Exploring accessibility in video games and one button game design.

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Abstract

This project will explore accessibility options within video games with an emphasis on one button game design and play ability. It will research the history of accessibility from both a hardware and software perspective through history up to current developments. In addition to establishing a big picture of what accessibility in gaming is currently, this research will also attempt to help identify gaps and demands as well as possible solutions to them.

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What is Accessible Gaming?

Accessibility has multiple definitions, most of which refer to the ease of reach of an object. The Oxford Dictionary uses terms such as ease to obtain, ease of use and ease of understanding (Accessibility, n.d.). While this broad definition may define the general intention behind accessibility in reference to gaming, it does not specify what that does, or should, encompass.

This lack of specificity has inspired one of the leading International Game Developers Association (IGDA) special interest groups in Game Accessibility to create their own targeted definition of accessibility in gaming. Their definition establishes accessibility in gaming as the ability to play games despite functioning under limited conditions. This includes not only mobility limitations, but also disabilities such as impaired vision or hearing as well as cognitive issues (Bierre et al., 2004).

Under this definition, game design can be approached from a perspective that addresses a large variety of accessibility concerns from the very beginning of a project. An independent group of game studios, academics, and specialists, collaborated to form a set of guidelines that could be utilized which address accessibility on multiple implementation levels ranging from basic to advanced. This can include simple options such as color blind mode, font sizing, targeted sound sliders, and input mapping. More complex solutions to providing accessibility options such as those for physically impaired gamers include options for assistive technology devices (Ellis, 2018). This set of guidelines allows for a working concept of what, specifically, inclusion can involve.

Why are Accessible Features Important?

Implementation of accessibility features during game development can be a time consuming and expensive addition to an already arduous process. This is especially true if features are considered late in the development process. Even something as common as adjustable fonts added during late stage development can cost time and add problems. If these features will increase the burden of the design process so much, why then is it important for developers to follow the guidelines and make their games accessible?

With a potential audience of over an estimated 30 million gamers in the United States alone, the demographic number could be very persuasive in itself (Parker, 2018). While initial reactions might be to argue for inclusivity in general, most companies will look for more solid evidence to back the argument of inclusion beyond an appeal to equality.

One piece by video game lecture web series Extra Credits believes that adding accessibility features to games will earn a developer fan loyalties, positive press, and overall good will. They even go so far as to suggest a developer would grow their customer base beyond the target demographic by offering these options (Portnow, J., & Winters, S., 2017).

This philosophy of features increasing marketability and sales is echoed by Eitan Glinert (2008) of Gamasutra. In the author's article, they demonstrate how even simple interface features can increase usability of a game and, therefore, increase the potential of it's profitability. Gilnert further emphasizes the importance of usability as a key metric in assessment of a game overall.

There are many marketing benefits to accessibility feature conscious games. According to one study performed by Information Solutions Group for PopCap Games in 2008, over one in five casual gamers on their platform identified as having a physical, mental, or cognitive disability. From a group of over 2,700 customers, this is not a trivial amount. Including features that make a game usable by these players would open the door to a broader player

base (Scott & Ghinea, 2013).

Game accessibility features have beneficial reach far beyond those of providing a better product to gamers with limitations. As mentioned by Extra Credits' commentary on Accessibility, basic level features such as difficulty modes and font size options allow not only for disabled users to enjoy the product, but also provide quality of life options for non disabled gamers. A player with limited time or someone who is new to gaming could utilize a difficulty setting. Players with smaller monitors would be able to better read text with larger font options (Portnow, J., & Winters, S., 2017).

These far reaching benefits to small basic features are part of what is called the Curb-Cut effect. In the Stanford Social Innovation Review, Angela Blackwell (2017) explains that curb cuts, the formed dips in public walkways, were initially designed for ease of wheelchair access. While they served their purpose, they benefited a great deal more people, not only wheelchair users. Parents with strollers, delivery persons with carts, pedestrians with luggage, even runners found curb cuts to be useful. One study on pedestrian behavior in Florida showed that nine out of ten people would go out of their way to use a curb cut.

This curb-cut effect illustrates the wide reaching benefits of designing accessible rich features into games. Not only will the product be more usable by disabled gamers, but it could offer a wide range of quality of life improvements to all players.

It is also important to note how drastically the cut curb changed the thinking of society. When first officially introduced, the dips in the pathways were novel and the source of international news Blackwell (2017). Now, curb cuts are so omnipresent they are barely acknowledged. They are simply a part of design by default now. When their use and commonality exceeds the design, it ceases to be labeled assistive and instead becomes considered normal (Morson, 2016).

Captioning is another excellent example of function exceeding design.

In one study conducted by Oregon State University and 3Play Media, over 2,000 students were surveyed across the United States to research the usefulness of captioning in the learning environment. The study showed that 98.6% of those surveyed indicated they found captions helpful and used them. The majority of students questioned stated everything from ease of note taking to understanding thick accents as their rationale for use. Of those, only 13% were registered as having a disability and, smaller still, only 6% indicated they utilized captions as accommodation for a disability. (Morson, 2016).

This overwhelming number further shows how assistive technologies often overlooked in games, such as captions, can be useful far beyond their intended design. While these normalized adaptations make activities easier for people without disabilities, it is important not to loose sight of the fact that they make things possible for those with disabilities who might otherwise not be able to participate at all. This principle can be applied to games on both a hardware and software level (Portnow, J., & Winters, S., 2017).

History of Accessible Gaming

Many of the first video games had little need to consider accessibility features. Their simplistic controls and visuals allowed for a broad audience to enjoy them with relative ease of use. In these early stages, the biggest limitation was often the lack of access to hardware that was needed to play these games. Often one had to be associated with academics, sciences, or government labs to play them (Ellis, 2018). One of the first games, Tennis for Two, consisted solely of a ball that bounced across a plain with a vertical divide. The controls were comprised of a paddle with a dial and one button as illustrated in figure 1 (Glinert, 2008).

Figure 1. Tennis for Two paddles (Digitalman2112, 2011).

Figure 2. Xbox One Controller (*Xbox Wireless Controller*, 2018).

The general history of accessibility in gaming is colorful and vast. Over the years there have been numerous contributions to the disabled player community in one form or another since the 1960's that forged a path which is growing with an increasing number of talented designers for the sake of enriching the lives of gamers with limitations (Ellis, 2018).

Over time games have become more complicated. What was once a simple dial pad and button now holds multiple thubsticks, direction pads, buttons, triggers and touch pads as seen in figure 2. Technology has allowed for advances in mechanics, graphics, and sound. These advances have come at a cost for players with limitations.

Recently, there have been many advances in accessible gaming thanks to public outcry and organizations such as Oneswitch and Special Effect.

Hardware.

Gaming hardware is a continuing problem for gamers without disabilities, let alone gamers with physical limitations. Recent research into the ergonomics of game controllers found that, in an effort to make

controllers as accommodating as possible to a general audience, the designs often completely exclude many groups of users. This includes players with smaller hands as well as those with physical limitations (Bhardwaj, 2017). Often times it would simply become a question of "Can I play this?". If the answer was no, the gamer would have to find a different game entirely (Parker, 2018).

Generally, many of the accessible controllers available to players were adaptions or 'homebrew' style devices that were available only through private sale. In the days before the internet made information easily accessible, this made it especially hard for players to be informed about the options available. They had to rely on interest magazines and word of mouth (Ellis, 2006).

There is some debate on when the first accessible game hardware was made available, however, one of the earliest examples of real progress in purpose designed controllers came from Ken Yankelevitz. While neither disabled, nor a gamer, Yankelevitz began a journey into controller design to fill a need in the lives of people with disabilities (Ellis, 2005).

In the early 1980's, Yankelvitz designed a flight controller prototype for the Atari 2600 that would be usable by disabled gamers who found the Atari controller too difficult. While Atari declined interest in the design, they did refer disabled customers to Yankelevitz for further information on his adapted designs. The first of Yankelvitz's controllers to be released for commercial availability was the QuadStick. An example of one of his early creations can be seen in figure 3. This was a flight controller that included a sip-and-puff control for the button with a simple joystick mechanism. They were sold for $75, at no profit to the creator, and were very popular (Ruder, 2015)

Figure 3. Children using an early QuadControl (*OneSwitch.org*, n.d.)

In 1984, Micro Command by Orion Data Ltd was made available for sale. This device for the ZX Spectrum consisted of a microphone, a large interface, and a cassette that would allow the user to control a computer using voice. The device claimed features such as instant response times, easy to program controls, and individual voice sensitivity. The reality, however, was very different for this accessible friendly control system. It was expensive, at a cost of £50, it had a limited list of supported games, and it proved to be unreliable in player tests (Ellis, 2005).

A review of the device by Paul Jenkinson (2017) found the Micro Command to be difficult to use and experienced trouble with the voice recognition. While admitting that the games included were intended to be demo's, he found them uninteresting and, ultimately, frustrating to play due to the Micro Command's trouble with understanding the speech inputs. Jenkinson also noted that he was unable to find any commercially released games that worked with the unit, contributing that to it's downfall.

Nintendo was one of the first companies to release an official controller catering to disabled players. Released in 1988 for the Nintendo Entertainment System, the hands free controller was designed with quadriplegics in mind for the US and EU markets. It came with useful features such as a sip-and-puff adopter for the A and B buttons as well as an

extended chin joystick for the directional pad. It even came with straps to secure the device to the player's chest (Ellis, 2006).

The device still had it's drawbacks. The controller was bulky and heavy, making it difficult to wear. At a cost of $120 for only the controller, it was not affordable for many households. In addition, games still required the press of a start button on a standard controller to begin play. This is a challenge that still persists with most Nintendo games (Ellis, 2006).

Following this, Nintendo partnered with Pathways Development Group Team Xtreme in the 1990's to develop third party 'Nintendo Approved' products for accessibility controllers. The organization developed several adaptable options of switch style controllers that could use combinations of appendages or breath for play (Ellis, 2006).

Software.

When considering software solutions to accessibility within video games, generally this would be referring to features built within the options of the game itself. This can include things such as closed captioning, difficulty settings, speed controls, and color blindness modes.

Despite the simplicity of early games, some players found them to be quite challenging even then. The first releases of Pong were considered by some users to be too fast or difficult to play. This was especially the case with young players as well as those with physical or cognitive disabilities. This obstacle was addressed in a few ways (Ellis, 2018).

One solution for the challenges faced by some Pong gamers was offered in the 1970's by JRW Electronics, INC. A conversion kit for the Atari Pong cabinets was offered under the name of Handicap Pong. The publicity material for the kit explained that it would add features which would allow the choice of paddle size, a button to change ball speed, an updated 2-axis joystick, and an on demand begin play button (*Handicap Pong*, n.d.).

The early 1980's saw a rising popularity in Atari home systems. The company demonstrated the importance of the curb-cut effect early on in with the inclusion of kids mode game options. Releases that featured these options were indicated with the teddy bear logo. These features were initially designed with children in mind and consisted of options such as game speed and difficulty levels that players could change through menus. Though they were initially implemented to assist young children in being able to enjoy games, the benefits were also felt by players with physical and cognitive limitations as well (Ellis, 2005).

Subtitles are a fairly common inclusion in current games. Some of the first game releases, however, did not need to consider them as there was little or no audio which required transcribing. An interview with veteran producer Kari Hattner of Hangar 13 Games explained that closed captioning was not important until games began to include vocals in the 1990's. Despite how long subtitles have been present in games, there has been little progress for them in that time. Closed captioning still suffers from a lack of standard guidelines. Also lacking are options that would help the visually impaired in specific ways such as font sizes, background colours and speed (Deryagin, 2018).

Current Options for Accessibility and One Button Gaming.

Hardware.

Adaptive game controllers have come a long way from the homebrew kits of the early console days. With the convenience of the internet, small businesses have taken advantage of the platform to sell their disability friendly devices to a large audience. One such company has grown from the original designs of Ken Yankelevitz.

Developer Fred Davison built upon the foundation of the Quad Control Joystick in his Kickstarter campaign for the new QuadStick. In an

interview with Yankelevitz in 2011, the aging engineer indicated that in his 30 years of business, he had only sold around 800 units (Dockery, 2011). Comparing that number to the 2014 Kickstarter campaign for the new QuadStick which exceeded it's $10,000 target with seven days remaining, it can be deduced that the exposure and demand for adaptive tech has increased (Matulef, 2014).

The rise of the internet has also seen a boom in Do-it-yourself (DIY) tutorials and kits. These not only accommodate those who enjoy a more personal approach, but also players with a need to customize their devices. Sites such as Youtube provide a whole video library of DIY instructions. Several organizations such as AbleGamers provide education and kits for creating and modifying game controllers (*The AbleGamers Charity*, 2017). Adafruit, a renowned learning repository for electronic education, contains several tutorials on modifying controllers in addition to creating custom devices using inexpensive circuit boards such as Raspberry Pi's (*Adafruit Learning System*, n.d.).

A larger problem occurs when specific switches become necessary to facilitate gaming in a comfortable and functional fashion. While they open many options to users, they are often expensive, cumbersome, and resemble medical devices. These switches are often produced by medical companies without gaming in mind (Parker, 2018).

While the majority of available adaptive controllers can be found in the DIY and small business markets, some console producers are now making an effort to make options available to gamers with special needs. The rise of social media has made companies more aware not only of the struggles many disabled gamers face when trying to enjoy a game, but also of the large demographic of gamers with limitations that exist. Most notable of these attempts is the new Xbox Adaptive controller from Microsoft (Parker, 2018).

Working closely with occupational therapy groups and non profit organizations such as AbleGamers, Microsoft began development on the Xbox

Adaptive Controller in July of 2016. The intention was to create a device which could easily be customized for the needs of each player. The designers also set out to specifically create a product that would look just like another gaming peripheral and not a medical device (Marihugh & Nadella, 2018). The designers were also keen to provide universal compatibility for external additions such as switches. This would allow for the device to work not only as a stand alone controller, but it would also allow unlimited customization through extensions which it would configure to the desired function. By this, it allowed users to bypass an otherwise complicated process of a software driven control system provided by the DIY kits (Parker, 2018).

The unit itself features large buttons and a sleek, comfortable housing that fits entirely within the aesthetic of Xbox products. While the unit can be used as a
plug-and-play device on its own, the most appealing design aspect are the rear 3.5mm jack ports. These allow users to plug in any compatible external switch to use for the 19 remapped ports to allow for ease of use. This becomes important to the usefulness of the product as the industry standard for adaptive switches is 3.5mm input jack (*Xbox Adaptive Controller*, 2018).

Several companies have teamed up with Microsoft to provide accessories for the controller. These include mounting arms, external switches, and port converters. While there are several options that would cover the majority of needs of users, the problem remains that many of the accessories are quite expensive. The list price of one Ablenet 1 3/8 inch mountable switch is $65USD (*Xbox Adaptive Controller*, 2018).

Using one configuration featured by PCGamer Magazine Spohn (2018) for a player with Spinal Muscular Atrophy as an example in figure 4, the total cost can be estimated using Microsoft's website. The adapter itself retails at $99USD. Add to this the 8 AbleNet Micro Light switches as seen in the image which retail at $85USD per switch. The modified control sticks were not featured on the site, however, another joystick model was listed at a retail price of $40USD. This adds to an estimated total of

$859USD (*Xbox Adaptive Controller*, 2018).

Figure 4. User testing the Xbox Adaptive Controller. (Spohn, 2018).

For many, this investment can be cost prohibited when requiring many accessories. White the cost may be considered high, it is still lower than many of the previously available options which would total in the thousands. This combined with the compatibility of the controller's software allow for it to be used as any xbox controller on console and pc. This fact may allow a user to consider it an investment for a number of devices (Spohn, 2018).

To date, the Xbox Adaptive Controller remains one of the most anticipated controller designed by and for gamers with disabilities. It is also one of, if not the only, device developed by a major brand company at the moment. As with any manufacturing, the higher the production volume of an item, the lower the cost.
Considering the relatively low volume of demand compared to a standard controller, the likelihood of costs for adaptive controllers lowering dramatically in the near future is slim (Spohn, 2018).

Software.

Inclusively has become a hot topic in recent years for game

development. With social influencers such as Kim Kardashian making large donations to disabled gamer charities, the topic is receiving more attention over time (Geekee, 2018). While adaptive hardware has made large advancements in recent years to provide better functionality and ease of use to disabled gamers, desired software features had remained relatively unchanged until very recently (Portnow, J., & Winters, S., 2017).

With over 60% of gamers utilizing subtitles when available, this feature has become a typical example of the curb cut effect in action within video games (Hamilton, 2018). Subtitles can be useful not only to players with impairments, but also by players using no sound or to ease language barriers. While there is still much demand for inclusion of subtitles in games, there is still no industry wide standard for implementing them if they are included at all (Portnow, J., & Winters, S., 2017).

Some features, such as remapping key-binds and mouse sensitivity, have become standard options in most modern games. These features allow a user with special needs to enjoy a game that might otherwise be unplayable entirely. In yet another demonstration of curb cut effect, key binds and mouse sensitivity are common features that non disabled gamers utilize on a regular basis (Hamilton, 2018).

Sound options are another example of accessible friendly features that have become staples in the average game menu. Having separate volume controls for music, dialogue, and sound effects allow the player to choose what is most comfortable for them based on their needs. This not only supports players with hearing needs, but helps all players to better enjoy the game (Baines, 2016).

How and what features to include for inclusiveness is a hot debate among developers. One detail rich option for developers is the Game Accessibility Guidelines created as a collaborative effort between specialists, academics, and game developers. Sources such as this one can help studios to create a standardized format for inclusive options. The guide even categorizes

features by suggested difficulty to implement so that developers can make clear decisions on what features are within their scope to include. Emphasis is now being made on including as many elective features within the options menu to be as inclusive to players as possible (*Game accessibility guidelines*, 2018).

Limited Mobility and Gaming

It is estimated that 2.6 billion people are active gamers globally. Of that, approximately 33 million of them in the United States are disabled (Mut, 2019). According to the facts and figures published by Scope (2019), an organization which promotes equality for the disabled, there were 13.9 million people classified as disabled in the United Kingdom alone as of a 2017 survey. The Office for Disability Issues further specifies that 11 million people are classified as living with a long term illness, impairment, or disability which is considered limiting. Of those, the government office reports that the most common impairments affect mobility (*Official Statistics: Disability facts and figures*, 2020).

In the same fact sheet, the Office of Disability Issues reports that disability holds an impact over the leisure and social activities of people living with these limitations. Data showed that those with disabilities were significantly less likely to participate in sporting activities. They do, however, seem to be more likely to visit museums and historic sites. While there is no conclusion as to why this is the case, there are some causes that could be explored (*Official Statistics: Disability facts and figures*, 2020)

Limitations in mobility could prevent the activity itself, such as participating in a sport. Lack of accessibility could also play a role by preventing guests from utilising the facilities such as seating or viewing areas. Despite the rights of equality granted to disabled people, evidence clearly suggests that there is an exclusion of the disabled from environments and social functions (Bonehill, Von Benzon, & Shaw, 2020).

Overwhelmingly, main stream video games are not designed to accommodate players with severe limitations. An article by Chris Mut (2019) critiques the game development industry for lagging behind in it's consideration of gamers who lack mobility and other physical limitations. This oversight ranges from minimal effort in design such as the inclusion of subtitles, to adaptive controls and extensive key remapping. An estimated 92% of disabled people in the United States playing video games. Despite this percentage, the industry has only recently begun to take steps to make games more inclusive to those with stronger limitations.

As intersectionally helpful as features such as subtitles may be, physical disabilities can require much more involved solutions. Often, they will require specialized hardware such as the unique controllers previously discussed. With purpose built adaptive controllers comes a need for early design considerations. This can include the ability to remap keys, create complex shortcut macros, and integrate with current adaptive control solutions available such as the Xbox Adaptive Controller. It could, therefor, be useful to take into account the specific limitations of some common mobility disabilities (Parker, 2018).

An Overview of Impacted Mobility

There are many disabilities which would lead a person's mobility to be severely impacted. This can be due to an accident which leads to temporary or permanent disabilities such as Spinal Chord Injury (SCI), loss of limb, or acquired brain injuries.

Mobility function can also be limited as a complication of an illness such as Multiple Sclerosis (MS), stroke, or paralysis. One other cause of physical impairment can come from genetics and birth defects such as Spina Bifida and Muscular Dystrophy. Still other disabilities, such as Cerebral Palsy (CP), can have a variety of causes that overlap any of these categories (*Types of physical disabilities*, 2018).

Spinal Cord Injury.

According to the World Health Organization (2020), between 250,000 and 500,000 people suffer a spinal cord injury every year globally. Spinal cord injury, or SCI, is defined by the World Health Organization as damage to the spinal cord due to trauma or disease. The intensity of symptoms related to the injury vary dramatically dependant on a number of factors such as the location of the injury and severity of damage. Damage can also be permanent or temporary.

The spinal cord, protected by the bones of the spine, is responsible for delivering messages between the brain and nerves. Through this system, we are able to feel sensations, control body functions, and move (University of Iowa Hospitals and Clinics, 2018). Any or all of these important functions may cease when the delicate spinal cord is damaged. Traumatic injuries can include contusions, fractures, and dislocation. One study conducted on the causes of traumatic spinal injuries found the most common cause to patients under 45 in the United States was largely motor vehicle accidents. The second type of spinach cord injury is non-traumatic. This includes diseases such as multiple sclerosis, infections, spinal tumors, and bone spurs. While a different cause of injury the end symptom results are often the same as found in patients of traumatic injuries (Chen, Tang, Vogel, & Devivo, 2013).

