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Testing the Feasibility of Using Skeletal Animation over Sprite Animation in Pixel Art Graphics

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Testing the Feasibility of Using Skeletal Animation over Sprite Animation in Pixel Art Graphics

Video game graphics grow more realistic every year, but pixel art graphics have kept their popularity. However, when it comes to pixel art animation, it is almost without exception advised to be animated by sprite animations, which can be challenging due to the work it requires. Skeletal animation would be more approachable and faster technique for animation. This thesis aimed to test the feasibility of skeletal animation in pixel graphics and how players regarded it.

For this research, 50 players participated in an A/B test, where each played two versions of the same dungeon video game, with the only difference being the enemy entities animation – one animated by sprites, other by skeletal animation. At the end they answered a questionnaire regarding their preferences.

The study found that while sprite animations were generally more favoured, there were many who preferred the skeletal animations or could see no difference between the two animation styles. This thesis concludes that skeletal animated pixel art graphics could be considered as an animation option, and in some settings, it might even work better than sprite animations.

Keywords:

2D graphics, animation, pixel graphics, video games

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Luurankoanimaation soveltuvuus pikseligrafiikassa verrattuna sprite-animaatioon

Videopelien grafiikat kehittyvät realistisemmaksi vuosi vuodelta, mutta pikseligrafiikat ovat säilyttäneet suosionsa. Pikselianimaatioita kuitenkin ohjeistetaan tekemään lähes poikkeuksetta sprite-animaationa, mikä voi olla haastavaa sen työllisyytensä vuoksi. Luurankoanimaatio olisi helposti lähestyttävä ja nopeampi tekniikka animointiin. Tässä opinnäytetyössä testattiin luurankoanimaation soveltuvuutta pikseligrafiikassa sekä pelaajien suhtautumista luurankoanimoituun pikseligrafiikkaan.

Tutkimuksen A/B-testiin osallistuneet 50 ihmistä pelasivat videopelin samasta tyrmätasosta kaksi eri versiota, joissa eroina oli ainoastaan vihollisten animaatiotapa. Toisen version vihollinen oli animoitu sprite-animaationa, toisen luurankoanimaationa. Pelaamisen jälkeen osallistujat vastasivat kyselyyn, joka selvitti heidän mieltymyksiään.

Opinnäytetyössä havaittiin, että vaikka sprite-animaatiot olivat suositumpia, useat suosivat luurankoanimaatioita tai eivät huomanneet eroa animaatioiden välillä. Työn tuloksena todetaan, että luurankoanimoitua pikseligrafiikkaa voisi pitää varteenotettavana animaatiovaihtoehtona, joka joissain tilanteissa saattaa toimia jopa paremmin kuin perinteinen sprite-animaatio.

Asiasanat:

2D-grafiikka, animaatio, pikseligrafiikka, videopelit

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List of abbreviations

2D	Two-dimensional
3D	Three-dimensional
Aseprite	Proprietary art software primarily for making pixel art
Dungeon crawl	Video game genre where the player navigates a labyrinth-like environment, battles monsters, and solves puzzles. The video game of this genre can be called *Dungeon crawler*
FPS	Frames per second
NPC	Non-playable character
Roguelike	Video game genre, derivative of Rogue (1982)
Unity	A popular game engine used to make research prototype video game

1 Introduction

Video games are increasingly popular today. Among the stressful and hasty lives, people wish to plunge into the world of video games after their work for the day is finished (Westcott et al., 2023). With the demand and need of video games, the industry has developed multiple different genres and styles so that everyone can find the most enjoyable game for themselves (Acaster, 2022). While some people enjoy relaxing puzzle games, other people wish to try their skill out in roguelike action games (Acaster, 2022). These fast-paced video games require quick reactions and dexterous fingers (Dye et. al., 2009).

Even as technology and graphics have dramatically advanced since the early days of video gaming, the pixel art style has kept its popularity (Kuorikoski, 2018, p. 186). While thought to be a retro style, it is more modern than ever and artists have figured out numerous new styles and forms of pixel art (Lee, 2020). Pixel art is considered one of the easiest digital art styles to approach in video games due to its simplicity, and thus pixel art graphics are a popular choice for beginner game developers (Zafeiriou, 2024). Suitable game graphics play a huge role in the prosperity of video games and while some styles are chosen mainly for aesthetics, some are selected to ensure the accessibility of the game (Kuorikoski, 2018, pp. 165, 185).

