provide, and are enriched by the learning that follows."*

Game designers support the theory of flow. Kim (2008) affirmed that game mechanics shape our behavior by "leveraging our primal response patterns," and by "engaging us in flow." McGonigal (2010) refers to this sensation of being in flow as the player being on the verge of an "epic win." When a player is on a verge of an epic win, they are in a state of deep concentration and focus trying to tackle a really difficult challenge that they believe they will accomplish. Games are excellent at keeping players on the verge of an epic win by continually finding the right balance in challenges. In modern games millions of points of data can be measured depending on the interaction with the game. By measuring this data it makes games incredibly supreme at generating the right probability of success for each individual player (Chatfield, 2010).

Games can adjust the challenge difficulty to match the player's skill in several ways such as allowing players to choose the game difficulty appropriate to them. In most games individuals will be given the option to choose playing the game challenges at different

levels of difficulties such as easy, medium, or hard. Often players will play a game from beginning to end more than once increasing the difficulty level each time.

## *Competition and Cooperation*

In the book, "The Most Dangerous Game," by Richard Connell (2008), a hunter is living on an island that becomes bored with his animal prey and so he begins hunting humans, as they provide the hunter with the ultimate challenge. An analogy can be made between the hunter and gamers. Once gamers have mastered playing against the game's artificial intelligence (AI) they will seek the most difficult challenges of all, playing against other players.

Online competitions have become an integral part of gaming communities, and millions of players compete against each other worldwide. Many digital games also integrate complex skill matching systems matching players of equal playing abilities, creating a higher probability for a close match. *Halo 2* (2004) was one of the first online multiplayer games that gave each player a level that could increase or decrease based on their performance. This level was applied to compare the player's skill level to other competitors of the same skill level to provide players with a well-balanced challenge in line with flow nearly every time they play. Since many online games include skill-matching systems, the latest *Gears of War 3* (September 2011) has taken it a step further giving inexperienced players a damage boost against the more experienced ones to balance the skill level.

In the past few years, digital games have invaded social networks with a large amount of success. Games such as Farmville have achieved much popularity amongst all types of people reaching millions of players, globally. A common aspect of many of the games on social networks (such as Facebook) is the ability to work together with your friends to play the game. Often in order to progress in one of these games (referred to as *Social Games),* the player will need to work together with their team by obtaining items from each other, thus creating heightened social interaction through the

media. It is also interesting to note the type of people playing these games. Although the younger demographic also plays these games, these social networking games appear to draw in the older demographics as well (Ingram, 2010).

## *Recognition*

In digital games another aspect they do well is display the users progress as they complete challenges, giving them instant feedback to the work they are investing into the game. Much time passes before seeing results in most intrinsically motivating environments. This means that players must rely on their own guesses to measure their level of progress. For instance, some feel intrinsically motivated to lift weights, yet someone must lift weights for months until any noticeable progress occurs. In addition it is up to the weight lifter to set their own goals, in line with flow theory the weight lifter will slowly increase the repetitions and weight in their workout to continually create a challenge adequate for their skill level. Digital games continually keep track of the player's goals and progress while visually displaying the information to the user with every step the make closer to their goal. Having a visual display to the user of their recorded progress in relation to their challenge is more motivation for the user to reach their goals or make it to the next level.

> "*Leveling is also autotelic in that reaching the goal is a pleasurable end in itself, particularly when the player has his/her eye on the slowly increasing level meter. There is something alluring about seeing that bar get to the end, only to start again. Often players will stay online more than they intended in order to complete that goal, to give the game a sense of closure and log off with the satisfaction of knowing that a concrete goal was reached*." (Calleja, 2007).

There are many ways that games display progress; by texts, points, progress bars or graphs. Points have been used since the very first console games and have served as a way to measure progress in a game. In the classic *Mario Brothers* (1983) the player knows when

they score a certain number of stars then they have completed the game. In addition to keeping score within the game earning points also drives for its potential to drive loyalty within users. Many companies like United Airlines use points to earn repeat business with their passengers gaining points every time they fly or even purchase certain items from affiliated companies. By earning points, on what United calls their *Mileage Plus System,* players are allowed to redeem their points for flights, car rentals, merchandise, hotels and more. According to United other non-gaming companies that have integrated this game mechanic include Amazon, Flickr and Youtube among many others.

Points and collecting objects are game mechanics that not only contribute to the progression of the game but also give the player what many game designers refer to as "Bragging Rights." Once a player has a high level of points it can contribute to their social status within the game. This can then be reflected in leader boards displaying the highest-ranked players within the game. Often players will play a game for countless hours simply to show the online community that they are of a high level. "When players are victorious at a challenging game, they realize they can do something well, probably better than most people, which makes them feel better about themselves (Rouse, 2000)." In a highly competitive online game, *Star Craft II* (2010), it recently started listing (by the player's request) the highest ranked players every week, eventually leading to a broadcasted online competition between these high-ranking players.

Games demand interaction, for every action the player does the game should recognize this and provide the player with feedback.

> *"Feedback is what distinguishes a game from every other form of entertainment. It's the interactivity that makes our games unique. Without it, the player would just be watching a movie on the screen."* (Bates, 2004)

One of the most attractive aspects of games is the feedback the game gives in response to players' actions. These responses enables the media to communicate with the player and draws attention to the game by creating changes based on the user's interactions, by stimulating the users' senses most often visually or audaciously. Speaking from experience, having stimulatory feedback can make a game more enjoyable and compelling to play.

Feedback can come in many different forms from stimulating visuals or sounds to words of encouragement given by the game itself. Feedback also "accelerates mastery (Kim, 2007)," by allowing the player knowledge of scores and how far they are from achieving their next goal or getting a perfect score. Feedback is extremely important not only in games but in all aspects of life, when a person is doing well at their job and the boss commends them on doing so in most cases it will motivate them continue to do well. Conversely, if the boss never instills feelings of appreciation when they are doing well then workers will most likely have less motivation to do a high-quality job. Even if the employee is not doing an adequate job at their work it is also important that the employee gains feedback on how they can improve and encouragement to do better.

It is similar in the gaming world, even if the feedback is given from an element within the game it will still encourage the users to continue to improve. Games often utilize word descriptions or an avatar to give social critique to the player. If the player is doing well and the game states "You have reached 10,000 points GREAT JOB!!," it can be a highly motivational factor to make it to 10,500 points. In the game *Halo 2* (2004) and the previous versions, the writers added a female character named Cortana who throughout the game would could praise the gamer if they were doing well, and tell the player to be careful if they take too much damage.

With the use of online multiplayer games and games for social networks it has taken feedback in games to a larger level, by allowing the game community to allot feedback on a single user's game status. Social games such as *Farmville* and *Millionaire City*

have taken advantage of this by enabling players to view and interact with their friends' games, such as harvesting their crops or staking a sign on the their farm. Players are also able to socialize by leaving comments or chatting within these games. *World of Warcraft* (2004) depends on socialization and collaboration between communities to successfully accomplish quests.

Console games have also begun to establish a connection to social networks to take advantage of the feedback opportunities they present. One of the leading developers for Microsoft XBOX 360's, Kinect Ubisoft, created a game called *Your Shape* (2010), a fitness training game that utilizes the full body motion capture technologies of the Kinect to create a workout by playing the game. In a presentation Ubisoft's international brand manager, Felicia Williams, discussed how the console game *Your Shape* could directly connect to social networks such as Facebook.

> "*It is going to be a community for the Your Shape players, to have an online profile to track themselves, their progress, and their goals as they play the game… the site will have Facebook and Twitter integration so players can share their stats, which the website automatically tracks as it interfaces with the game* (Nutt, 2010)."

## *Curiosity and Control*

Curiosity is a basic part of our human nature, when we are young we are told not to touch the oven because it is hot. However, most children will need to find out for themselves and will touch the oven anyways. According to Malone (1981), curiosity is:

> *"One of the most important features of intrinsically motivating environments is the degree to which they can continue to arouse and then satisfy our curiosity."*

Curiosity is the defining feeling that initially sparks intrinsic motivation (Malone, 1981). If a person lacks curiosity then they will lack interest in the subject or the willingness to learn. Experiencing intrinsic motivation through flow without curiosity is much more

difficult. “Concentration, interest and enjoyment in an activity must be experienced simultaneously in order for flow to occur (Csikszentmihalyi 1997 cited in Shernoff et al., 2003).”

According to Malone & Lepper (1987 cited in “Intrinsic Motivation”) curiosity can be separated into two parts: sensory and cognitive. Sensory curiosity is the environment creating a stimulation of our senses, attracting us to engage with the stimulating element. It is also said that stimulating sensory curiosity is a result of abrupt changes that are perceived by the senses. In comparison cognitive curiosity is formed when the learner feels that their knowledge about a subject is incomplete or inconsistent.

It is our nature to seek out sensory stimulus whether it is going out to a dinner to stimulate our taste buds or watching a theater performance to stimulate our hearing and sight. Creating a variety of stimuli is important in evoking our curiosity. A major advantage of video games in modern media is the way they are capable of stimulating our sensory curiosity. Modern video games are known for holding stunning visuals. As the console systems improve in their performance it offers a high range of visual surprises to the user such as animated backgrounds highly detailed characters, and leaves and trees blowing in the wind. Game players will take time to admire the beautifully rendered landscape of the game world or spend hours simply navigating the game to attempt to discover something new. Some players spend hours in one sitting, attempting to make it outside of the game map created by the level designers merely for their own curiosity.

There are many types of learning environments that affect individuals diversely. Curiosity may be sparked through subject psychology, while others may feel repelled by it. Like school subjects, digital games range across all fields attracting the interests of all target audiences. One player may enjoy to play 3D First Person Shooters (FPS) with an in-depth narrative while another may despise the violence of FPS but enjoy a social networking game such as *Farmville*.

Games are able to maintain our curiosity in a variety of ways that other learning atmospheres cannot, such as giving individuals the freedom to explore at their own pace and experiment with the game environment whilst creating a vast array of stimulation to our senses. By allowing the player to control what happens in the game world it allows them to control the level of stimulation, giving them the freedom to explore it allows them to search for what stimulates them. As Callja (2007) states "Games aim to arouse…To explore new lands has been an inherent part of human nature since the beginning of our species, places we yearn for the most are those that are different from our everyday surroundings and whose image is promoted and popularized by the media"

## *Narrative, Fantasy and Creating Emotion*

There is something highly enjoyable about being projected to an unordinary wondrous place using our own imagination or through storytelling. Fantasy that we find in many forms of entertainment such as movies or books is accessible through the use of a narrative. Narrative is the art of storytelling and narratives have the power to captivate us for long periods of time without any additional form of stimulation. Many books are without imagery, using only text and good story telling they are able create highly engaging experiences hence the saying "once I picked the book up I could not put it down." Digital games are able to take the art of storytelling to new levels then other forms of entertainment by putting the player in control of the narrative. Rouse (2000) states "In games, players get the chance to actually be someone more exciting, to control a pulp-fiction adventurer, daring swordsman, or space-opera hero. While in books or films the audience can merely watch as the characters lead exciting lives, in a well-designed computer game a player will actually get the chance to live those lives themselves."

By creating the game world the way the player wants to they are able to create a deeper connection to the game world as it is more

personalized. Callja refers to this as *Narrative Involvement*, stating "The pleasure of development in World of Warcraft revolves around improving one's character by increasing his/her levels and obtaining better items. Some of the participants have identified this as the most alluring aspects of MMOGs."

Through fantasy and personalization in the game world amongst other aspects, players can develop an emotional connection to games. Through the author's own experience with action games has experienced an increase in heart rate an emotional response to game world. According to Rouse (2000) "Players Want an Emotional Experience As with other forms of entertainment, players may be seeking some form of emotional payoff when they play a computer game. This can be as simple as the adrenaline rush and tension of a fast-action game like Doom. Or it can be considerably more complex, such as the player's feeling of loss when her friendly robot companion sacrifices himself for the player in Steve Meretzky's Planetfall….Emotional range is not something computer games have explored as much as they could."

# Problem Statement

The current study examines motivation through game mechanics in a musical learning environment, more specifically the guitar-learning environment. As discussed in previous sections, game mechanics (when applied correctly) are powerful facilitators of motivation. For this reason it is the project goal to develop a greater understanding of how to effectively implement game mechanics in a self-taught mediated guitar-learning setting to increase the motivation of the user to engage in the learning process. As stated in research by Percival, Wang and Tzanetakis (2007):

> *"The question of motivation is a current area of research in Education and in the design of computer games. Millions of children (and adults) spend hours each day playing computer games; many game-players even pay a monthly*

*fee to play online games. If we could design a computer-assisted music education program that was half as addictive as the leading online game, this question would be solved."*

Further research is needed to understand specifically why games are so motivating and how to apply this level of consistent motivation to learning environments. This dissertation aims to contribute to research in this area through guitar learning games by conducting a study on measuring and improving a learner's motivation to practice the guitar in a self-taught mediated guitar learning environment by effectively adding game mechanics. The goal of the current author is to measure the quantifiable difference in motivation when implementing game mechanics to a self-taught mediated learning experience. Also what factors are contributing to this influence will be taken into account. Thus, the problem statement is as follows:

*"To determine to what extent the addition of game mechanics will improve user motivation when learning to play the guitar in a self taught mediated guitar learning environment."*

The knowledge gained from this study will not only be restricted to guitar learning environments but can be transferred to other learning situations by gaining insight on how game mechanics can be applied throughout them. The current study would prove to be useful by inspiring more game companies to develop games that aim to educate their players in ways that extend outside the entertainment aspect of the game world. In addition, educational institutions would benefit by understanding the impact games can have on the learning process through motivation. In doing this they can exploit this knowledge to establish more engaging learning experiences through the use of game mechanics.

# Method

This dissertation aims to increase intrinsic motivation through self-taught mediated learning when playing the guitar through game mechanics separate from gaining additional influence from a personal instructor. Therefore only methods that an individual can learn on their own without hiring outside resources will be discussed. It was first thought to compare user motivation of a guitar learning game to other existing mediated guitar self-training methods such as guitar tabs, online training videos or purchasable software such as *GuitarPro 6* (2010) or *GarageBand* (2011). However, the vast number of methods to train an individual the guitar, would be difficult to compare to learning a game. This is because some methods would be preferred by some and not by others.

For example, an online video that displays a person teaching a melody on guitar may prove useful to some while others would be discouraged from using this method because the trainer presenting the information may be too fast for the learner's skill level. In addition the way the information is presented would have to be consistent for both test groups and have to be displayed in addition to the game mechanics.

In order to get more accurate data that would help prove the influence that game mechanics can have on user motivation, it was decided that an independent guitar-learning interface should be designed that can work in conjunction with the game design. By using this tactic the user learns to play the guitar the same way in both test groups the only difference is one group will have the inclusion of game mechanics with their learning process and the other will not, eliminating the existing variables of comparing the game design to other methods of mediated guitar training.

In order to accomplish the task of teaching the user how to play the guitar through a newly designed interface it would require carefully examining existing methods of mediated guitar

learning methods to make sure the designed interface is capable of teaching at a beginner level.

With a learning interface in place, and having the only difference be the game mechanics the next question would be how to measure motivation. Motivation is described as the learner's having an wiliness to have an extended commitment to engage in a new area of learning. In order to measure motivation an experiment would need to be conducted comparing Ways that were thought about to measure this could be through personal interviews, questionnaires and the possibility of gaining empirical data through using computer devices. In a related study motivation was measured based on subjective questionnaires. Questionnaires would allow for accurate interpretation of the learners This study is also not concerned with simply creating a game that teaches a learning experience but how to use game mechanics to create a higher desire to learn when compared to other methods of learning the same subject, in this case learning the guitar. Many pervasive games exist on the market, often for free that combine a learning experience with gaming and it is not the intent of this project to create another learning game but to further the knowledge of how to best use game mechanics in enhance the user's desire to commit to the learning experience. This study would be beneficial for game designers and educational researchers who have interest in enhancing motivation in education through the use of games.

# Analysis

## *Anatomy of the Guitar*

For this section an understanding of the different parts of the guitar is required as much of the terminology. Figure 1.0 can be reffered to

for a detailed image consisting of all the parts of the guitar, but only the parts referred to for this project are described in writing.

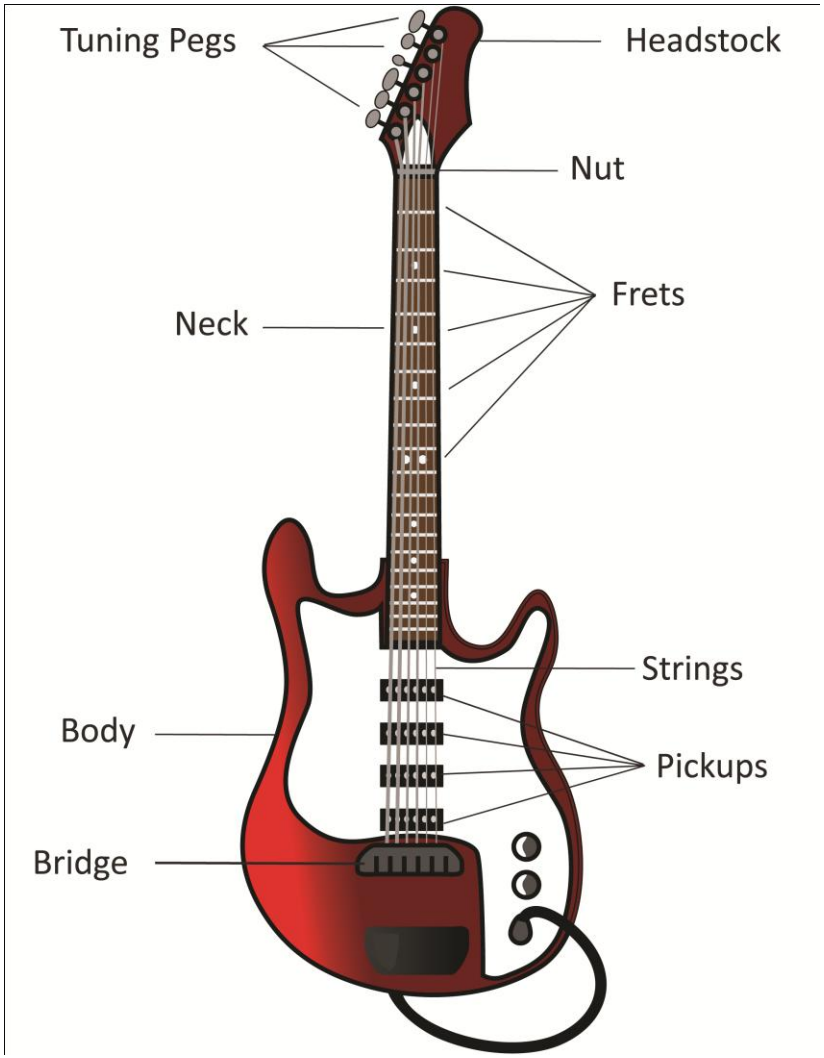



**Figure 1.0:** Illustration of the anatomy of an electric guitar

***Neck:*** The part of the guitar that extends from the body to the headstock. The neck of the guitar contains the frets, fret board, tuning pegs, and headstock of the guitar.

***Strings:*** Standard guitars consist of 6 strings although can be created with more, some extending up to 18. Strings are most often made with metal or polymers and extend the length of the guitar. Sound is created by vibrations in the strings transferred through the body of the guitar.

***Fret:*** On real guitars, Frets are metal strips located along the neck of the guitar, and embedded in the fret board. Frets divide the fret board scale length with a specific mathematical formula. Pressing the guitar strings against a fret determines the strings' vibrating length will thus alter the pitch of the string played. A standard classic guitar has 19 frets while electric guitars generally have 21 to 24 some being built with up to 27 frets. Frets are given numbers and

are used in music notation to describe where to hold the strings down to produce the correct tone. On some guitar game controllers, such as the *GuitarHero*, colored buttons and no strings often define the frets, even though the strings could simplify the process of creating music within a game.