SCIs can be catagorized into two main types of diagnosis; complete, and incomplete. A complete spinal cord injury is considered the least likely to improve and the patient will generally loose complete function below the level of injury. For example, if a patient were to suffer a complete SCI to their lower spinal region, they will loose functionality of their lower nerves. This would include sensations of touch or temperature as well as ability of movement to the legs. This is usually referred to as Paraplegia or partial paralysis. Were a patient to be diagnosed with a complete SCI of a higher location such as the neck, this would result in a more dramatic loss of ability that would include the arms. This is generally called Quadriplegia, the paralysis of both legs and both arms (University of Iowa Hospitals and

Clinics, 2018).

Incomplete SCIs include three types of injuries which may or may not allow for improvement. Anterior syndrome is dependant on injury location. While patients will loose movement and many types of sensation below the injury level, they can still retrain a sense of position of the limbs as well as the ability to feel vibrations. Central syndrome primarily causes a loss of motion and sensation in the arms. Finally,
Brown-Séquard syndrome is responsible for the loss of function and sensation to one particular side of the body below the level of injury (University of Iowa Hospitals and Clinics, 2018).

Dependant on the type of SCI, as well as any other contributing health factors, the gamer could have substantially limited mobility. This would greatly impact the player's ability to manipulate a control input required for a game. With the growing complexity of game controls, SCI gamers find more difficulty in playing the games they want. This can be addressed through the use of specialized adaptive controllers, such as the QuadStick, which have been purpose built to consider the specific needs of players with severe physical limitations (Dockery, 2011).

In some cases, games have served as a method by which patients have found a form of physical therapy as well as entertainment. A recent study into the use of active video game play as a therapeutic tool showed promise across several disabilities. Games designed around physical movements such as Wii Sports (Nintendo, 2006) and Dance Dance Revolution (Konami, 2019) were utilized with adapted controllers targeted at upper extremity use for the study. Some participants included in the study were identified as SCI patients. Participants with limb mobility limitations and amputations reported increased energy efficiency and a reduced need for assistive devices after play (Staiano & Flynn, 2014).

Through the use of a self designed adaptive controller and camera setup, SCI patient Carl-Akira Fujinami was able to become a ranked player

in one of the most popular online games, League of Legends (Peel, 2014). As a quadriplegic, Fujinami had to make unique modifications to handle the control system of the game that were specific to his abilities of motion. Multiplayer online battle arenas often are characterized by their complex controls required in order to effectively play. While a significant amount of customization can be done via key mapping, the developers put a strong priority on competitive and tournament level play (Powell, 2019). As such, accessibility features have largely been ignored by the development as has been noted by several media critics (Phu, 2017).

Cerebral Palsy.

The Center for Disease Control (2019) defines Cerebral Palsy (CP) as a group of disorders that affect movement and balance. It occurs when the developing brain suffers injury, such as birth complications or infections during pregnancy. Labeled as the most common motor disabilities in childhood, studies suggest that 1.5 to 4 per 1,000 births will have Cerebral Palsy. Further data reports that 1 in 323 children have been diagnosed with CP. While a small percentage of cases happen post birth in what is called Acquired CP, the overwhelming majority of 85-90% are before birth. This is also referred to as Congenital CP. There is no cure for Cerebral Palsy, however, early intervention and dedicated therapy has shown to help increase the quality of life and independence of CP patients.

Cerebral Palsy can be divided into three syndromes; spastic, dyskenetic, and ataxic. Spastic syndrome is primarily presented through mass movement, as opposed to fine controlled motion. Children with spastic syndrome display slow mobility with great effort. Spastic diplegia affects mostly the lower limbs, while upper limbs often retain normal motor function. Spastic quadriplegia, however, severely impairs the upper and lower limbs equally. Children with this form of spastic CP often display difficulty with vision, speech, and epilepsy. Hemiplegic spastic patients will typically find difficulty in arm movement. This is also commonly accompanied by sensory deficits, behavioral problems, and poor muscle mass (Gulati & Sondhi,

2017/2018). A 2008 survey conducted in the United States found that 77.4% of children identified with CP in the region were classified as spastic (Center for Disease Control, 2019).

Dyskinetic syndrome patients will often experience rapid and unpredictable muscle contractions leading to involuntary movement of the limbs and digits. Difficulties in muscle control can also lead to slow and strained motion in muscle groups further from the body core. Patients with Dyskinetic CP often find ongoing difficulty in actions such as grabbing and holding. They are also prone to increased discomfort with prolonged postures and muscle stress. Ataxic CP, while rare, is also most likely to improve with time (Gulati & Sondhi, 2017/2018).

Further to the mobility effects of Cerebral Palsy in itself, often significant co-morbidities which can have profound effects on motion present as well. Epilepsy, a
condition affecting the nervous system by causing seizures, is one of the most common conditions affecting CP patients at approximately 45%. Also observed are orthopedic disorders and persistent pain, both of which can greatly impact mobility of gamers (Gulati & Sondhi, 2017/2018).

A broad generalization could compile a list of challenges that players with Cerebral Palsy must face when attempting to play many commercial video games. The most common and apparent of which is the affects that CP has on the hands and wrists. One common trait found in people with CP is non standard limb positioning due to spasms or muscle shortening. This can present as hands, fingers, or arms resting or flexing in extreme positioning such as the palm of the hand pressing to the forearm (Gulati & Sondhi, 2017/2018). This causes difficulties in holding and manipulating most traditional controllers available on the market.

Further obstacles are encountered when taking into consideration the wide range of muscle control and fatigue limitations that most CP gamers will face. In many cases, an adaptive controller would be necessary to address

this. There is some suggestion that body movement capture systems such as the Kinect (Microsoft, 2010) or Leap Motion (Ultraleap, 2020) have seen success in allowing children with CP to participate in games. In addition, accessibility features built into the game allowing compensation for speed and accuracy could prove helpful (Cerebral Palsy Guide, 2020).

The mobility challenges presented to patients with Cerebral Palsy can vary greatly between people even within the same classification of syndrome. While there is no cure for CP, research strongly suggests that early diagnosis along with a physical rehabilitation therapy routine can greatly improve mobility function and increase independence from early on. This leads to higher quality of life in adults with CP (Gulati & Sondhi, 2017/2018).

Research is showing that video games can provide more than just entertainment. They can also be a strong tool in helping with physical therapy routines. One study into the effects of adding the Wii-Fit Nintendo (2007) alongside more traditional balance improvement therapy in children classified as having mild CP found a marked improvement in balance function as well as independence (Tarakci,

Ersoz Huseyinsinoglu, Tarakci, & Razak Ozdincler, 2016). Another study also utilizing the motion based controls of the Nintendo Wii had increased effects on upper extremity therapies in patients with cerebral palsy compared to more traditional rehabilitation (Avcil, Tarakci, Arman, & Tarakci, 2020).

Multiple Sclerosis.
Players with Multiple Sclerosis (MS) face quite a few challenges when it comes to gaming. While the cause of MS is largely unknown, researchers believe there is evidence to suggest it could be genetic or perhaps even from viral exposure (National Institute of Health, 2020). It is estimated that over 2.3 million people worldwide have been diagnosed with multiple sclerosis (National Multiple Sclerosis Society, 2020). Public Health England (2020) reports that there are 105,800 individuals in England diagnosed with MS.

Multiple sclerosis is considered an unpredictable, chronic disease affecting the central nervous system. Damage caused to the nerves can interfere with signals sent between the brain and various parts of the body. While it can present itself in children, it is most often not displayed and diagnosed until adulthood between the ages of 20 and 50 (National Multiple Sclerosis Society, 2020).

The symptoms of MS can vary in intensity not only from person to person, but from episode to episode. While life expectancy of an individual diagnosed with MS is slightly below average, it is not necessarily considered a fatal illness. Modern treatments and therapies have increased the quality of life of MS patients dramatically. That being said, however, the symptoms of the disease do generally worsen over time.

The unpredictable nature of Multiple sclerosis leads to a very broad scope of symptoms that individuals can display. This is further complicated by the fact that symptoms can appear in waves or episodes of varying intensities. For some, they may experience a constant presence of symptoms while others may go years between episodes (National Multiple Sclerosis Society, 2020).

Some of the most common symptoms found in MS diagnosed individuals heavily involve the functionality and comfort of the limbs. Sensory disturbances such as 'pins and needles' sensations, numbness, itching, and pain are common complaints.

Others experience muscle stiffness, weakness, spasms, tremors and even paralysis. This can present in the arms and legs of the affected person. This broad spectrum of symptoms can lead to many challenges when it comes to video games. A player may have trouble holding and manipulating a standard controller. They may also experience muscle fatigue or soreness faster from a commercial controller. Tremors and spasms can make precise movements difficult in a mouse or controller (National Institute of Health, 2020).

As seen in other disabilities that affect mobility function, the use of video games as a therapy has been studied with more frequency in recent years with promising results. One recent study into the use of video game based

rehabilitation therapy in patients with multiple sclerosis found that participants saw a significant improvement in ability over time (De Giglio et al., 2016). This theory that video games can be used as therapy to improve the symptoms of multiple sclerosis patients is also supported in a blog post by MS advocate Devin Garlit (2018). In his post, Garlit writes about the challenges he overcame to play games. A physical deformity in his hand unrelated to MS made holding and using a typical game controller difficult. The drive to be "normal" pushed Garlit to develop the muscle control needed to be able to enjoy games without the need of adaptive technologies. The author goes on to express his belief that forcing the skills and connection between hand and brain has become important to his life.

Gaming As Therapy

When reading the wealth of articles, published studies, and blog posts available on the subject of games for the disabled, one common link becomes clear: games hold strong potential to be used as a therapeutic tool. The benefits of video games reach far beyond just a physical therapy tool as well. They can provide a holistic approach in one package. They can simultaneously be educational, physical, entertaining, and uplifting (Garlit, 2018).

A study into depression in disabled adults found that 57.8% of participants were found to have depression linked to their disability. With the World Health Organization classifying disability as one of the major causes of depression, these results are not surprising (Cagan & Unsal, 2014). Aside from low mood and loss of interests, depression in itself has been linked to reduced functioning of thought, speech, and movement. It can also be associated with weakness and difficulty in motivation.
Research has shown that the symptoms associated with physical disabilities can be exacerbated by the presence of depression. As an example, a person who may experience pain and fatigue from multiple sclerosis has a risk of those

symptoms increasing in intensity when they also suffer depression (Deschênes, Burns, & Schmitz, 2015).

Depression has also shown to impact long and short term memory as well as cognitive functions. Several studies have been undertaken by researchers in recent years to explore the effectiveness of video games as a helpful tool in helping clinical depression. While there have been some studies into video games and cognitive functionality, they were primarily undertaken with healthy young adults. The promising and consistent positive results led the way for more specific research into how this could be used in other avenues. One study undertaken in Germany in 2018 aimed to assess the affects that fast past action games have on the cognitive functions of clincinally depressed individuals (Staiano & Flynn, 2014).

Participants of the study were asked to complete Questionnaires as well as play specific games during the trial. Assessments were then completed of the participants. The researchers found that after a 6 week course of training with an action game, the participants showed higher levels of cognitive ability in comparison to a control group (Staiano & Flynn, 2014).

Jesse Schell (2019) writes that games are an excellent means of promoting emotional positivity. As gaming forces the brain to engage with something different, players can find escape and relaxation. Similarly, the story and asthetics of the game can help to improve mood. Sport, action, and fighting games can help the player to vent their frustrations. Through the use of games as a method of informal therapy, a player can refresh their mind and mood so they can gain a better perspective of things.

Devin Garlit (2018) also writes about their own experience with depression and anxiety in conjunction with multiple sclerosis. The author details their enjoyment of video games by using words such as distraction, escape, and immersion. While experiencing painful episodes or low mood, Garlit would turn to video games as therapy to focus on a task that was entertaining as well as mood lifting. It is reasonable to assume that, just as games are an enjoyable hobby for players without disability, they would be

universally uplifting to players with them.

Just as games have caught the attention of researchers as a tool to help depression, it has likewise been the subject of interest as a means to assist with physical therapy for disabled patients. One such study looked into the use of games to assist with motor training in children with cerebral palsy. Of particular note, researchers tested the inclusion of gaming as a motivational aspect toward physical therapy. The results showed a high level of motivation in the participants. An interesting, and perhaps unsurprising, note discussed by the researchers was the loss of interest when the games in this study no longer offered a challenge to the players. A lack of variety in the available games used was also a contributing factor in waning interest (Sevick et al., 2016).

One writer for The Mighty discussed their belief that gaming, specifically with a controller, helped to improve the use of their hands. As discussed with a previously mentioned disabled gamer, this is yet another example where the author describes forcing them self to manipulate a controller effectively in order to improve as a gamer. The unintentional therapy by that action, in their opinion, produced lasting effects in both physical improvement as well as increased hand eye coordination. This particular author reveals that returning to games which required quick reflexes, they found the game much easier to play (Catherine S, 2016).

While it can not be said that video games can or should replace traditional forms of physical and cognitive therapies, research is showing positive and encouraging evidence that they can be a high effective tool to use in conjunction. Players who may have otherwise not participated in therapy of their own will also seem to find some therapeutic benefits as a side effect.

Game Design Theories

One of the first questions that may come to a game designer is what

players would like. Generally speaking, gamers want to play good games, and designers want tomake good games (Rogers, 2014). The question then becomes; how can a designer accomplish this goal? Like any artistic medium, game design has established a plethora of techniques and theories to help creators bring their ideas to life from conception to the player's hands.

Players often want to experience something through games which they can't inthe real world. That could come in the form of heroic acts, magical abilities, and imaginative environments found in many variety of game genres. It can also present as feelings of accomplishment or intelligence through solving puzzles and leveling up. Thisdesire of wish fulfilment leaves a large blank canvas that designers can use to paint the picture they want the user to experience (Rogers, 2014).

With so many options left open to designers, it becomes important to narrow down the vision so the design does not become bloated and fall apart. One way to accomplish this as a first step in the process is to consider the genre, the target audience, and the desired experience. Another step in the design process is to examine the four basic elements that build a game. This includes mechanics, aesthetics, story,and technology (Schell, 2008).

Mechanics are the base rules, procedures, and goal of the game. They also define how the player can, and can not, reach that goal. It is the presence of the mechanics that make a game unique from other entertainment. Aesthetics refers to the overall feel and appearance of the game. This includes aspects such as art styles, sound, and atmosphere. What that the player sees, hears, and often feels can be attributed tothe aesthetics. Storyincludes the events that happen within the game. This can be toldin many ways including dialogue, cinematics, and even through the environments.
Finally, technology encompasses the materials used to make the game possible. This can be something as simple as paper and pen, or as complex as custom game engines (Schell, 2008).

Accessibility Challenges.

   While there is a growing awareness of the need for accessible design in game development, there still remains a significant lack of inclusivity within most modern releases. Now that the hardware technology has caught up to demands and brought standardization into base design such as the 3.5mm jack inputs, core game design will need to follow through with an effort in standardizing accessible features and mechanics. This, however, may be a more immense undertaking than simply drafting the design guidelines. These protocols must then be utilized and unforced by the industry for a widespread change of design philosophy (Glinert, 2008).

   In his article on inclusive game design, Glinert (2008) suggests that developers avoid accessible game design due to a misguided belief that accessible games are not playable by mainstream users. One example given by the author is a game designed using audio ques for visually impaired players that contains little or no visual components would not be interesting to gamers who have no visual impairments.

   Gilnert (Glinert, 2008) cautions that designing specifically with accessibility in mind can lead to the alienation of non disabled players. Considering the ratio of the comparably larger non-disabled gamer demographic to the smaller pool of gamers requiring accessible features, it could be seen as a major risk to design a game for a small group of users. The question can then become, why not both? Solid game design can incorporate the needs of disabled gamers while also appealing to mainstream players as well. The article emphasizes the importance of usability as a key metric in assessment of a game, while also being aware of the target demographic the game is designed for.

   With the formation of the Game Accessibility Guidelines, along with suggestions posed by experienced gaming charities such as SpecialEffect, Oneswitch, and AbleGamers, there is a wealth of resources available to designers to create a game that can be enjoyed by a broad reach of players. Despite the wide use of subtitles, some games still do not include them. Or do

not include them completely (Glinert, 2008).

One audio impaired respondent to an early survey conducted on game features (See Appendix A.) explained their frustration at the lack of subtitles during the ending scene in a game that had been captioned to that point. These small considerations can make big impacts on the player.

Naughty Dog, a game developer based out of California, has recently become an example of how well done accessible game features can be. The developers made accessibility of particular importance when designing Uncharted 4 from the very beginning. After considering feedback from disabled gamers, Naughty Dog's designers implemented special features that would assist players in need (Sarkar, 2016).

Human Factors and Ergonomics.

As discussed, there are a great many challenges that arise when designing for accessibility. This becomes especially complicated when taking the full breadth of variation in specific needs as a larger picture. Looking back on the examples given previously of SCI, CP, and MS, they share similarities in mobility limitations, however, the needs of each player will vary drastically due to the specifics of their individual disability.

When creating items or environments that are intended for human interaction, applying the principles of human factors and ergonomics can help assure that it is well designed and appropriate for use. Human factors and ergonomics (HFE) is the study of how people interact with the items, environments, and tasks around them.
Understanding human factors allows the designer to match products to users more efficiently and safely by balancing human strengths and limitations. While ergonomics itself is generally used to refer to the design of physical items for optimum safe use such as a chair or keyboard, it can often be used synonymous with human factors (Salvendy, 2012).

Design of controllers, as one example, put an emphasis on the comfort, fit, and handling of the device. For controllers designed for inclusion

with major consoles, the designers must take into consideration a variety of measurements of the average user such as hand size, grip, posture, and finger reach (Salvendy, 2012). Much of this information is available to designers through published anthropometrics standards manuals. These handbooks provide the detailed measurements needed when creating hardware to be used by people without the need to perform the massive undertaking that a large scale study would be to obtain this information (Tillman & Tillman, n.d.).

Ergonomics is of particular interest to the creation of adaptive controllers. A gaming device for disabled users must be more than functional within the software, it must also be safe and adjustable to the needs of the user. The more complicated the controller, the more considerations must be made. Designers must take into account how the controller will be mounted and adjusted. Bad posture not only leads to discomfort, but in the case of users with disabilities it can further irritate injuries and symptoms. This is just one example of the need for human factors principles to be applied for good and safe design (Salvendy, 2012).

The discipline of HFE encompasses a broad range of interactions, many of which can be applied to game design. Human characteristics such as individual differences, task-related factors, and physiological and anatomical aspects can be included. Information presentation and communication issues such user control features, software design, and visual communication apply well to game design. Display and control design issues including input devices, visual displays, and controls are of particular use to game software and hardware designers (Salvendy, 2012).

It is easy to dismiss the idea of ergonomics when designing games. Without proper understanding, it could be confused as something only important to physical items such as controllers. While human factors play an especially important role in the hardware of games, it is also a meaningful tool in software design. This is particularly so when the design is driven by accessibility needs.

To address these issues, an ergonomics checklist can be utilized to

help guide the design. The checklist poses questions to the designer such as the ones found in figure 5. Of distinct interest to accessible game design would be questions related to simplicity of presented information, font type and size, and control movements (Salvendy, 2012).

V. Factors Related to Information and Control Tasks

Information
1. Has an appropriate method of displaying information been selected?
2. Is the information presentation as simple as possible?
3. Has the potential confusion between characters been avoided?
4. Has the correct character/letter size been chosen?
5. Have texts with capital letters only been avoided?
6. Have familiar typefaces been chosen?
7. Is the text/background contrast good?
8. Are the diagrams easy to understand?
9. Have the pictograms been properly used?
10. Are sound signals reserved for warning purposes?

Control
1. Is the sense of touch used for feedback from controls?
2. Are differences between controls distinguishable by touch?
3. Is the location of controls consistent and is sufficient spacing provided?
4. Have the requirements for the control-display compatibility been considered?
5. Is the type of cursor control suitable for the intended task?
6. Is the direction of control movements consistent with human expectations?
7. Are the control objectives clear from the position of the controls?
8. Are controls within easy reach of female workers?
9. Are labels or symbols identifying controls properly used?
10. Is the use of color in controls design limited?

Figure 5. Ergonomic Factors Checklist for design (Salvendy, 2012).

Also of note are questions related to Human-Computer Interaction such as the ones found in figure 6. These guidelines, while not specifically created with game design in mind, can be useful to help improve the overall user experience (Salvendy, 2012).

Human–Computer Interaction
1. Is the human–computer dialogue suitable for the intended task?
2. Is the dialogue self-descriptive and easy to control by the user?
3. Does the dialogue conform to the expectations on the part of the user?
4. Is the dialogue error tolerant and suitable for user learning?
5. Has command language been restricted to experienced users?
6. Have detailed menus been used for users with little knowledge and experience?
7. Is the type of help menu fitted to the level of the user's ability?
8. Has the QWERTY layout been selected for the keyboard?
9. Has a logical layout been chosen for the numerical keypad?
10. Is the number of function keys limited?
11. Have the limitations of speech in human–computer dialogue been considered?
12. Are touch screens used to facilitate operation by inexperienced users?

Figure 6. Ergonomic Factors Checklist of human-computer interaction (Salvendy, 2012).

Design Considerations.

After the initial design decisions have been made and the developer knows what type of game will be made and for whom it is intended, the creative process can begin. One method that can be encouraged for the early stages of this process is brainstorming. This group activity is an excellent method of collecting ideas that can be narrowed down and refined later.

When all participants can freely share and discuss their ideas, it allows for much greater possibilities (Rogers, 2014).

By using brainstorming, designers can lay down general ideas for the themes, genres, and mechanics they want to include in the game. Ideas for story lines and aesthetics can also be fleshed out from brainstorming. Ultimately the scope of the project will need to be narrowed to keep within time and budget constraints (Schell, 2019).

One design factor to consider when deciding on the elements of a game is flow. A good flow will allow the player to focus on the game and immerse themselves within it. Breaking the balance of the flow can cause the user to loose their concentration and, ultimately, their interest. Good flow is a balance that comes from a few components (Schell, 2019).