The graphics in video games are almost always animated, and in 2D graphics the animation is most often done by either skeletal animation or sprite animation. Sprite animation is usually hand drawn and created frame by frame, making it very laborious and time consuming, yet it gives the animators and designers more freedom with the art style, characters, their movement and expressions (Kuorikoski 2018, p. 185). Pixel animation is created from these sprites and is sometimes said to be “the video game style”, as it was the first used in early video games due to technological limitations (Kuorikoski, 2018, p. 185). Skeletal animation is used in 3D and 2D graphics alike. Skeletal animation needs only minimal redrawing, as it requires only the original sprite (or “mesh/skin”) in which the bones (also known as “skeleton”) are added by

supporting software, such as Unity, Blender or Maia. The sprite is then animated into life by manipulating these bones into certain keyframes, creating a fluid, 3D looking animation (Garagefarm.net, n.d.). These bones create certain restrictions in animating, which often makes the technique unsuccessful for pixel animation. While skeletal animation is faster, pixel animation has unique style and greater artistic freedom. Animating pixel art graphics using skeletal animation is an unexplored method whereby its success is undetermined. This thesis attempts to determine whether it would be possible to animate pixel art graphics in skeletal animation for faster production while keeping the animation fluid and give a positive gameplay experience in a fast-paced video game.

To answer this research question, animations for an enemy entity for a dungeon crawler game in pixel art graphics using sprite animation and skeletal animation were created. The two versions of the enemy were implemented in identical video game maps. The participant preferences were measured in an A/B test approach with a questionnaire regarding their two gaming experiences. The animations and the entity used were part of a video game Willow Guard developed by a Turku-based studio MiTale Oy. Willow Guard (2025) is an action-based role-playing game with roguelite elements.

This thesis is structured as follows: Chapter 2 presents the literature review and state-of-the-art in sprite and skeletal animations. Chapters 3 and 4 describe the research prototype and research methods. Chapter 5 introduces the results of the questionnaires and Chapter 6 discusses the findings of said results as well as research limitations and suggestions for future research. The conclusions are drawn in Chapter 7.

2 Literature review

In the early days of video games, graphics were simple and targeted to - in today's light - simple equipment. Computers were able to portray only a limited number of colours and could show a strict number of pixels on screen. To make a game more interesting and complex than Pong, the graphics needed to be engaging (Kuorikoski, 2018, p. 165). Space shooter and other games, still using pixels, but with more colour and animation came forward. Video games are now more popular than ever, and even with highly realistic graphics available, people still enjoy pixel art games (Kuorikoski 2018, p. 188; Zufri et al. 2022, p. 27).

2.1 State-of-the-art

A pixel is the smallest individual element in a raster image. A raster image is an image with a limited resolution, consisting of a selected number of pixels in different colours that, when viewed from a distance, forms an image (Sony Electronics, n.d.). A high-quality raster image can be, for example, a digital photograph and no individual pixels should be differentiated from the image. Putting multiple pixels together in a specific configuration leads to forming a desired shape. Adding colours to individual pixels results in the transformation from shape to a recognizable picture. This is pixel art, and an example of progression is shown in Figure 1. In pixel art, it is important that each individual pixel can be distinguished within the picture without zooming to keep the signature, mosaic-like style (Zufri et al. 2022, pp. 27–28).

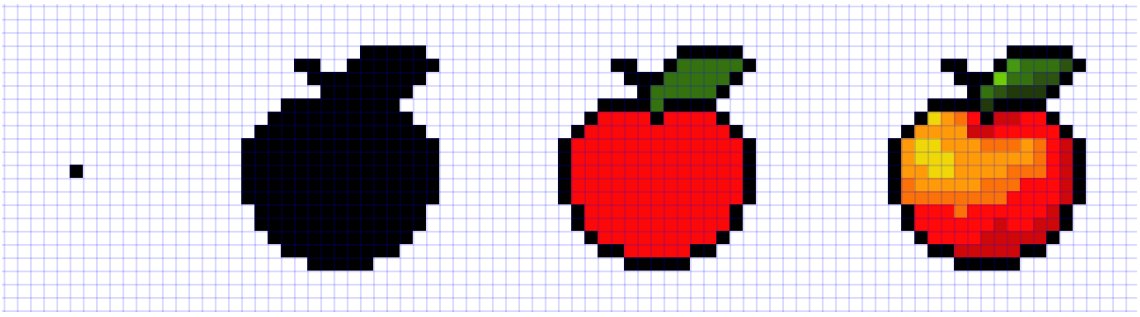

Figure 1. Progression from a pixel to pixel art.