***Body:*** The core of the guitar that on an acoustic guitar includes the soundboard and bridge, and produces the sound from the string vibration through its resonant cavity. On electric guitars the resonant cavity is replaced with pickups, transducers that detect the strings vibrations and convert the mechanical energy into electrical energy allowing the sound to be played with an amplifier.

***Guitar Pick:*** Made of various materials and shaped like a triangle with rounded corners the guitar pick allows the player to strum or pick the guitar strings without touching their fingers to the string itself.

## *Self-Taught Mediated Instrumental Learning*

In order to design an independent interface that was capable of teaching the guitar many different mediated guitar-training methods needed to be examined taking the most effective learning qualities deemed helpful in assisting the learning process. The following text discusses the pros and cons of the self-taught mediated guitar training methods found during the author's own experience learning to play the guitar.

Guitar tablature (also known as Guitar tabs) is a widely used form of music notation, utilized even in advanced guitar training software. Today many starting to play the guitar and even advanced users prefer to utilize a form of tablature. This is a simplified version of traditional music notation that can depict rhythm, but that does not give information such as classic music notation in the form of quarter and half notes. So, although the guitar tabs show how to

play the correct notes, they lack in showing the learner how to interpret the rhythms correctly.

Individuals, representing their own interpretations of a song, create guitar tabs that can be found online and free of charge. Perhaps one would see this as a problem as the learner will be learning according to a biased version of this music, as it is highly individual. However, what is to say that this is any more individualized than learning from a private instructor. Furthermore, individuals learning from the web may and have the option to decide to view more than one video, reducing the individualization and the possible biases that are associated with it.

The web-method is a very popular modern way to learn guitar due to its availability, free access, and variety of accessible songs. Guitar tabs display information needed to play a song in many forms, sometimes simply listing the name of the chords and the order to play them to complete the song. The most common way guitar tabs present the music is to have a visual representation of the six guitar strings displayed horizontally accompanied by numbers telling the learner which fret and string on the guitar to play, shown in image 1.0. Lidskog (1997). If there is no finger holding a string down, the guitar tab will let the learner know whether or not to play the string displayed by an open circle if the string is to be played or an "X" next to a string that should not be played. Guitar tabs are also useful because they tell the user how many times to play each chord and usually include the entirety of the song.

Depending on the person supplying the tab it will also include information for more advanced guitar players such as when to mute the strings or when to "hammer on" or "pull off," Saverrain (n.d.). More advanced guitar tab applications have been built such as *Songsterr* (2011) or *GuitarPro* 6 (2010) enable the user to play the song at half speed so they can attempt to play along with the song at a slower pace. These applications also include a metronome (a mechanical or electrical instrument that makes repeated clicking sounds at an adjustable pace, used for marking rhythm) if the user

wishes to practice the rhythm more accurately. Moreover, these programs allow users to edit certain attributes of the song such as adjusting the volume of the instruments and tuning their guitar.

```
I've seen alot of transcriptions of this song that have the correct chords
listed, but have left out the song's guitar fills, the parts played by the
second and third guitar, and the often overlooked (and faintly heard) riff
at the very end of the track, so here goes.

To play this song along with the CD, you must put a capo behind the 2nd
fret and play the following chords. All tablature positions are relative
to the capo.

Chords used:

         EADGBe
Em7      (022033)
G        (320033)
Dsus4    (xx0233)
A7sus4   (x02033)
Cadd9    (x32033)
Dsus4/F#  (2x0233) [note:some people think this is a G/F# (200033)]

Here's the rythym of how the chord in the verses should be played:

   Em7            G              Dsus4       A7sus4
e--3--3--3--3-3-3-3-3--3--3-3--3-3-3--3--3-3-3--3--3-3-3-3-3-3----
B--3--3--3--3-3-3-3-3--3--3-3--3-3-3--3--3-3-3--3--3-3-3-3-3-3----
G--0--0--0--0-0-0-0-0--0--0-0--0-2-2--2--2-0-0--0--0-0-0-0-0-0----
D--2--2--2--2-2-2-0-0--0--0-0--0-0-0--0--0-0-2--2--0-2-2-0-2-2-0----
A--2--2--2--2-2-2-2-2--2--2-2----------------0--0----0-0-0-0------
E--0--0--0--0-0-0-3-3--3--3-3-----------------------------------------
```

**Image 1.0:** Image of the guitar tab “Wonderwall,” by Oasis.

Retrieved from: http://www.guitaretab.com/o/oasis/13758.html

```
#----------------------------------PLEASE NOTE-------------------------------#
#This file is the author's own work and represents their interpretation of the#
#song. You may only use this file for private study, scholarship, or research.#
#----------------------------------------------------------------------------#
#-- File created with Instab - http://www.pconline.com/~smcarey/instab.html --#
#----------------------------------------------------------------------------#

Author/Artist: Oasis
Title: Wonderwall
Transcribed by: Saverain

p pull off
h hammer on

Capo 2nd Fret

----------|-----------------------------------------------------------|--------|
----------|----3--3--3-3-3-3-3--3--3-3-3-3-3--3--3-3-3-3-3-3-3---3---|--------|
----------|----0--0--0-0-0-0-0--0--0-0-0-2-2--2--0-0-0-0-0-0-x---0---|--------|
----------|-2--2--2--2-2-2-0-0--0--0-0-0-0-0--0--0-2-x-2-x-2-2p0-x---|--------|
----------|-2--2--2--2-2-2-2-2--2--2-2-2-0-0--0--0-0-0-0-0-0---2p0-|--------|
----------|-----------------------------------------------------------|--------|
  Verse  Slightly Palm Muted

----------|----3-------2-3-2--------------------------------|----------------|
----------|-------3----------3--------------------------------|----------------|
----------|----------------------2--------------0-------0------|----------------|
----------|---------------------------------0-------0h2--------|----------------|
----------|-3-------------------------0h2---------------------|----------------|
----------|-------------------------0-----------------------|----------------|
  Inter

----------|----3-------2-3-2--------------------------------|----------------|
----------|-------3----------3--------------------------------|----------------|
----------|----------------------2--------------0-------0-----|----------------|
----------|---------------------------------0-------0h2-----2-|----------------|
----------|-3-------------------------0h2---------------------|----------------|
----------|-------------------------0-----------------------|----------------|
```

**Image 1.1:** Image of an advanced guitar tab “Wonderwall,” by Oasis with advanced notation. Retrieved from: http://tabs.ultimate-guitar.com/o/oasis/wonderwall_ver5_tab.htm

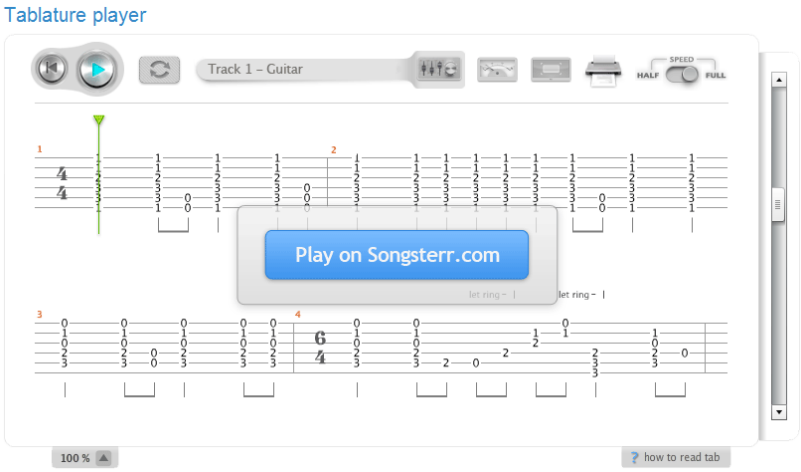



**Image 1.2:** Image of a guitar tab "Wonderwall," retrieved from: http://www.fretplay.com/tabs/o/oasis/wonderwall-tab.shtml

Despite their easy accessibility and simplicity, many issues were discovered attempting to learn from guitar tabs at a beginner level. One of the major concerns is the information provided can be created by anyone and often the guitar tabs differ greatly from one another even though they are intended to be the same song. It also can be difficult to find a guitar tab that encompasses more than one helpful learning attribute. For example, some tabs only list the name of the chords but do not show how many times to play them or where the learner is supposed to place their fingers. Others may list how many times to play each chord but not the names of the chords or which direction to strum (up or down). In addition, at a beginner level, the guitar tabs take some training to understand how the different parts of the guitar are represented in the tab yet can still be considered quicker to learn for beginners than traditional music sheets without formal music training.

From the authors' perspective the guitar tabs worked best when combined with video tutorials from websites like justinguitar.com or YouTube.com because the video tutorials can complement the guitar tabs by giving information to the learner that the tabs can't and visa versa. Video tutorials are found useful because they give the combination of real video imagery of the trainer holding the guitar and audio of the trainer vocally taking the user through the steps needed to play a song and modeling what the song is supposed to sound like. Often video tutorials will include

information such as the strumming pattern symbolized by either up and down arrows or letters D (strum down) and U (strum upwards). Video tutorials usually supply the learner with the name of the chords and the finger positions to play each chord recommended by the trainer. Some videos also include chord tablature supplementary to the video as shown by Young (2008). This is done to give the individual an accurate display of the music notation. Learning video tutorials were found useful as they gave information that the guitar tabs would not provide such as a visual image of how to strum the guitar and additional practicing advice such as how much time to play each day and how to use a guitar pick. Therefore, it can be deducted that these videos would best be appropriate for beginners.

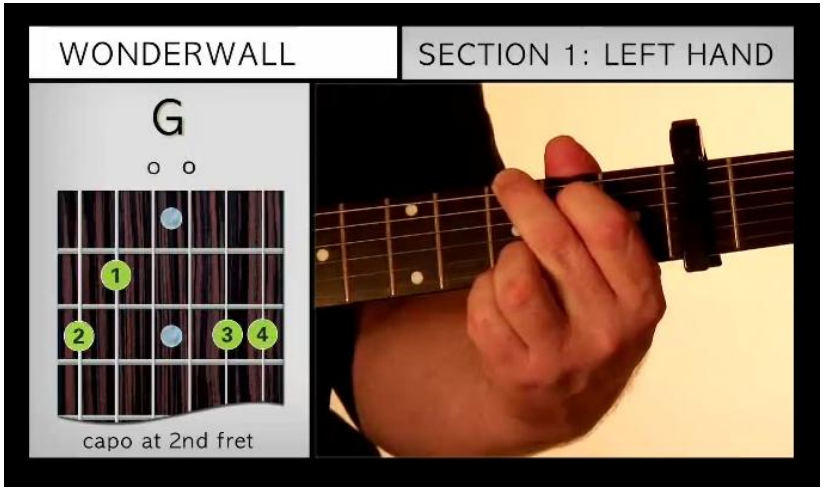



**Image 1.3:** Image of the video tutorial "Wonderwall," by Oasis. Depicting the chord and finger positioning, Young, (2008).

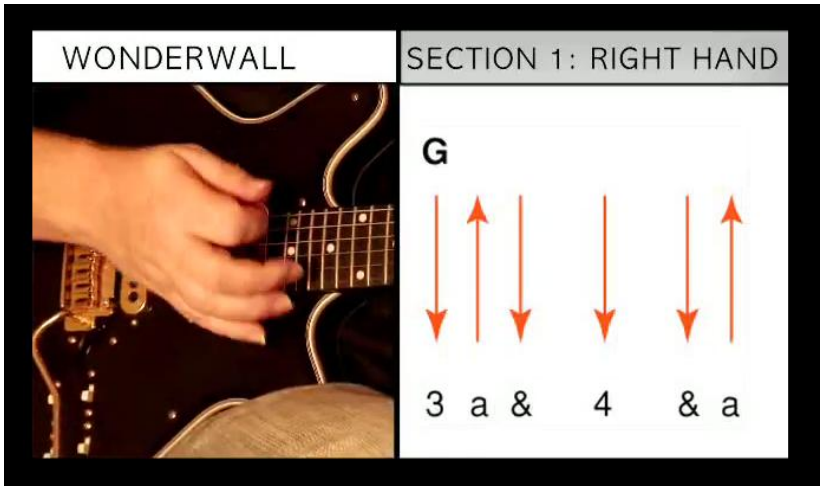



**Image 1.4:** Image of the video tutorial "Wonderwall," by Oasis. Depicting the Strumming pattern and rhythm, Young, (2008).

One of the major drawbacks found with applying a video trainer is that the video continually presents information without a pause, requiring the learner to take their hands off the guitar to rewind if it was presented too quickly. Finding the correct finger positions to play a chord can take some time and the learner will often need to pause the video to mimic the trainer's hand positions or fast-forward if they want to skip to a certain point in the song. Video trainers also most often only discuss one chord at a time and lack the ability for the user to read the music as a whole. Being able to see the music is very important when learning so the user can continually visualize the order of the chords and how they are played. Since many training videos are offered for free (many can be found simply by searching for the song you want learn on www.youtube.com) and from non-professional guitar teachers it can be difficult to find a trainer that explains the information clearly and that is clearly understandable.

More complex software has recently been developed such as Apple's *GarageBand (2011),* which incorporated a sophisticated mediated guitar-training environment called *"How Did I play?*." Possibly the best improvement to this method of guitar training in comparison to video trainers or Guitar tabs is that the user is able to plug their guitar into the computer via USB and the software is able to give feedback on the playing ability. *"How Did I play?"* incorporates features such as a chord trainer that displays an image

of chord tablature similar to what can be found online but when the user plays the chord on their own guitar the computer the software will recognize if they played the chord correctly and give feedback. "*How Did I play?"* also encompasses a mode that enables listening to specific songs on *GarageBand* and play along with them. When record is pressed on the interface the accuracy and timing in comparison to the song playing will be tracked at the bottom of the screen and a number is given for the hit percentage. After the song completes the hit percentage data can then be saved and later compared to other attempts at the song, displayed in a line graph of the progress over time.

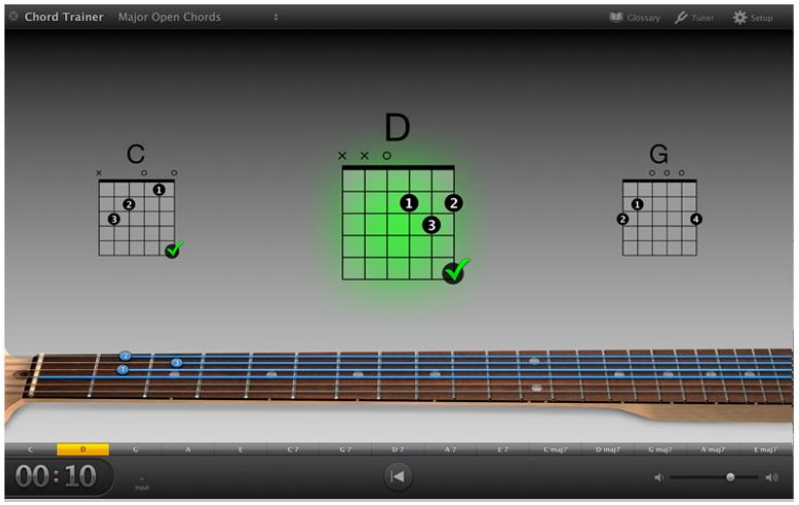



**Image 1.5:** Image from the *"How Did I play?"* Chord training feature from GarageBand (2011).

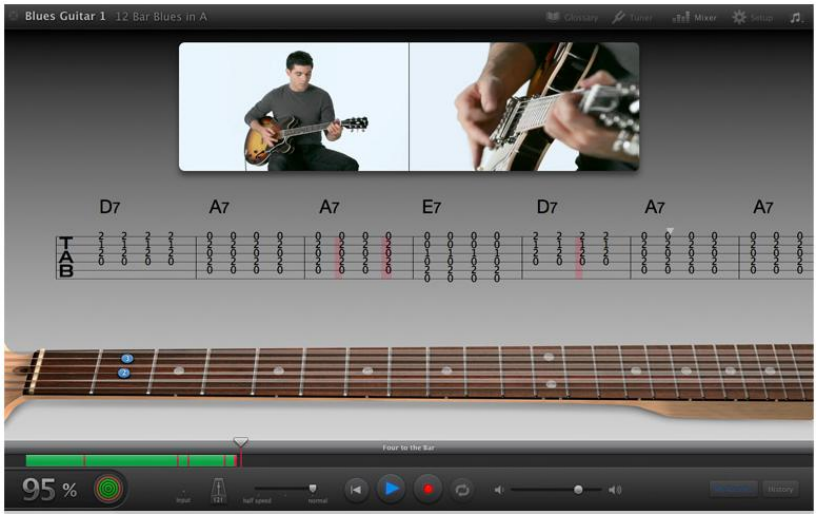



**Image 1.6:** Image from the *"How Did I play?"* play along feature from GarageBand (2011).

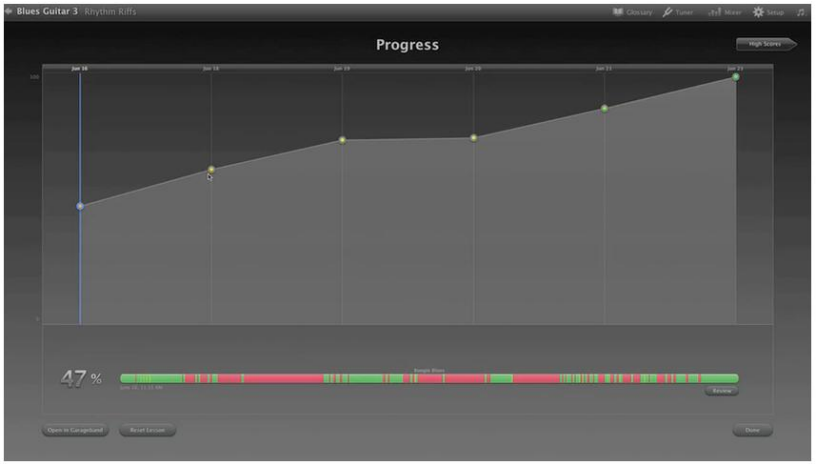



**Image 1.7:** Image from the *"How Did I play?"* Track progress feature from GarageBand (2011).

In the many guitar-learning methods discussed, the way music is visually presented can greatly differ. In some guitar tabs, video tutorials and the *GarageBand (2011)* chord trainer in *"How Did I play?"* the chord notation is displayed vertically, using numbers to represent finger positions and particular strings to play. This method was most easily understood by the author through beginning guitar training and could be more useful possibly for other beginners, giving more information on how to play each specific chord. Yet, it lacks information such as how many times to play each chord, strumming pattern and rhythm when playing a song.

Another method used in most guitar tabs and guitar learning software more closely resembles traditional music notation, showing the continuation of the piece from left to right. In online guitar tabs this is represented by displaying the guitar strings

horizontally, showing the user when and how many times to strum the chord while using numbers to represent which fret to push the string down instead of which fingers to use. This method also includes information on open strings to play or strings that shouldn't be played at all yet most often does not contain the strumming pattern or where the user should place their fingers to play a particular chord. This method of reading tablature might be more suitable for more advanced guitar players due as it focuses a mostly on rhythm and less on finger positioning.