Having clear goals established allow the player to focus on the task they are given. The uncertainty that comes with a lack of a goal can cause users to be disengaged from the activity. Linked to this is another important component; focus. Players must be kept engaged with the activity or their mind will wander. This will inevitably end with the player loosing interest in the game (Schell, 2019).

Direct feedback when a task is performed or a goal is achieved is yet another method that is important to making a game flow properly. A delay or lack of feedback from the action will likewise cause a feeling of uncertainty and lack of focus from the player (Schell, 2019).

Finally, evolving challenges is a key role necessary to keep the user engaged and focused. This factor requires balancing to get right. Challenges set must feel achievable without being too simple. The player wants to feel a satisfaction of beating a challenge, however, a challenge that feels too insurmountable will discourage the user and they are likely to loose interest quickly. The key then is to find the balance between the two (Schell, 2019).

One Button Design.

      The possibilities of one button gaming are deceptively simple. Quite a lot more than may first be considered can be achieved with only a single switch input. Some of the very first commercial games operated on little more than a single button. In the early design stages, it is useful to consider what can, and can not, be accomplished. When breaking down the numerous possibilities of use into three categories such as movement, attack, and interaction, even those can branch out into dozens of further options (Green, 2005).

      When taking the large scope of this branching tree into consideration, it becomes easy to see how diverse even a game designed for a single switch can be. In their breakdown on one button game design, Berbank Green (2005) warns that single switch design can work with practically any game, however, controls could be inconvenient and not intuitive. The author further warns that assigning actions to multiple switches could just as easily end in sloppy results. The key then becomes considering the player experience carefully in the design to be sure it is enjoyable to the user.

Research Aim and Objectives

Aim

      The main focus of this project is the exploration of accessibility within video games with an emphasis on one button game design. Investigation into the history of accessibility, the current availability of accessible options, and the future of accessible gaming, is an important contribution to the general awareness of the struggles disabled gamers face. Insight into considerations developers can make to help alleviate some of these struggles can help to build a better platform for all gamers. Investigating design of games for single button use for profoundly disabled gamers is one approach to this exploration.

      By compiling this research it would then be possible to analyze everything learned and create a set of guidelines that could be useful

considerations when developing a game for disabled players. Particularly in relation to the design of single switch games. These guidelines can then be applied to a small game level which can be reviewed by users.

Objectives

The aim of this project can be achieved through various paths. Firstly, the literature review is invaluable to help gain insight into the past and present availability in regards to accessible gaming options from both a software and hardware perspective. Understanding how games development as an industry is approaching the growing needs and wants of disabled gamers can contribute to building a big picture of what gaps still remain.

Building from the established research made from the literature review, combined with user feedback, a series of simple games can be designed that use the principles learned in an attempt to further understand the unique demands of one button games from a design and hardware perspective. Feedback and discussion of these, and other existing one button games, will provide a more complete understanding after final analysis of the project.

As part of the initial proposal for the project, this series of games were meant to be included in a bigger project with another PGE student to be developed in cooperation with a local school for disabled children. The goals of the software would be dictated by the tutors on benchmarks they would have liked to have seen from the students such as reaction times. Unfortunately, this fell through and the project was adapted accordingly to produce a product that instead demonstrated the information learned.

Research Methodology

The purpose of this section is to evaluate and establish the methods of research used throughout the project with a brief reflection of the benefits

and constraints of the chosen method. Research specifics will also be outlined to narrow thescope of the project and gain a better understanding of the approach.

Research Methods

Video games are an entirely interactive and personal media. To more fully explore the topic, it will require participatory feedback from relevant players to help gain insight into the wants and needs of the target demographic (Gray, 2016). Critique on accessible games both from a design and hardware perspective will also be important to access interest from players in need. Additionally, the evaluation and inclusion of existing research into the topic will help to form a complete picture. Due to the exploratory nature of the project, the Qualitative research approach would be the best fit for this. Heavy reliance on previously published relevant data will also be of invaluable use to this study when analyzing the results.

Qualitative data collection puts emphasis on the exploration of a subject. The base concerns of this method are on understanding reasoning and observing to gain insight. This is a method which acknowledges generalization and abstract such as images, media, and sound, as part of it's data collection methods. Qualitative research allows for an organic method of research which is more complimentary to the nature of game design (Collins, 2018). While quantitative data can be useful for pure statistics, itis less valuable overall when regarding the feedback of disabled gamers in regards to disability features in game design (Walliman, 2017).

While the method selected is the most appropriate when considering an ever changing dynamic of game design, it is important to consider the limitations of it. As qualitative collection relies heavily on the understanding of the design and it's feedback, there are concerns that should be taken into account with regard to focus groups. There will be little, if any, direct access to disabled participants during the design and testing stages of this research.

While this study was initially designed to work in conjunction with a local school for disabled children, there is always a possibility that access will be limited or revoked. Due to the volatile nature of reliance on subject feedback, previously published data can help to fill gaps left by these possible limitations (Collins, 2018).

After consideration, it was decided that the best method for obtaining user feedback for this study would be through the form of online surveys. In their book, authors Drachen, Mirza-Babaei, and Nacke (2018) suggest consideration into time restraints, access to resources, and capabilities when deciding on a method of user research. These three factors played a big role in the decision to use surveys. With limited access to target demographic participants, and a research lab, it would make other methods difficult if not impossible. It also seemed largely unnecessary to conduct any more involved testing, especially for the initial data gathering.

A carefully constructed survey that would be posted via sites such as Reddit would allow me to gather the initial information that I needed without the need for in person participation or use of facilities. This method is also suggested as a good way to receive information from a wide range of participants as well as being a very flexible method. Distribution through a site with a large user base such as Reddit would make it possible to reach a wide amount of users within targeted groups using specific subreddits such as those for gamers and disabled gamers (Drachen et al., 2018).

It was also of note that the authors warned some forms of in person surveys, such as focus groups and interviews, sometimes resulted in inaccurate or dishonest answers from participants (Drachen et al., 2018).

There will be three survey stages in addition to data gathering for this research. The goal of the first survey will be to collect a broad range of information on gamers with an eye toward the needs and concerns of gamers with disabilities. This information will ultimately give me a better picture of what games the players enjoy, the difficulties they face, and the types of

accessibility features they use or find lacking.

The second survey, posted as a follow up to the same groups, will be to gather information on a carefully selected group of games that could prove helpful in researching the good and bad elements of accessible designed games. Participants will be asked to play a selection of small games before answering questions for each one in order to ascertain what aspects the gamers felt were good and bad.

Finally, the last survey, once again distributed through the same subreddits, will be a specific self conducted play test and survey of the demo game constructed as a culmination of the information gained from the prior research. The information gathered here will also help in the iterative design process.

Through a combination of the information gathered by the literature review and the surveys, a better understanding of the elements that make a good one button game can be obtained. This understanding of the research can then be demonstrated in practice through the creation of a small demo game which applies the learned principles. Zimmerman, Stolterman, and Forlizzi (2010) suggest that by designing a product for a research purpose, the perspective of it can be changed and understood. As the purpose of this research is to explore accessibility and one button design, the research through design principle is very appropriate to better understand what has been learned.

This research by design can be applied through the game level in an attempt to view the key ideas of good one button design in a single demonstration. The game level also functions as a clear visual example of the collected information that can be passed on to the player in an experience which in many ways is easier and faster than a written form. The final survey conducted can be used to help determine if the target goals of the demo game were met (Zimmerman et al., 2010).

An iterative stage can be performed at this point based on the responses to the questionnaire following the play test. This step will help to address any oversights as well as contribute to the better understanding of the design. The iterative process is an important part of research by design. Gaining feedback and referring back to the literature while making changes to the product helps in its own way as part of the learning process (Zimmerman et al., 2010).

Following this research and design process, the results of the final survey can be analyzed and the findings can be reported. The project as a whole can also be reflected upon in this end stage.

Disabilities Considered for This Project

Disabilities considered for this research will be defined as long term loss of mobility function, through illness or injury, which would profoundly affect the ability to use traditional game controllers and common game mechanics. These disabilities can be divided into two major categories. The first category is musculoskeletal disability. This is defined as an inability or limitation to perform activities that involve body parts affected by muscular or bone deformation or disease. Examples include the loss of a limb through birth defect or accident. This can also include deformities or disease such as Muscular Dystrophy (*Types of physical disabilities*, 2018).

The second category includes neuromuscular impairment as seen in spinal cord injuries (SCI), cerebral palsy, stroke, or head injuries. These are defined as an inability to control the movements of body parts affected by disease, injury, or degeneration of the nervous systems (*Types of physical disabilities*, 2018).

Specific Needs and Considerations

While accessibility in games is of general interest for this project, the main focus is consideration of one button design. With that in mind, there are a few special needs that must be considered when discussing the purposeful design of a one button game.

Physical Disabilities.

Physical limitations are the primary consideration in this research. In theory, a game playable with a single large scale button should be accessible to the largest demographic of players. This can include gamers who have become physically disabled due to injury or illness and have large scale loss of function. Theoretically, the single button could be replaced with any switch that is comfortable to the player such as a sip-puff control if necessary. For this research, however, the limitation has been placed on a large simple switch as seen in figure 7.

Figure 7. Single switch one button controller (Raphy, 2015).

As previously outlined in the literature review, The focus will be on three causes of physical disability to use as examples of the target demographic for this research. Specifically, players with SCI, Cerebral Palsy, and Multiple Sclerosis. This will allow for me to examine documented limitations that I may otherwise not have considered due to my own oversight as a non physically disabled person.

Beyond the concept of limited mobility, there are some other things of note when looking at these three disabilities. For example, players with MS may experience symptoms very differently from day to day. As such, the ability to adapt to the changing comfort levels and abilities is an important consideration. The use of a single switch input would go a long way in helping the player to approach that particular difficulty in the way most effective to them.

A similar challenge can be found in patients with Cerebral Palsy. Often, symptoms can manifest different from person to person within the same syndrome classification. Due to this, what works as a solution for one player may not be possible for another. This is another example of where a single adaptable input can be used as a versatile solution.

Cognitive Disabilities.

Cognitive limitations can often accompany severely limiting physical disabilities in people who fall into either impairment category. That being said, the prevalence of cognitive disability within people who have neuromuscular impairments can be much higher. Neurological ailments and injuries can deeply affect the cognitive functions of a person. Due to the wide range of difficulties that must be taken into account when designing for cognitive disabilities, they will not be considered for this research (Gotfrid, 2016).

Sensory Disabilities.

Similarly, visual and audio disabilities will also largely not be considered for the purposes of the one button study. Some minor

considerations will be taken into account with regard to colors used. While the baseresearch explores all accessibility needs, the necessity of narrowing the scope of one button game design demands that extra parameters would ultimately be to large of a burden for this project. It is, however, important to note that sensory impairments are prevalent within the gaming community in general. It is therefore noteworthy to explore the needs of these gamers within the broad scope of accessible gaming features. While this subsection of disability definitions may seem the most straight forward when considering for game design, it is not without unique challenges on it's own.

Player Questionnaire 1

At this stage, a broad questionnaire was developed to get an idea of the challenges specific to disabled gamers, as well as their preferences (see Appendix A). While there are many methods of collecting data that could be used, a questionnaire was chosen for its flexibility, ease of distribution, and versatility. Holding targeted focus groups for this demographic would be difficult and potentially costly. Drachen et al. (2018) describe online surveys as good way to address this problem while still collecting valuable information provided the questions are designed well.

It is also believed that, due to their anonymity and lack of an interviewer, respondents have a lower bias in their answers. The responses from a questionnaire provide a way to collect information from a sample that can be used to define the demographic (Drachen et al., 2018).

Of specific interest was getting a better picture on what hardware they used, the challenges they faced in commercially available games, and what features they would like to see become more commonplace. The survey also collected some general demographic information such as age grouping, the nature of their disability, and their gaming habits in case that could be needed later.

The majority of questions were left open ended for the respondents to leave inas much feedback as they wanted. Not being a disabled person leaves opportunity for blind spots and it would be a disservice to the research to limit the questions. Instead, the voice of the players could come through entirely. The forms were also left completely anonymous to protect the identity of the respondent and allow for anamount of confidence in answering.

Lacking the participation of the school originally intended for the project, it was decided instead to make the questionnaire publicly available through online outlets such as Reddit, Discord, and social media platforms. This was the best opportunity with limited resources to reach as many people as possible.

Schell (2019) suggests that online forms from Google are free, easy to setup, familiar with many people, and a time saver. It was decided to utilize Google forms asmy format for these reasons. After designing the survey, a link to the document where participants could easily and anonymously fill it in for submission could be posted. Asit was important to keep all results anonymous, the questionnaire did not collect any form of identifying information for follow up questions or interviews.

While the information collected from this first questionnaire would help to get a broad picture of the types of accessibility features desired by disabled gamers, it would also provide good feedback that could be used towards designing a one button game.

Section one of the questionnaire asked for some general demographic information. This would be helpful to identify the feedback given by players with a disability versus respondents who did not identify as having one. With that, it would bepossible to take a closer look at what those living with the challenges of a disability prefer. Questions such as preferred genre, favorite games, common challenges, and age, also provide information that can be considered when designing a single switch game later in the

project.

Information that might be helpful from this data collected could include the average age of respondents, their preferred gaming platform, and their favorite game types, with an assumption that they would be most the most likely to respond to other portions of the research. They could then be viewed as the target demographic.

Another specific question that was asked was if players felt that games aimed toward disabled players felt patronising. Early on in my research, several games were played that were intended specifically for players with disabilities. When discussing these games with the project supervisor, the question was posed if players, particularly those without cognitive disabilities, found them to be patronizing. It was thought that many of the titles sampled felt "childish", especially if they were clearly aimed towards adults. Why did the simplified mechanics have to translate to a kids game?

While not directly asked about household income, in hindsight this could have been useful information to have when considering the hardware requirements of the demo game. Ultimately the lack of information did not make a major impact on the overall decisions. What was asked, however, was about adaptive hardware used by the respondents. This can give clues to available funds used for gaming by the household, however, that would be entirely speculative.

One concern about the questionnaire responses could be that the answers were faked. In some cases this could be less frequent during a focus group or in-person survey, however, after discussion it was felt that false answers were not likely to be a commonplace problem. Drachen et al. (2018) suggest that the anonymity of online surveys reduces the prevalence of bias in the answers. After analyzing the data, a judgement call can be made if any answers seem obviously faked.

This series of questions is also helpful to the game design process

when utilizing the lens of the player. Schell (2019) suggests the importance of taking a break from thinking about the game and instead focusing the attention on the player. Asking questions in regards to the likes, wants, and expectations of the users is a good habit of a good designer. Collecting this information from the respondents will allow for a more player focused design of the product.

Game Concepts and Rationales

While designing games to be used with only a single large button switch may, at first glance, seem simple enough, the challenges become more defined on closer inspection. Video games are created as interactive entertainment. Without sufficient interactivity, a player will generally not find entertainment in a game. It is then important to take into consideration all aspects of creating an entertaining and 'fun' game when examining one button design. In this exploration, three popular example games will be taken from a pool of mobile game apps with limited mechanics and purpose built single switch games. Feedback provided by players should help to discern what are good and bad qualities of these titles.

One Button Games.

Single button game design is limited in comparison to modern games, however, the potential for mechanics is quite vast. The single button has two states: on and off. There can also be some variations of this depending on the complexity of the movement allowed. The button can be held down for a duration, pressed quickly, or released in an off state. Adaptions within the code can add further layers of complexity. Pressing a button could activate a jump. Pressing it again could create a double jump. This particular example of a mechanic can be found in several existing games such as Devil May Cry and Lego Star Wars. The question then starts to become at what point does a single button mechanic cease to be accessible (Green, 2005).

Arguably, the answer to that is when a mechanic is no longer

realistically achievable with the limited motion of the player. This can be a question of timing. How quickly the player can comfortably use the control is an important factor. Another consideration is that what one player finds comfortable, another may find impossible.

This is one of the hurdles of designing for accessibility. While it is certainly possible to adapt complex games to utilize simple control switches, that does not necessarily mean that the game is accessible to those with severely limited mobility (Green, 2005).

It can be argued that, when designing a game that would be played by users with a variety of specific needs, single switch gaming could be an excellent solution. Adaptive controllers can often be complicated in their design, requiring numerous inventive ways to mount and position input elements for safe and comfortable use. While devices such as the *Xbox Adaptive Controller* (2018) allow for the ease of connecting together input elements that are most comfortable for the user, it can still require a complex mounting and positioning solution for optimal use. In contrast, a single switch requirement allows the player to enjoy a game without needing to consider such a complex system. The user will only need to customize the position for a single switch device. For players with non standard limb positioning, such as found in patients with Cerebral Palsy, this can allow for safe and comfortable entertainment.

Barrie Ellis suggests that the ideal one switch game for those with profoundly limited mobility be one that can be started, play, and replayed using only a single control (*OneSwitch.org*, n.d.). Using this definition as the base goal for design, a game can begin to be developed around that.

Taking all of this into consideration, is one button game design the optimal solution to designing games for players with physical limitations? It is my opinion that the only reasonable rationale is that it is simply A solution. The optional solution will be entirely up to the individual player and their needs. Just as there is no one adaptive controller that fits all disabled players,

there is no one style of game that will.

Having said that, there are a few factors that can be considered. Single button gaming can, conceivably, be compatible with virtually any system it is designed for. As the controls are limited to a single switch, any device that allows for a single input can host it. This makes it extremely versatile. This can also allow for inexpensive and accessible methods of publishing. The game can be developed for PC to accommodate the large demographic of users, or even an inexpensive device such as a Raspberry Pi which could be made available to low-income households.

Another possible consideration is the relatively minimum training required to use and understand a game with only a single switch. The limited options and abilities allows for ease of use for a wide audience of players. This is especially true when looking at the range of limitation outlined by the disabilities considered for this exploration. A single switch game would allow the player to select an input method that is most comfortable and convenient for them to use. This is important when taking into account the wide array of ways that players with Cerebral Palsy, Multiple Sclerosis, and Spinal Cord Injury can experience their limitations. It also allows for differences in how the player is experiencing discomfort on that particular day such as is often the case in persons with MS.

Exploring Mobile Games.

One place to look for inspiration on what can be done using simple controls with interesting mechanics is mobile games. Many of the top trending app games are designed with mechanics that can easily be translated to a single switch. The majority of mobile app games are designed to accommodate simple touch controls such as tapping and swiping. While some more complex titles also incorporate device tilt and more complicated touch patterns, there are still plenty of releases that rely on only one or two basic mechanics.

Here, three different games with a relatively high download rate

will be explored and analyzed for their abilities to be played by gamers with severely limited mobility. Also of interest will be to analyze how these games could be converted to a one switch option that can be played on a pc. Important design factors will be considered to help complete an idea of what creates a good one button game. For these examples, reviews relevant only to game play mechanics and accessibility will be used for analysis.

One popular app game genre is tower stacking puzzles. Generally, the player will attempt to stack blocks as high as possible by timing their fall onto the tower while the block moves across the screen. With over 50 million downloads and a 4.4 rating on Google Play store alone, one popular example of this game type is Stack (Ketchapp, 2018). It is available on Microsoft, Apple, and Android products.

In this game, colored blocks move horizontally across the screen automatically. The speed of their movement increases over time as a mechanic to raise the difficulty level. The player must tap the screen to lock the block in place and drop it onto the stack. Any overhang of the block from the piece beneath it will cause the block to break so that it will shrink in size accordingly as seen in figure 8.
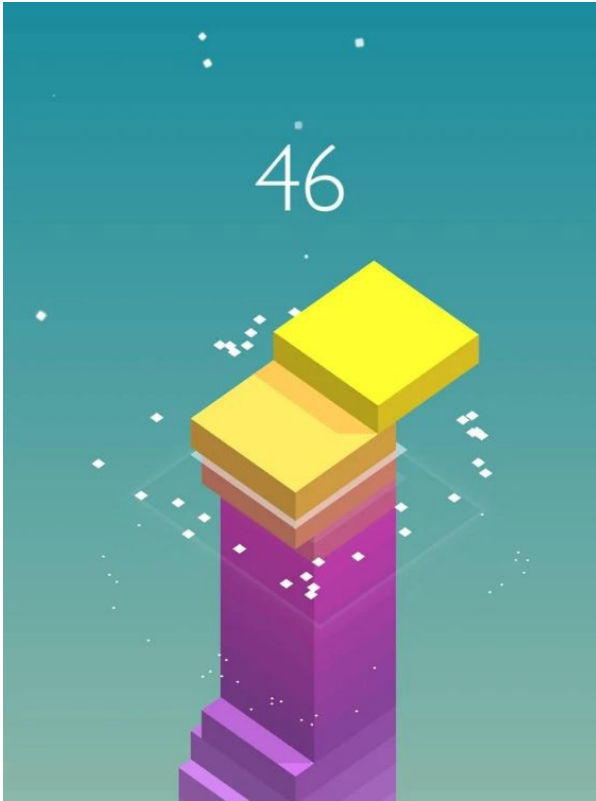
Figure 8 . Screenshot of the game Stack (Ketchapp, 2018)

.

The game lends itself to a self defined difficulty in the re-sizing of the tower stack based on the block previously dropped. As accuracy is reduced, the top blocks will become smaller due to the overhang. Smaller targets will require an increased accuracy to continue building the tower upwards.

Looking at the reviews posted on the Google Play store, positive remarks indicate that the game play is smooth and feels nice. There are some concerns at the lack of settings and players felt that having the ability to turn off the sound or have control over the speed of the game would be beneficial. Overall, the majority of reviews collected indicate that players found this game to be fun and addictive (Ketchapp, 2018).