In video games, animation and the game's visual look play an important role to increase immersion and engagement by captivating the player (Ermi & Mäyrä, 2005). Almost all pixel art video games have some sort of animation implemented and are typically played from a third-person perspective, meaning that the player can always see their character on the screen. In this perspective, it becomes critical for the animation be clear and expressive (Carter, 2021).

From the early days of Disney until today, studios have figured out numerous methods for creating animation. For pixel art graphics, the most recommended way of animating is frame-by-frame animation (McArthur, 2023; Pixel Overload, 2022; Saultoons, 2020). As the name says, the process involves drawing the animation one frame at the time. To ensure the animation is clear and seamless, one might find it easier to draw so-called keyframes first and fill the remaining frames based on the required movement. In computer graphics, the frames are referred to as sprites, and thus this technique is called sprite animation (Unity Learn, n.d.). For example, Figure 2 shows a pixel image of a dog with the tail in two different positions, and repeatedly switching between these pictures would create the effect of a wagging tail.

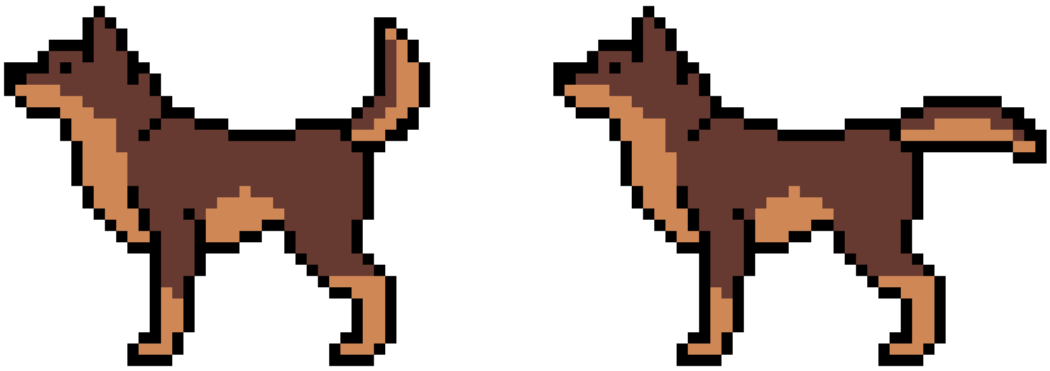

Figure 2. Wagging tail in sprite animation.

As pixel animation is constructed by individual pixels, the importance is in the details. The animated character must be well designed, so that the intended animation is understandable (Kiwi, n.d.). If the readability is poor, the animation will merely be coloured pixels appearing and disappearing on the screen.

Another popular animation technique used in video games is skeletal animation (Garagefarm.net, n.d.). Skeletal animation is primarily used for 3D-animation but can be applied to 2D animation in a similar manner. For a skeletal animation, the individual character parts, for example legs, arms, head, etc. must first be drawn and each part must then be rigged with bones. After the individual parts have been rigged, the bone structure is pulled together to form a complete skeleton. Then it is animated by moving the skeleton to certain key position and letting the animation software fill in the movement between the positions. This ensures the animation flows and looks smooth. As skeletal animation is widely used for 3D-animations (Visutsak & Prachumrak, 2009), it is considered most suitable for higher-resolution 2D-graphics, while low resolution pixel art graphics are usually advised to be animated using sprites, as even a single misplaced pixel in the animation loop can be irritating to look at (Schlitter, 2018). By animating everything frame by frame, each pixel can be monitored more closely. Skeletal animation produces smooth animation and is almost never considered for animating pixel art graphics that are by design jumpier and more ragged due to the low frame rate and sharp edges of the pixels.