One last self-taught guitar learning interface that must be analyzed is that of *GuitarHero* (2005). Normally not thought of as an interface for reading music notation although it presents new ideas on how music can be read in a game context, therefore it should be analyzed. First published in 1995 *GuitarHero,* brought yet another new interface for reading music, incorporating what is referred to as the *"*fret highway*."* The fret highway has the player looking down the neck of the guitar while the notes are displayed moving towards the player. They must then play the note correctly when it reaches the bottom to the screen resulting in either a note hit or missed. Until recently the fret highway has only been used with imitation guitars using game controller like buttons instead of strings and the notes were consisted of blocks of color that corresponded to the color of the button the player needed to push. However, with recent advancements in technology the interface is now playable with guitar-controller hybrids and a real guitar made available by *Fender Guitars* (2011).

Furthermore, the latest game *RockBand 3* (2011) has made alterations to the original fret highway to allow the player to learn to play a real guitar through the interface. *RockBand 3,* because of its ability to incorporate a MIDI guitars with what they call "pro-mode," that attempts to teach individuals to play guitar, the closest in resembling what this author would like to design for the guitar-learning game.

Instead of colors to mark the buttons on the interface, *RockBand 3* has incorporated numbers to represent the fret the user is supposed to play, similar to how it is displayed in guitar tablature. *RockBand 3* offers other elements that appear to be helpful in training someone to play guitar in a game context, showing the user a visual representation of the guitar, displaying the strings and frets used with numbers while giving feedback to the user if they played the notes or chord correctly. The game also is aware of the players' finger placement when touching the strings. Moreover, it displays the position on the screen with the intention that the player does not need to look down at the guitar to know if their fingers are in the correct position. Another advantage this interface has is the rhythm, showing that the user needs to play the note or chord when the marker reaches a certain point. Furthermore, *RockBand 3's* "pro-mode" contains music notation for advanced players, such as when to "hammer on," or "pull off."


**Image 1.7:** Image from pro mode in *RockBand 3,* (2011).

The fret highway interface in *RockBand 3* assimilates many elements from guitar tablature and is an innovator in guitar to computer interaction. Nevertheless, it is not without criticism. For instance, this interface still pertains more to gamers then people trying to learn the guitar. In a review of this system features the real Fender guitar with the game *RockBand 3*, Rebecca Dirks (2011) interviewed several participants after attempting to learn guitar in "pro-mode". A guitar beginner had this to say:

> *"It can be more difficult at times than learning from TAB books. While you can incessantly loop sections of songs, the loops are predetermined and zeroing in on a particularly difficult part of the section is impossible."*

An advanced guitar player who participated in this review said:

> *"On more difficult settings, what appears on the screen may not jive with the part that you already know, resulting in missed notes, poor scores, and frustration knowing that you can't follow a game at the same level you can actually play a song."*

In addition some of the songs provided in *RockBand 3* are very difficult to play on guitar, because of this, certain notes and chords are omitted to make them easier to play taking away from realistically learning the music in the song.

The fret highway display has been adopted by many music games including *Power Gig Rise of the SixString* (2010), and online game *Super Crazy Guitarman 2* (2010) yet the main criticism of this interface from the author's perspective is that the musical information is always presented on a timeline. Learning to play a chord correctly can take a long time, for some much longer than others to find the correct finger positioning and the learner should not feel that they are in a hurry to understand the music notation. With *Pro Mode* in *RockBand 3* (2011) they have partially solved this issue by letting the user play at five different speeds yet even the slowest pace does not always give sufficient time for a beginner to find their finger placement of a chord. Professional trainer, Sandercoe (n.d.) stresses the importance of practicing as slow as possible when learning to play. Practicing correctly no matter how slow is a key factor in the learning process because your brain is recording every step and attempting to play something faster than the users abilities will lead incorrect learning (Sandercoe, n.d.). Furthermore, practicing guitar is also often about repetition of a single chord or going back and forth between two chords over and

over again to build muscle memory. Furthermore, with the fret highway interface presenting the next note or chord in succession eliminates the possibility to dissect the song and learn individual parts.

To prove if game mechanics (when added to a self-taught guitar learning experience) will have a difference in the learner's motivation to practice guitar it is crucial that the individual can actually learn to play guitar with the interface. From the above analysis of the different self-taught and how their interfaces display musical notation, a newly designed learning interface must be created that can work together with the game mechanics. The new interface must also be tested to confirm that it is capable of teaching and refinements must be made to ensure the interface does not interfere with the player's learning capabilities. The Design section of this report will elaborate on the design and methods used for creating the learning interface.

## Guitar Computer Interaction Methods

Turning the guitar into a gaming interface is an intriguing yet difficult task to accomplish. Fortunately, digitalizing music from the guitar and other instruments is an innovation hotspot and there are many existing guitars and devices that could have been utilized in this experiment. In order for the player to interact with the game by using a guitar several guidelines must be met. First, a 'Musical Instrument Digital Interface' (MIDI) device needed to be found, that would turn notes and chords played digital data the computer could read. Special software was needed to understand and interpret the MIDI data and convert it into information a game engine could employ to trigger the game play.

Early in the analysis phase existing software to bridge the game Engine Flash CS5 with MIDI data was discovered. This bridge (*MIDI Bridge*) consisted of software that was created in *Java script* and was specifically designed to import MIDI data into Flash CS5 through an easy-to-use interface and was free of charge. Using this software

could easily allow the interpretation of the MIDI data and a game could be made in Flash CS5 that would be controlled using this software, with these elements in place all that was needed was a MIDI device to convert the electrical signal from the guitar into digital data.

There are many software programs and MIDI controllers that are able to turn a musical melody into a digital audio file but for this experiment the device needed to be able to precisely recognize the exact chords being played by the guitar in order to see if the individual played the chord correctly or incorrectly which would then determine the outcome of the game-play. There are many MIDI controllers that were financially affordable and were simultaneously able to recognize single string tones through a guitar pickup such as the Roland GK-3 (n.d). This would interpret the MIDI data but only with single notes plucked on the guitar. It was desired to have the player learn to play chords on the guitar therefore instead of learning individual notes therefore only polyphonic devices, being able to recognize two tones or more at once were considered.

One of the first devices considered for this project was the *Axon AX 50* guitar to MIDI controller. Although discontinued by the manufacturer, *AXON,* this device appeared to be a good option for converting the guitar signal into MIDI data and could recognize the sound, polyphonically. *The Axon AX 50* appeared to be the best choice over the many other MIDI controllers on the market such as the *Roland VG 88* and the *Yamaha G50,* because unlike these devices it could easily connect from a pickup on the guitar to a computer through USB and supply the MIDI data in raw format. Raw data is important because it is ideal for converting the data to a code usable by Adobe Flash CS5. Most other MIDI controllers were primarily used for creating synthesized sounds through an amplifier from the guitar and contained many additional musical components that were not desired for this project and causing the price to increase in these devices. Unfortunately because the *Axon AX 50*

was discontinued it could be scarcely found only available on bidding sites such as 'EBay' and the price was raised close to the prices of the other MIDI controllers that were too expensive for the scope of this experiment. So other options were explored.

Other options considered, were devices such as the *Melodyne* (2011) software created by the company Celemony Software GmbH. *Melodyne* is innovative software that can recognize individual notes in polyphonic audio material played from a piano or guitar after the track has been recorded. By simply importing an audio file, created by the piano or guitar, the software will in a matter of seconds recognize the individual notes played and display them on a *Melodyne's* digital editing software program enabling the user to edit the notes in various ways such as correcting wrong notes or change the chords played by the guitar. The *Melodyne* software also possesses the capability of recording the instrument being played directly though a microphone input, eliminating the need for creating an audio track first to be imported into the software. Using the microphone input would be considered the optimal way to capture the music played by the guitar as it would require no additional devices other than a microphone.

Even though this software is a big step forward into the future of technology that can digitally analyze and interpret data from a musical instrument it was abandoned for the use in this project due to the delay it took to convert the music into individual notes. A test was conducted where a guitar audio file was imported directly into the *Melodyne* software and a matter of 2-3 seconds were used to convert the sound signal into an audio file. Although this is highly innovative technology, it is still too slow for utilizing it within a game context.

Similar software such as the *Akoff Music Composer* (2001) was found. As the *Melodyne* software is more concerned with editing audio in the post-production the *Akoff Music Composer* is designed for recoding a sound from an instrument and converting it into MIDI data through a microphone without the need for chords or any

additional MIDI devices. This software can almost instantly recognize polyphonic sound input including notes and chords and then displays what notes you played on a virtual keyboard. This software would be an excellent solution as it would allow the game to be played online. Thus, anyone at their home computer and owned a guitar would be able to connect with the game. Though this solution was considered optimal, a few problems existed. The first problem was that the software was not always fully accurate. This could have been due to the quality of the microphone, how the strings are played or the differences between guitars producing different tonal qualities altering the software's perception of the tone. The *Akoff Music Composer* is still under work as a result the algorithms used in the software are not perfected, resulting in partially non-consistent data. Another issue is that this software did not produce raw MIDI data that could be abstracted and used to interface with a game engine. The raw MIDI data from the instrument could only be used by *Akoff Music Composer* allowing users to record and exported their guitar input.

Although freely playing the guitar and having a microphone be able to interpret the MIDI data would be the preferred solution for interfacing the guitar to the game problems such as, delay interpreting the data, accuracy and obtaining the raw MIDI data made these solutions inadequate for use in the game. Because of this another option was explored, MIDI Guitars. MIDI guitars are generally a combination of a guitar and digital software that allows computers to read MIDI data from the guitar instantly. This option was not considered first as they normally are only a representation of a guitar that may not feel quite like the real thing.

Several MIDI guitars are currently on the market and are usually designed specifically for use with games. This includes the *Fender Mustang Pro* (2010), a MIDI controller designed specifically for use with console games such as *GuitarHero* (2005) and *RockBand* (2007). The *Mustang Pro* looks similar to an electric guitar but

replaces the guitar strings that would normally run across the fret board with buttons, one button representing the string position on each fret. The strings on the body of the guitar are actual guitar strings that can be strummed and plucked in combination with holding down the fret buttons to create music. This option could be easily connected to the computer via USB and would provide the raw MIDI data needed but at the cost of the genuine feel of playing a real guitar.

**Image 2.0:** Image of the *Fender Mustang Pro* (2010), MIDI guitar-controller.

Fender guitars realizing the desire game players had for increased guitar realism in their gaming controllers released the first fully functional electric guitar that could be played with an amplifier and simultaneously provide MIDI data through USB. This device is called the *Fender Squier Stratocaster Guitar Controller* (2011). The guitar seemed like a great option as it would provide the necessary components for the game in this experiment, giving the player a real guitar to play and supplying the raw MIDI data needed to control the game play. However, this device will not be released until March 2011 in the U.S.A. and May 2011 in Europe and therefore would not be available in time to use for this experiment.

**Image 2.1:** Image of the *Fender Squier Stratocaster Guitar Controller* (2011).

Testing with the device would also need to be done as some reviews have said that it was not always accurate, players using it in *RockBand 3* replied sometimes when they played a note correctly it was not always recognized by the guitar (Dirks, 2011). It would take some testing to see how compatible this guitar would be with the game designed for this experiment, but could be useful for future development.

The *YouRock Guitar* (2010) is a simple plug and play device that is a representation of an actual guitar consisting of six strings at the body of the device where traditionally strumming of the guitar would take place. It has the entire neck of an actual guitar complete with the correct number of frets and even makers representing various fret numbers but replaced the six guitar strings along the fret board of the guitar with a finger touch pad eliminating the need to hold down strings. This device also is compatible with many software programs and could be interfaced with existing games such as *GuitarHero* (2005) and *RockBand* (2007) for the Xbox 360, Playstation 3 and Nintendo Wii. The *YouRock guitar* also supplied the raw data, which would be ideal for converting the data to code usable by Adobe Flash CS5.

This device was considered a near ideal option for the experiment and although technically it met all the requirements needed from a MIDI controller it did not fully give the feeling of actually playing the guitar. After testing the device out amongst other guitar enthusiasts

it was clear that the device felt still somewhat far from playing the real thing, the strings were not always sensitive enough to sound when strummed like an actual guitar and felt like hard plastic instead of nylon or metal strings and attempting to play chords on a fret lacked the feeling of holding strings down. Although the device felt different from playing a real guitar, it was predicted that it could still be utilized to learn to play chords, which could be transferred to the real thing.

Although the *YouRock Guitar* did not have strings, technically it was a great option as it could interface with the game with little to no delay. It was also affordable compared to the other MIDI devices and would serve as a useful device for this project. Accordingly, this device was chosen as the best interaction device with the game for this experiment.

**Image 2.2:** Image of the *YouRock Guitar MIDI Controller* (2010).

# Design and Implementation

## *Learning UI Design:*

Design of the interface used to teach the learner chords played on the guitar called the “Learning User-Interface (UI),” was influenced

by research done on self-mediated guitar learning methods, discussions with other guitar players, testing and the authors own experience learning to play the guitar. Through the design process the learning UI underwent several revisions to create an optimal visual learning experience. It was crucial to the experiment that the learner could actually learn to play guitar from the system in a short period of time. Consequently the knowledge presented in the learning UI needed to be clearly comprehensible. As the game was meant to be a learning experience, beginners were the main target group. Thus considerations were made to support them to quickly learn to play chords through this interface. This section will discuss the different design processes and elements used for creating the learning UI based on the study from the analysis.

*Musical Notation*

As written in the analysis, there are numerous ways musical notation can be displayed. The representation of a chord on guitar can be shown horizontally or vertically. In non-traditional music notation chords can be displayed using numbers to represent either the fret or finger number. If the finger number is displayed then markers must be used to let the learner know which fret they are intended to play on. Many design iterations were made to find the most easily understood method of how to display the chords. Through the author's guitar playing experience having a small visual diagram of the part of the neck of the guitar containing which frets and strings to play was the easiest to grasp at a beginner level. However, once the chord was learned having a layout that showed how many times to strum each chord was desired. Other factors must be considered such as strumming pattern, most guitar tablature does not tell the learner to strum the guitar up or down. More often in guitar tablature it will show whether or not all 6 strings are supposed to be strummed in the chord or only a few represented by an X if the string should not be played and an O if the string should be played openly (without placing a finger on the string). Advanced forms of music notation such as muting strings,

"hammer on," or "pull off," we're not desired as these techniques would be too advanced for most beginners.

There were many design considerations created to see if the musical notation could be simplified, making it easy for beginners to quickly understand how to place their fingers and play the chord correctly in a short amount of time. From the authors own experience at a true beginner level it was found easiest to learn to play a single chord by having a diagram of the fret of the guitar and where to place the fingers as this can help the learner to better visualize the guitar they are holding. This form of musical notation shows the six strings of the guitar and uses numbers to represent the user's finger placement. For this reason the method was chosen to display the chords on the learning interface. Nonetheless, it was altered to simplify and still add knowledge to the interface.

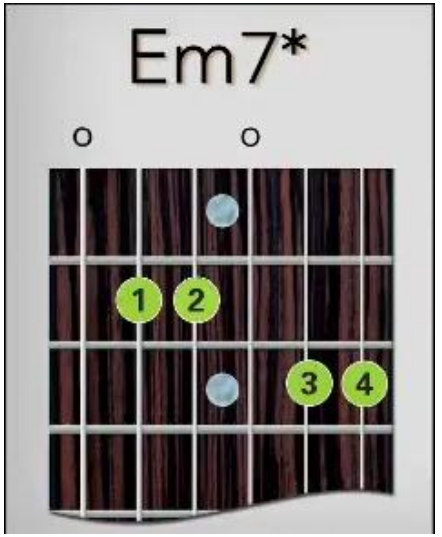



**Image 3.0:** Image from Young, D. (2008). *Training video: Wonderwall by Oasis.*

The design was further simplified by accompanying the visual chord representations with an image of a hand to show the synchronicity of the fingers to the numbers. Both number and color representations of the finger placement in relation to the chords were designed to see if one could be understood quicker than the other. In a test of five subjects four out of five enjoyed seeing the color representation, but preferred the numbers, as they felt easier to understand. For this reason numbers were used. Furthermore,

numbers are commonly used to display finger positions in existing guitar tablature and using numbers could avoid conflicts if the user had prior knowledge of reading music.

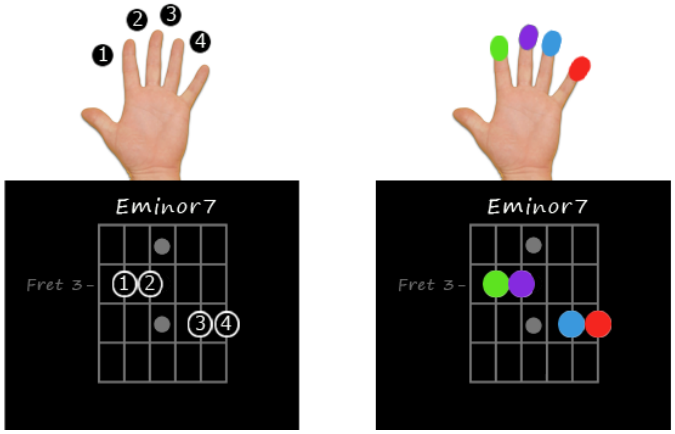



**Figure 3.0:** Early design of the chord display on the learning UI.

One disadvantage to having a diagram displaying the frets on the guitar with finger placement is that due to the size of the diagram it could be difficult to display multiple chords simultaneously if there are space constraints. It is important when training in the guitar not just to attempt to play a single chord at a time, but to learn one chord and then learn how to quickly shift the fingers to the next chord. The interface was designed to accompany multiple diagrams of the chords in succession relative to the song so the learner could visually see an accurate diagram of the chords and how to play them while being able to see how to move from one chord to the next without needing to take their hands off the guitar.

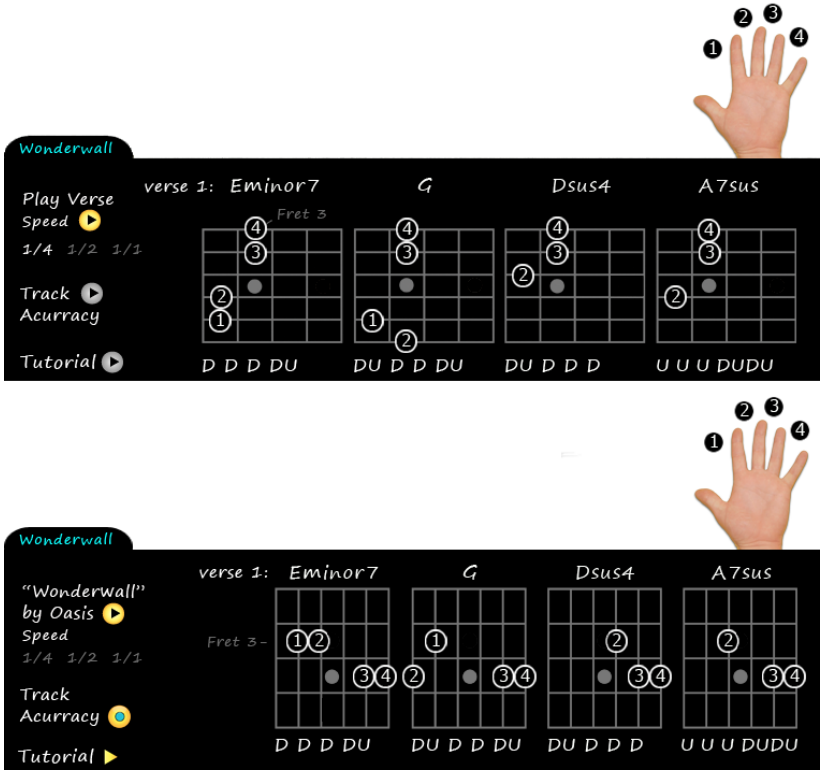



**Figure 3.1:** Design of Multiple chord layouts including hand to locate finger positions.

One of the major questions concerning this method of learning is how would the learner prefer to view the orientation of the chord as images found online display the chords either vertically or horizontally. To solve this problem a test was done giving 12 random participants two separate visual diagrams displaying an early version of the learning UI, one with the chords displayed vertically and the other displaying them horizontally. The participants were then handed a guitar and asked to play the four chords presented in the learning UI. All of the 12 participants were instantly drawn to attempt to play the chords on the diagram depicting the chords horizontally. Thus it was decided to have the chords be displayed this way.