Providing the player is able to accurately and comfortably tap the device's screen, the game should be entirely playable with that single action. Problems start to occur if a player is unable to manipulate their hands in a way that is translated by the device's touch ability. There may also be difficulties due to screen sizes. With the automatic increase in speed and no options to slow game play, the difficulty level of the game play could also pose

obstacles for disabled players. The concept of the design itself, however, stands strong as an entertaining and enjoyable puzzle game that can theoretically be created for use with a single large scale button switch.

Another popular download on the app store that has remained a fan favorite over time is Temple Run and it's successors. Temple run fits a category that is referred to as an endless runner (Studios, 2017). In this title, the character runs automatically and unending through a obstacle course style track. Various blockades on the track require the player to interact with the screen by swiping up or down. An upward swipe will cause the character to jump over a barrier such as a tree root or gaps in the path as seen in figure 9. When the player performs a downward swipe motion, it will cause the player character to slide under obstructions such as through holes in walls or under an arched tree root.

Figure 9. Player character jumping a gap in Temple Run 2 (Studios, 2017)
.

More complex mechanics come into play when it comes to directional turns. Though the game itself is an endless runner, the player is required to interact with the trajectory of the character by swiping to the appropriate direction to turn the character so it stays on track. Failure to turn at the right time will result in a game over.

Use of the tilt sensors in mobile devices has been included in the Temple Run franchise as a way to influence the character's placement on the path. Tilting the device to the left will cause the character to keep to the left side of the path. This is incorporated into a mechanic by encouraging the player to collect coins for points that are often laid out on one side of the path.

Though the game mechanics are simplistic, Temple Run suffers from many of the same problems as Stack when viewed from a perspective of accessibility. Screen size, tap recognition, and movement requirements may make this title unplayable by some gamers as well. This is especially the case with game mechanics that require the player to tilt the device in order to manipulate the location of the character within the game space. Those with physical limitations may have difficulty maneuvering their device to accommodate for this need. Similarly, however, the concepts of the game are solid and, with some planning, can translate into a single switch button control based design.

Player feedback of the game is overwhelmingly positive at a 4.3 star rating out of 5 on the Google Play store. Reviewers felt the controls were satisfying and easy to understand. Players also comment on the fun factor of the game despite it's difficulty level. Critiques left by users include requests for a difficulty setting or the ability to adjust the speed of the game. One review specifically left feedback wishing the speed of the running was adjustable to accommodate for slower reaction times.

The final game examined in this study is Ironpants. Inspired by a discontinued game titled Flappy Bird, at over 140,000 downloads this clone stands on its own as a popular casual app game available on iOS and Android (Applava, 2014). Though developed to be a challenging game, the core mechanics of Ironpants are possibly the simplest ones out of these three examples.

Just as in Flappy Bird, Ironpants players control an endless moving character in this side scrolling platform game. By tapping the screen the player creates an upward thrust to their character as they continuously fly to the right of the screen. Subsequent tapping will cause the character to rise higher. As such, players can largely control the altitude of their character by tapping the device screen to push the character to a desired height.

The developers provide three ways to experience the game. In the Tap Mode, the player simply taps to provide upward momentum. In Hold and survival modes, the player will hold the screen to make the character continually rise. Releasing will cause the character to go down.

The challenge comes from the level map. Obstacles are presented in various forms such as the wooden boxes seen in figure 10. These barriers will form a gap which the player must navigate their character through as they fly on their endless path through the course. While the mechanics may initially make the game seem too oversimplified, the obstacles are much more difficult to navigate than they appear.
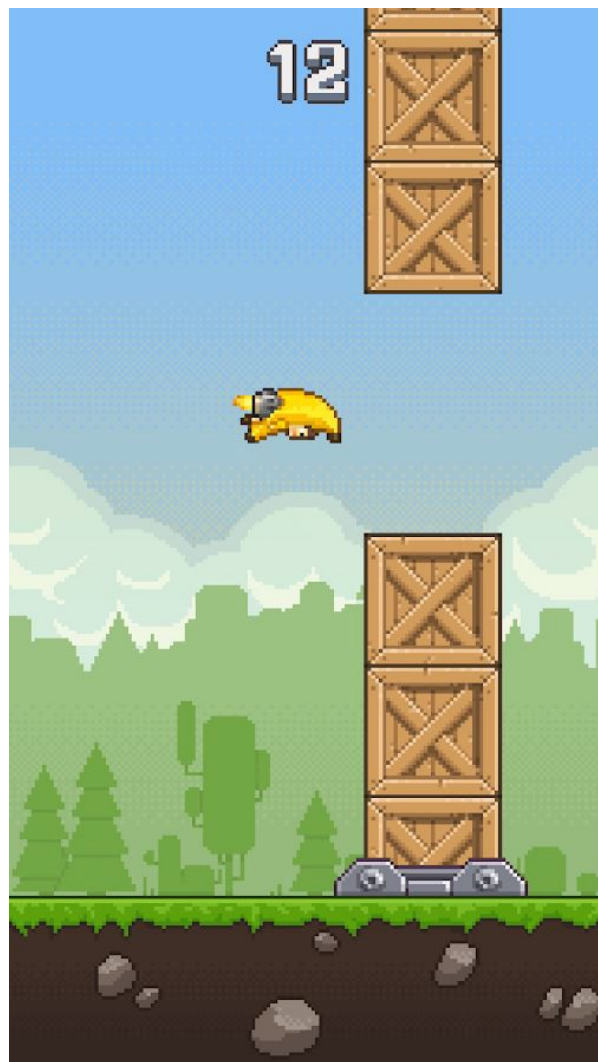

Figure 10. Player character flying through a gap in Ironpants (Applava, 2014)

.

One interesting aspect of Ironpants is the inclusion of a third play mode: sound activation. In this setting, the player controls the character by

use of short or long sounds rather than touching the device screen. While making any sound will cause the player character to rise, the intensity and length of the sound plays some part in the momentum of the lift. The inclusion of a sound mode for Ironpants is an interesting twist on the traditional game play. While there is no evidence that the designers had disabled players in mind when implementing this mode, it clearly has potential to cater to gamers with physical limitations.

The game offers no settings or difficulty levels to choose from. The challenge of Ironpants is simply to survive as long as possible. The game keeps score of the number of obstacles cleared rather than a more traditional tally of counting levels completed.
Due to this, players often feel frustrated by the inherent difficulty of Ironpants (Applava, 2014).

As with any game, the ability to adjust difficulty through the settings is an important step for designing for accessibility. This is especially true for a game such as Ironpants. While some players may relish in a game's difficulty, many will become frustrated and upset. This is reflected in many of the comments left on the Google Playstore for the game. By providing difficulty settings or the ability to adjust settings of speed and sensitivity, the player can better control the game in a level that is comfortable for them.

Adjustable settings aside, the simple core mechanics of Ironpants make it a good candidate as an example of one switch games. The tap and hold controls easily comply with the capabilities of a single switch device. Instead of tapping a screen, players would simply tap the large scale button instead.

With a 3.5 star rating on the Google Play store, Ironpants appears to have mixed reviews. Closer examination of the user feedback indicates problems with the ad system within the game rather than the game itself. Ignoring commentary on that issue leaves a very positive view of the game.

While difficult, players generally enjoyed the challenge presented to them. There are also positive comments on the simplicity and smoothness of the controls. Feedback also indicates that players had fun with the voice activation mode (Applava, 2014).

Player Questionnaire 2.

At this stage, a second questionnaire was distributed online through the same avenues as before. Drachen et al. (2018) state that online surveys are an easy and fast method to collect large amounts of data. With limited access to participants on campus, an online questionnaire was once again the
go-to method to collect information from players.

Distribution of the questionnaire was, primarily, via social media and subreddits for relevant interests such as gamers and disabled gamers. The questions for this round were designed to be as flexible and open ended as possible to allow for respondents to express their ideas without limitation. The questionnaire was made publicly available for approximately 2 months.

The goal for this questionnaire was to gain feedback from a sample of players, preferably those with physical limitations, on three games selected from the top recommended on oneswitch.org. These games were chosen based on their popularity and reviews on the site.

A brief introductory section gathered information on the player to get a better picture of the demographic of the participants. This information would establish age ranges, if the respondent had a physical disability, the use of adaptive hardware, and if their disability affected their ability to play games normally.

In the following section, players were directed to the download location for each game. They were then asked to play the games and fill in their opinions on the questionnaire. The same series of questions were asked for each game. The point of which was to gather opinions from players to get

an idea on what they liked, disliked, and what changes they would make. All questions were left with long answer boxes so the respondents could include as much information as they wanted. This allows for the questionnaire to be flexible and give information that may not have been thought to ask

for.

To get an understanding of player preferences with visuals, an entry asking if they found the graphics appealing was included. The responses to this question could be valuable information when designing the demo game. User preferences from the sample demographic can be taken into account based on the visuals of the games. This can be art styles or colour pallets as an example.

Also of importance were two questions regarding the ease of understanding. Specifically, the aim was to know if the instructions were easy to find and understand, and if the player was able to figure out the mechanics well enough. The goal of this question is to establish good and bad examples of conveying instructions and intuitive mechanics.

Information about the controls, specifically if they felt smooth and natural, was also listed. During early research into some single switch games, it was noticed that a common complain was how frustrating it could be to navigate menus and how unnatural gameplay controls felt with the single input. It was my hope to gain insight from the players on what, specifically, they found good and bad with one button mechanics.

The responses to this questionnaire can once again be used in the player focused approach to the design by utilizing the lens of the player. The answers given by the respondents can tell more about the likes and dislikes of the users as well as get an idea for the features and challenges desired (Schell, 2019).

Exploring One Button Games.

There are several existing repositories forpurpose designed one button games. Oneswitch itself maintains a library of over 100 titles of varying quality to download for free that function with a single switch. It also hosts a challenge for developers to remake classic games with one button compatibility (*OneSwitch.org*, n.d.).

While not the only library destination for finding single button games, OneSwitch is certainly one of the easier choices when searching for games that are compatable with single switch needs. Aside from hosting downloads on their site, they also link to other pages where players can find available games to try. One big draw tothis organization in general is the complete descriptions offered for each title including any warnings that might be useful such as speed limitations, difficulty modes, and physical requirements (*OneSwitch.org*, n.d.).

It could, therefore, be considered a good representation of the single switch games available to those in need. A top 11 curated list of games is made available by the organization as a starting point of recommended titles. Of these available titles, the top three were chosen as test examples of what one button game design should, or should not, be. They will also be compared to the selected mobile games in regard toease of play for those who require a single switch game.

In 2006, the Retro Remakes community hosted a one month game challenge fordevelopers to create single button only games. The first choice from the recommended list, Alice Amazed, was one of the submissions for this challenge. As such, it was a purpose built game that could function with a single switch control (Ellis, 2006).

Alice Amazed appears as a relatively polished game that is available on OneSwitch's library as well as the developers website for free download. According tothe game's manual, the plot revolves around the familiar characters of Alice and the White Rabbit who have become lost within

a hedge maze and are looking for the way out (Michi, 2006).

The game itself is presented through several mini games that are accessed while navigating through the hedge maze. They mimic classic game mechanics that can be found in many popular retro games. In one example, Ace Invaders, the player must avoid being hit by spears by hiding behind the defensive towers as seen in figure 11.

The starting screen does contain an options menu where players can set the difficulty level of the games. These settings seem to mainly affect movement speed with easier modes slowing the motion more and harder modes speeding it up.
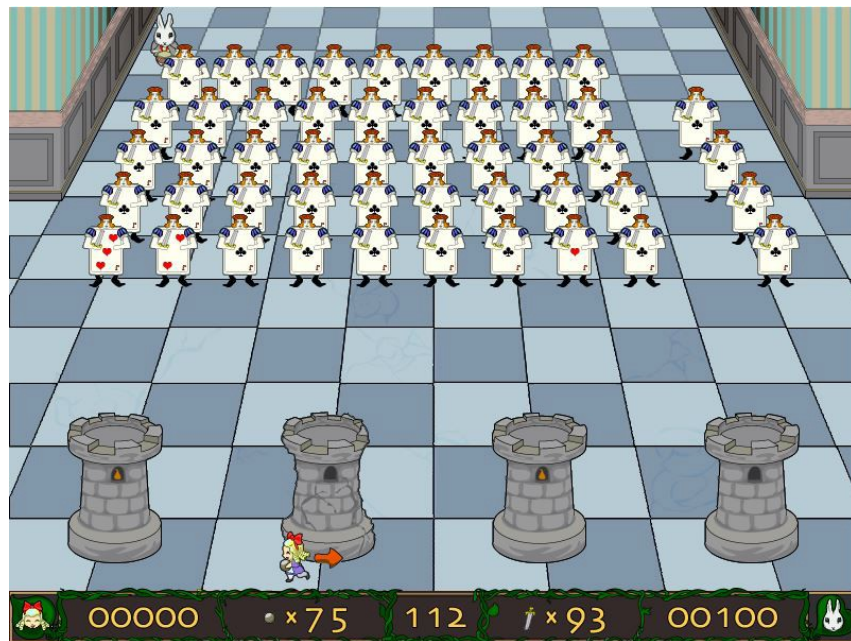

Figure 11. Ace Invaders mini game from Alice Amazed (Michi, 2006)

.

Looking at this particular mini game example, a good use of simple one button mechanics can be found. Alice moves in one continuous direction until she hits the side wall. At that point, the character will turn and move the opposite direction until reaching the opposite wall. This movement repeats automatically until the player is hit or intervenes. Pressing the switch will cause Alice to turn direction as is indicated in figure 8 by the reversing arrow. In this way, the player can direct Alice to cover from the projectiles while the defense towers attack the Cardians.

The instructions for this mini game, while not displayed in any obvious way onscreen, are easy enough to grasp for anyone who has played games before. With only a single button interaction, the player can quickly ascertain the mechanic that is required of them. The same can be said for Climbing the Wells, another mini game in the set.

In this challenge, the player must climb out of a well by jumping onto the ascending platforms until they reach the top of the screen where a bucket will lead them out as seen in figure 12. Similar to Ace Invader, the player sprite will move continuously in one direction until it hits a wall and reverses. The only mechanic available to the player through their switch is to jump. Combining these two, the player can navigate the platforms by timing their jumps. They must also avoid hitting enemies while moving upward through the map.
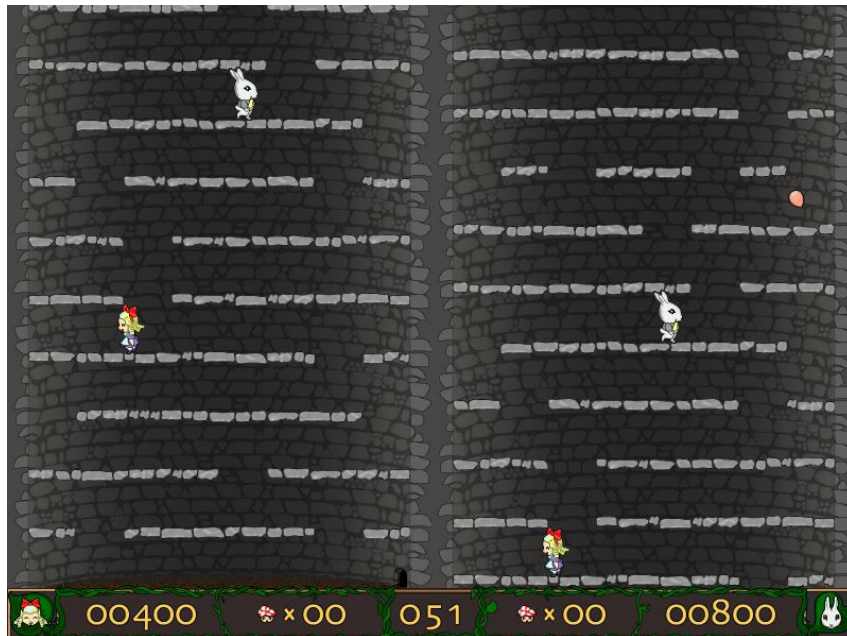

Figure 12. Climbing the Wells mini game from Alice Amazed (Michi, 2006)

.

Similarly to the Ace Invaders example, the relatively simple mechanics are easy to pick up despite a lack of instruction displayed to the player. A quick play around with the single switch will clearly demonstrate that the button is meant for jumping. The on screen graphic icons at the bottom as seen in figure 9 helps the player to understand that collecting the

mushrooms is a good thing.

One common link between both mini games is the distinct lack of instruction. This maintains throughout the entire game, including the menu itself. While this is not exactly a problem for some of the mini games where the mechanics are obvious to anyone who has played classic games, this could pose a major issue for gamers who have not. There are, however, some instances in the game where the lack of clear instruction made for a frustrating experience.

The main map that is navigated to enter the minigames is depicted by a hedge maze. Various icons are located throughout and the players appear to navigate via the selection arrows on the left for single player as seen in figure 13. The game will highlight each arrow in turn on a timer. When the desired directional arrow is highlighted by the red frame, a button press from the player will select it. The game character will then move in that direction until they hit a barrier. The main menu also works with this timer based highlight mechanic for selection.

Figure 13. Hedge Maze from Alice Amazed (Michi, 2006)

.

None of the mechanics within the Hedge Maze section pose a problem in and of themselves, however, without any clear instruction on how to navigate, what the icons mean, or even what the goals are, the player can be left feeling lost and frustrated. Volunteer players who tested Alice Amazed and were surveyed (see Appendix B) on the game after found it of particular annoyance. Respondent's opinions indicated that players found the hedge maze to be confusing and they did not understand what they needed to do in order to "win".

Players felt that the timed menu selection, while helpful, found it tricky to navigate. If the timing is off, the player could select an option they didn't want. It maybe important to note that similar responses were given for any timed choice system in the one switch games tested. It may also be important to note that none of the respondents to the survey indicated that they identified as being disabled to a point of needed a single switch game or device. The overall sentiment seemed to indicate that, while Alice Amazed's intention and presentation was nice, the overall execution was pretty poor.

Of final note in regards to Alice Amazed, the instructions for this game were found as a separate document within the install folder. To access it, players would need the ability to navigate to the destination folder and open the document. They would also need the ability to read it and scroll through it. One surveyed respondent replied that the manual being outside of the game itself made it, effectively, non existent. It is noteworthy to mention that this ability to access the document would also be needed to load the game itself.

Also found on the recommended list is a title that has gained some following among the fans of silly games, Dracula Cha Cha (Lobo, n.d.). This one button game has a difficult time being wrangled into a single genre. It is a take on a Konami mobile game Tomena Sanner (*OneSwitch.org*, n.d.). One article by Alice O'Connor (2018) describes it as a one button, auto walking,

mini-game mash-up. It is difficult to disagree with that label. It is also a good contrast to some of the complaints found in Alice Amazed.

In Dracula Cha Cha, the player finds them self in a series of colorful side scrolling levels that are matched with sock hop style soundtracks such as the Green Door by Jim Lowe (O'Connor, 2018). Dracula, as controlled by the player, navigates through a series of quirky mini games such as the dance competition against a zombie Santa Clause as seen in figure 14. These mini games are combined with typical side scrolling mechanics such as jumping and fighting. This is all done with a single button. More importantly, it is done well.

Figure 14. Dracula dance off with Zombie Santa in Dracula Cha Cha (O'Connor, 2018)

.

While the description of this odd game's mechanics may sound complicated, in reality it is executed easily and smoothly. By default, the interactive key is mapped to the space bar. There is, however, the base game is just as easily played with a single switch button. As part of the side scrolling segments, the character will automatically walk to the right in an endless motion. Tapping the button once will cause Dracula to jump. A second or third tap subsequent to the first interaction will cause a double or triple jump for extra height to reach collectible rewards. Similar to the jump,

a single press of the button also works as an automated attack when the conditions are activated such as well an enemy is within range.

At several points during each stage, the character will end the walk cycle toperform a mini game challenge such as the one seen in figure 11. Here, the player must tap the button in time with the red bars moving across the indicator to mark a success and win the challenge. In other cases, the player may have to hold the switch to cycle through options while releasing will select the choice. Overall the interaction system is designed well and players find the game enjoyable and easy to work with.

In direct contrast to the lack of information that Alice Amazed provides to players on screen, Dracula Cha Cha provides important instructions at the bottom of the screen to inform players on how to interact with various challenges. When instructions are not necessary, clever dialogue is placed in this location as well that comments on the player's actions. Survey respondents found the location of the instructions a little awkward, but noted their appreciation at the attempt to inform players of necessary information.

One major point of attention came from the lack of any settings. Players felt that difficulty modes or speed settings would go a long way in making Dracula Cha Cha more accessible to players with slower reaction times. Some respondents also commented in a similar sentiment to the reaction time necessary to trigger double or triple jumps. They felt some players might have a difficult time with the repeated fast motions needed to activate these mechanics. A sensitivity or timing setting could help to correct this and make the mechanic more comfortable to those in need.

The final game examined for this study is Aurikon, another title created for the Retro Remakes Competition (*Aurikon*, 2005). This space shooter was purpose designed to be used with only one switch and is featured on OneSwitch.org's recommended list. It is also one of the more polished space style shooting games available there (*OneSwitch.org*, n.d.).

In Aurikon, the player controls a ship as it follows a set path through space. The player will shoot backwards as they are pursued by enemy ships which will appear on the screen behind them. Various weapon types such as proximity mines, laser blasts, and rapidfire beams are randomly assigned in a queue. Tapping the button or, in the case of the default the space bar, will activate the top of the queued list and fire the selected weapon at the enemy ship as seen in figure 15.
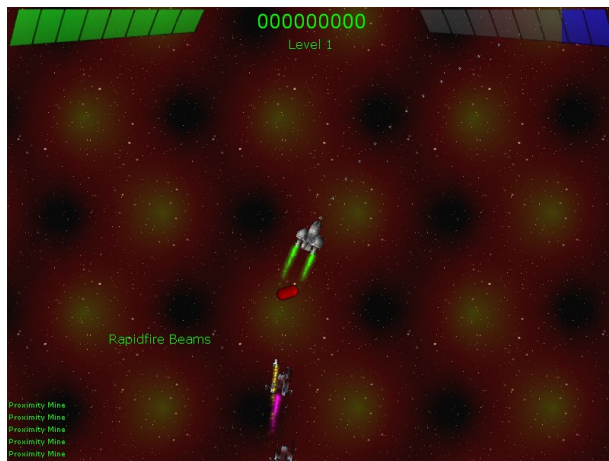

Figure 15. Player ship firing a proximity mine at enemy ships in Aurikon. (*Aurikon*, 2005)

.