The problem in using skeletal animation for pixel art graphics is that it stretches the pixels in various directions, which could easily appear to be unnatural and unappealing. When all the graphics are pixel art graphics and pixels are always axis aligned, warping and tilting pixels could easily stand out in a negative way (Kuo et. al., 2016). The Figure 3 shows how the pixels of wagging tail are deformed when using skeletal animation. It should be noted that the frames shown in Figure 3 are keyframes from the animation and the generated animation itself had multiple frames between these two keyframes.

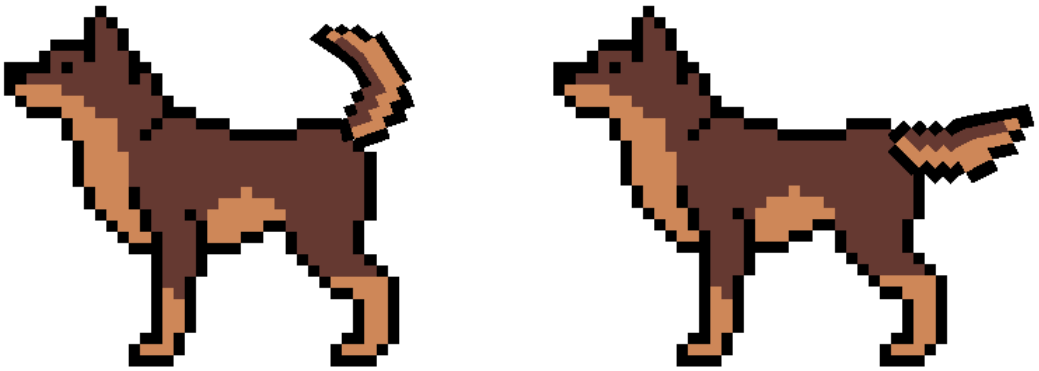

Figure 3. Wagging tail in skeletal animation.

To avoid the twisted pixels of skeletal animation, one might try to rotate the required parts of the character in the drawing program and produce sprite animation. This method, however, generates new issues, as pixel art cannot hold its shape during the rotation (Kuo et.al, 2016). The art program (Aseprite in the example) tries to calculate new placements for the pixels during rotation, but the number of pixels in the rotating area is limited, which results in jittering, missing pixels or added pixels in wrong places, making the end product jagged (Figure 4). For this reason, this method is generally unworthy to use and thus it is not studied further in this research nor is it used in the research concluded in this thesis. It is simply given as an example and a reason why sprite animation is usually fully hand drawn.

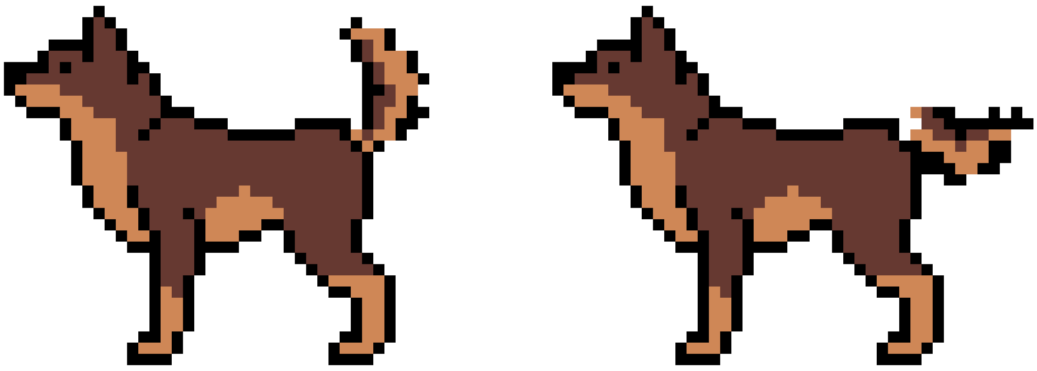

Figure 4. Wagging tail with the tail rotated in Aseprite.

2.2 Similar work

As of today, little to no academic research has been done on whether people can distinguish skeletal animation from sprite animation in pixel art graphics. However, the topic has been discussed by individual game developers and hobbyists in various forum posts (Landonbay, 2020; wishie, 2014) and comments (noppander, 2023; Wikman, 2023) for many years and skeletal animation has been mixed with pixel art in a few video games and projects such as Death's Gambit: Afterlife (2016) and Skul: The Hero Slayer (2021), most known example likely being the Moon Lord in Terraria (2013).