From the participants feedback a few other important discoveries were made. In traditional music notation the higher the note is on the page the higher the tone of the instrument, when learning to play guitar with guitar tabs the top line always represents the bottom string on the guitar (the string with the highest tone.) This is how the design was displayed when testing the 12 participants. However, it was noticed that true beginners tried to directly mirror what was on the chord diagram resulting in the learner believing that the top line on the diagram represented the top string on the

guitar. Since beginners would have the most difficulty reading the music it was decided to mirror the frets used in the guitar onto the diagram, having the top of the chord display represent the top of the guitar.

Moreover, when asked if the hand displaying the numbers to correspond to which fingers to use was useful or not, most of the participants said they did not notice the hand but naturally knew what numbers represented which finger. For later versions of the learning UI, the hand was removed and replaced with a diagram of a hand actually holding the guitar strings in the tutorial only.

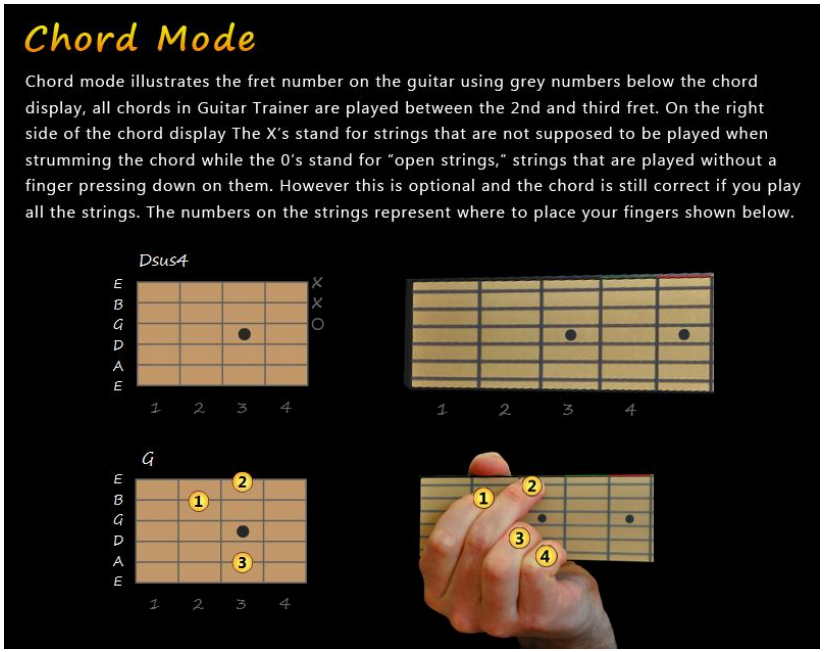



**Figure 3.2:** Image from the tutorial displaying how to grasp the chords.

In comparison to this method of displaying chords most guitar tablature display the strings with numbers representing which fret to play the string. However, it does not show which fingers to use. For this reason this method of learning does not need the visual space of the previous method and is able to include other aspects of learning a song such as how many times to play each chord.

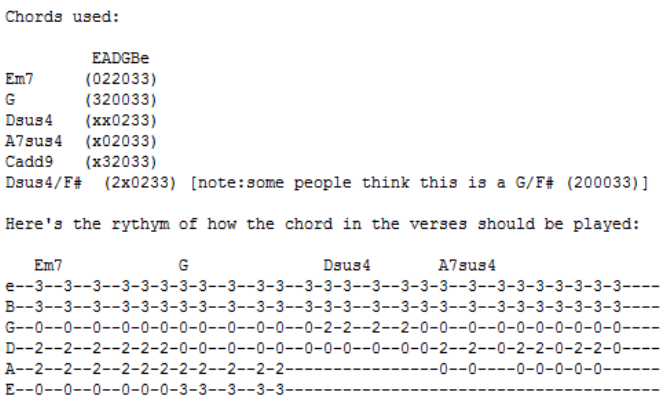



**Image 3.1:** Image of the where the musical Information is displayed horizontally, Lidskog (1997).

Both methods of learning were considered valuable as someone who has never played guitar before would most likely need a diagram that shows them their finger placement. Once they learned the chord they may desire more information such as how many times to play each chord, the strumming pattern and rhythm.

In the test comparing both the horizontal and vertical presentations of the chords, even though most people had never played guitar, the learning curve significantly differed between each test participant. Realizing the fluctuation in learning pace between even amongst true beginners, some quickly playing each of the four chords and others struggling to play a single one, it was decided to add different levels of information to the learning UI that players could choose from based on their skill level.

This information was divided into two different modes referred to as *Chord Mode* and *Tab Mode.* In the tutorial it was explained that chord mode would be best suited for beginners and tab mode is available if the player would like more knowledge on how to play the song. Chord mode is the first type of musical notation displayed in the learning UI. Here the individual is presented with an image of the chord designed to look like the *YouRock Guitar* utilized in the experiment containing the six guitar strings (or in this case touch sensors and numbers to represent the user's finger placement). Supplementary information was inserted, such as the name of the chord, numbers of the fret 1-4 on each chord display and the name of the strings (E, A, D, G, B and E). Since the participants were playing music from real existing songs, markers were used to

recommend whether the open strings should be played or not to sound more accurate to the original song, represented by either an "O" or an "X." In one situation of the Green Day song "Good Riddance," another maker was used, X2 next to the first chord signifying that this chord should be played twice.

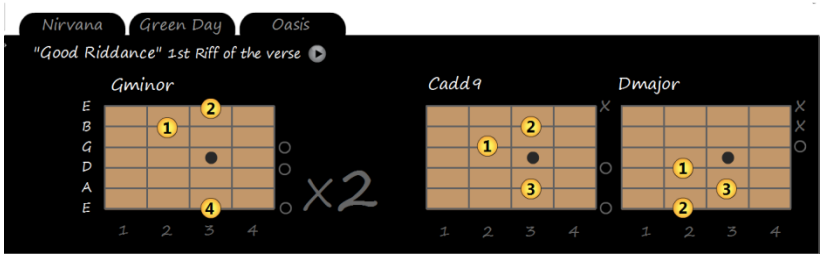



**Figure 3.3:** Image of the learning UI when learning "Good Riddance (Time of Your Life)," in *Chord Mode.*

If the participant wanted to know more details about the song or preferred to learn in a different way than they could select tab mode. When the participant selected tab mode the chord display would be replaced by the six lines of the guitar strings spanning across the learning UI containing multicolored numbers representing each chord, string and fret to play. In the tutorial the subject was instructed that the numbers now represent the fret position while the colors help the user visually determine when they need to play the next chord.

Tab mode resembles much of the guitar tablature online displaying each time the user needs to play the chord shown by a repeating the fret numbers and defining the rhythm based on how far apart the chords are from each other. To further assist the player in trying to match the rhythm of the chords to the original song, when the user presses the play button in tab mode a white marker appears and moves over each chord when it should be played in unison with the music.

In most guitar tablature the strumming pattern is left out but can be found in many video tutorials. Some videos display this in the form of arrows pointing up or down or the letters "D" for down and "U" for up. Learning the strumming pattern is crucial when trying to play an existing song and it was desired to add the pattern to the tabs

mode. The addition of the letters “D” and “U” were placed underneath each set of numbers representing a chord to let the player know which direction to strum the chords.

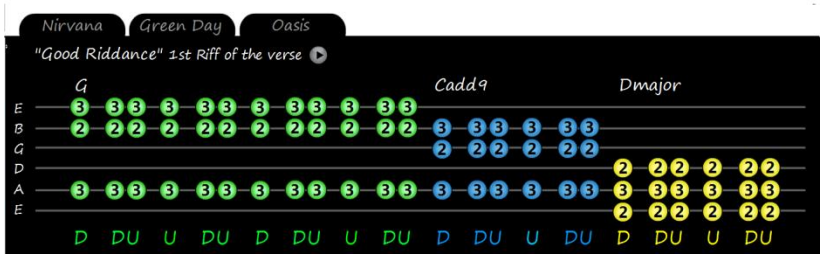



**Figure 3.4:** Image of the learning UI when learning “Good Riddance (Time of Your Life),” in *Chord Mode.*

## *Song selection and navigation*

When beginning to learn to play guitar many learners will naturally want to play their favorite songs. However, some songs the learner may desire to play might be too difficult for them. Hence many online video trainers and websites often suggest music to learn. It was believed that having the learner play music from popular song titles would provide a more engaging experience and be more enjoyable then having them practice a variety of chords in no particular order. Most trainers will suggest that the learner start playing scales as a warm-up before trying to play chords. Learning to play a scale is a great way to train beginner’s fingers to move about the fret board and prepare for learning chords. For this experiment, however, it was considered more valuable to have the test participant spend their practice time playing chords rather then warm-up exercises for this reason teaching scales was omitted. By having the user focus on learning chords instead of practice exercises like a scale, more data could be obtained if they had learned to play the chords correctly.

The music to have the test participants attempt to learn was verses from: “About a girl,” by Nirvana, “Good Riddance (Time of Your Life),” by Green Day and “Wonderwall,” by Oasis. Many songs were considered for this project. These particular classics were chosen due to their popularity, playability and similarity to one another. Only the first verse from each of these songs was chosen. This was

done as not to overwhelm the beginners with too many chords to learn but still give them options for different songs to choose from. It was also noticed through discussions with other guitar learners (in addition to the authors own experience) that often when learning a song in a self-taught mediated guitar learning environment, beginners will only learn the first verse of a song before starting a new one, possibly returning later to complete the first song. For this reason some video tutorials and guitar tabs will not teach a song in its entirety but popular verses instead that are referred to as *guitar riffs.*

Due to the popularity of the guitar riffs in these songs many training videos and guitar tabs could be found and compared to each other. Because most musical notations of popular songs found online are subjective to the author of them, this often causes conflicting information between different guitar tablature. When searching for online music notation there is no 100% guarantee that the music exactly matches the original. As a result, the guitar riffs displayed in the learning UI were taken from existing guitar tabs and video tutorials, chosen due to their perceived accuracy in comparison to the original and consistency amongst the found online musical notation. These riffs were also the most easily learned in the author's own guitar learning experience largely due to their similarity to one another. The second chord played in "About a girl," a G Major was also the first chord played in "Good Riddance." The chord *Gadd5* the same as a G Major but using one extra finger is the first chord in "Wonderwall." Other similarities included the E minor chord, which is the first chord played in "About a Girl," converted to an E minor7 for the first chord in "Wonderwall," and the D major played in "good riddance," and switched to a Dsus4 in "Wonderwall." In addition all the chords played in these riffs could be played using only the second and third fret.

As mentioned above it was noticed that the learning curve greatly differed between test subjects and true beginners would sometimes struggle to play a single chord. By having similar chords in each of

the songs and limiting the available chords to the second and third fret it would give beginners an aid in learning a variety of chords from multiple songs. This was desired as to make the learner feel a greater sense of accomplishment if they were able to progress through multiple songs rather than having them get stuck playing a more difficult chord. The music notation of the riffs in the songs were accessible based on tabs used in website navigation. Each one was titled after the song artist: Nirvana, Green Day and Oasis The three tabs are displayed in order from left to right, based on the song difficulty. “About a Girl,” the verse underneath the Nirvana tab, first from the left was considered the easiest to play as it contained only two chords to learn the E minor and G Major. The Green Day riff contained three chords including the same G Major chord in “About a Girl,” Cadd9 and D Major. “Wonderwall,” from Oasis, considered the most difficult has four chords: Eminor7, Gadd5, Dsus4 and A7sus4. When the test subject first comes to the application the Nirvana tab is displayed. Then again, the learner could click with a mouse on any tab and the chords to play the specific riff would be displayed. Each tab also contained an audio recording that would play the riff once the user clicked the play button and could be stopped by clicking the button again.

## *Game Design*

An extensive design process was developed to bring a game, titled *GuitarTrainer* to the desired quality that was perceived good enough to have a positive effect on the learner’s level of motivation. Based on the literature review, game mechanics were attributed to most of the motivational topics already covered including: *Challenge, Recognition, Curiosity, Control, and Narrative, Fantasy and Emotion*. Game mechanics pertaining to competition and cooperation were not used for this experiment, as the goal was to test if individual motivation could be enhanced in a single practice session. Also, it would require more resources than are currently available such as the use of two MIDI guitars. Although competition and cooperation would have been desired for the experiment, it

was not feasible at this time, and hopefully will be able to utilize for further research conducted on this topic. It was anticipated that effectively implementing the other mechanics would be sufficient in increasing the learner's motivation for this experiment. This chapter will discuss the design process for implementing the various game mechanics discussed in the analysis, in order to enhance the participant's motivation.

## *Narrative, Fantasy and creating Emotion*

Many different ideas for how the game should look and function were conceptualized before designing the actual game. In the beginning there were ideas such as an asteroid shooter game where if the learner played the chords at the correct time a ship would shoot missiles that could destroy the asteroid before destroying itself. Another game idea was to create a two-dimensional (2D) fighting game where a guitar player would travel the world saving cities from various monsters with his super powers of rock and roll, inspired by the game *Brutal Legend* (2009.) These ideas were abandoned because it was desired to see if a greater connection or emotional response could be given if the narrative and character design was more relative to someone who was learning the guitar.

By designing a game that players could relate to and want to play in order to progress in the narrative it could have an effect on their emotional response to the game, thus enhancing their focus on the practice session. Therefore the idea was conceived to have a story of a guitar player who would make his way to rock fame by gaining different stages and band members along the way. This game would attempt to develop a deeper level of focus on guitar playing by developing a deeper connection to the game world. In order to do so several game mechanics were created in order to further involve the player including character customization, different levels, and a narrative.

Since the focus of the game is to increase the player's learning capabilities through interaction with the game by playing the guitar, the game mechanics needed to be implemented in a way that

would augment the player's knowledge of the guitar. It was originally intended to have a series of quests that the participant could attend, allowing different chords or song riffs to be played depending on which quest was chosen. During each quest they would also gain allies and new quests to assist their guitar learning abilities while aiding the player in achieving the overall goal of rock stardom. Some of the quests included scenes such as meeting with journalist who would ask the participant to play some chords. Afterwards the player would be rewarded with a column in the paper about himself or herself. Though this idea would give the player a lot of control over the story line and also experience a variety of different scenes with different characters, it was considered too complex for the time needed to complete the project and therefore the current version remained a simplified form.

The second revision of the narrative included three stages: interaction, practice and perform. In the beginning the player would be confined to their practice room where they would be able to interact with various objects or perfect numerous tasks around the room within the game by playing the guitar. In the beginning the player would be able to complete two tasks such as cleaning up the practice room, changing the background poster or reading a rock magazine (image). Playing various chords on the guitar that corresponded to individual tasks, would complete them. In order to clean the room the correct chord needed to be played and, for instance, a piece of laundry would go into the appropriate drawer of the dresser displayed in the room. By playing another chord correctly the player would be able to switch between several posters each time they played the chord, the other two chords displayed would allow the user to enter either practice or perform mode.

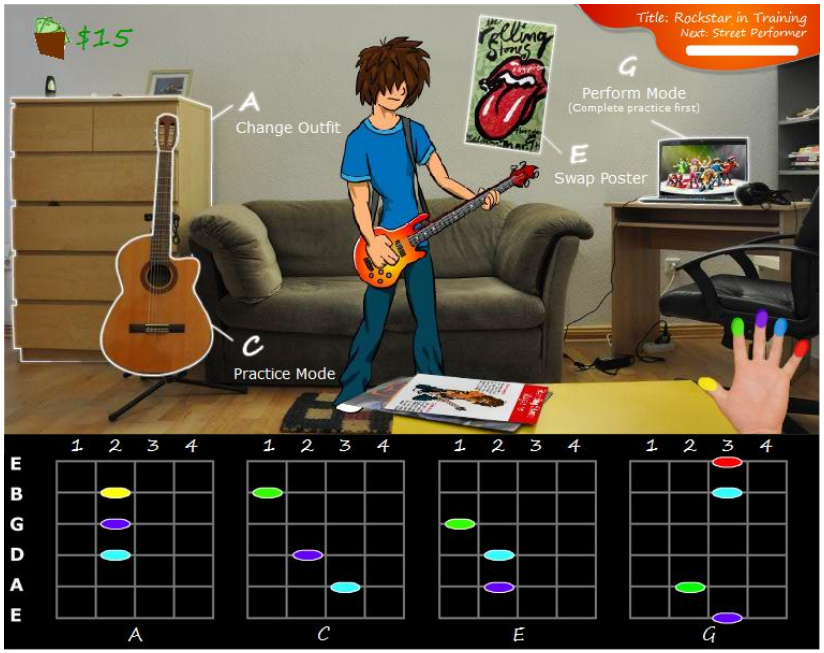



**Figure 3.5:** Concept art from the interaction phase of the first iteration of the game.

Practice mode would take the player to a new interface where some added game mechanics would be made available including: achievements and a scoring system tracking the participants hit percentage on the chosen song. It was intended for the practice mode to instruct how to play a verse to the chosen song before entering performance mode. Performance mode would visually represent the overall level. If the participant was at level one, "street performer" when in perform mode, an image of a street with virtual people would be displayed. If the participant continued to practice the guitar in reality the virtual people would walk by in the game and deposit change to the player and consequently the cash amount would be displayed. In performance mode the participant would be able to apply what they have learned in the song to gain cash points leading to certain rewards that they could then purchase for their interaction stage such as a fish tank, rock magazines and new guitars. Each new item bought would become interactive with the addition of a new chord for the user to learn. For example, if they purchased a subscription to *GuitarTrainer* magazine, the magazine would then be available on the table, after playing the correct chord linked to the magazine. The magazine would open exhibiting different articles that the player could flip through by playing the chord repeatedly.

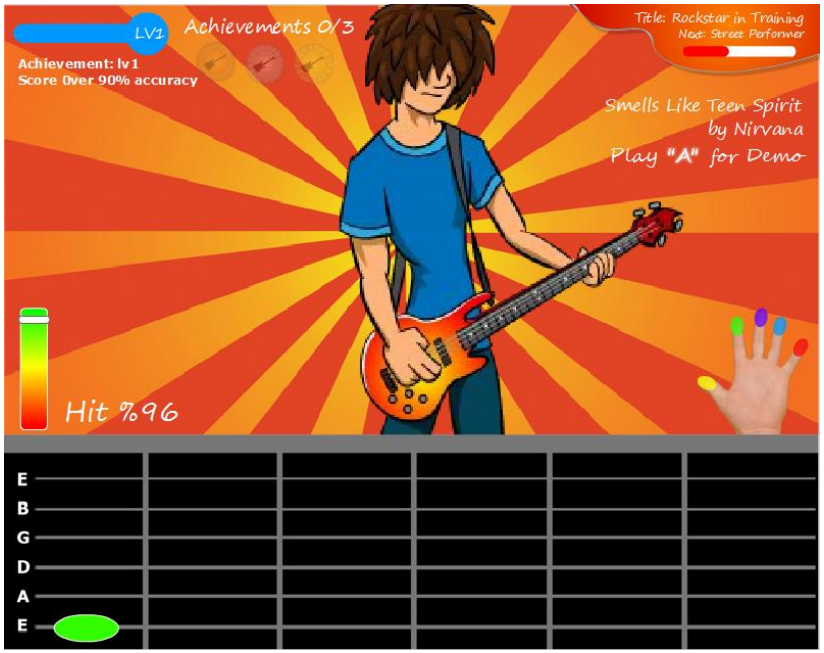



**Figure 3.6:** Concept art from the practice mode in the first iteration of the game.

Having a task such as cleaning the room by repeatedly playing the same chord would not encourage the player to play multiple chords continuously, as was desired to challenge the participant to learn a range of chords. Furthermore, having to switch to practice mode to learn to play a song and perform mode to gain rewards would limit the freedom the player had for experimenting with various songs in a single mode. This design of learning gave the player less control as how they learned to play guitar was stricter in its structure, requiring them to complete specific tasks in order to proceed to the interaction mode and further needing them to first choose practice mode in order to gain entry to the perform mode to earn rewards. The tasks in the story such as cleaning up the room or changing the poster felt limiting as only one chord was associated with each task and a limited number of tasks could be made available at one time. With further development on this approach the game could offer a valuable learning experience by completing tasks for the striving guitar artist. Yet, after several conceptual designs of how this idea could work it needed to be revised again as certain elements of the game design were not considered optimal for the learning experience.