In addition to the battle system, the player may also press and hold the interactive button to activate a speed boost. This can be used to move faster along the linear path to escape projectiles or, in some instances, to select an optional path and change the ship's trajectory. The mechanics are well presented and polished, allowing for a very smooth and natural feeling to the game.

The main menu itself features a timed selection system similar to the one experienced in Alice Amazed. It allows for a quick exit of the software by using the escape key although they tell you that it is not necessary at all for the gameplay. It is nice of the developer to note this clearly on the menu. The speed of the selection cursor felt slow enough to allow the player to make their desired choice. One interesting design choice is that the options for adjusting the game speed, thrust speed, and menu speed itself, are

directly on the main menu screen along with the play selection as seen in figure 16.
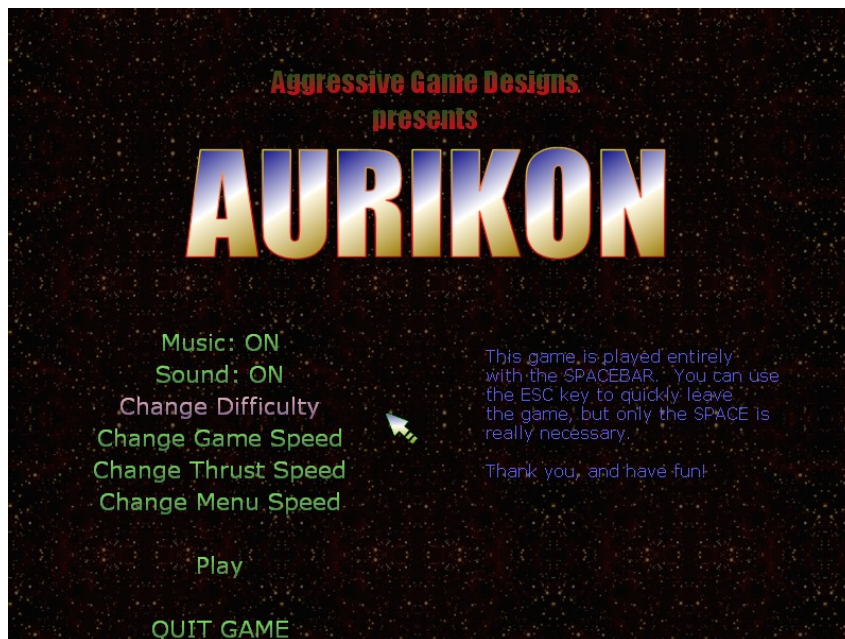

Figure 16 . Aurikon's main menu screen. (*Aurikon*, 2005)

.

Players who provided feedback on this title in the short survey (see Appendix B) appreciated the options being directly on the main menu. Respondents commented that they felt the developers gave players a lot of ways to adjust the game to their desired comfort level. There were no complaints about the game mechanics or input methods other than some players feeling that the game was not as exciting as it couldbe. Only one player reported going beyond level 3. Other feedback noted that it was not very stressful to play and that it was nice that there were ways to make it even less,or more so, depending on the options.

Important Observations.

After exploring these three popular single switch games, some key notes can be made when considering game design for one button titles. Options are an important way to allow players to comfortably interact with their game. Through options, the developer can allow the gamer to find settings that allow them to best enjoy their experience in a meaningful way. This can include

even basics such as difficulty settings, timer tuning settings, and even sensitivity settings for their switch. Developers looking to be more inclusive in their design can take this further to examine settings for audio and visual impairments.

In addition to settings, instruction is also an important feature that was mentioned often by all respondents. The inclusion of clear instructions in an easy to find manner such as an on screen display is a simple way to ensure the player will not be weighed down by frustration at not understanding the goals. One recommended method can be found in Overcooked 2 (Team17, 2018). An easy to understand instructional screen is displayed for the player to read at their own pace as seen in figure 17. The player must press and hold the trigger for a period of time in order to close out of the instruction.

Figure 17. Overcooked 2 instruction screen (Craddock, 2018)

.

Defining Target Demographic

As with the study into the single switch games, a specific target demographic was formed to keep in mind while developing the list of criteria for design. The term disability has a wide reach and can encompass many illnesses, injuries, and limitations. The dictionary simply defines disability as a physical or mental condition that limits the activities of a person (Accessibility, n.d.). Without narrowing the scope of the definition, creating a design to

encompass all disabilities would be impossible for this project.

For the specific purpose of this design, the target demographic will be players who have limited mobility which restricts their abilities to the use of a single large button switch for game play. This can manifest not only through pressing the button with a hand, but also through any necessary non traditional configuration of the switch. Simple examples may include mounting the switch to be pressed with a chin, elbow, foot, or otherwise.

While not specifically use or tested in this study, other adaptive switches that can be accommodated by one switch designed games may include eye-blink switches, grasp switches, sip-puff switches and more. The focus on this study is primarily on the design and not on specific assistive hardware as the emphasis is on what is comfortable to the player.

The design will not accommodate for visual or audio impairments. It will also not specifically account for cognitive limitations, however, many accessibility options for limited physical mobility overlap with considerations taken to be inclusive to players with mental disability as well. Basic examples of this overlap can include difficulty settings and speed options.

The age range, while it can be important, is not of major concern in this situation. Initially, this project was intended to be researched in conjunction with a local school for disabled children. Fairly early on in the research it became clear that this was not likely to occur due to a breakdown in communications. While the intended audience was originally to be school aged children, the project does not need to limit itself exclusively to this demographic. Instead, this study will broaden the interest gap to include a general audience over the age of 7.

By the current Pan European Game Information rating system (PEGI), this would fall under a PEGI 7 rating. This category allows for mild, non-detailed and non-realistic violence (PEGI, n.d.). While it would be extremely unlikely to include even that in this project, allowing for a PEGI 7 level rating opens design options up to include shooters or mild combat such as seen in many of the explored examples.

Design Theory For One Button Games

Methods to good single switch game design can be gained in three ways. Firstly, it is important to remember that, although designed with an eye toward accessibility, one button games are still games. As such, their elements can be designed by using established principles applied to any game.

Second, by compiling the analysis and user feedback of the selected games. Particular attention should be put on the user feedback to gain a better idea of what, specifically, the players themselves found positive and negative about a title. Any feedback from reviewers who self identified as disabled would be of added value to the analysis.

Finally, standards and suggestions by experienced game designers and disability gaming charities are valuable portals for information on the subject. The information found in Game Accessibility Guidelines (*Game accessibility guidelines*, 2018) along with advice from OneSwitch (*OneSwitch.org*, n.d.) will be the main resources for this section.

Design Elements.

Schell (2019) explains that game design can be broken down into four basic elements; mechanics, story, aesthetics, and technology. Mechanics relate to the doing portion of the game. How a player can move, the types of actions they can perform, the rules, and goals. This is, arguably, the most important part of the game. Schell explains that the mechanics are, in essence, the game itself.

Aesthetics refer to the how a game looks, sounds, and feels. This important element has a direct relationship with the player and their experience. This key element of design sets a mood for the game and should work in harmony with the mechanics (Schell, 2019).

Story is the events that unfold as the player progresses through the game. Like aesthetics and mechanics, good game design will harmonize these two elements with the story to create an immersive and cohesive experience. Finally, technology is the material which makes the game possible. This can be as simple as paper and pencil, or as complex as custom designed game engines (Schell, 2019).

While all of these elements are important in the overall design of a game, the created product for this research will only focus on three. Due to the simple nature of the demo, as well as the time-frame and requirements of the project, story will be not considered in this design.

Options.

As seen in the majority of reviews and feedback on both the mobile games and the one switch games, players stress the importance of including options to tailor the gameplay to fit more comfortably to their needs. While, generally, this includes choices for gameplay speeds, trigger sensitivity, and timer speeds for auto selection menus, this can include a great deal more.

Remapping, or keybinding as it can sometimes be referred to, is a common option in many commercial titles for good reason. While more prevalent in PC games, it is still rare to see in console option menus. Remapping serves as more than simply a tool to make important gameplay mechanics more comfortable for players on either a permanent or situational basis. The ability to remap the essential inputs can make a game playable at all for users of adaptive technologies. It is also useful to consider the reflection of remapped controls when displaying in-game prompts to keep from confusing users. This is a strong example of small quality of life considerations that make a big impact for all gamers (*Game accessibility guidelines*, 2018).

Sensitivity control options is another important inclusion for a good settings menu. Due to variations of different adaptive switches, allowing the player to adjust the sensitivity through the settings is especially important. Some

gamers with restricted movement may requite high sensitivity for their controller while others may be more comfortable with lower settings. Options to reduce sensitivity may also be helpful to reduce simulation sickness (*Game accessibility guidelines*, 2018).

Difficulty levels can be a hot button issue among the gaming community. With some arguing against the inclusion of difficulty options for games that target a 'hardcore' demographic, it can also be seen as an argument against inclusiveness. Speed settings and difficulty level settings can often be one in the same. When considering a player who may be restricted to using a head switch to boost their speed in Aurikon, their reaction speeds will be drastically different from someone with more range of motion using a hand button. Difficulty levels should reflect their description and intention (*OneSwitch.org*, n.d.).

Controls.

There were few specific comments by gamers on the controls themselves for the surveyed games. Instead, feedback came in the form of how comfortable or easy to use the mechanics were. There are still some clues to be gained from this information. The simpler the required input for the mechanics was, the more players appeared to comment on the ease of control. In a game designed for use with a single switch, there are few options for input combinations. Even so, designers must be cautious of how much demand they put on players of games designed for those with physical limitations.

By definition, a one switch game should be entirely playable and navigable using only a single switch controller. This can mean a single key on a traditional keyboard, a single button on a mouse, or a custom adaptive switch. As a general rule of thumb, it is recommended to stick with the space bar or left mouse button as default traditional controls. These are considered the most comfortable of the standard configuration and provide the easiest conversion for those using an adaptive controller (*OneSwitch.org*, n.d.).

One exception to the single button rule that is acceptable is the use

of the escape key as a means to exit. It is recommended that escaping once should quit to the main menu. From that menu, using escape again should exit out the software entirely (*OneSwitch.org*, n.d.). It would be beneficial to allow for this to be rebound to another key for those who may find alternative placement more comfortable, or gamers who intend to use a separate adaptive switch for that purpose (*Game accessibility guidelines,*2018).

Instructions.

As seen in some examples such as Alice Amazed (Michi, 2006), lack of clear instructions presented in an easy to access format can be a strong contributing factor for a low success rate of a game. While it may be easy to think that a game containing simplified mechanics usable with a single switch does not need instructions, that logic would be flawed.

The inclusion of an easy to understand instruction card on screen or, for more complex games, an interactive tutorial, will help a player to understand what is required of them. This will prevent frustration and allow a user to enjoy the game. Another option, as experienced in Dracula Cha Cha (Lobo, n.d.), would be to have a convenient permanent location for any instructional messages that the player could see at a glance.

Demo Game Design

Using what has been learned during the exploration of accessibility in games, a small demo game can be designed that incorporates the key important factors of a well constructed single switch game. There are a few criteria that can be established for the initial design plan that can contribute to a quality demo. The concept wire frame devised during the design phase can be found in Appendix C.

Initially, the project was developed around the idea that a series of small single switch games would be developed in cooperation with a school for

disabled children.

Additionally, a programmer was intended to be working alongside me in the development process as part of their own research project. This joint effort would see the creation of a small game library that would be tailor made to the specific need of the students. It would include programming that would track various improvements made by the students over time from playing the games. These included response times and accuracy ratings as an example.

Unfortunately, the original project fell apart due to lack of cooperation from the school as well as a lack of participation from the programmer. It was then decided that a product would be made instead to demonstrate a culmination of the information learned from the research project. A list of important considerations would be compiled using the literature researched and, from that, a small demo game would be developed that showcased these considerations.

Genre and Theme.

Schell (2019) describes theme as the idea that ties together the elements of the game. The author suggests that the presence of an overarching theme for a game can help the final product to be more engaging for the player. Despite the simplicity of the artifact created for this research, establishing a theme for the demo can help to keep the design cohesive.

A small brainstorm of keywords that could be used to establish an overall theme was created 18. From the basic ideas, some brief branching keywords were made. Ultimately, the theme of positive emotions was chosen to help direct the design. It was felt that accessibility was a goal of the project and childhood games were an inspiration rather than a theme.

The theme of positive emotions would help to determine the aesthetics and the mechanics of the design. With this enveloping goal of creating a relaxing and positive experience for the player, the genre could then be chosen.

Game genres can be thought of as a classification system to organize

games by characteristics. Some examples include Role playing Games, First Person Shooters, and Puzzles. These genres describe the type of game-play that can be found within a title. Further genres can go on to categorize titles based on artistic style such as Anime or Live Action. It can also include pacing like turn based or real time (Arsenault, 2009).
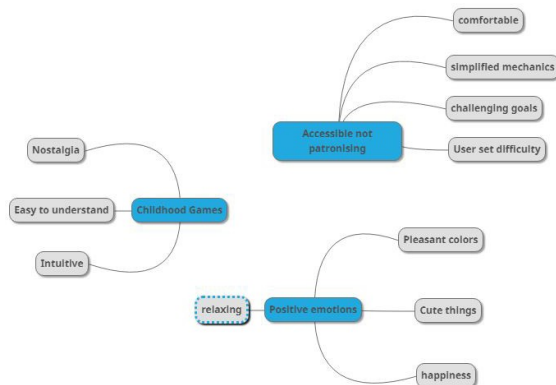

Figure 18 . Brainstorm session to help decide on a theme for the game.

When deciding on a genre for the demo game it was beneficial to look at two sources. First, the popular games available on the app store. As this was intended to be a small demo with simple mechanics that would fit within the criteria of the one switch design guidelines, games developed for a device with limited control function was a good source of inspiration.

Searching the app store on Android and Apple turned up a multitude of candidates that could be used as good examples of games with simple mechanics and high playability. Puzzle games in particular seemed to be the best fit to the aims of this research. Their mechanics were often simplistic and easy to understand while the game-play could offer increasing challenges. They also appeared to have the most flexibility when considering the needs for physically limited players.

One other genre of game that was examined early on was the idea of a side scrolling type. This could come in a simple platform style game or an infinite runner. While the general mechanics of either of these choices could be

simplified to a single button, the programmer working with me on the project felt it would take much longer to smooth out the motions and balance the timing and difficulty curves. That being said, the infinite side scrolling runner idea was a strong second to a puzzle style game.

The second source for inspiration on the game's genre was found in traditional children toys. Stacking toys, specifically blocks, becomes a skill very early on in childhood development. It is believed that children as young as 18 months begin to grasp the skills of building block towers. These base stacking and organizing skills are key developmental milestones. As such, they are a skill that sticks with people as they mature through life. The simple act of stacking blocks becomes recognizable almost instantly (Sharma, A., & Sheridan, M., 2014).

Having a game in which the intention can be discerned almost immediately by visual queues can go a long way in conveying instruction. Raph Koster (2013) shows that, when faced with a problem, human instinct is to try solutions that have worked in the past. This fact is further emphasised by the idea that people are highly resistant to disregarding learned behaviors. By presenting the player with blocks to stack, coupled with limited and simple mechanics, they should have little trouble in interpreting what it is they are meant to do from the start.

When considering simple to understand rules and mechanics that would compliment a single switch based design, there could be a myriad of possibilities to choose from. When taking one step further to also consider learned behaviors that could help the player to recognize the goals through visual ques, the concept of a stacking puzzle game seemed to be a good choice that fit.

One way of thinking suggested by Schell (2019), is to view the game concept through the lens of accessibility. By this, the author explains that it is good to make sure the player can visualize what the first actions in a puzzle should be. Decisions must be made to help support this design concept by asking if the player is able to understand the game easily and how they will obtain the directions.

In this design theory, the author continues on to describe how

puzzles that behave like something familiar are easier to grasp by the user. In this case, by choosing the familiar stacking game it makes it more likely that the player will intuitively understand the objectives they must achieve (Schell, 2019).

Other games considered as inspiration for the design were likewise found in early childhood development activities. Simon Says is one game commonly used to help children improve their memory skills. It is similarly easy in it's mechanics. The player is tasked with remembering a sequence of triggers. They are then asked to repeat back that sequence in the correct order to move to the next level. The goal is to repeat sequences of increasing difficulty until the player fails at a sequence or the game ends. In some modes, there is no end. In this case, there is often a high score goal rather then a completion of the game itself (Sharma, A., & Sheridan, M., 2014).

While this game could be interesting from an aesthetic and technical aspect, it would be difficult to execute in a one button setting. It is likely that selecting the blocks in the sequence while limited to a single input would ultimately make for a frustrating and boring experience that would not create a positive feeling.

Similarly, another recognizable childhood favorite of Memory was examined. In this game, the player is asked to reveal tiles and find the matching tile by remember the location of it's pair. The goal of the game is to reveal all the matches in the least amount of moves possible. The mechanics once again for this would be simple, however, the tile selection process would be tedious and time consuming. This would ultimately detract from the positive experience that is being aimed for.

After considering the options, it was decided that a block stacking game would be suitable for the project as the mechanics could work with one switch. Additionally, the action of stacking would be intuitive to the player based on the theory of early childhood developmental games of stacking. This could be brought together coherently through the overarching theme of

positive emotions through use of pleasing graphics, smooth simple mechanics, and potentially sound (Sharma, A., & Sheridan, M., 2014).

Visual.

Visuals are an important part of any game. In this demo, the goal is to present something that is pleasing to look at while also being easy to focus on.

Though this demo will not specifically examine it, any colour palette chosen for a game should consider colour blindness options during the design phase (*Game accessibility guidelines*, 2018).

Research into colour preferences in children has shown that young children often prefer bright primary colours. This may be largely due to their underdeveloped vision and their ability to see certain colours. As they grown, tastes change and in contrast to the lively colours preferred by children, adults lean towards less saturated shades (Naranjo-Bock, 2011).

In one study, researches found that adults had a tendency toward shades of blue. This same study also found that adults associated certain colors with emotions such as red for angry and yellow for happy. Children had very different choices in their emotional colour connections. They had fewer defined associations and often chose several colours per emotion. Blue was often matched with sadness while red was considered happy (Munger, 2005).

While primary colors may appeal more to young children, they can be harsh on the eyes. This is especially so when viewed for long periods on a screen (Anthony, 2018). The choice to use multiple colors was also made to keep the game visually interesting. A palette for the blocks was created to stand out against the more pastel palette for the backgrounds. In this way the blocks will be easy to see against the more muted background as seen in figure 19.

To add further appeal and interest, faces were added to the blocks. Three states were created as seen in figure 20, not only for fun, but also to help indicate actions to the players. A worried looking face would show on

the block before and during the drop. Once landed, the face would change to a happy one. Finally, a dizzy face would display when the blocks topple and fall over.

Figure 19. Chosen colour palette reflecting the blocks on top with the background gradients on the bottom.

Figure 20. Three face options for blocks

The "cute" face styles were chosen to be appealing based on the rising popularity of "cute" culture. With it's origins in east Asia, specifically in Japan as "kawaii", the cute aesthetic has been increasingly adopted by western cultures as a popular visual in multiple forms of media and fashion. This is especially found in teens and young adults, a demographic for which this demo is mostly targeted (Pellitteri, 2018).

Aside from the popularity of this particular aesthetic, there are findings that viewing these kawaii images creates a feeling of pleasantness and can help invoke a sense of happiness to the viewer (Nittono, H., Fukushima,

M., Yano, A., & Moriya, 2012). In the use of these kawaii style faces on the blocks, it could help promote the feeling of enjoyment while playing.

The blocks themselves were created in a greyscale image to simplify the process of incorporating them into the blueprints of the Unreal project. As the blocks would have to be converted to flipbooks, Unreal's method of handling animated sprites, a time saving method of approaching this was to initially create the sprites in greyscale and allow for Unreal to assign the colors based on the RGB values selected from the colour pallet.

In addition to the blocks, four sky images were created to serve as backdrops to the gameplay. three were night sky scenes with gradients of blues and purples. The third was a light blue day sky with clouds as seen in figure 21. A pixel art style was chosen to compliment the simplistic look of the blocks and keep with the "cute" aesthetic. The complete set of assets created for this demo can be seen in Appendix C.
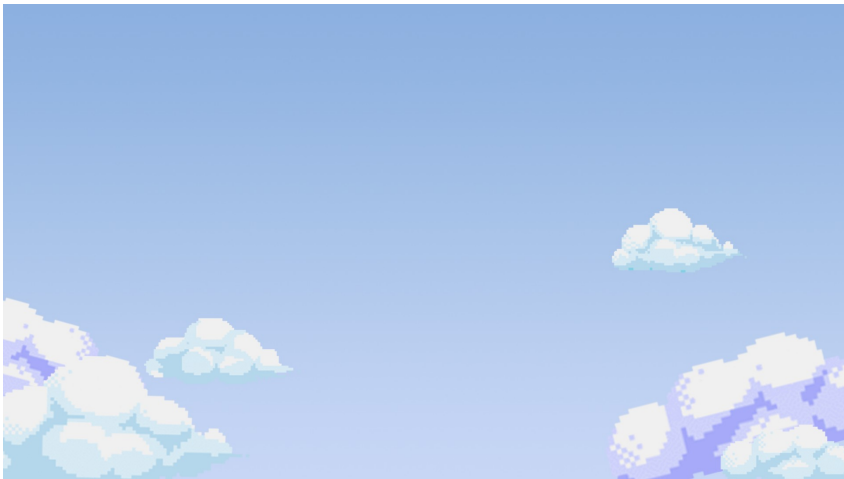

Figure 21. Day themed background with pixel clouds.