In November 2015, a Reddit post showed a gif of a skeletal-animated pixel character on a thread titled "Bone/limb-animations with pixel art, does it work?" (Instinctx, 2015). The post gathered many positive comments that expressed surprise in that the technique worked and how good it looked. Negative comments in the post were not related to the animation. The person who posted the gif explained that they were able to change the looks and clothing of the animated character by changing only one of the sprites instead of animating countless new sprites for each animation. Other than reducing resource costs, the new technique made the animations look smoother.

In December 2016, Toni Martin (with the username pixelsmil) posted his workflow in making the pixel game graphics for a video game Dan the Man (2015) into the Spine 2D forums. Martin exclaimed he was suspicious of using skeletal animation in pixel art due to the pixels deforming. Despite this, he decided to try animating the pixel art graphics in Spine2D, a program made specifically for skeletal animations. He also created sprite animations for the same animations for comparison. Some brief testing indicated that people didn't notice the difference between the two animations. Martin (2016) posted this comment as his reflection on the skeletal animated pixel art graphics:

> It's easy to see the wrong things in the spine character after reading this or analyzing closely, but the general feeling is as an usual pixelart sprite moving around. People didn't notice this (also we are using this skeleton for some enemies too) so I think it's good news!

Over time people have been trying to figure out ways to use skeletal animation with pixel art without deforming the pixels. There are individual programs like 3DPixelArtize (2025) and Pixelartor (2019) which both require a 3D character. After the 3D character is animated in a desired way, the program pixelates the character and provides you the sprite sheet needed for 2D animation. This way not a single sprite needs to be animated by hand, but plainly pixelating a picture or illustration doesn't usually provide a clean and understandable pixel art. The character can read as pixel art, but as no details have been paid any attention, many of those can have disappeared during the rendering, making jittering a visible issue. One of the newest plugins for Aseprite called PixelLab.ai functions in a similar way, but this time you can "rig" your 2D-pixel character inside Aseprite. After assigning the bones to your character, you can move them in the way you want, and the plugin then generates the sprites for the animation using artificial intelligence. With all these programs the produced animation certainly works as intended, it is artistically questionable; upon closer inspection the animation looks wonky, minor parts of the character are missing, some sprites have significant about of jittering and would require hand-made edits to ensure

understandable and aesthetically pleasing animation (PixelLab, 2024; tombmonkey, 2015).

ThirdPixel Interactive released a 2D fighter video game called Smack Studio (2024), which also includes a pixel art creating software for players to create play as their own characters. Based on the information, Smack Studio only requires the character art as whole and as limbs drawn separately, and then it would be able to animate the character in real time with no 3D models needed (Smack Studio, 2023). The videos of the video game showcases that there is no warping nor tilting pixels as the game draws the sprite again after every move. Out of all the possible ways to animate pixel art graphics using skeletal animation, this one rises to the surface as one of the best with the cleanest end products (heyitsbuddah1270, 2023).

The positive and surprised comments on forum posts suggest that using skeletal animation with pixel art is an uncommon practice that potentially produces good quality animations. The number of new programs trying to implement skeletal animation in pixel art indicates the demand for a tool to make understandable and aesthetically pleasing pixel animations without having to animate and draw everything by hand. The lack of market research and disparity between expectations and user feedback are significant factors discouraging game developers from utilizing skeletal animations in pixel art graphics. Studios instead fall back on the tried and tested method of handmade sprite animation, even if the use of skeletal animations could save time and costs and allow for easier modification. The ease of use of skeletal animations may also open new possibilities for smaller studios and hobbyists with no experience in art to create their own assets.

The aim of this thesis is to test people’s preferences with sprite animation and skeletal animation in pixel art graphics and whether video game players can distinguish the animation styles from each another in a game setting. This thesis investigates the feasibility of using skeletal animation with pixel art graphics by asking research participants to identify differences and express

their thoughts on an animation done with two different (sprite and skeletal animation) techniques. The thesis has the following hypotheses:

1. The participants will generally prefer sprite animation (Dungeon A).

2. Participants will notice the animation styles are different.

3. The participants who play a lot of pixel art games or video games in general will prefer sprite animation (Dungeon A).