It is a fine balance between creating a learning game that allows freedom to experiment to learn alone while giving the joy of progressing in a game simultaneously. The previous iteration of the

way the user progressed in the game story restricted the player's ability for free play on the guitar. Therefore, it was decided grant more control to the user, allowing the game narrative progress in relation to how the user preferred to play the chords, instead of the learner progressing by playing the required chords based on the game story. Because the test participant would only be required to play for one test session and the goal was to have them practice for 10 – 15 minutes, the game story and narrative needed to occur at a much faster pace than most online games. Also, the target group would be able to choose their own practice time and depending on their schedule it was possible for them to only play for a short period of time. For this reason a more linear storyline was developed that would quickly progress if the participant continued to practice the chord exchanges correctly.

The final iteration of the narrative gave a brief outline of the story situating the player in the place of the in game character, allowing them to feel like a beginning guitar player with dreams of making a band and performing on stage. When starting the game players would begin in a garage band style setting, cement floor brick wall with a poster, couch, bike and skateboard in the background. At this stage the player would be given the title "Garage Band." After making it to level two the player's title would change to "Solo Performer." At this stage the background would change to an illuminated platform with lights shining down on the player, slowly fading between different colors to give the player the satisfaction knowing because of their success practicing the guitar their character has progressed to making it on stage. As mentioned in the tutorial, one of the goals of the game is to gain band members to strengthen the player's band. Every level after level two adds a static image of an additional band member and adds the title of the band member to the level meter. The band members are earned by making it to the next level and added to the player's avatar are: Singer/Bassist (level 3), Drummer (level 4), Backup Guitarist (level 4) and Sound Mixer (level 5).

**Figure 3.7:** Image of the band members the player could earn when playing *GuitarTrainer.* Illustrations done by Chris Gebrosky (2011).

To further the involvement in the narrative and develop a more emotional connection to the game the player was also given the possibility to design their own avatar to represent themselves. Social games like *Farmville* have had a lot of success allowing the player to quickly and easily customize a character that is unique to them. By allowing the player to create their own avatar, this author believed to give them a more personal connection to the game thus adding a longer investment in time played. Both male and female avatars were developed that would be given to the participant based on their gender.

Customizing the character was optional to the user, to give the participant more control of the learning experience. The user could customize their character by clicking on the customize button in the upper left corner of the screen with their mouse. Like the "Challenges" button the character customization window slid out displaying the different attributes the player could alter on their character. Customizing the character was designed to encourage the user to learn a variety of chords by assigning different chords to each adjustable aspect of their avatar. By playing an E minor or E minor7 the player's character would switch between five different hairstyles. G Major or Gadd5 would change the avatar's expressions ranging from a relaxed guitar player with eyes and mouth closed to a more intense rocker look. Cadd9 or D Major would change between six different outfits and playing a Dsus4 and A7sus4 would a swap through the avatar's guitars.

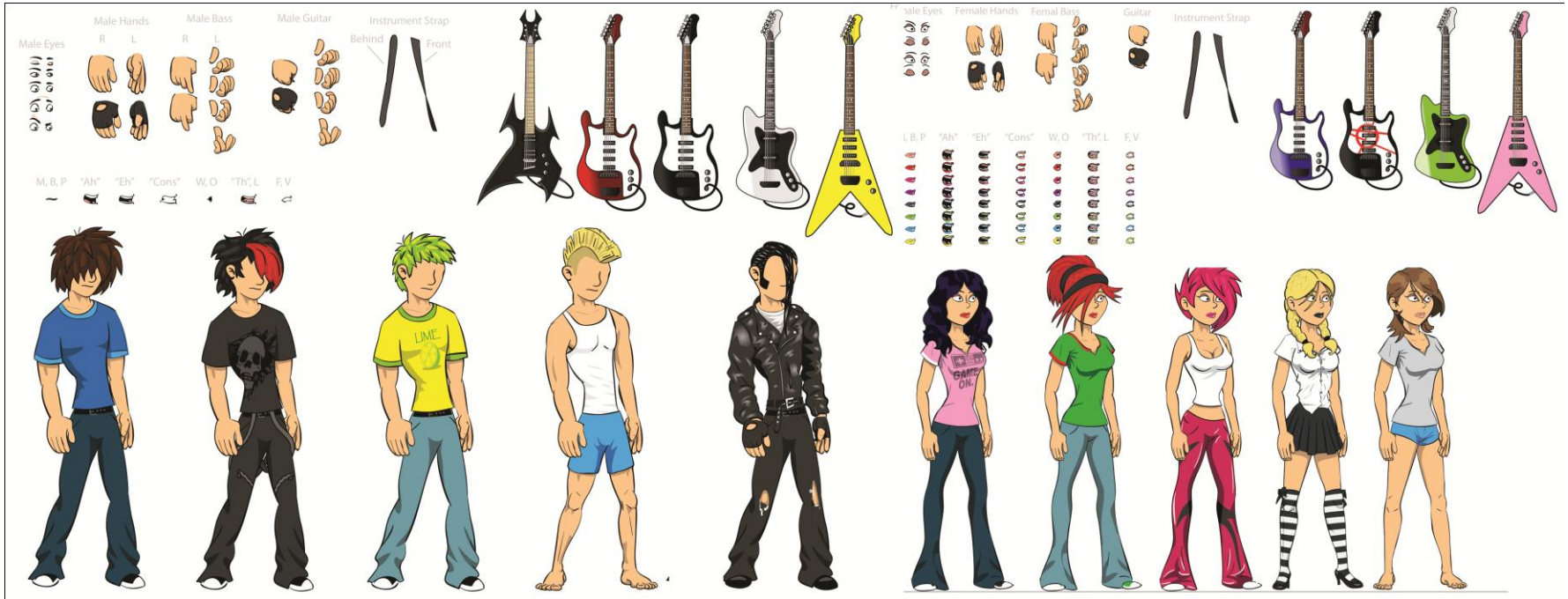



**Figure 3.8:** Display of the different customizable attributes of the male and female avatar. Illustrations done by Chris Gebrosky (2011).

The characters were graphically designed to display a range of extravagant outfits, guitars, expressions and hairstyles, some that may even appear humorous to the player. Having a variety of different attributes to alter about the player's avatar was anticipated to spark their curiosity, wanting to see all the available options of customizing and giving more control over the game play.

By allowing the user to customize their character in unique ways it could create a more personalized and deeper connection to the game play. In addition to customizing the attributes of the character, the avatar was designed to develop a further connection to the player through interaction. When a chord was played correctly, the avatar would in return strum their guitar too. This reflection was meant to develop a lively interaction between the player and the avatar possibly altering the player's emotional

response to the game. By creating an emotional experience through the game it was anticipated that the learning experience would become more enjoyable, more desirable and consequently lead to an extended practice time.

## *Challenge and Recognition*

The most extensive section of the literature review focused on the idea that players want a challenge. With any great challenge, success will be met with a intrinsic reward of self-progression. Just as most subjects such as snowboarding or even trigonometry, learning to play the guitar from a beginner level is a difficult challenge. The problem with many learned subjects is that it can be difficult to achieve a level of flow. Learning to play the guitar, for example, has a steep learning curve. A beginner may spend hours practicing without noticing a considerable amount of progress and may become less motivated to continue practicing. This is also true with most school subjects where a student may be given an assignment that could take months to complete. The student could work intently on this assignment and in the end receive a single reward based on their performance. Having this long period of time to solve a single problem and without continual recognition for progress can be very ineffective at motivating someone to continue the task.

Games solve this problem by giving multiple short-term goals leading to a larger overall goal and continually giving positive recognition for work done, every step of the way. The challenges in *GuitarTrainer* were modeled after many social games found on Facebook. Many of these games have achieved a large user base due to their short-term goals and constant rewards. These games unlike others such as WOW are able to captivate people for a short period of time, stopping into the game world for 15 – 20 minutes, but continue to do this on a daily basis. The was most desired from a guitar learning game, because it is more important to practice for shorter periods of time but continue to practice daily then do extended hours one or two times a week. Based on this system

several challenges providing the user with recognition upon completion were developed for the game including: achievements and progress bars. There is an infinite number of ways that game mechanics can be formulated to create a motivational experience. These are the ways that are thought to be most effective for the current game design.

Supplementary to the challenge of learning chords on a guitar further challenges were given with virtual rewards for completion. It was desired to have the participant learn as many chords as possible during their practice session offering an in game challenge and reward system to motivate the participants. It was optional to complete the challenges, rather than requiring them to do so. This was done to avoid giving biased results when compared to the non-game mechanics group. Giving the option to complete these challenges could prove if the learner really felt compelled to accomplish these goals. The learner could view their progress on the challenges by clicking with the mouse on the challenges button located in the upper left corner. Once clicked, a list would slide out from the left side describing each challenge with their current progress.


Image 3.2: Image from Particpant #38's progress on the challenges.

The challenges were described as playing all chords in each song riff. This was done with the intent to motivate the player to challenge themselves with all the chords presented instead of repetitively

playing easier chords. Also, to keep in line with flow theory each challenge was designed to increase in difficulty as the learner improved with the chords in each song, providing a new- more difficult- challenge each time the previous one was fulfilled. Three levels of increasing difficulty were created for each challenge and designed to be altered based on the results for the non-game mechanics group. For instance, if the average beginner in the non-game mechanics group played every chord in "Wonderwall" two times then a challenge would be made to encourage playing the chords three times. To recognize the player for completing these challenges each level would result in a new, higher reward such as earning bronze, silver and gold medals. The first challenge "Complete all chords in 'About a girl'," gave the user three levels of a virtual medallion. "Good Riddance," rewarded the player with record symbols and by playing all the chords in "Wonderwall," the learner received trophies.


Figure 3.5: Chart displaying all the possible achievements to receive from the challenge list and their level of difficulty to achieve.

To further motivate the learner to continue attempting these challenges a progress bar was created showing how many times the learner needed to play the chords in the guitar riff to make it to the next level. To the right of the progress bar the next level and medal to be earned was displayed with a symbol of a lock, a common

symbol used in games to represent an achievable object or level. Once the learner completed a challenge they were given a notification on the screen congratulating them on completing the challenge and encouraging them to proceed to the next challenge. The notification lasts 10 seconds before fading away, giving ample time to read the notification and without needing to take hands off the guitar to remove it.


Image 3.3: Image of a notification the player would receive when they completed a challenge.

As mentioned in the literature review, leveling up is an important part of gaming, giving the player a consistent feeling of accomplishment and continually offering the challenges of making it to the next level. The challenges list serves as short-term goals for the player to accomplish with added recognition, while an overall goal was presented as a level bar in the upper right of the screen. The level included five levels: each one would be made more difficult to achieve than the previous one and similarly to the challenges the difficulty to level up would be based on data from the performance of the control group. If the participant was able to successfully move up to the next level, they would be rewarded with progression in the narrative and new stimulus such as level changes and extra band members.


Image 3.4: Image of the leveling system shown by a progress bar in the game.

The level bar was designed to increase every time two of the displayed chords in the guitar riffs were played consecutively, which is referred to in the experiment as a chord exchange. When learning to play the guitar it is not as effective to have the learner play a single chord multiple times but to build muscle memory by moving their fingers from one chord position to the next. For this reason the learner was rewarded with an increase in the level meter only when they made a chord exchange but not by continually strumming a single chord. The possible chord exchanges included: E minor – G Major, G Major – Cadd9, Cadd9 – D Major, E minor7 – Gadd5, Gadd5 – Dsus4 and Dsus4 – A7sus4. Each chord exchange could also be played in reverse order so if the learner did a chord exchange from an E minor to a G Major and then from a G Major back to an E minor they would be awarded two progress points on the level bar.

## Interaction Design

Human to game interaction through a guitar was an integral part of the development for this project. Several components connecting the MIDI guitar to the UI needed to be developed to control the interaction and game-play by playing the *YouRock Guitar*. It was essential to the project that participants learn to play particular chords and is rewarded with feedback for playing them correctly. In order to do so the MIDI data needed to be interpreted correctly by the software and interfaced with the UI to create this interaction.

Most self-mediated guitar learning experiences are judged primarily with the ears, listening to see if the chord played sounds correct in relation to the song. With the use of the MIDI guitar it was made possible to give visual feedback based on how participants played chords. This was done by bridging the MIDI data

to Flash CS5 with the software *Midibridge* and then linking that data to specific commands within Flash. With the *YouRock Guitar* connected to the computer via USB the software *Midibridge* would recognize the device and could view the information from the device when played. When the *YouRock* device is played it will supply a number visible on the *Midibridge* interface representing the note played. These numbers would tell which string was being held (touch sensor on the *YouRock Guitar*) and where it was located on the fret board. For example, pressing down on the "B" string (on the second fret) would produce the number 47 on the MIDI data display. These precise numbers from the MIDI data allowed for a series of chords to be formed and utilized, creating an interaction with the interface.

When each note is correctly played the number that corresponds to the note is then set to "true". When all of the numbers needed to complete the chord are equal to true then the chord is considered true and will trigger feedback within the UI such as the chords illuminating in the learning UI and the avatar strumming the guitar in the game design version. Once the chord had been completed all note values were set to return to false so this action could be repeated. If a chord was equal to true it would stay true until the next chord to the right displayed in the learning UI was correctly played and then what was called a chord exchange would be made.

In order to play the chord correctly the user did not need to strum all the chords at once but could also play the strings individually and when the all the numbers required for the chord were complete it would register as the chord being true. This was considered okay as some beginners might try to play the strings individually and expect feedback to see if they had played it correctly. However, setting the notes to true once played created the issue of having chords played at random times by not resetting the notes to false unless the entire chord was played. For instance, if note 47 was played, the first note in the E minor chord, then it would stay true until the second number needed, 52 was played completing the chord. This created

feedback from the game and the numbers would be set back to false. To resolve this issue a chord counter was implemented in the software that kept track of how many notes were played on the *YouRock Guitar*. The chord counter was set to count down from eight, and each time a note was played it would subtract one. Once the chord counter reached zero, all notes would be reset to false.

Eight was the chosen number as it gave the player some room for unsuccessful attempts at the chord. Since each chord contained 2 – 3 notes, several attempts could be made at playing the chord correctly before the notes would be set back to false. Although testing this implementation seemed to resolve the issue it also had the ability to register chords incorrect even when they were correctly played. If six or seven notes were played consecutively without a chord from the game being correctly played in between then the eighth note could be played the time the player would have correctly completed a chord. This would result in the chord registering as false even if each number in the chord was correctly played. However, continually testing the interaction design proved that the chances of this happening was too confined to create a noticeable difference yet it created a much more accurate reading of the chords even amongst beginners.

As mentioned before, the chords used in this project are E minor, E minor7, G Major, Gadd5, Cadd9, D Major, Dsus4 and A7sus4. These chords consisted of two to three individual numbers obtained from the MIDI data defined the chord as correctly played. Some chords could be played in multiple ways and therefore considerations were made in determining what was playing the chord correct. For the first chord played in the verse from “Wonderwall,” E minor7 could be played with the addition of the “E” string or without. From experience the verse to “Wonderwall” sounded more correct to the original if the “E” string was added, it was also easier to play the entire verse as the rest of the chords all included holding down the “A” and “E” strings on the third fret so the two fingers holding these strings never needed to move.

If the user wanted to play the E minor7 without the “E” string, it was decided that the chord would still be considered correct but the chord would be displayed instructing the learner to play it as shown. The E minor7 with the addition of the “E” also caused conflicts with the A7sus4 as it contained all the numbers in the A7sus4 resulting in both being played every time the E minor7 was played. This problem was corrected by leaving the “E” number out of the E minor7. A similar conflict arose with the G Major and the Gadd5 as the Gadd5 was the same as the G Major only with the addition of one number. The Gadd5 was only present in the chords listed for “Wonderwall,” which could also be played with the G Major according to some online guitar tabs and videos. Therefore, if the user played a G Major or Gadd5 both would be deemed correct when attempting to play either of the chords.

Other issues that could result in a miss-calculation of a chord being correctly or incorrectly played mostly had to do with the *YouRock Guitar* itself. The guitar strings were not as sensitive as real guitar strings and thus did not always recognize a note being played if the string was played lightly. The touch sensors also appeared to be less sensitive when attempting certain chords, mainly the Cadd9. Often when practicing the Cadd9 it appeared to register less than other chords and thus the issue could either have been software related or a result of the sensors on the *YouRock Guitar*. Additionally, the *YouRock Guitar* would continue to register notes as long as fingers remained in contact with the touch sensors on the fret board making it so some notes could be played without strumming. Case in point, if the player strummed an E minor chord, kept their fingers in this position and only moved their middle finger in position to complete the G Major chord then it may register as a completed “G” chord without the need to strum the *YouRock Guitar* again. Although the system was not 100 percent accurate all of the time, it still proved to work and recognize the individual chords being played with a fair degree of precision amongst beginners and advanced players alike in a final systems test.

# Test Design

## Hypothesis

The hypothesis of this test is the addition of game mechanics to a self-taught mediated guitar learning experience will increase the participants' motivation to practice guitar. Conversely, the null hypothesis is that there is no increase in motivation.

## Variables

Independent variables are the elements of the experiment that can be manipulated to produce different conditions for comparison that will ideally affect and change the dependent variable. The current study possesses two independent variables: the addition and omission of game mechanics. The outcome or dependent variable is whether motivation had improved within each subject. The two scenarios should be designed to teach the users to play the guitar exactly the same way but having one scenario consist of various game mechanics designed to motivate the user, without aiding in the user's knowledge of guitar.

To measure motivation of the user between the test groups three dependent variables are defined: Practice time, enjoyment of the interface, and the desire to continue practicing using this method after the completion of the project. Practice time is the amount of time passed from when the user starts the experiment to when they have finished. As the saying goes, *Practice makes perfect*, the longer the user practices the instrument the better their skills will become. This variable should be designed for the user to decide on their own free will, letting them choose how long they would like to practice for. By allowing the user to decide when to stop it can be determined how long it takes before they no longer have the motivation to continue practicing.

It is known that everyone has different schedules and thoughts occupying their mind. These differences can be a reason for the differences in practice time as some may choose to practice for lesser amounts of time simply because they have somewhere they need to be rather than because they want to stop practicing.

However, increased motivation intended by the application of game mechanics is believed to create a deeper level of focus, directing more attention to the game creating a sense of time loss leading the player to practice for longer. If enough participants are accurately tested for the time they spend practicing the guitar in similar scenarios then the mean will depict if there is a noticeable difference in motivation to continue practicing between the two groups and the results will be valid. Because the time spent is optional to the user the results must be analyzed carefully to eliminate any outliers, such as people who play for a significantly shorter or significantly longer time periods than the rest of the participants.