Gameplay.

With such a simple concept as stacking blocks, there is little need to over complicate the gameplay mechanics of the demo. With that in mind, there is really only one physical mechanic that the player will experience: dropping the block at the right time by activating the button when it is in the location they want.

When the block appears on screen, it will automatically move horizontally across the top of the play area. When it hits a side, it will begin movement in the opposite direction. This back-and-forth pattern of movement will continue indefinitely until the player triggers the action button. When they do, the block will fall from it's current location in a straight path below it. This can be demonstrated visually in figure 22.
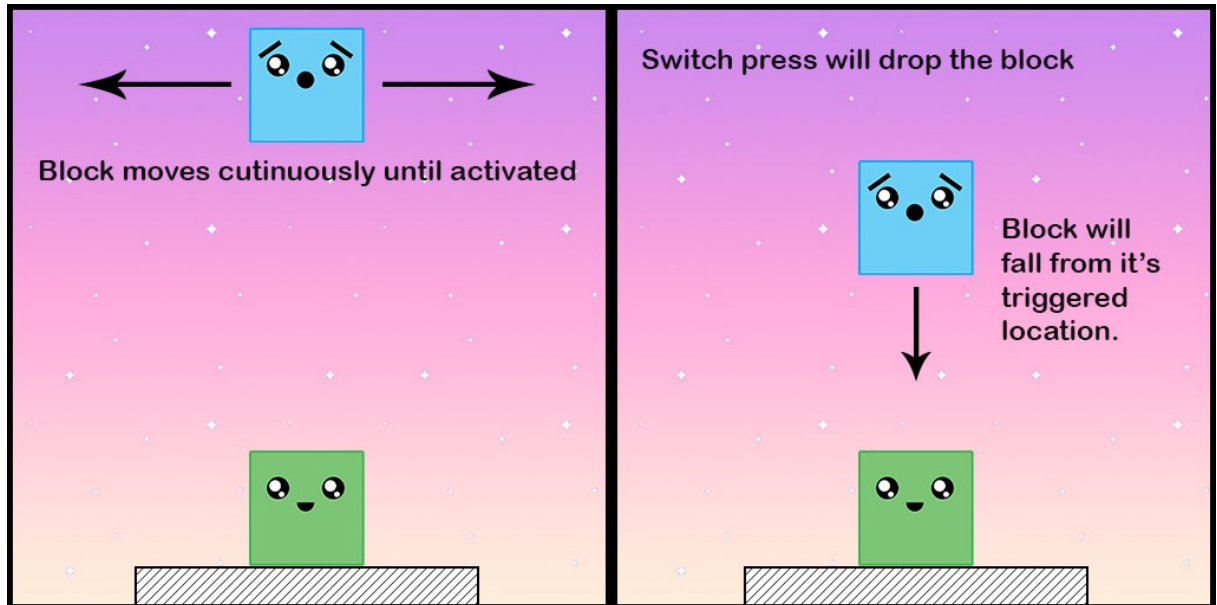

Figure 22 . Basic gameplay demonstration.

Ideally, the player will time the drop to stack the cubes in a tower. As the block will fall directly from the location it was in when the action key was triggered, the block will land based on that location. Timed correctly, the block will fall onto the stack and the game will continue. It will also change the face from worried to happy as a visual indicator that the move is good. Timed incorrectly, the block will miss the stack entirely or topple off of the stack if not seated well enough on it. This can be seen in figure 23.
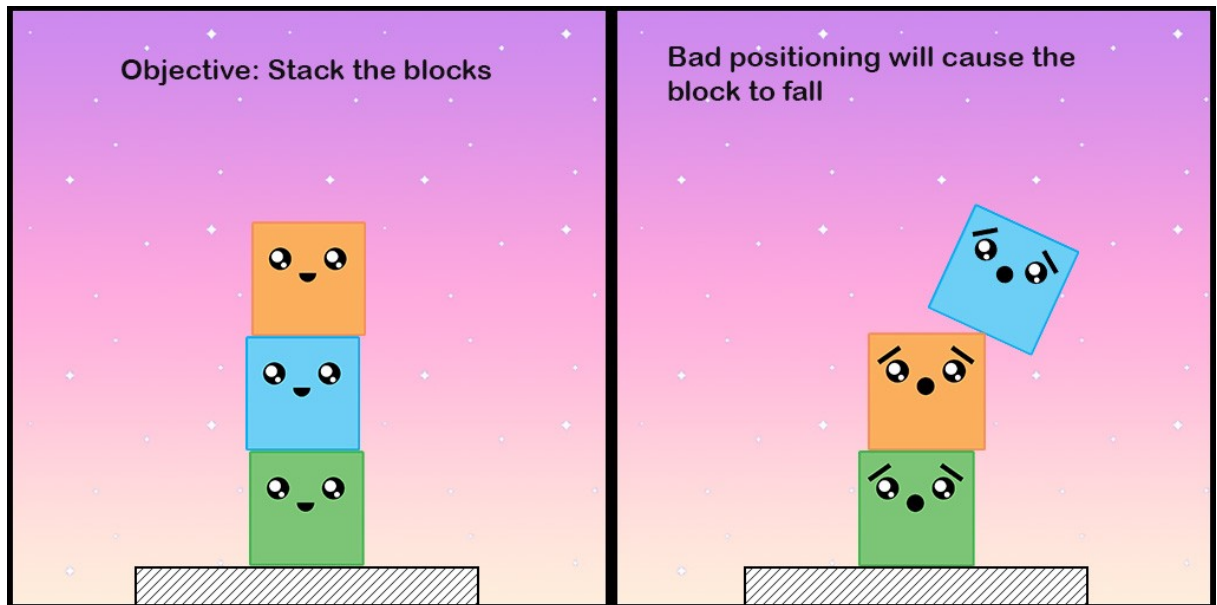
Figure 23. Dropping the block.

If the placement of the block is bad causing it to fall off of the stack or miss it entirely, the block will fall to the base platform. While falling the blocks will change from a happy face back to the worried face as a visual indicator of the action. When the block falls to the platform, the face will then change to a dizzy expression as indicated in figure 24. This serves as a visual queue of the game ending action, presented in a way that can be still be funny to look at. It is not the intention of the design to punish the player for loosing. It is hopeful that the "cute" dizzy faces will allow the player to keep a good feeling despite the game ending and encourage them to try again.
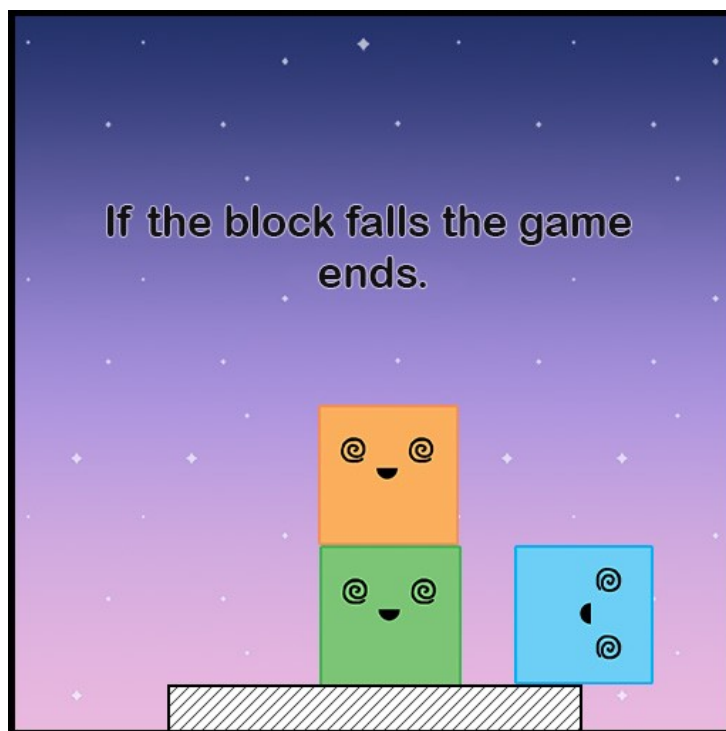
Figure 24. The game ends when the block falls from the stack.

By default, the action button will be set to the spacebar on the keyboard, or left click on the mouse as recommended. This will allow ease of play from users of both devices while also allowing a standard key remapping for players using alternative assistive technologies (*OneSwitch.org*, n.d.).

Input.

In theory, any device which allows for at least a single input signal to be sent to the software could be used with this game as long as it has the ability to be remapped from an existing keystroke. In this case, the input key will be defaulted to spacebar as suggested by the accessibility guidelines. The guidelines also suggest that the ability to remap keys be included in game options as a basic feature (*Game accessibility guidelines*, 2018).

As is often the case with accessibility, the best device is the one which is most comfortable for the user. Due to the wide range of needs from disabled players, there is no one adaptive input which can, or should, be promoted. That being said, there are some general examples that can be used for research and testing purposes (*Game accessibility guidelines*, 2018).

While any switch device can be used, the main device utilized during the project was a large round button with an approximately 13cm surface, that could be connected to the pc via USB port such the one seen in figure 7. Recommended guidelines suggest adaptive hardware be made available with 3.5mm connection jacks. This style button is certainly available in that format (Ellis, 2006).

Other examples of available adaptive hardware that could be used in place of a keyboard or button would include a sip & puff switch, a grip switch, a head switch, or an eye blink switch to name a few. Any one of these devices would work as only a single input switch is needed for the control of the game. The choice is entirely left to the player to pick what is most comfortable and convenient for them.

This becomes important when taking into consideration the array of limitations that a player with physical disabilities may have. By creating a game which uses only a single input that can be remapped using any switch that is desirable by the user, it becomes inclusive of most needs.

When looking at the button used in the design and testing of this research, it can be applied to some needs from the example requirements as covered previously. The large button surface eliminates the need for players to manipulate mice, keyboards, or controllers which may be difficult or strenuous for them. It also reduces the need for surface accuracy that might be required to use a key or small scale button. The overall goal is to reduce the strain and discomfort on the player. While a single button will never be a solution for all situations, it is a good option for some players (Ellis, 2006).

Options.

An important feature that was made clear through both the guidelines as well as the feedback of the mobile games and the one switch games were options. Allowing the player to enjoy the game in a way that is most comfortable to them is one of the basic accessibility features available.

In this demo, it can be achieved through providing optional settings.

Due to the simplicity of the game, there was no need for a large array of options for the player to choose from. It was instead decided to provide game difficulty mode selections. Initially, three modes were made available to choose; Easy, Medium, and Hard. Each selection adjusts the speed in which the cube moves across the top of the screen with easy being the slowest setting and hard being the fastest. The game will default to the lowest setting so that players can adjust to the mechanics.

After some review, the names for each difficulty setting were changed to reflect the speed rather than to imply a player's skill which may offend some (Portnow, J., &Winters, S., 2017). The new modes were instead called Slow, Medium, and Fast as a direct link to the speed of the cube.

As this small project did not consider audio or visual limitations, there were no options to reflect this. In a more complete game, however, it would be best to include options for volume settings and color blindness.

Menus.

The menu screens were another feature that would require some thought. Taking into account feedback regarding the one switch games explored, it was decided that a main screen with automatic highlighting on a timer would be the best approach. It was also decided that the options settings would be contained within a separate menu accessed through the main menu screen.

The game will comprise of two menu screens. The main menu as seen in figure 25 will appear when the game initially loads or when the player returns from the settings menu. The auto-highlight menu system will change between play and options on a timer. The currently highlighted selection will display as a light or "highlighted" font which should be easily recognizable as seen in figure 26. On the left image, play is selected.
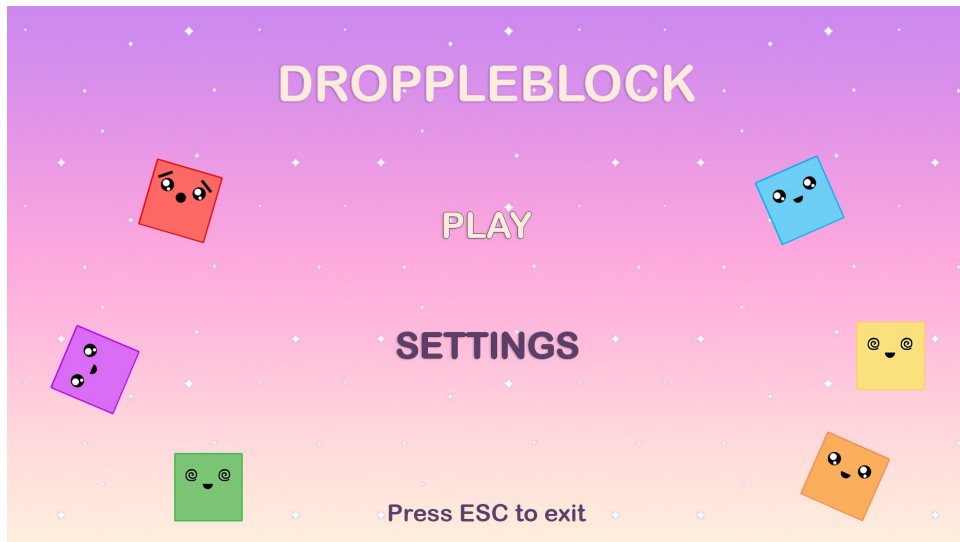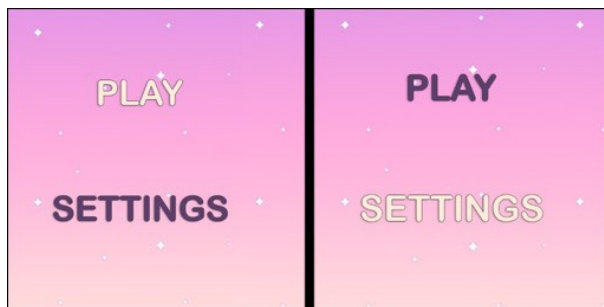
Figure 25 . The main menu screen.

Figure 26 . The menu options as they appear when highlighted.

The settings selection will bring the player to the settings screen where the difficulty mode of the game can be chosen as seen in figure 27. As on the main menu, this menu will also use the timed highlight system to make selection easier on the player.
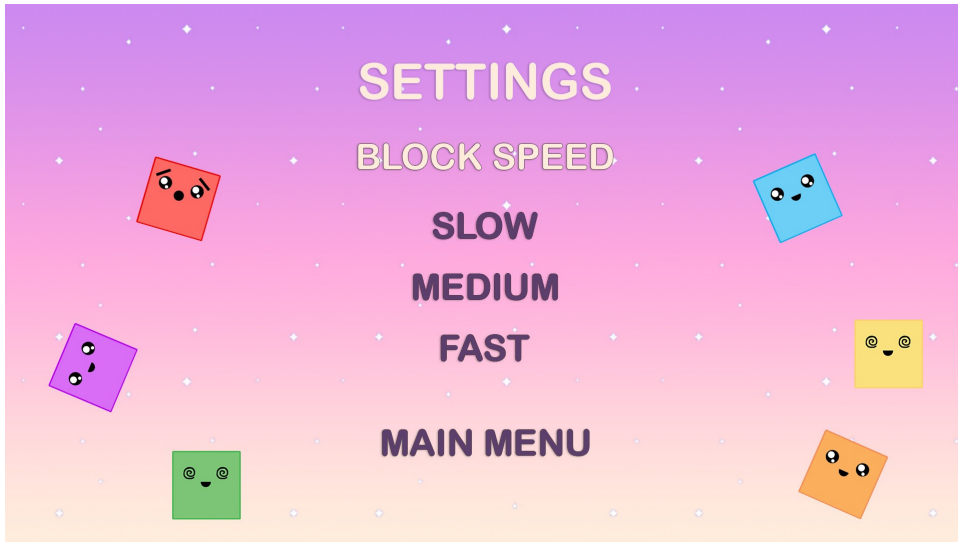
Figure 27 . The settings menu screen.

While not a menu, one important screen that appears after the play selection is the instructions panel as seen in figure 28 . Evaluation of the feedback from the one switch and mobile games put a great deal of emphasis on how important it was for the instructions to be clear and easy to access. Having this simple visual guide appear before gameplay begins is the easiest method of ensuring the player can view them despite any limitations. A tap of the action button will dismiss the instruction panel and begin the gameplay. It is anticipated that the visual guide will be enough for the player to grasp the mechanics in conjunction with the familiarity of the stacking activity.
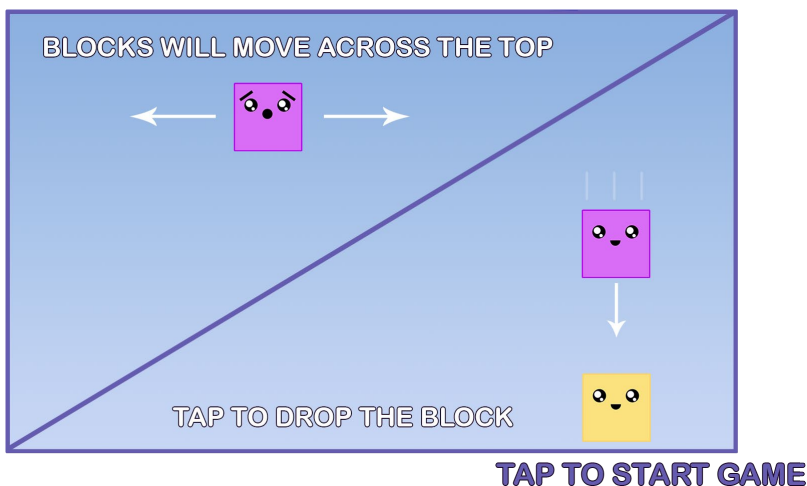

Figure 28 . The instructions screen.

Product Specifications

Designing a one switch game that is playable requires thought not only into the design itself, but also into the usability of the product on equipment available to the player. Computers that are capable of running high end games can be expensive and not readily available to all households. A 2104 study of computer ownership and internet access within the UK found that 85% of households owned a home computer, with 84% being connected to the internet (Horsfield, 2015). A 2015 study conducted by the Entertainment Software Association estimated that the PC was the most popular gaming device with 62% of American gamers preferring it (*Essential Facts About the Computer and Video Game Industry*, 2015).

Due to the prevalence of computer access for gamers coupled with the relative ease of producing a game for use on the PC, it is logical to make one switch games for the PC gamer demographic. This is further enforced when considering the availability of adaptive switches to be used for the PC. In the first questionnaire conducted online (see Appendix A), respondents who indicated they were disabled gamers overwhelmingly replied that they preferred PC as their gaming platform as seen in figure 29 below.
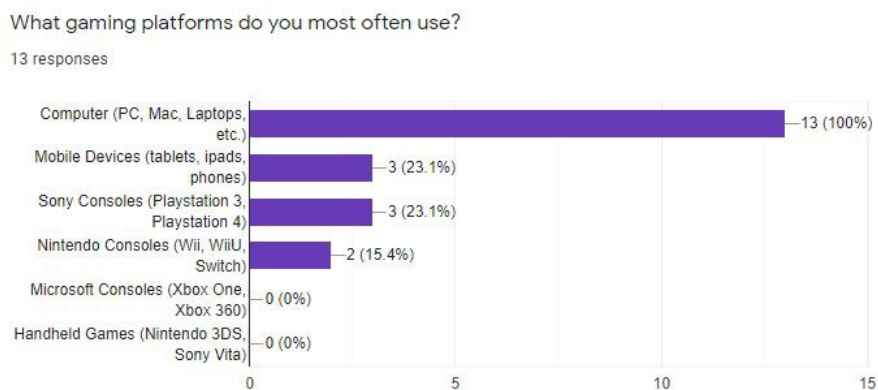
What gaming platforms do you most often use?

13 responses

Figure 29. Gaming platform use.

Another contributing factor in deciding to develop on the PC, which is specific to this project, is a lack of ability and knowledge to publish on any console. In addition, the programmer working with me on this project is most comfortable developing on and for pc. Originally, a small collection of single switch games were intended to be loaded onto a raspberry pi style console using a simple selection system which could be affordably assembled and distributed to the students of the special education school.

Though that plan ultimately was abandoned due to a breakdown in the communication with the school, the idea of developing the software to be used on a simple system remained. The easiest way to accomplish this was to focus on the PC as the development platform.

Unreal Engine was chosen as the platform to create the demo in due to it's ease of use and familiarity for the programmer and myself. This would allow me to make changes and import assets into the project myself rather then to rely on the coder to do everything for me as would have been necessary with another game engine.

Hardware Requirements.

In the current form, the game package requires a windows based PC or laptop to run, though it could be made possible to run on a smaller hardware set such as a raspberry pi unit. Generally, hardware requirements are suggested by developers based on testing over different configurations. As that

is not possible for this demo, the requirements for a comparable game created in the same engine will be used as a suggestion. It is worth noting that this demo would, theoretically, be friendly to even low end systems.

Neon Infinity HalcyonDayDigital (2019), a low resource 2D game released recently, suggests the following hardware requirements to run the game:

- Processor: Intel (R) Celeron (R) CPU N3350 @ 1.10 GHz
- Memory: 2 GB RAM
- Graphics: Intel (R) HD Graphics 500

Software Requirements.

When considering what software requirements would best serve this one switch game demo, various operating systems were explored. The game engine itself contains the ability to publish the demo for all major systems, including Android and iOS. Currently, access was only regularly available to Windows computers while developing the demo. A 2017 article by Tom Warren (2017) reported that Apple revealed Windows 10 had four times the amount of users to Mac systems.

This could indicate that emphasis should be placed on Windows systems when restricted to a choice. For the purposes of this game demo, the package was ported for Windows only. The technical information provided by the two major game engine packages Unity (*System Requirements for Unity 2018.3* , 2018) and Unreal Engine (*Hardware and Software Specifications*, 2018) show that both engines can produce games that are compatible with Windows versions as low as Windows 7 SP1. With a 2009 release date, Windows 7 could be considered an antiquated operating system by today's standards. That does not, however, rule out the potential for continued wide spread use of this version.

Iterative Design

With the product developed to a playable stage, it was then distributed for testing and feedback. The method for this process was similar to the one switch game testing and feedback done previously. A questionnaire and download link for the game were distributed via the same methods as done previously via social media and subreddit groups. Players were given three weeks to try the game and complete the questionnaire.

The questions for this feedback phase were similar to the questionnaire on the one button games. Demographic information was collected to ascertain average age of the players, their disability status, and if they used a single input device to try the game.

Responses indicated that 78.5% of users identified as having a disability. The exact breakdown can be seen in figure 30 below. With the majority of respondents identifying as having a disability, there is a good opportunity to receive relevant feedback on the test games from the target demographic directly.
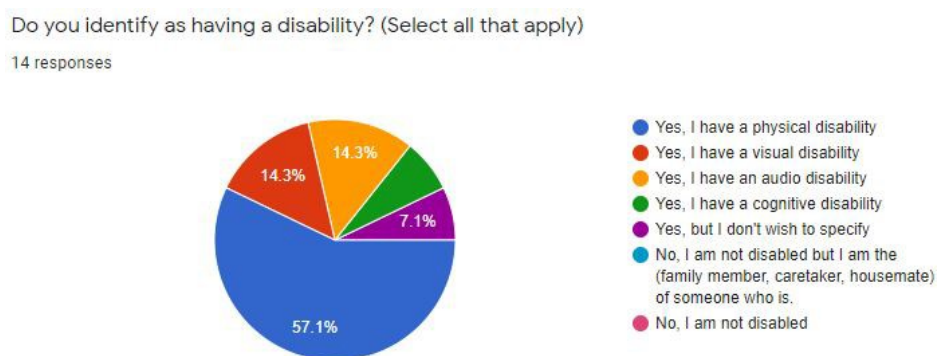

Figure 30. User disability breakdown.

Following this section, targeted questions about the game itself were asked. The first set of questions were to determine if the aesthetics and graphics were pleasing to the player. They were also asked if the visuals invoked any sort of feelings. This information could be used not only to make changes in the

game to cater it more to the demographic, but also as a way to refer back to the literature and see how the theories hold up with the opinions of the small sample.

The next section asked specifics of the gameplay. This included targeted questions to determine if the players experienced the controls as smooth and natural. Additionally, they were asked if the timing for selections was adequate, and if they felt physically comfortable with the game. Schell (2019) recommends questions that target the player's overall feelings towards the game, such as if they were ever bored or frustrated.

Finally, the respondents were asked if they utilized the settings menu. They were also asked to detail what settings they changed, if any. This information would be useful to know what settings, on average, were changed by the players for ease of use and comfort. This feedback could be used to evaluate changes to the default settings.
They were also asked to detail any changes or additions they would make to the mechanics or settings to make the game more comfortable and enjoyable.

Based on the feedback provided through this questionnaire, one can then be able to consider any changes to the product that would be necessary to address the needs of the users. Due to time constraints, any major changes to the overall visuals or design of the game would be noted in the research but not implemented in practice.

Likewise, only one iterative play test will be scheduled in the interest of time. A round of testing and questionnaire similar to the first will be distributed through the same avenues. It is reasonable to hope that many of the initial participants will then try the iteration of the game and provide feedback.

Findings

There is a positive growth in research in to, and the implementation of accessibility in games. In recent years, specialists in the

field of Accessibility have beenbringing AAA studios together for workshops and discussions at leading development conferences such as the Game Developers Conference (GDC) to raise awareness and teach methods to improve in making games accessible. With industry leaders such as Naughty Dog bringing significant accessibility features for players with limited motor functions to big ticket games, they set an example of how the industry can move forward in this area. It also sets a precedent to prove that making games highly accessible does not mean diluting the experience of the game (Noclip - Video Game Documentaries, 2018).

Accessibility features in games are not strictly useful to players with disabilities. Many features that are classified as basic in the *Game accessibility guidelines* (2018) simultaneously act as quality of life features for users who are not disabled. One example covered previously which illustrates this well is the inclusion of subtitles. Not only does this help the hearing impaired, it also helps in situations where players may be playing without sound or have difficulty understanding what is being said. Curb-cut-effect additions to games are appealing across a wide range of player demographics that include disabled and non-disabled players alike (Portnow, J., & Winters, S., 2017).

Despite the growing demand for accessible media, there are some areas which have seen slow growth. Subtitles can again be used as an example here. Closed captioning has had little development in the past and still has no standardization regarding font sizes, scalability, and font selection. This delay in progress is starting tocatch up in recent years however it remains a point of contention within the disabledgamer community (Deryagin, 2018).

Results from the first questionnaire (see Appendix A) helped to shape the direction of the research going forward. With 80% of respondents indicating they played games for more than 7 hours per week as seen in figure 37, they can be considered a good sample of regular gamers.

As shown in figure 31, 61.5% also indicated they identified as having a disability which would affect their ability to enjoy games. Of those respondents who were classified as disabled, 55% marked themselves as having a motor related impairment. 44% indicated an audio impairment. Only 11% stated they had visual orcognitive disabilities.
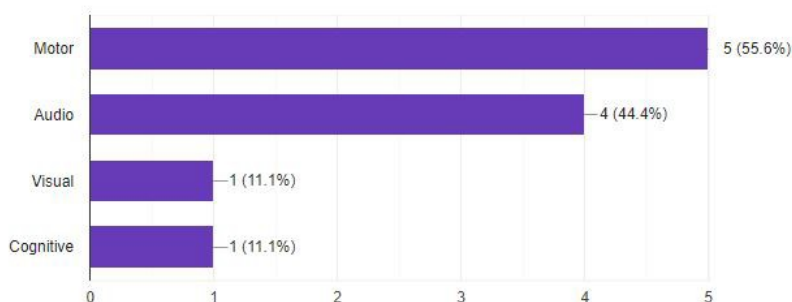

Figure 31. User disability classification breakdown.

These numbers provide an indication of how many respondents are among the target audience for this research. That being said, many of the same complaints from players were listed regardless of the individual's disability. One common remark was the need for better subtitle functions and audio options. Another comment which was mentioned frequently was the lack of mobility friendly mechanics other than key remapping options.

While there was no individual game title that was mentioned more often than others as a favorite, the majority of responses indicated Role-Playing games as their favorite with 70% as illustrated in figure 32. Second was First person shooters at 61%.Several write in comments for favorite game indicated their enjoyment of RPG's because of the strategy and puzzles involved.
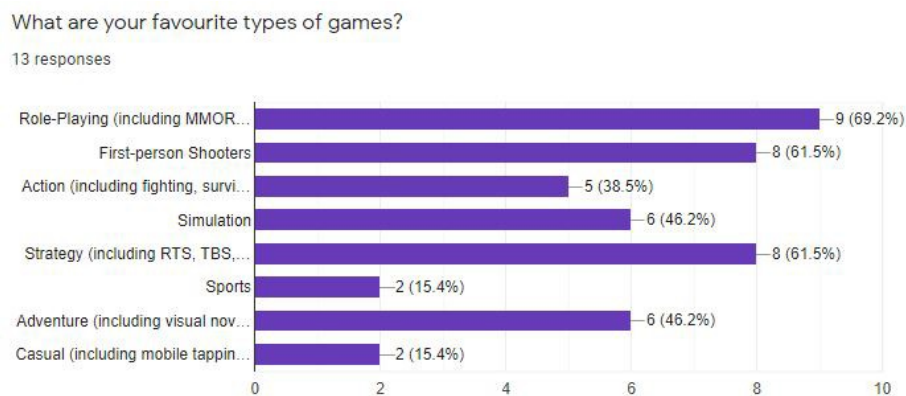
What are your favourite types of games?

13 responses

Figure 32. User game genra preference.

While this was useful information, it ultimately had only a small effect on thechosen product developed. Time and ability constraints did not allow for something asinvolved as an FPS or RPG style game to be made in a meaningful way, using a small playable level. Rather, the takeaway with this information was on the puzzle element.

The second questionnaire posted was intended to gauge player feedback onexisting one switch games to get an idea on what they found positive and negative about them. The sample size was about the same as the first set of respondents.

The user metrics gathered in the beginning of the questionnaire indicated that 57% of the respondents identified as having a physical disability as seen in figure 30.
The second highest percentage was equal between visual and audio impairments at 14%. The remaining replies were cognitive or did not specify. There were, interestingly, no users who indicated they were not disabled.

While 57% of users responded that they sometimes have difficulty playing with traditional controllers and mechanics, 71% replied that they did not use any kind of adaptive technology to play as shown in figure 33. There was no scope to determine their reasoning for that choice.

Do you make use of adaptive technologies to play games? (Ex. adaptive controllers, switches, alternative mice.)
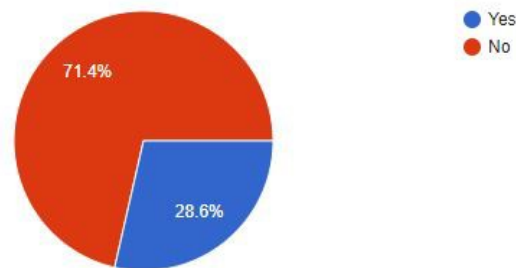
14 responses

Figure 33. Use of adaptive technology.

Player feedback to the three selected games for testing were generally very similar. In the first game, Alice Amazed, the most common complain with nearly all respondents was that the mini games were too difficult to figure out due to lack of instructions. Several users detailed that despite trying to find them, they did not see any information on how to play the game at all. There was only an external text document included with the package that briefly explained the basic game controls.

This lack of instructions made the game difficult for players and many voiced their frustration and, ultimately, lack of interest in it. The two mini games that received the most positive feedback were the pelican basketball game and the well climbing game. This seems to be in-part due to a learned understanding of the implied goal based on past gaming experience rather then any clear instructions provided by us. The second most common complain about this single switch game was the controls.
They were frequently described as confusing, clunky, unresponsive, and not smooth.

In an almost direct contrast to this first feedback, the second full game was given very positive responses in regards to the clear instructions, smooth controls, fun mechanics and quirky style. Of the three games reviewed, Dracula Cha Cha was the only one which players indicated they

would purchase and recommend. It is therefore considered a good example of what was done right in terms of design and presentation.

Feedback on Aurikon indicated that, overall, players felt it simple enough to play but boring. There were no users who found it difficult to understand and the instructions were understandable. The fault then seems to be within the game itself and, partially, in its graphics. The most common feedback on if the respondent found the game fun, was that it was fun initially but got boring fast.

A careful review of the covered literature in combination with the player feedback in the questionnaires can give quite a good picture on the key features that should be included in any game targeted towards players with physical disabilities. While the visuals of the game had an appreciation, players indicated that the most important features to include should be clear instructions, smooth controls, and fun mechanics.

It can also be concluded that, based on the literature covered for this research, options that allow for difficulty and speed settings is very important. This is especially so for a single switch game where players may be profoundly disabled or have a delayed response time which could impact menu selections and gameplay (Ellis, 2006).

Another accessibility feature that is important and widely used is subtitles. Font, scale, and color all have an important place in this category. As this is considered a basic accessibility feature in the *Game accessibility guidelines* (2018), it is an important consideration for the design of the game level.

The first iteration of the demo game, while containing the bulk of the necessary design, was not without flaws. Upon receiving it from the programmer, the game was released on public forums such as Reddit and Twitter along with a short survey to be filled out with feedback. While the respondent count was much lower than hoped, the information given was useful none the less.

Two obvious flaws stood out immediately in the first build. The main

menu screen was lacking in any way to close the program easily as seen in 34 . Players would have to force close the application through windows. While this would have ideally been addressed in the original design document, the failure to include an exit option was an oversight. Upon personal testing of the demo, it never occurred to myself or the programmer to include it as we could easily exit the software manually. As it was not a problem to either of us as non-disabled users, it was not obvious that this was a problem for the target audience, until it was pointed out during the survey. This was an excellent example of how easily it can be to overlook a key feature or functionality, and provided us with an important learning experience. It further showed how vital user feedback from the target demographic is during the earliest stages of development, in order to identify such blind spots.
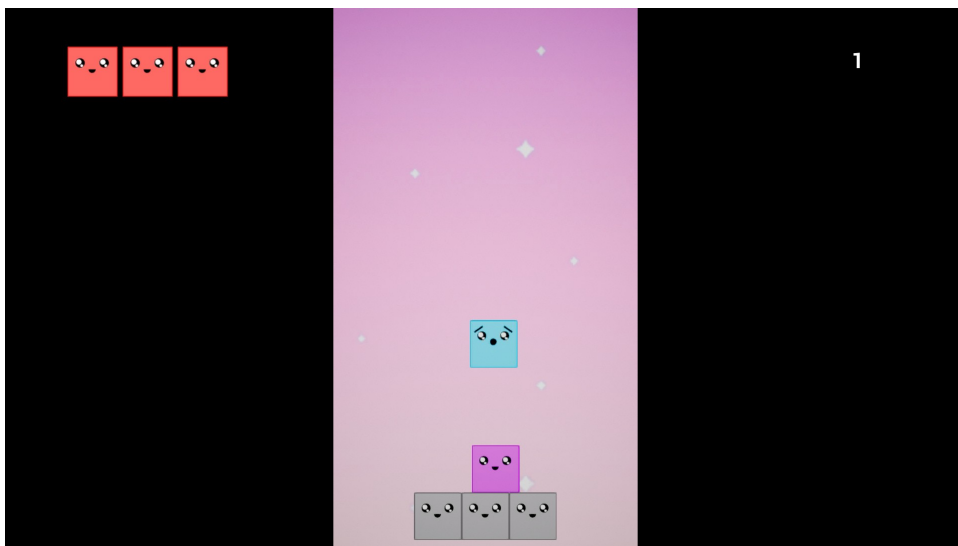

Figure 34 . The first main menu screen.

Another major oversight was the lack of inclusion of the instruction panels.Despite the lack of clear instructions, feedback from respondents indicated that none of the players had difficulty determining the main objective and controls of the game. While this could be a good indicator in the choice of game mechanics through the use of familiarity, it did not comply with the previous findings and original design toinclude instructions.

The game play mechanics themselves were translated very cleanly from the initial design mock ups. The gameplay itself felt smooth and was

easily understood. The players were additionally given a stacking counter to track their progress. In doing this, players would be able to set their own personal challenges with minimal stress. A life indicator was also added to the corner as seen in figure 35. When a block falls, a life would be deducted from the 3 block total. This was added from the original design to give a slight challenge to the game.
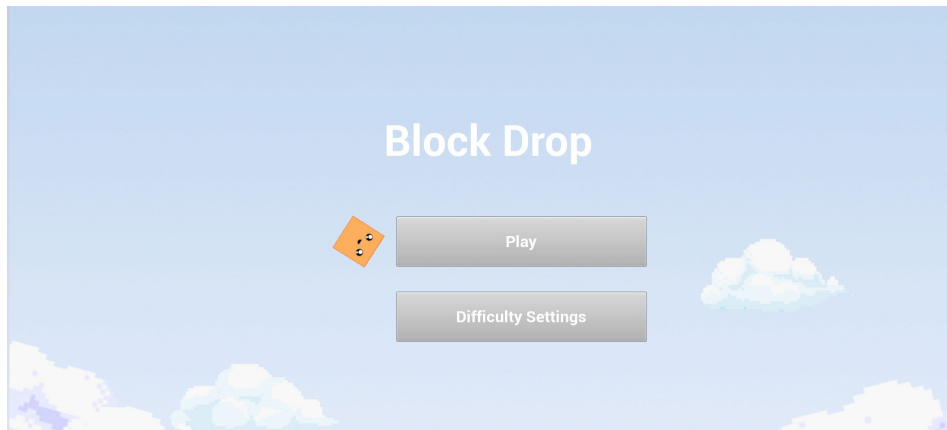

Figure 35. Block Drop gameplay screen.

Players also indicated that the white text color and choice of font made the dialogue slightly difficult to read against the background. While there was very little text that required reading, it was an important critique that needed to be addressed. Users additionally found that the selection timer for the menus was a little slow and could be made slightly faster to avoid aggravation.

While feedback for the first iteration of the game demo was found to be overall positive, several changes needed to be made to fit the specifications of the design. The revised edition came with several changes.

The main menu underwent several small changes to produce a better overall design as well as account for the feedback received on the first demo test. The font of the menu was changed from Unreal Engine 4's solid white block Roboto text to a slightly more stylized "Luckiest Guy" font that was easy to read while still being attractive Astigmatic (n.d.). A thick black outline was added to the text to make it stand out and be more comprehensible as seen in figure 36.
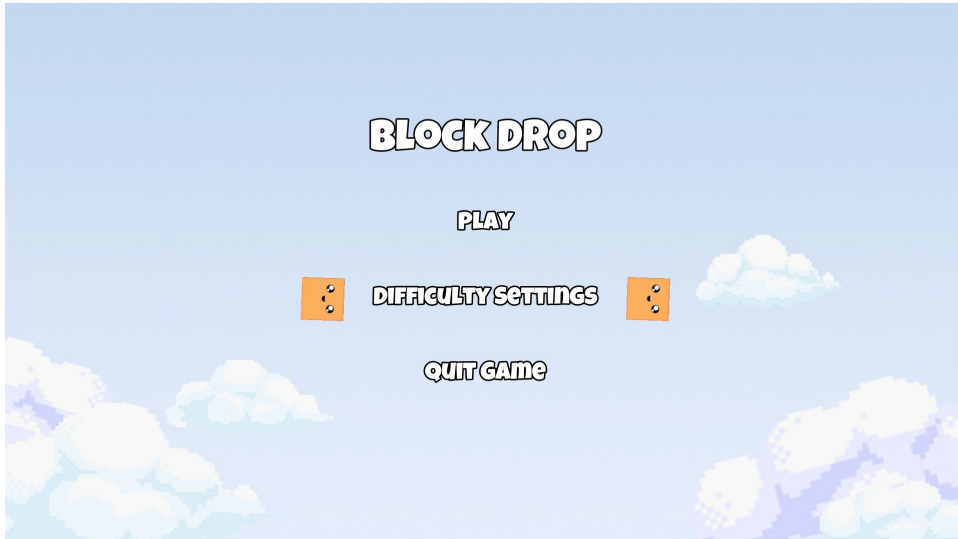
Figure 36. Block Drop revised main menu.

The grey buttons were removed and the spinning block that indicated the current selection was mirrored on the right side of the option as well to create a more pleasing symmetrical appearance. An additional option to quit out of the program was added to the main menu as well. In addition to the visual changes, the timer for the auto selection was modified to speed up slightly. The original cycle speed was found to be on the slow side. The new timer, while still allowing comfort for users who may require a slow speed to input their choice, was increased enough to also accommodate for players who did not require this. This compromise should appease both demographics.

Another important significant change to the demo was the inclusion of the created instruction screens. These had intended to be inserted after play was selected, however, the programmer forgot to include them. This oversight was rectified in the revision version and placed on a three second timer, after which the card will delete and play may begin. As this was found to be tedious and unnecessary to include every time a new game was started, a clause was added to the code so the instructions would only display once per instance of the software opening.

While incidental to the core game play and required features, the addition of randomized backgrounds was also added to this final version of the demo. Each time the player begins a new game, one of four background wallpapers will be randomly generated to display. This serves no other purpose other than to add visual polish and interest to the game.

These changes were compiled to create the final revised version playable version of the demo. While this version was not tested through a feedback survey, the features match closely to the criteria defined during the design stage. As such, it should be successfully playable by gamers with limited mobility. The difficulty level settings should further allow for a wide availability of profoundly limiting physical disabilities provided the gamer can make use of a single switch input.

At the recommendation of the examiners, an effort was made to reach out to experts in the fields of video games and accessibility. Unfortunately, the effects of the Covid-19 virus were felt globally, limiting the ability to get the desired access and interaction. Despite several emails, little to no response was received from the people contacted. Given more time, or a more normal environment, it would have been valuable to gain their feedback.

Discussion

Accessibility In Games

One of the biggest learning experiences during this exploration into accessibility was the realization of self biases that were present upon entering into the project with. Despite efforts to remain as neutral as possible while researching this topic, there were quite a few preconceived ideas about what was available, what the community might want, and how obvious some things should have been that presented themselves over time.

One example that stands out upon reflection of the full body of research was self confirmation bias. Initially, there was the idea that very little was being done in the way of progress in gaming accessibility. Early on in the research for this thesis it was discovered that there were, in fact, many individuals working toward this goal that had made impressive strides. While it could be argued that AAA studios have been less proactive to making changes, perhaps it would be unfair to put that label on the industry as a whole. Instead, it would be more accurate to say that the gaming industry has been making great efforts to be more inclusive in their designs.

With the release of new adaptive technologies such as the Microsoft Adaptive Controller, it appears that customized accessibility is within reach for many gamers. Unfortunately, it is still often cost prohibitive for many. This price tag was another fact that came as a surprise during my research. The £50 expense for a single button, while perhaps easily affordable for some, is a considerable sum for many others. For large custom setups, the sum can quickly add up. Luckily, many charitable organizations offer assistance to low income families to help offset some of this cost.

Another example that was found to be surprising was in the field of closed captioning. This was one more way in which self held beliefs were proven to be largely misinformed. As a person who does not often make use of subtitles, there was little awareness at how little the practice had evolved over time. It was startling to learn of the troubles that many who need these features face on a regular basis.