Time spent studying the chords on the screen is not considered effective practicing and neither is playing the same chord over and over again. Learning the guitar requires the learner to be physically active, making mistakes and increasing muscle memory by becoming faster at correctly shifting from one chord to another. Guitar instructor, Justin Sandercoe (n.d.), in his online video tutorials said when learning guitar it is not beneficial to practice what you know, it is important to practice what you do not know. For this reason this project seeks to increase practice efficiency in the game mechanics group compared to the non-game mechanics group by motivating the user to increase the variance of correctly played chords on the guitar. What is meant by variance is that many participants may learn two chords and just stick to those, but by motivating the user to practice a larger variety of chords they will have learned more about playing guitar during the test session. When learning a song the participant should take the time needed to play the chord correctly before they move onto the next chord. As they continue to do these movements they will gradually become faster at completing the chord change. It is also possible by measuring the number of chord changes per minute it can be analyzed how fast the user is progressing if game mechanics can

motivate the user to successfully complete more chord exchanges than the group without the game mechanics.

The last dependent variable is the user's desire to continue practicing the guitar using application/game design they used during the test experiment. This is a subjective question asked to the participant after they have practiced the guitar under the independent variable. It would be most effective if a longer test could be created testing the participant's desire to continue practicing guitar using the given method over several days but this would require a much larger experiment beyond the scope of this project, for the time begin. However, by asking the right questions at the end of the test it can determine the overall desire that the participant has to continue practicing guitar using the method and then compare it between the two test groups.

## *Participants*

To create a test scenario that will generate valid results is crucial in defining the correct target group for this experiment. Any average person can learn to play the guitar. Therefore the test participants do not need to be restricted to a specific category such as gender or profession. Although, it is desired in the experiment not to motivate those who already have guitar experience but for those with little to no guitar experience because they are the ones who could need additional motivation to practice and become good. The current author's theory behind this is that once guitar players can play a few songs they will have more motivation to continue to practice due to their increased abilities and enjoyment of seeing instant results of their progress. It is believed that beginners will benefit more from having a learning environment that will assist them in the learning process. Therefore the target group should be guitar players who do not continually practice on their own, as the experiment is a learning process the guitar players should not have knowledge of how to play the chords presented before entering the test scenario.

People from all ages, professions, ethnicities and genders have learned to play the guitar and they do. The only largely considerable

advantage a beginner guitar learner may have over another in the case of profession, gender or ethnicity is if they come from a musical background. When attempting to teach a skilled piano player how to play chords on a guitar it was observed that although they had knowledge of a musical instrument, holding down strings and strumming a guitar felt foreign to them. Still it could be that the participant has knowledge of a string related instrument such as bass guitar it may be easier for them to understand and play the guitar. For this reason it should be noted if the participant plays a different instrument but does not play the guitar, to see in the test results if there is a significant difference in motivation across the dependent variables but these participants should not be placed into a different guitar experience category or excluded for the experiment.

Although there may be either more male guitar players than female or visa versa, this is not a defining factor in what makes a person capable of learning the guitar as there are both female and male guitarists of all different skill levels. For this reason gender should not be a factor in the results but it should be a fairly equal number of participants should be targeted to eliminate if gender is indeed a factor for in the test participants.

Age is also a factor in this experiment as it is common knowledge that younger ages have the mental capabilities to learn faster and become more engaged in the learning process than those who are older. Sandercoe (n.d.) states from his teaching experience, that students that are roughly 18 years and younger learn quicker than those of an older age. Therefore, the desired age range for the test participants will be from 20 to 30 years old to diminish the chances of greater motivation of learning process due to age.

An additional factor to consider within the test participants is whether they are left or right-handed. Most guitar players utilize right-handed guitars and not just for the reason that they are right-handed. The author of this dissertation is left-handed but feels much more comfortable playing the guitar right-handed. It is

important to have the participant list if they are left or right-handed to determine if there is a lack in motivation to practice simply due to preference of hand placement.

## *Experimental Method*

The experimental method for this test will need to be a between subjects design as each participant will need to be assigned to a different condition. The control condition will be the mediated guitar-learning environment without the use of game mechanics and the experimental condition will incorporate the game mechanics. If within subjects design testing were used, which would test each participant with both conditions it could produce in accurate or biased results as the participant will have already improved their knowledge of guitar from the first condition before proceeding to the second condition. Therefore it is better when testing the users motivation to practice guitar if the two groups are compared against each other. However, due to the nature of a between subjects design individual differences between users can create a difference in results. This is why the test participants and scenario should be chosen carefully to represent the population of the desired target group.

The test desired to create the most comfortable learning environment for participants as possible, since when most individuals learning guitar practice on their own it is in the comfort of their own homes, with their own guitar and no one else present. However, because the test required a fairly elaborate set up and the participant needed to be evaluated on several different measures, a controlled environment was required and needed to be designed to be as comfortable and distraction-free as possible. It was thought that by having fewer distractions the participants could engage themselves more in the test environment and the most accurate results could be produced.

## *Evaluation Methods*

To obtain a well-formed understanding of how the different interfaces could be affecting the participant's motivation, several

methods of evaluation were designed to analyze the participant before, during and after the experiment. Pre- and post-questionnaires were designed to analyze the participant before and after the experiment, also followed by a face-to-face interview with the participant to further discuss their experience with the interface. During the test the participant's interaction with the interface, their data would be unknowingly recorded through computer logging. This included data such as the chords played, chord-exchanges made and total practice time. For the game design group supplementary information was recorded including the possible the customization of a character and achievements earned.

As noticed in previous experiments there are a significant difference between those who have played guitar a little and those who have never touched one. Thus a pre-questionnaire was required to obtain information about the participant before undergoing the test. This could be used for further analysis to determine causes for extreme differences between the test subjects. Some questions in the pre-questionnaire were designed to offer a general understanding of the participant including their gender, age, if they played music games like *GuitarHero* (2005). The participant was also asked if they were left or right handed to see if this made a difference in their results as the *YouRock Guitar* could only be played right handed.

The following questions pertain to the participant's music knowledge and playing ability. Three questions asking the players guitar playing experience, experience with other instruments and level of desire to learn to play guitar were asked on a Likert Scale from 1 to 7. Asking the participants their level of guitar playing experience would determine how they should be compared to participants from the other group. On the questionnaire 1 was said to equal never playing guitar before, 3 playing once a month and 7, practicing regularly. This question was followed by a multiple-choice question, asking the player how they learned to play. The participants' guitar playing abilities could also be affected by their musical experience with other instruments, such as bass guitar. For

this reason an open-ended question about other instruments they might play followed by a scaled question on their experience with this instrument. The last question asked the participant about their desire to learn to play guitar, this question corresponded to a question in the post-questionnaire asking the participant their desire to continue practicing guitar with the interface used. This question was asked to later compare between the groups to see if there was an overall difference in desire to continue to practice using one interface over the other.

During the test phase the participant's interaction with the interface was evaluated with computer logging. Since the interface was played using a browser, computer logging of the data was incorporated using the Modzilla Firefox Browser add on, *Firebug*. *Firebug* enables an output window for flash files played on browsers. Using this add on data from the MIDI guitar could be obtained instantly as the user practiced. For this experiment data was recorded from each participant including: chords correctly played, chord exchanges made and total time played. When the participant had completed the tutorial they would click a start button starting a timer that would record their practice time in seconds on the *Firebug* log. Only time spent learning the chords on the interface was considered practice time therefore if the participant did not understand the interface and needed to see the tutorial again by clicking on the help menu their time would be stopped and then started again once they returned to the main interface.

Each time a chord was played it would be recorded in the data log. Also, because the participant's progress was evaluated on the number of chord exchanges they made, each chord exchange was also logged including the name of the chord exchange and the time in seconds the participant completed the exchange in relation to the practice timer, i.e. E minor – G Major time = 203.116. By tracking the times participants made chord exchanges, it would be possible to see how they progressed over the practice session and what

chords exchanges were made and how much time passed between each chord exchange. Further data would also be recorded such as what songs the participant attempted to learn, how many times they referred back to the tutorial. For the game design group how many challenges the participant completed, the overall in game level and if character customization was made were also included in the data log.

During the practice time it was desired that someone was present in addition to the participant not for guidance but for observation to monitor the participant. This needed to be done in a way that did not make them feel like they were practicing in front of an audience as this could make them feel pressured or uncomfortable. A separate computer was set up across the room with a divider in between the participant and the observer allowing the observer to listen to the participant's progress and if they were having any difficulties without them feeling as if they were being continually monitored. During their practice session: If the participant asked for help they were given short answers or asked to refer back to the tutorial but no additional information such as how to play the chords were given.

The time the participant spent practicing was to be decided by the user. This way it could be determined if the game mechanics had an effect on their desire to continue practicing, thus enhancing their motivation to continue. In the beginning of the test the participant was instructed to click a stop button in the lower right corner when they had decided they no longer had the motivation to practice. The stop button then recorded their overall practice time minus the time they spent viewing the tutorial. After the test they would be asked to fill out a post-questionnaire followed by an interview on their experience.

The post-questionnaire consisted of open-ended and scalar questions to learn about their experience such as: if it was frustrating, enjoyable and had an effect on their motivation to continue play. The open-ended questions pertained to the

participant's experience asking their reasons for discontinuing to play and if their was anything in particular that made them want to play until this point. Another question asked them to answer if there was anything they found frustration or enjoyable about the interface and to describe their impressions of *GuitarTrainer*. This would be to gain better feedback on the emotional experience the players had with the software. If the participants had a more enjoyable experience then they would most likely feel motivated to continue to play for longer. Whereas if they felt the software was frustrating then the participant would be more likely to give up and discontinue to play.

To reinforce the emotional experience the players had, scalar questions asked on the Likert scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree if they found playing guitar with *GuitarTrainer* an enjoyable experience and if they found it helpful in learning the chords presented. If they found it both helpful and enjoyable the participants would most likely feel more motivated to continue practicing and return for more afterwards. To solidify the question if they had motivation to continue playing with this software after playing with *GuitarTrainer* the question was asked would they like to continue to practice guitar using this method, 1 being they would not like to continue to play using this method 7 they would definitely like to continue to practice guitar using *GuitarTrainer*. The answer to this question would be compared to the pre-questionnaire, what is their desire to learn to play guitar. This way the participant's total motivation to play guitar before and after using the software could be compared between the two groups to see if the game mechanics had a difference. Following the post-questionnaire a brief interview was given for a chance for the participant to elaborate on their experience.

# Results

Measuring motivation for this project has revolved around improving the participant's willingness to make an extended commitment to engage in a new area of learning. The new area of learning was proposed to the participants through an interactive application that would teach them to play guitar. Measuring the participant's motivation was conducted in several ways such as: Measuring their desire to practice for an extended period of time, their willingness to perform a higher variety of chords, and desire to continue to practice with this method after their initial practice time was over. This chapter will compare the results found by testing for increased levels of motivation between 59 participants: 13 female and 46 male. 30 participants used the guitar training software developed for this test with game mechanics and 29 who used it without.

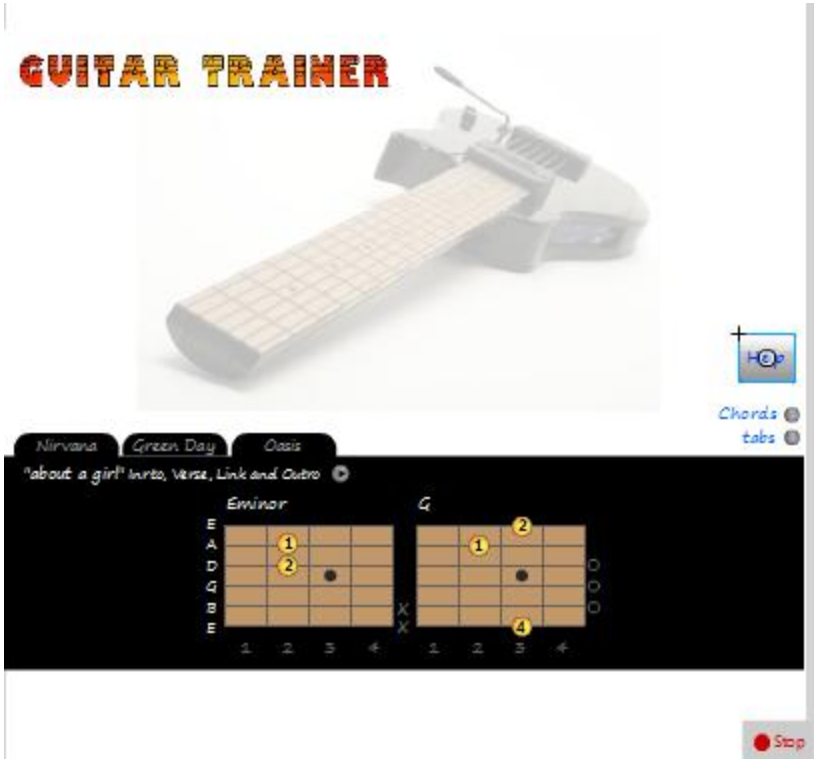



**Image 4.0:** Image of the control group's version of the software.

The test was conducted at Aalborg University, Copenhagen, on April 11th – 22nd 2011, testing 59 students from the Medialogy department. The test environment consisted of a large room, at one end was the test set up consisting of the *YouRock Guitar* (2010), a laptop connected to a 21" monitor screen that displayed the

learning interface (1000px x 789px). On both sides of the monitor a Logitec Z5500 5.1 surround sound speaker were added to increase sound quality. The *YouRock Guitar* connected to the laptop via USB in order to deliver the MIDI data to the system and through the *YouRock Guitar's* Audio out port was connected to the Z5500 speakers. When strummed the speakers would deliver the sound of the *YouRock Guitar* and if the chord was played correctly the interface would react, accordingly. The participant was also given a wireless mouse to control certain commands on the interface such as navigating through the tutorial or clicking on the *Help* button. The participant was also given a guitar pick if they preferred playing with this method

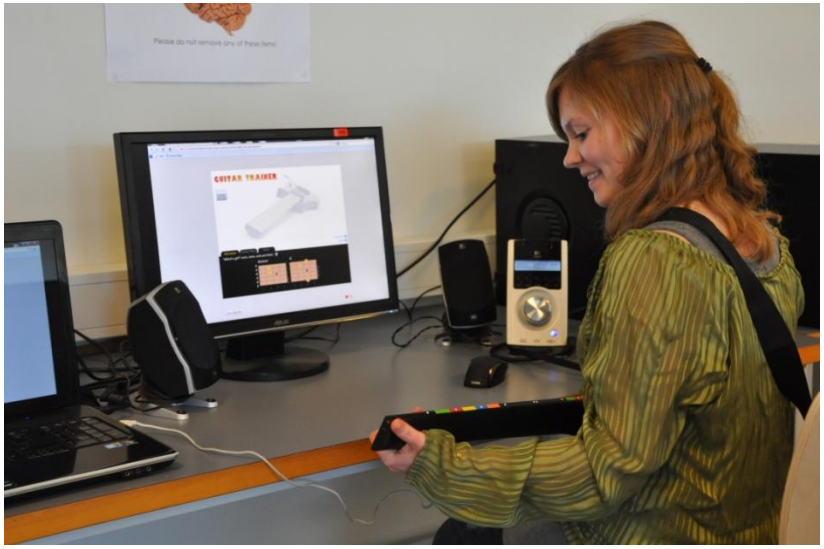



**Image 4.0:** Image of the test set up including hardware used, the image on the screen was from the control group.

It was necessary for the study to determine the participants playing abilities to see if there was a difference in motivation dependent on their previous knowledge of the guitar. In the pre-questionnaire the students were asked to list their guitar playing abilities on a scale from one to seven. One being they have never played guitar before, three if they play once a month and seven if they practice regularly. All participants answered that they were either a level one, two, five

or seven. Participants were also separated into two groups of different level guitar players, beginners if they replied with a one or two and advanced if they answered with a five or seven.

Of the control group (without game mechanics) 17 answered with a one (that they had never played guitar) and seven said they were a level two. Thus, creating a total of 24 participants at a beginners level in the control group. In the game design group 14 were listed as level one guitar experience and nine were level two giving a total of 23 beginners in the game mechanics group. In the advanced group for the control group five participants said they were a level five and one a level seven, a total of six advanced participants. The advanced group had the same results as the beginner group, five participants at a level five and one listed as a seven.

## *Practice Time*

An independent T-test was utilized to compare the control group against the game mechanics group for the total practice times. Only one participant was eliminated from the beginners game mechanics test group, because they played for a total of 64.18 minutes (3851.039 sec.), only stopping after they received a blister on their finger. Including this participants' data would have skewed the results and left them inaccurate, and less valid. Omitting this participant left the results with a comparison of 28 gamers (22 who were beginners and six advanced) vs. 30 non-gamers (24 beginners and also six advanced). The average practice times shown by the mean results for each group were calculated and are listed in the table 1.0.

| Test Group | Number of Participants | Mean (sec.) | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Total Game | 28 | 739.41 | 386.92 | 73.12 |
| Total Control | 30 | 458.49 | 200.10 | 36.53 |
| Beg. Game | 22 | 667.59 | 309.70 | 66.03 |
| Beg. Control | 24 | 476.24 | 191.87 | 39.17 |
| Adv. Game | 6 | 1002.74 | 547.42 | 223.48 |
| Adv. Control | 6 | 387.48 | 235.21 | 96.02 |

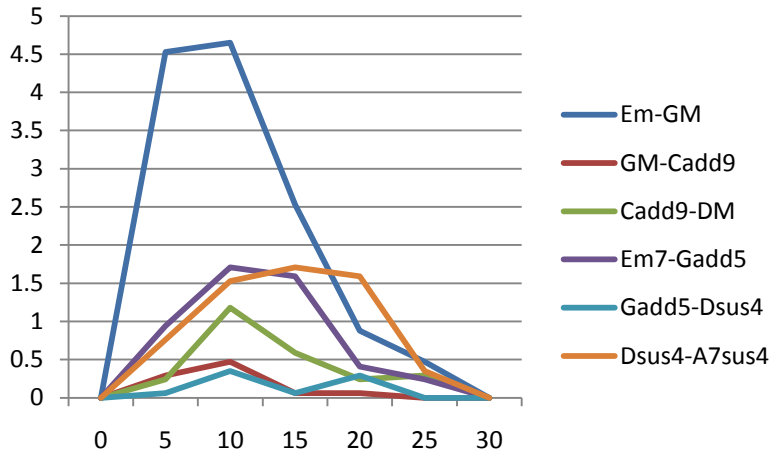
Table 1.0: Total Practice Time

The quality of the practice session, seeing how the participants played between both groups in relation to their practice time was also calculated. This would ensure that the participants continued to practice guitar during their session instead of, for instance, admiring the background to the game mechanics. Additionally the question of whether differences existed between the average amounts of chord exchanges completed between the two groups over time was explored. This was done by calculating the means of the amount of chord exchanges played in five-minute intervals for each chord exchange.

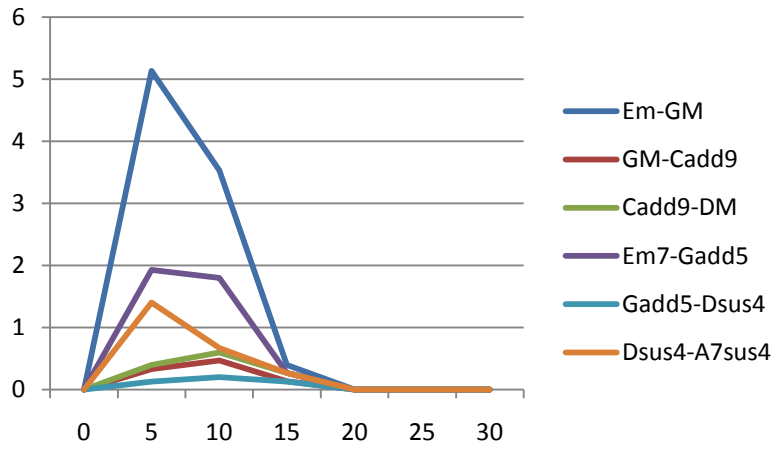
A few test participants were eliminated from the line display depending the impact they had on the data. In example, for the line graph although some participants were able to play chords but did not make chord exchanges therefore data about their progress was not recorded. This included participants #1, #2, #7, #12, #19, #22, #24, #27 and #28 from the control group and participants #48, #55, #56, and #57 from the group with the game mechanics. These participants were not ruled out of the practice time results because they did attempt to practice with the software for some time, some even proved to play chords and get feedback from the software. However, these participants would only decrease the mean values of the chord exchanges over time but would not contribute much

contribute to the data when comparing between the two test groups, therefore were eliminated.