When taking into consideration the literature reviewed and the feedback received from players, a clear contribution to the overarching problem of insufficient accessibility features is the lack of a nationally or globally recognized standard. Some experts have been making efforts to resolve this gap in standardization. One good example of this can be found in the *Game accessibility guidelines* (2018), a collaborative effort between accessibility experts and game developers. As more developers adopt these guidelines into their designs, it may help to push other studios to follow suit.

Another desirable development would be the institution of a system of game accessibility information labeling which would help players determine if a product is suitable or desirable for them. Such a system would allow a customer to know its accessibility capabilities without needing to purchase the game first. It is also suggested that a common adoption of such a system would help to make publishers more aware of the accessibility gaps in their products which they may wish to address in order to gain the various labels (*OneSwitch.org*, n.d.).

Player Feedback

From the beginning, part of this exploration into accessibility in games was intended to be directed by player feedback. Initially, this was to be in the form of interaction with a school for children with special needs. Ideally, through working with the students and facilitators, feedback could help drive the research and design of the product. Unfortunately, as that level of access did not occur, the next solution was to reach out to the gaming community at large through online forums such as Reddit and social media avenues.

Despite efforts to reach a larger audience for feedback on the various questionnaires, it was difficult to bring in any large numbers with responses. As helpful as the replies were, it would have offered more information if the sample size was increased. That being said, the number of respondents from the direct target audience was higher than initially expected. This helped to contribute valuable insight into the wants and needs of players with disabilities.

The demographic information collected from the respondents was intended to help put the feedback into context from the angle of the type of player. A person who only plays games casually on a mobile phone for an hour a week may have very different opinions as opposed to a more experienced gamer who spends several hours per week on more complex games over time.

With 80% of users replying with an average playtime of 7 hours or more per week as seen in figure 37, it can be assumed that the majority of feedback would come from the angle of a frequent gamer who would have opinions formed based on more experience with different games. Additionally, with 61.5% of respondents identifying as having a disability, it can also be assumed that feedback will largely come from the viewpoint of a player who has direct experience with accessibility needs.
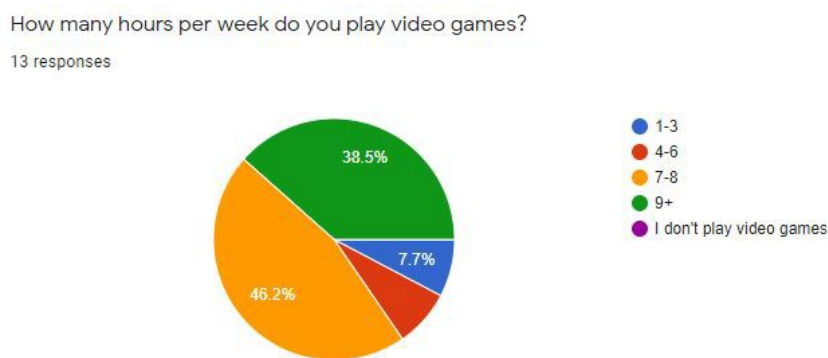

Figure 37. Hours played by respondents.

Feedback from the first questionnaire indicated that players struggled the most with a lack of good subtitle features in part due to audio or visual disabilities. This included options such as font, size, and color. It is worth noting that the feedback on closed captions was marked not only by respondents who identified as having an audio or visual disability, but by those who did not as well. This further supports the literature in that the benefits of subtitling reach beyond the portion of the audience that has a disability. This can also be seen as further evidence towards the curb-cut-effect (Blackwell, 2017).

The second most frequent comment on what players would like to see or have previously had difficulty with in games is lack of options for players with limited mobility. While there is acknowledgement to the ability to remap keys in most option menus these days, there is a more significant issue surrounding the game mechanics themselves. The ability to remap a key to an adaptive button is of little use to a player with physical limitations if they are

still unable to perform the action.

There are few solutions to this problem that do not involve a critical look at how the game mechanics are designed during the concept phase. Naughty Dog's title Uncharted has been recognized for it's inclusive approach toward mechanics for players with disabilities. They have adapted more traditional approaches through methods such as setting adjustments that allow the player to set a rapid trigger press to be replaced with a button hold. By doing this, the player would simply need to press and hold the switch rather than "button mash" (Hamilton, 2018).

While this may seem like a relatively simple addition made to an otherwise complex game, it has profound effects for players who would not be able to perform the action required otherwise. Games with quick-time events that require the rapid button mashing motion were previously unplayable entirely by certain gamers. Incorporating this change in the options menu changes a game from unplayable to accessible for some people.

Moreover, these types of additions to Uncharted garnered positive publicity for the game itself as well as the company. Josh Straub (2016) rated the game barrier free and new standard of accessibility in their article for DANGERSystem. The comments on the article by readers suggest there was a great deal of excitement from the disabled gamer community for a title that was playable barrier free. Though it was difficult to find any data to give numbers regarding specific results from Naughty Dog's marketing campaign for Uncharted 4, it is reasonable to believe that the accessibility features in it opened the door to new players.

An important lesson was learned during the design and testing of the demo game created for this project. Despite having a solid amount of literature as well as player feedback from the previous questionnaires, there were still oversights to simple features that should have been included from the beginning. Namely, the failure to include an accessible friendly way to close the application.

While it is entirely possible that a more experienced developer would have thought to include this from the beginning, this oversight was not caught until the testing phase. This design error was due largely to able-privilege. This could possibly be a challenge inherent to all abled developers who design games with a disabled audience in mind.

There are several ways that one might correct such oversights from happening. One suggestion is to include a carefully thought out task list of features during The design phase of a game. All accessibility options and concerns can be addressed and noted at that time. This makes tracking the additions of these features easier at a glance by the developers. In this example, it was a simple error to correct, however, that may not always be the case.

One good tool to help develop this tracking list of features is the *Game accessibility guidelines* (2018). Utilizing these guidelines as standard practice can help designers to include as many basic accessibility features in a standardized way. It may also help move the design into a more inclusive direction by examining other features not initially considered. This is another example of where inclusion does not have to mean the dilution of the game.

Another method of checking features is to perform user testing early on in development. Many studios already implement such a feedback system through Alpha testing. The feedback gained from these tests can help to catch oversights in the early stages. It was through this system of player testing and feedback that this oversight was able to be corrected and include an additional way to exit the application.

Conclusions

Accessibility in gaming, while still woefully missing from a vast majority of titles, has grown dramatically in recent years. While there are still issues revolving around standardization and availability, developers on both hardware and software sides have been making marked efforts to bring

accessibility into the spotlight and put more focus on options that include gamers from all walks of life.

Including advanced options for accessibility can increase the time and budget of a game, however, the potential benefits can more than compensate for this by growing the fan and customer base for a developer. While recent developments have led to calls for more standardized rules in inclusion options, the games industry as a whole will need to listen more to the fan base most in need for them to move forward.

Standardization would reduce or eliminate the added cost in programming. A proper suite of accessibility controls could then be included at a much-reduced coding burden, and with a much higher outreach. This change is the next big step that will have immediate beneficial impact on the gaming industry, both by expanding their potential audience, and because of the marketing benefits of the improvement.

While it is not possible to say that single button gaming is the ultimate solution to designing games for players with disabilities, it can be concluded that it is a good option. The design of a one switch game is deceptively simple. The mechanics available with even just a single switch can become complex depending on the design. In this way, it is possible to design a game that can be inclusive to all without losing quality and functionality.

The adaptability of a single button game also lends to it being a good solution. With only one input necessary to enjoy the game, the player can use any device that is most comfortable to them. This allows for virtually any gamer to participate in the enjoyment of the game as they will not be limited by the input device.

Another factor to consider in the design of a single button game is the inclusion of settings that allow the user to customize their experience to fit their comfort level. This can be audio settings, font settings, or difficulty or speed settings to name a few examples. These options, together with the versatility of single input device options, allows for a highly adaptable and

universally enjoyable experience.

      While it is ultimately the choice of the player what style of games and adaptive equipment they enjoy most, designing a game to include extensive adaptability options for players ensures that it can be played by the largest possible audience. This changes the conversation from "how can I change things on my end to enjoy this?", to one of "I can play this."

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Appendix A

Survey conducted online to access base information about gamer views onaccessibility in gaming.

Accessibility in Games

This survey will help research into a Master's on accessibility in video game design. All responses will be completely anonymous, and information gathered is for academic research only. If you need any assistance in completing this survey, I would be happy to explore alternatives that are most comfortable for you.

Tell me a little bit about yourself.

None of these questions are mandatory, however, they will be extremely helpful to establish a more accurate bigger picture.

How old are you?

Short answer text

How many hours per week do you play video games?

◯ 1-3

◯ 4-6

◯ 7-8

◯ 9+

I don't play video games

Do you classify yourself as a disabled person?

○ YesNo

○

If so, which class of impairment do you identify as having? Please check all that you feel apply.
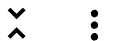
☐ Motor

☐ Audio

☐ Visual

☐ Cognitive

After section 1 Continue to next section ▼

⌄ ⋮

Lets talk a little bit about your disability andhow this affects your gaming.

None of these questions are mandatory. You may skip to the next section if you wish.

Please tell me about any impairments you feel affect your ability to playvideo games. Feel free to be as detailed as is comfortable for you.

Long answer text

How long have you had this/these impairment(s)?

Long answer text

Please tell me how your enjoyment of video games has been impacted by disability. In particular, it would be helpful to know the biggest concerns youhave when it comes to playing games (such as difficult handling controllers, slow reaction times, difficulty in reading text.).

Long answer text

After section 2 Continue to next section ▼

Now lets talk about games!

None of these questions are mandatory. You may skip to the next section if you wish.

What gaming platforms do you most often use?

- [ ] Computer (PC, Mac, Laptops, etc.)

- [ ] Mobile Devices (tablets, ipads, phones)

- [ ] Sony Consoles (Playstation 3, Playstation 4)

- [ ] Nintendo Consoles (Wii, WiiU, Switch)

Microsoft Consoles (Xbox One, Xbox 360)

Handheld Games (Nintendo 3DS, Sony Vita)

☐ Other...

Do you ever play with other people?

◯ Yes ◯ No ◯ Other...

Do you play online games?

◯ Yes ◯ No ◯ Other...

What are your favourite types of games?

☐ Role-Playing (including MMORPG, JRPG)

☐ First-person Shooters

☐ Action (including fighting, survival, rhythm and platform)

☐ Simulation

☐ Strategy (including RTS, TBS, RTT, MOBA)

☐ Sports

Adventure (including visual novels, interactive movies, text adventures)

Casual (including mobile tapping games, party games, trivia, match 3)

What game did you play most recently? Did you enjoy it? Why or why not?

Long answer text

What is your favourite game? Why?

Long answer text

Do you require any assistance to play video games? This can includeadaptive controllers, screen magnifiers, or even another person.

Long answer text

Lets talk about accessibility in games.

None of these questions are mandatory. You may skip to the next section if you wish.

Are there any games you want to play but feel that for some reason you arenot able to? If so, what changes would you make to this game so you can?

Long answer text

Do you feel that any platform is more user friendly in terms of accessibility

Long answer text

Have you ever played games that were designed specifically for gamers withdisabilities?

Long answer text

If you answered yes above, did you feel that any of those games werepatronising? If so, please explain why.

Long answer text

What are some accessibility options you would like to see more from game developers that you feel are not being included regularly? Do you think thesewould be easy to implement?

Long answer text

Do you use any of these assistive technologies to play video games?

◯ Touchpad ◯ Stylus ◯ Joystick ◯ Trackball

Keyboard

Mouse

○ Screen Magnifier

○ Captioning

○ Motion Control ○ Switch Interface ○ Adapted Controller ○ Joystick

○ Eye Tracking

○ Voice Recognition

○ Other...

If you use modified controllers or other hardware please tell me about them.

Long answer text

Did you purchase these or were they custom made?

Long answer text

Have you been limited in options of assistive technology that would havehelped you to enjoy games due to price?

Long answer text

Have you ever made your own assistive technology to overcome anaccessibility issue? This can include hardware or software.

Long answer text

Are there any games that did not have the accessibility options needed foryou that you were able to overcome through other means?

Long answer text

Appendix B

Survey conducted online to gather information about the selected One Switch games and explore player feedback.

Section 1 of 4

One Switch Games Survey

This survey will help research into a Master's on accessibility in video game design. All responses will be completely anonymous, and information gathered is for academic research only. If you need any assistance in completing this survey, I would be happy to explore alternatives that are most comfortable for you.

This survey will be asking opinions on the gameplay mechanics, visual appearances, and overall feeling towards 3 selected PC games available on Oneswitch.org. Respondents are not required to be disabled to provide feedback. Thank you so much for your time!

Let's learn a little bit about you!

As a reminder, all questions in this survey are completely optional and anonymous.

Do you identify as having a disability? (Select all that apply)

◯ Yes, I have a physical disability ◯ Yes, I have a visual disability ◯ Yes, I have an audio

disability ◯ Yes, I have a cognitive disability ◯ Yes, but I don't wish to specify

No, I am not disabled but I am the (family member, caretaker, housemate) of someone who is.

No, I am not disabled

If so, does the nature of your disability make video games difficult for you toplay with traditional controllers and mechanics?

○ Yes ○ No

○ Sometimes

Do you make use of adaptive technologies to play games? (Ex. adaptivecontrollers, switches, alternative mice.)

○ Yes ○ No

Please choose your age group.

○ Under 17

○ 18-24

○ 25-34

○ 35-44

○ 45-54

○ Over 55

After section 1   Continue to next section   ▼

Alice Amazed

This section will cover the Alice Amazed game found at http://www.oneswitch.org.uk/OS-REPOSITORY/GAMES/PC/DOWNLOAD/VARIOUS/AliceAmazed.zip

Did you find the graphics appealing?

Long answer text

___

Tell me about which mini games you enjoyed most and why.

Long answer text

___

What level did you reach?

Long answer text

___

Did you have any difficulty figuring out how to play any of the mini games?

Long answer text

___

Were the instructions easy to access and understand?

Long answer text

___

Did you find any mini game in particular difficult to play?

Long answer text

___

Did the controls feel smooth and natural?

Long answer text

Did you make use of the settings menu?

Long answer text

Would you consider this game fun?

Long answer text

Were you able to fully enjoy this game?

Long answer text

Did you make use of a single external switch to play this game?

Long answer text

Would you purchase this game based on your experience with it?

Long answer text

Would you recommend this game to players with disabilities?

Long answer text

Is there any other feedback you would like to offer about this game?

Long answer text

⌄ ⋮

Dracula ChaCha

This section will cover the Alice Amazed game found at http://www.oneswitch.org.uk/OS-REPOSITORY/GAMES/PC/DOWNLOAD/PLATFORMERS/Dracula.zip

Did you find the graphics appealing?

Long answer text

Did you have any difficulty figuring out how to play this game?

Long answer text

Were the instructions easy to access and understand?

Long answer text

Did the controls feel smooth and natural?

Long answer text

Did you have any difficulty with performing actions that required fastersubsequent motions such as double and triple jumping?

Long answer text

Would you consider this game fun?

Long answer text

Were you able to fully enjoy this game?

Long answer text

Did you make use of a single external switch to play this game?

Long answer text

Would you purchase this game based on your experience with it?

Long answer text

Would you recommend this game to players with disabilities?

Long answer text

Is there anything else you want to say about this game?

Long answer text

Aurikon

This section will cover the Alice Amazed game found at http://www.oneswitch.org.uk/OS-REPOSITORY/GAMES/PC/DOWNLOAD/SHOOT-EM-UPS/Aurikon.zip

Did you find the graphics appealing?

Long answer text

Did you have any difficulty figuring out how to play this game?

Long answer text

Were the instructions easy to access and understand?

Long answer text

Did you make use of the settings options available?

Long answer text

Did the controls feel smooth and natural?

Long answer text

Did you have any difficulty utilising the hold trigger mechanics?

Long answer text

Would you consider this game fun?

Long answer text

Were you able to fully enjoy this game?

Long answer text

Did you make use of a single external switch to play this game?

Long answer text

Would you purchase this game based on your experience with it?

Long answer text

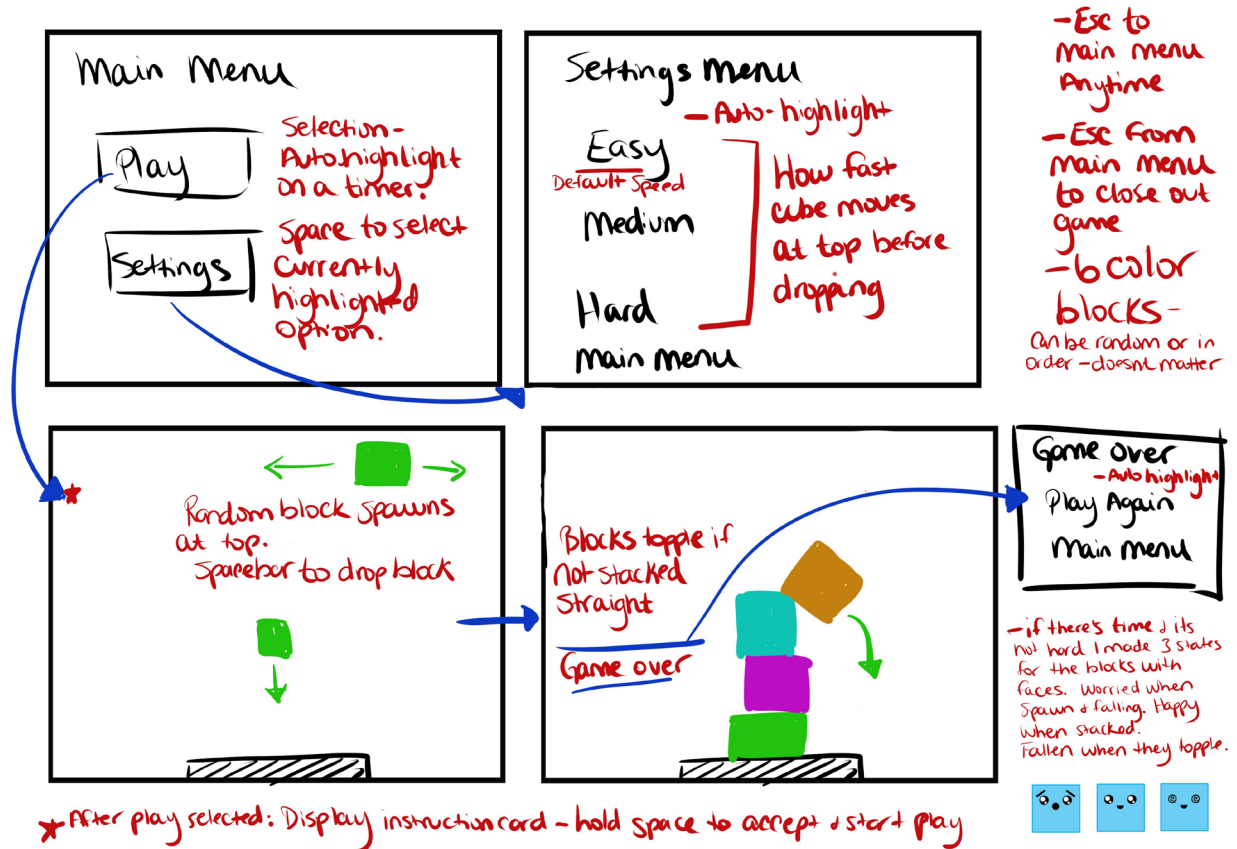Would you recommend this game to players with disabilities?

Long answer text

Is there anything else you want to say about this game?

Long answer text

Appendix C

The wire-frame diagram of the initial game design provided to the programmer who assisted in the creation of the game demo.
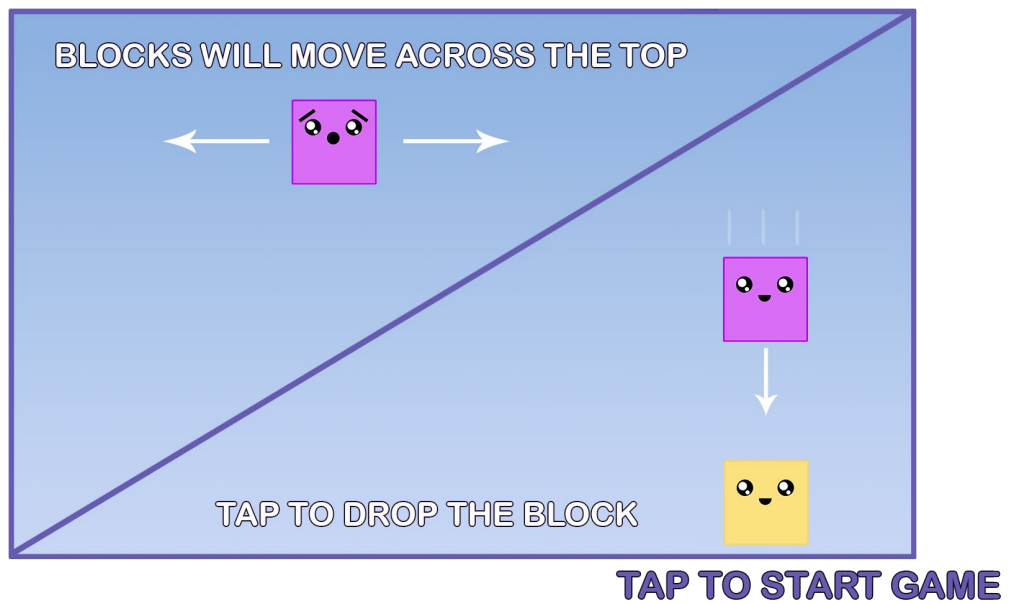

The full list of assets created for the demo game.

Faced blocks in grey scale.

Backgrounds created.

Instruction Card.