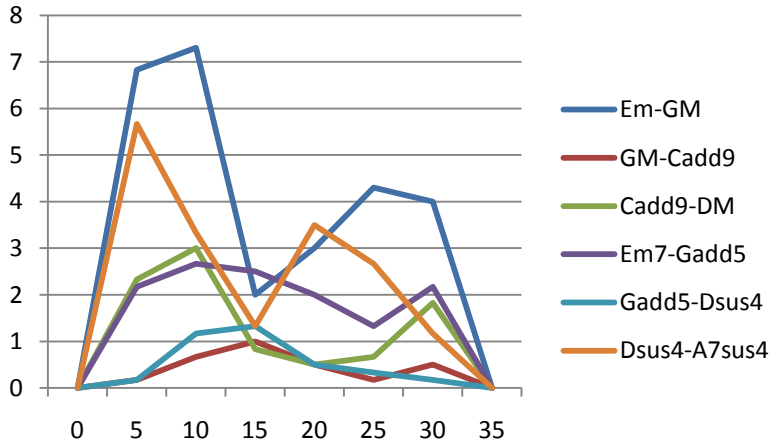
On the other end of the spectrum a few test participants were eliminated for achieving significantly high scores different than the rest of the participants in their category. This included test participant #42, a beginner from the game design group who played for over an hour and scored much higher in multiple chord exchanges then the rest of the participants in this group. Other participants that were eliminated were participants #51 from the beginning game design group and #11 from the control group. These participants were eliminated because from their data it was apparent they continually made chord exchanges between the E minor and G Major, scoring a significantly higher amount in this area when compared to other participants. All the advanced players data was utilized as they were all able to complete a number of chord exchanges. Although most of the game design group scored much higher than the control group, this was more consistent than the few extremes from the beginners group. Leaving the remaining participants, 17 gamers and 14 non-gamers from the beginner's category, six participants for the advanced category for both the game mechanics and control group.



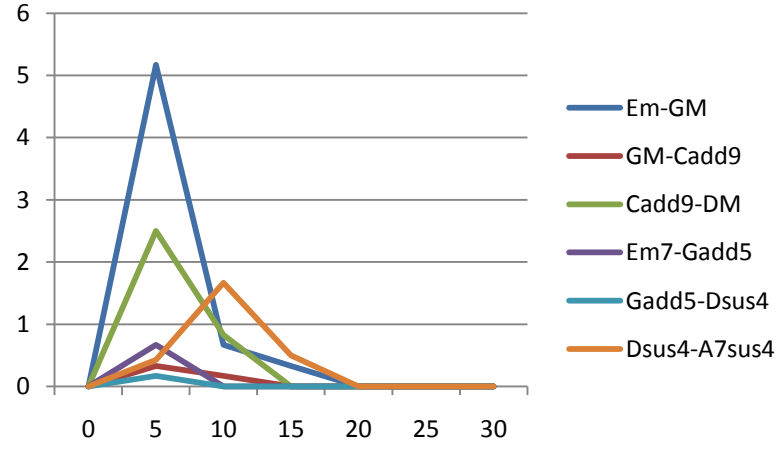

Graph 1.0: Beginning gamers mean chord exchanges over time.




Graph 1.1: Beginning Non-gamers mean chord exchanges over time.




Graph 1.2: Advanced gamers mean chord exchanges over time.




Graph 1.3: Advanced Non-gamers mean chord exchanges over time.

## *Difference in Chords:*

Several of the game mechanics were designed to encourage participants to attempt each chord in the song and play them multiple times, such as the character customization and challenges. If participants played a larger variety of chords in the game mechanics group then the motivation to do so could be influenced by the game design. To analyze this, data was collected from the computer logging and percentages of the total amount of chord exchanges made were divided into percentages and shown on pie chart. The same participants that were removed from the line graphs showing the progress over time were also eliminated from this data as to not skew the results because of a single participant. The data can be compared in the figures below, both beginning and advanced participants between the control and game design group.

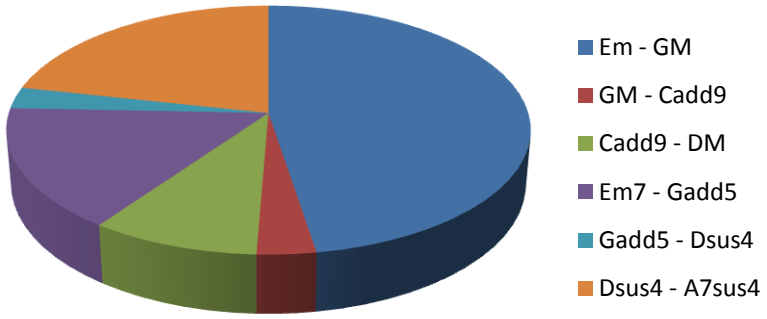



Chart 1.0: Beginning Gamers pie chart of total chords played.

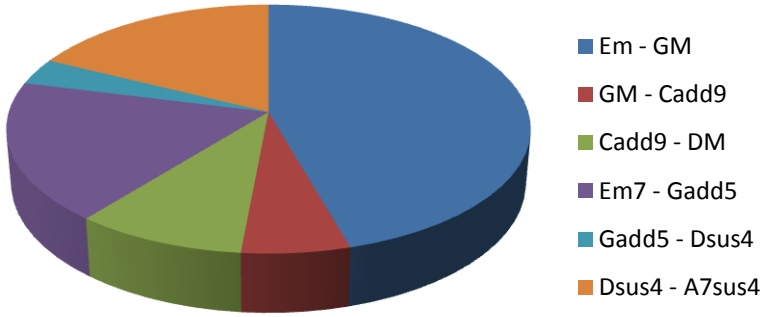



Chart 1.1: Beginning Non-Gamers pie chart of total chords played.

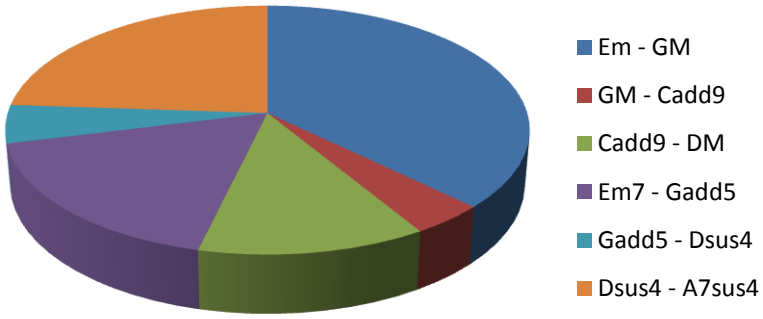



Chart 1.3: Advanced Gamers pie chart of total chords played.

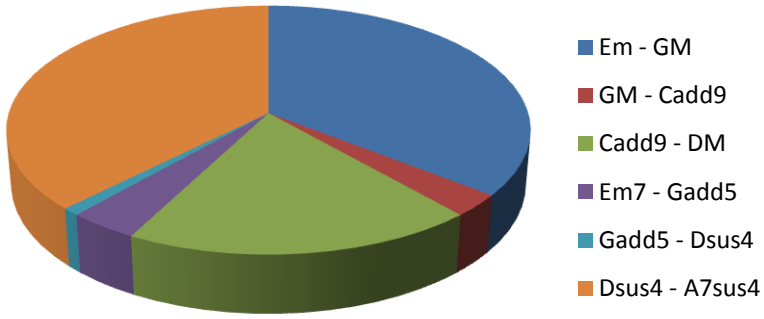



Chart 1.4: Advanced Non-Gamers pie chart of total chords played.

The results from the pie charts show, slight differences between the groups. In both the beginner groups they played more Em - GM chord exchanges than anything else. While the control group for the beginners played more GM – Cadd9 chord exchanges the gamers played more of the Dsus4 – A7sus4. For the Advanced groups the gamers played a good variety of chord exchanges, like the beginner group, they played more Em – GM chord exchanges but also expanded to play a higher level of Cadd9 – DM, although less GM – Cadd9 chord exchanges.

For the advanced non-gamers, they played a significantly higher percentage of Cadd9 – DM chords exchanges then any group, also playing a high percentage of Em – GM and Dsus4 – A7sus4.

## *Enjoyment, helpfulness and desire to return:*

The questions of the participant's enjoyment, how helpful they found the software in learning and their desire to return were compared between the two groups for the total, beginning and advanced participants. The results for the participants' levels of enjoyment after using the software are listed in table 1.2. Supplementary, other answers from the player's impressions of the software were devised into the categories positive, negative and neutral. Positive responses were categorized such as "liked application and feedback," "good for beginners" and "nice and informative". While negative impressions of the game included answers such as, "too difficult," and "couldn't understand." Neutral answers included constructive criticism including answers like, "would like more feedback." The results of these answers show 14 positive, 10 neutral, and six negative for the control group and 17 positive, 10 neutral, and only two negative for the group with the game mechanics.

| Test Group | Number of Participants | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Total Game | 29 | 3.79 | 1.05 | .19 |
| Total Control | 30 | 3.30 | 1.24 | .23 |
| Beg. Game | 23 | 3.74 | 1.05 | .22 |
| Beg. Control | 24 | 3.38 | 1.31 | .27 |
| Adv. Game | 6 | 4 | 1.10 | .45 |
| Adv. Control | 6 | 3 | 0.89 | .37 |

**Table 1.2** Total Level of Enjoyment, Gamers vs. Non-gamers.

## *Desire to continue*

It was known that possibly many of the participants would have the desire to learn the guitar before entering the test, and it was desired to know if the addition of game mechanics to this software would increase their motivation to continue learning with this method. In the results in the table 1.3 the mean score of the participants desire to play guitar before undergoing the test and

their desire to continue using the software (if they had access to the system) are compared between the two test groups in separate independent T-tests listed below. The T-tests are once again categorized by total, beginning and advanced participants followed by a table including a comparison of the difference between their initial motivation to play guitar and their desire to continue practicing with this software after the experiment. The results below show that both beginning and advanced gamers had a greater desire to continue practicing guitar with *GuitarTrainer,* after the practice session when compared to the control group. This data shows the mean desire the different groups had to play the guitar before the experiment, question number nine on the pre-questionnaire when compared with their desire to continue using this software, question number three on the post questionnaire. The table below is an overview, comparing the means and including the numerical difference of their desire to continue practicing with

| Test Group | Number of Participants | Desire to learn Mean | Std. Deviation | Std. Error Mean | Desire to Continue Mean | Std. Deviation | Std. Error mean |
|---|---|---|---|---|---|---|---|
| Total Game | 29 | 3.93 | 1.90 | .35 | 4.90 | 1.61 | .30 |
| Total Control | 30 | 4.37 | 1.83 | .33 | 4.00 | 1.89 | .35 |
| Beg. Game | 23 | 3.65 | 1.90 | .40 | 4.78 | 1.62 | .34 |
| Beg. Control | 24 | 3.92 | 1.67 | .34 | 4.29 | 1.83 | .37 |
| Adv. Game | 6 | 5.0 | 1.67 | .68 | 5.33 | 1.63 | .67 |
| Adv. Control | 6 | 6.17 | 1.33 | .54 | 2.83 | 1.83 | .75 |

Table 1.3 Desire to Learn to Play Guitar and Desire to continue playing with Guitar Trainer.

the software. The following results show that the advanced control group had the highest negative discrepancy between the desire to learn and the desire to continue. Whereas the advanced game mechanics group, conversely, showed the smallest discrepancy between the two variables measured and interestingly had a positive difference. The beginning game mechanics group, had a much higher positive difference between the two variables, than the control group. Possible causes for these results will be analyzed in the discussion section.

| Test Group | Desire to Learn Mean | Desire to Continue Mean | Difference |
|---|---|---|---|
| Total Game Mechanics | 3.93 | 4.90 | + 0.97 |
| Total Control | 4.37 | 4.00 | - 0.37 |
| Beg. Game Mechanics | 3.65 | 4.78 | + 1.13 |
| Beg. Control | 3.92 | 4.29 | + 0.37 |
| Adv. Game Mechanics | 5.0 | 5.33 | + 0.33 |
| Adv. Control | 6.17 | 2.83 | - 3.34 |

**Table 1.4** Desire to Learn to Play Guitar and Desire to continue playing with GuitarTrainer. Mean scores of all groups showing differences between the means.

### *How Helpful Was GuitarTrainer?*

Determining the degree that the participants found the software helpful in their learning process would also support the answer to if they would feel more motivated to continue practicing with this software. Below are the results pertaining to this topic. The results showed that the beginners and the advanced group with game mechanics found that the Software, *GuitarTrainer*, was more helpful in learning to play the chords in comparison to the control group.

| Test Group | Number of Participants | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Total Game | 29 | 3.86 | 1.09 | .20 |
| Tot. Control | 30 | 3.12 | 1.23 | .23 |
| Beg. Game | 23 | 3.91 | 1.04 | .22 |
| Beg. Control | 24 | 3.33 | 1.27 | .26 |
| Adv. Game | 6 | 3.67 | 1.37 | .56 |
| Adv. Control | 6 | 2.50 | .84 | .34 |

**Table 1.5** Was Guitar Trainer Helpful? Gamers vs. Non-gamers.

Beginning gamers found it more helpful than the advanced gamers.

# Discussion

Several of the game mechanics seemed to prevail over others when effecting motivation for different types of players. In the control group, players strived to obtain feedback by making the chords light up after playing a chord correctly. One participant from the control group responded with:

*"Nice feedback when you get the right combination. That really motivated to move forward." – Participant #3*

Although the feedback gave the player's encouragement to move forward some beginners were unable to make it to this point, not developing a full understanding of the software in the beginning. This is why some players were unable to conduct chord exchanges and thus, ended their practice session. While some beginners found

it simple to understand, others did not. Although they strived for feedback, they were met with frustration when they did not play them correctly. Hence the tutorial in the beginning should have been incorporated into the game instead of read through, making certain the beginners effectively understood the software before being set loose on their own.

Although a few did not fully understand the software, the majority was able to play chords correctly and progress their scores. Some beginners made it past the struggling phase, to play a single chord right. They appeared to develop a greater interest in the challenge of learning, and continuing to desire feedback through their progress. Through the discussions and post-questionnaire the results showed that overall the game mechanics had a positive effect on the average participant's willingness to extend their practice session and desire to continue playing with this software. It was known that the target group would have different agendas. The test was done at a university where many students had their own projects to test and work on. Consequently they might have been pressed for time. This would have a significant impact on the amount of time they spent practicing the game. Nonetheless, the results suggest a significant difference between the game design group and the non-game design group then it could be said that the game mechanics had an effect on the participants willingness to extend their time practicing regardless of their agendas as all test participants were taken from the same sample group of students.

When comparing the total practice time of the gaming group vs. the non-gamers, it was clear that there was a significant difference between the two groups for both the beginning and advanced groups. The mean practice time of the beginner game mechanics group is equal to 11.13 min. (667.59 sec.), while the mean practice time for the control group is 7.4 min (476.24 sec.). The game mechanics group felt right over the desired practice time of 10 – 15 minutes. Whereas the group that played without the game mechanics resulted in a much lower practice time. This was also

apparent when comparing both the beginning and advanced categories. Although these results are in favor of supporting the theory that the game mechanics group would feel motivated to practice for a longer time then the control group these results to gain a further analysis to gain further assumptions on why this could be true.

One of the first aspects of the data observed is the standard deviation, which is very high in both groups and even higher in the game mechanics group. It was clear from the beginning of testing that the amount of practice time would vary greatly between each of the participants. In the control group the practice times ranged anywhere from the lowest practice time of 1.59 minutes (95.18 sec.) to the highest practice time of 13.6 minutes (816.14 sec.). The game mechanics group had a range between 2.03 minutes (122.01 sec.) and 24.23 min (1454.06 sec.). Having such a significant range of test times between the participants produced a high standard deviation. A much larger test group would be needed in order to create a more consistent variance between the norms, especially in the advanced group since the amount of participants was very low.

Although the standard deviation was high, the mean practice time still showed the game mechanics could have had an overall positive effect on the motivation for the majority of test participants to continue to play. Through further analysis of the post-questionnaire reasons why some players stopped or continued to play between the groups could be determined. Similar reasons for ceasing the practice session was due to time lack of time: 22 participants stated that their reasons for discontinuing to play was due to a lack of time (12 from the control group and 10 from the game mechanics group). Other reasons for stopping the practice session included: Too difficult or a lack of understanding for some that did not develop a fully understand the software. For those who did understand some responded with ending their practice session due to sore fingers. However, from the open-ended questions many of the participants within the game mechanics group gave positive

feedback directed towards the game mechanics motivating them to continue playing. From the beginners group some participants responded with the following:

> *"The achievements really spurred me to continue, I was losing interest and then all of sudden I was like whoa! and I continue to play."* - Participant #39.

> *"I was motivated to play each of the chords at least once."* - Participant #44

> *"Yes! Very entertaining! And motivating (you gain cups if level is completed.)"* - Participant #45

The challenges presented in the game design appeared to be intriguing by many, but the challenge of playing the chord correctly in itself proved to be a highly motivating part of the test. A few participants during the beginning of the game focused on some of the game mechanics such as earning achievements but after learning a few chords then their focus would shift to learning to play the music presented, and some entered "Tab Mode," to try to improve their rhythm. A participant from the game mechanics group stated:

*"The missions were an ok motivation to get started, but after the 2nd challenge I just tried to play the 3rd song (oasis) guitar hero style = 100 percent attempt."* – Participant #42

From much of the feedback from the discussions, post-questionnaire's and post discussions it appears that the main motivation for player's to continue was the need for an achievable challenge over the other game mechanics involved. Of the 29 game design participants only six actually modified their avatar. The data logging showed that many participants initially opened the customization window in the beginning of their practice session, and then closed it without altering their avatar. Some of the more advanced players customized their avatar but only after they had completed all the other challenges. Most participants were compelled by the challenge of playing the chord correctly in order

to earn the feedback that followed. Many comments from both the control group and the game mechanics group commented on the desire for feedback when they played a chord correctly, one participant stated:

*"I like it being software. Normally I would look for chords in books or so, but this gives the opportunity to supply feedback to the play as well, and that motivates to improvement."* – Participant #24.

It was also noticed within the advanced group that in some cases their only reason for discontinuing to play was because they had run out of challenges, completing all the game had to offer. In one discussion the participant from the advanced group was asked if the game mechanics had an effect on their motivation to continue playing, the participant answered with no but in their post questionnaire when asked their reasons for stopping their practice session they replied with:

*"There was no more achievements and I tried all of the different appearances, I wanted to unlock everything."*- Participant #36

Other similar responses from the advanced group included:

*"Wanted to complete all challenges before quitting." "I didn't want to stop halfway. I wanted to complete."* – Participant #37

Of the six advanced players five felt compelled to fully complete the game, the minimum amount of time an advanced player practiced for while completing the game was 9.4 minutes (563.86 sec). The one participant from the advanced group who did not complete the game had the lowest practice time of 8 minutes (479.56 sec.). In the beginner group four participants were able to fully complete the game the lowest practice time while being able to complete the game was 11.28 minutes (676.749 sec.). The next best time was significantly longer with 16.45min (986.79sec). These results could

suggest that the game took over 9 minutes for most advanced players to complete and over 11 minutes for the best beginners as there was not a feature implemented that logged the end of the game. Since both these times are much higher than the mean practice time for both the control and game mechanics group this result shows that the challenge of completing the game appeared to have an effect on extending the practice time for some of the participants.

The line graphs show the fluctuation in the number of chord exchanges over a 30min period. From the non game design group it is apparent that most productivity in the practice session happens between zero and ten minutes, then slowly decreasing until 20min. For both game design groups this time is extended, showing a again a high increase in chord exchanges between zero and ten minutes then decreasing towards the 15 minute mark, however around this time many of the number of chord exchanges made then begins to increase again around the 16 – 17 minute.

This is caused because some participants from the game design group chose to extend their practice session giving the graph a slight increase around 16 to 17min. Although this data is intriguing, due to the small number of total chord exchanges that actually happen per 5 minute intervals it only takes a few participants to make a difference, even though the extreme high scores were omitted from this test. However of the 59 test participants it was only gamers who chose to continue practicing after the 15min mark.

In the pie charts it is apparent that the most chords played by all groups was the Em – GM chord exchange, this was the first chord exchange presented in the game and also was considered the easiest to play which is most likely why it was the preferred choice to play for beginners. The beginning groups played a fairly close range of chords, possibly too close to determine if there was any significance due to the game mechanics. The advanced groups played higher percentages of Cadd9 – DM chords. These graphs could be skewed by a few participants who may have practiced a

single chord exchange more than others, making it hard to determine if the game mechanics actually had a difference in their motivation to play a greater verity of chords.

Some of the most effective results in determining if there was a difference in motivation created by the game mechanics came from the questionnaires. For the question on how enjoyable they felt practicing with *GuitarTrainer* was, it can be deducted that there was an overall greater feeling of enjoyment felt from the participant's using software that contained the game mechanics. This is also shown during the comparison with both beginning and advanced users when measured with the control group. The increased level of enjoyment was also reflected through observational techniques during the experiment. When testing the game design group an interesting yet ubiquitous behavior was observed. Within the test scenario for the first time, the participants started to laugh. Three of the total game design's group, two beginners and one advanced player experienced continual laughter throughout their practice session. This was an unexpected surprise of the test, which further validates the increased enjoyment felt by the group using the game mechanics.

This laughter also meant that there was an emotional connection to the game on a different level then the group without game mechanics. When one goes to the movies and watches a comedy if it makes them laugh they will sit and stay focused throughout the whole film, if it turns out not to be then they could possibly get up and leave. Laughter is not something that is generally sought after when practicing guitar but the elevated comical emotional experience felt by the participants most likely contributed to desire to continue practicing. Having laughter also points to possibly having a high level of involvement these participants were experiencing when playing *GuitarTrainer,* as their focus was solely on the game itself. Moreover, as several participants added in post-discussions and the post-questionnaires, the game had an effect on their emotional state, creating a more relaxing learning

environment when playing the game version. This made them desire to continue to play for longer.

*"Not stressful, turns it into fun which makes me want to practice longer,"* – Participant #50

*"Overall fun, didn't think I was wasting time."* – Participant #40

Not all, but some of the participants from the control group responded with more feelings of frustration or a lack of interest towards the software, which were less noticeable in the game mechanics group. Some of the responses in the post-questionnaires from the control group included:

*"I think it could be a useful tool if I had more motivation and/or experience playing a guitar."*

*"Too difficult…and I'm not really that interested"* - Participant #4

The responses for how helpful *GuitarTrainer* was in teaching the participant to play varied between both groups. In the beginners group some said that it was too difficult to understand while others said it was easy and explained very well. Some advanced players said that it would be great for beginners while others thought it would be too difficult. Many of the critiques said that easier chords should be presented with more instruction, although most beginners were capable of playing all chords. Advanced guitar players who had learned through guitar tabs did not like how the strings on the chord display was switched compared to guitar tabs online. However, the general consensus when asked to rate the helpfulness of *GuitarTrainer* in learning to play the guitar was higher in each category beginning and advanced for the game mechanics group.

The interesting aspect of this question is that nothing about adding game mechanics to the software was designed to assist the participant in their understanding of the music or how to play. In

fact the game mechanics were specifically designed not to give the gamer group an aid when learning the music compared to the control group. Consequently, both beginning and advanced participants concluded that the game with the game mechanics was more helpful in teaching them to play the different songs. This could mean that the participants felt it was more helpful not from an informational standpoint but through something possibly emotional. This also reinforces the results of having the game be a more enjoyable experience, which could be the reason they deemed the software more helpful with the game mechanics. One participant commented on the game mechanics as initial motivation in relation to their learning experience stating:

*"I don't know how to read sheet music, notes, chords, etc. but it seems as if I can learn to play tabs easily enough with this game. I could easily spend the next 30 hours getting the 3 songs perfect (as I did with "frets on fire" PC game which also only had 3 songs at first)…this, I play with as much enthusiasm as I have guitar hero! Great!!"* – Participant #42

The desire to continue practicing with *GuitarTrainer* after the practice session was also higher in both the advanced and beginning categories. For the advance players many of their reasons for not wanting to continue practicing with this method was a result of the MIDI guitar itself as most of them wanted to play with a real guitar. For the game design group some advanced players also needed a greater challenge then the current game had to offer, being able to beat the game entirely in one practice session. However, if the game play was extended it could also extend the practice time. In the Control group some advanced players demanded more chords and music to learn.

The beginning group Initially having less of a desire to play guitar, ended up having a much larger increase in desire to continue practicing with the software after the test session, therefore game

design group having an overall enjoyment of the practice session must have also contributed to their desire to continue.

# Conclusion

It was clear from the study that the game mechanics overall had a greater effect on the participants' motivation, both beginners and advanced guitar players. This was done by influencing participants to make a greater extended commitment to learning software through the implementation of game mechanics to the learning game. This was shown through extended practice times, desires to practice with the software again, increased levels of enjoyment and the feeling that the game mechanics were of greater help in their learning processes. When reflecting on the entirety of the project, it unraveled many questions about game mechanics such as that they can be applied to learning games while opening up new thoughts to how to the gaming experience can be improved in learning software to increase further player motivation.

From the experiment it is believed that increasing intrinsic motivation in games is largely based on a series of challenges and rewards. The reason why games are so motivating is because they are able to develop a system that gradually challenges the player at their own pace while matching their skill level, sparking their curiosity, as well as continuing to provide an abundance of feedback and stimulation for their efforts. The challenges, feedback and stimulation in some games are so powerful that they are able to alter the player's emotions compelling them to have an even greater interest in the media.

Not all game mechanics can be applied to a learning experience or a game for that matter and have the expected outcome result in higher motivation. Consequently, when utilized precisely and correctly, the motivational aspects of game mechanics can be effectively applied towards mediated learning experiences, which this project provides a good example of. Game mechanics should not impede the learning experience, but should aid in encouraging,

and guiding the individual while provided added stimulation to maintain their focus and yet relax them during the learning process. Training the guitar, amongst many other subjects, can be an intrinsically rewarding experience in itself and by applying game mechanics appropriately it can assist on the quest for self-improvement.

This study has enhanced the author's motivation to continue to further pursue a future in creating more effective, highly motivational mediated learning experiences through the implementation of game mechanics. If applied properly, learning games of the future will progress to a level that is equal to the leading online games and it is up to game designers to bring them to this level. With the latest innovations in game design and technology in mind, it is the author's wish that more companies will place greater emphasis on creating games for the future that extend a deeper connection to reality within the learning game settings, instead of focusing solely on the world inside a box that cannot be employed in the real world.

# References

*Addicting Games*: *Super Crazy Guitarman 2* (2010). Retrieved from: http://www.addictinggames.com/supercrazy2.html

*Akoff Music Composer 2.0* (2001). Retrieved from: http://www.akoff.com/music-composer.html

Bates, B. (2004). *Game design* [2nd Edition]. Boston, USA: Premier Press & Thomson Course Technology PTR.

Brutal Legend. (2009). Retrieved from: http://www.brutallegend.com/home.action

Calleja, G. (2007). *Digital Games as Designed Experience: Reframing the Concept of Immersion.* Victoria University of Wellington.

Carl, W. (1994). Flow- A psychology of optimal experience: History and critical evaluation. Unpublished manuscript. Rochester Institute of Technology. Retrieved from: www.waltercarl.neu.edu/PDFs.flowpaper.pdf

Carmen (2008). Soldiers in physical therapy find healing in Wii. *IUWii*. Retrieved from: http://iuwii.com/index.php/214/soldiers-in-physical-therapy-find-healing-in-wii/

Chatfield, T. (2010). 7 ways games reward the brain. *TED TALK.* Retrieved from: http://www.ted.com/talks/lang/eng/tom_chatfield_7_ways_games_reward_the_brain.html

Connell, R. (2008). *The Most Dangerous Game.* Rockville, MD, USA. Arc Manor Publishing.

Dictionary.com (2010). "Motive". Retrieved from: http://www.merriam-webster.com/dictionary/motive

Dirks, R. (2011). *Squire Stratocaster Guitar and Rock Band Controller Review.* Retrieved from: http://www.premierguitar.com/Magazine/Issue/2011/Jan/Squier_Stratocaster_Guitar_and_Rock_Band_Controller_Review.aspx?Page=2

Fender Squier Stratocaster Guitar Controller (2011). Retrieved from: http://www.fender.com/promos/2010/rockband3/theguitar.php

Fender (2011). Retrieved from: http://www.fender.com/#/tele-bration

*GarageBand '11* (2011). Retrieved from: http://www.apple.com/ilife/garageband/

*Gears of War 3* (September 2011). Retrieved from: http://www.youtube.com/watch?v=b84V4RkPwNM

Gebrosky, C. (2011). http://www.chrisgebrosky.com/

Gee, J. (2003). *What Video Games Have to Teach Us About Learning and Literacy.* New York: Palgrave / MacMillan Publishing.

"GK-3" (n.d.). Roland US. Retrieved from: http://www.rolandus.com/products/productdetails.php?ProductId=651&ParentId=55

*Guitar Hero* (2005). Retrieved from: http://hub.guitarhero.com/

*Guitar Pro 6: A tablature editor, a score player, and a backing band all in one,* (2010). Retrieved from: http://www.guitar-pro.com/en/index.php

*Halo 2* (2004). Retrieved from: http://halo.xbox.com/en-us/intel/titles/halo2

Huitt, W. (2001). Motivation to learn: An overview. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University. Retrieved from: http://www.edpsycinteractive.org/topics/motivation/motivate.html

Ingram, M. (2010). Average social gamer is a 43-year-old woman. *Gigaom.* Retrieved from: http://gigaom.com/2010/02/17/average-social-gamer-is-a-43-year-old-woman/

Intrinsic Motivation (n.d.). Retrieved from: http://education.calumet.purdue.edu/vockell/edPsybook/Edpsy5/edpsy5_intrinsic.htm

Kim, A. (2007). *Putting the Fun in Functional.* Retrieved from: http://www.slideshare.net/amyjokim/putting-the-fun-in-functiona

Kim, A. (2009). Game mechanics for interaction design: An interview with Amy Jo Kim. *Bokardo.* Retrieved from: http://bokardo.com/archives/game-mechanics-for-interaction-design-and-interview-with-amy-jo-kim/

Lepper, M., Corpus, J. & Iyengar, S. (2005). Intrinsic and extrinsic motivational orientations in the classroom: Age differences and academic correlates. *Journal of Educational Psychology, 97, 184-196.* Doi: 10.1037/0022-0663.97.2.184.

Lidskog, F. (1997). TAB: Wonderwall by Oasis. Retrieved from: http://www.guitaretab.com/o/oasis/13758.html

Loom (1990). Retrieved from: http://loom.mixnmojo.com/

Lucas, G. (2011). *Lucas Learning: A Force for Young Minds.* Retrieved from: http://www.lucaslearning.com/index.htm

Malone, (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science, 4,* 333-369.

Mamen, E. (2009). Loom. Retrieved from: http://www.adventureclassicgaming.com/index.php/site/reviews/200/

*Mario Brothers* (1983). Retrieved from: http://www.mariobrothersonline.com/

McGonigal, J. (2010). Gaming can make a better world. *TED TALK.* Retrieved from: http://www.ted.com/talks/lang/eng/jane_mcgonigal_gaming_can_make_a_better_world.html

*Melodyne Editor* (2011). Celemony Software GmbH. Retrieved from: http://www.celemony.com/cms/index.php?id=products_editor

Minor, R. (2010). Healing with wii-hab. *The Leader-Herald.* Retrieved from: http://www.leaderherald.com/page/content.detail/id/524891/Healing-with-Wii-hab.html

MIT. (2001). *Games-to-teach Project*. Retrieved from: http://www.educationarcade.org/gtt/home.html

*Mustang Pro* (2010). Retrieved from: http://www.engadget.com/2010/06/11/rock-band-3s-gear-priced-keytar-and-pro-guitar-sport-midi-out/

Nutt, C. (2010). Ubisoft's big strategies: Dominate kinect, develop fewer games, says detoc. *Gamasutra*. Retrieved from: http://www.gamasutra.com/view/news/30815/Ubisofts_Big_Strategies_Dominate_Kinect_Develop_Fewer_Games_Says_Detoc.php

*Opera Fatal* (1996). Retrieved from: http://www.opera-fatal.de/opera_mainframe.htm.

Online Music Games: Piano, Drums, and Guitar (2011). Retrieved from: http://www.flashmusicgames.com/index.html

Percival, G., Wang, Y. & Tzanetakis, G. (2007). Effective use of multimedia for computer-assisted musical instrument tutoring. *Proceedings of the International Workshop on Educational*

*Multimedia and Multimedia Education, 67–76, Augsburg, Bavaria, Germany.* Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.89.4435&rep=rep1&type=pdf

*Power Gig Rise of the SixString* (2010). Retrieved from: http://www.powergig.com/

Prensky, M. (2011). *Social impact games: Entertaining games with non-entertainment goals.* Retrieved from: http://www.socialimpactgames.com/index.php

*RockBand* (2007). Retrieved from: www.rockband.com

*RockBand 3* (2011). Retrieved from: http://www.rockband3.co.uk/

Rouse, R. (2000). *Game design: Theory & practice.* Plano, Texas: Worldware Publishing, Inc.

Sandercoe, J. (n.d.). *The best guitar instruction on the web.* Retrieved from: http://www.justinguitar.com/

*Saverrain. (n.d.).* TAB: Wonderwall by Oasis. Retrieved from: http://tabs.ultimate-guitar.com/o/oasis/wonderwall_ver5_tab.htm

Shell, J. (2010). Design outside the box. *DICE*. Retrieved from: http://www.g4tv.com/videos/44277/dice-2010-design-outside-the-box-presentation/

Shernoff, D., Csikszentimihalyi, M., Schneider, B. & Shernoff, E. (2003). Student engagement in high school classrooms from the perspective of flow theory. *School Psychology Quarterly, 18,* 2, 158-176.

*Songsterr: Guitar Tabs with Rhythm* (2011). Retrieved from: http://www.songsterr.com/

*Star Craft II* (2010). Retrieved from: http://www.starcraft2.com/

*Super Crazy Guitarman 2 (2010).* Retrieved from: http://www.addictinggames.com/supercrazy2.html

*World of Warcraft* (2004). Retrieved from: http://eu.battle.net/wow.en/

Young, D. (2008). *Training video: Wonderwall by Oasis.* Retrieved from: http://www.youtube.com/user/ilearntoplay#p/u/11/0eQ7EM9riN4

*YouRock Guitar* (2010). Retrieved from: http://www.yourockguitar.com/

*Your Shape* (2010). Retrieved from: http://yourshapecenter.uk.ubi.com/

Zeigler, J. (2011). *Downloadable piano and music software.* Retrieved from: http://pianoeducation.org/pnodsoft.html

# Appendix

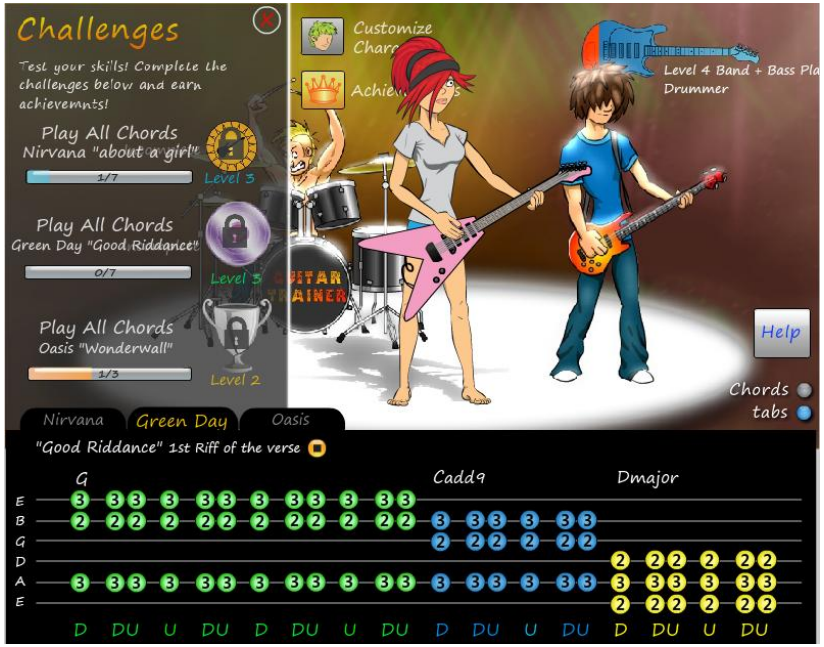



Image 4.0: Progress of participant #40

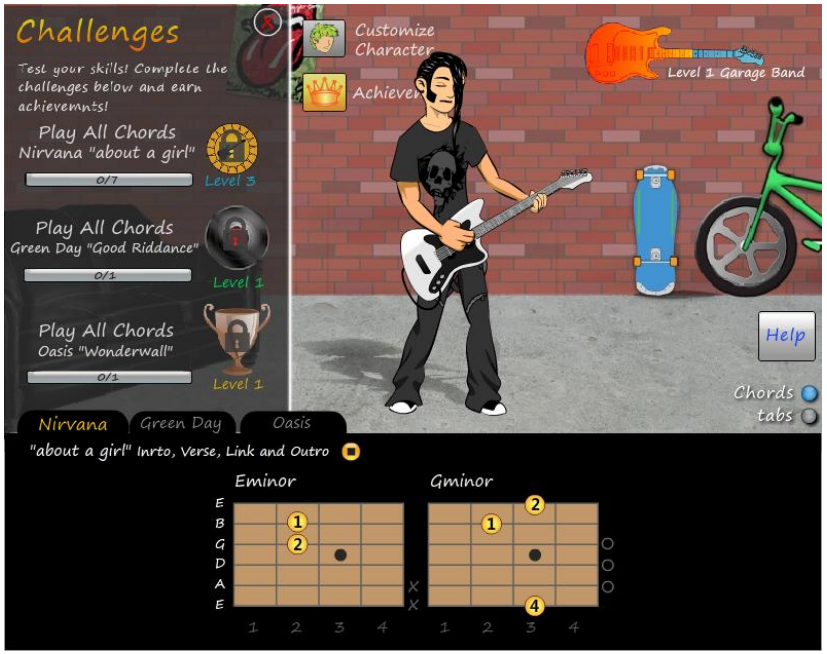



Image 4.1: Progress of participant #52,


Figure 3.8: Progress of participant #34


Image 4.3: Progress of participant #39