3 Research Prototype

The game area was designed to be a dark circular dungeon, where the player started from the bottom and had to move clockwise around the map to get to the iron gate at the end (Figure 5). By going through the gate, the players would progress to another floor with a similar layout. Three floors portrayed a similar setting, all of them containing three identical enemies approaching the player from specific spawn points that are circled in yellow in Figure 5.

Figure 5. Image of the first floor of the dungeon.

To gain a better understanding of people's preference between skeletal and sprite animation in pixel art graphics, the testers played two versions of a dungeon level from MiTale's video game, Willow Guard. The only difference between the two dungeons would be the way the enemies are animated. The dungeons would otherwise look identical and progress the same way, and the enemies would spawn from the same places. The dungeon was portrayed as an ascending tower with three floors, but for majority of the players the first floor was the only map they played, due to either time spent in the dungeon, the difficulty of the game or the player's unfamiliarity with the game style.

The enemies were programmed so that they would approach the player and when in close proximity, attack and reduce the health of a player, possibly killing the player and thus forcing them to restart the dungeon. The enemies were killable and died when the player hit them with the player character's sword enough times.

In addition to the enemy-bears, the players could break other objects in the game. These objects included barrels of poison which exploded upon hit, some furniture items and breakable boxes that gave in-game currency (shimmer) and valuables. The players were unable to profit from the found items, but the experience of finding rewards in the game increased the immersiveness and enchanted the overall gameplay, which in turn made the players focus more on the gaming experience instead of stressing about the testing setting. The poison barrels offered an alternative way to defeat enemies, but also a risk to the player themselves as the timed explosion of the barrel dealt damage to everyone around. Every floor had glowing green pots which the player could break and regain some of their lost health.

As the dungeon level was already built for the upcoming game, no changes to the level itself were made for this test. Only the enemies were modified to be easier and the damage they dealt was reduced, so the gameplay would be easier for unexperienced players while the experienced players had extra floors for the dungeon. This was done to ensure that everyone would be able to kill at

least one enemy, and that everyone would be able to progress in the game to get more results for the questionnaire.

The enemies in both dungeons were the same with their difference only being the animation. The enemy selected for this research was Bearspike, a bi-pedal bear-like creature with long claws and spikes growing on its back. Bearspike appears in the upcoming game as a boss-level creature and it will be animated in the sprite animation method, meaning that all of its animation consists of multiple different frames shown after one another.

Figure 6. Bearspike's running animation as a spritesheet.

Bearspike was one of the first original enemy designs for the game. The development started from drawing a concept which was later drawn in pixel art. The enemy had 4 different animations: idle, running (Figure 6), melee-attack and death. All of those animations had 6 to 10 different sprites that were then shown in order to create an animation that was then repeated endlessly unless the animation changed to another. One frame was visible for 0.2 seconds before changing to another.

For skeletal animation, the Bearspike's pixel design was broken into individual pieces: head, legs, hands and torso were all separated and spread on the canvas to create a sprite atlas (Figure 7). The head was separated from the skull and jaw in order to open and close the mouth.

The only difference between the sprite-animated design and the skeletal-animated design was one of the bear's legs. Bearspike's left leg was flipped for skeletal animation, as in the sprite-animated idle pose its legs are pointing in two different directions and in the running animation (spritesheet in Figure 6) Bearspike's left leg can be seen turning between the steps. It was attempted to flip the leg between the steps in skeletal animation, but the attempt was unsuccessful, so the mirrored leg was used in all of the skeletal animations for the sake of more coherent animation. When both legs pointed in the same direction, the bear didn't look as weird or unbalanced as it did with the legs pointing to opposite directions as in the original sprite-animated version.

Figure 7. The sprite atlas of the skeletal-animated Bearspike.

The sprite atlas was then transferred to Unity, where the image was identified as a sprite and then edited in the skinning editor. As the game Willow Guard was done in Unity, it made sense to use Unity for making skeletal animation instead of another 2D-animation software. As the body parts were separated on the sprite, the skinning editor identified them as different objects and assigned them their own geometry to ensure the sprite could warp in the desired way when the bones were moved (Figure 8). Some body parts were identified as one due to them being too close to one another, but they were separated in the editor. Some body parts were also given more vertexes in order for adjusting the warping.

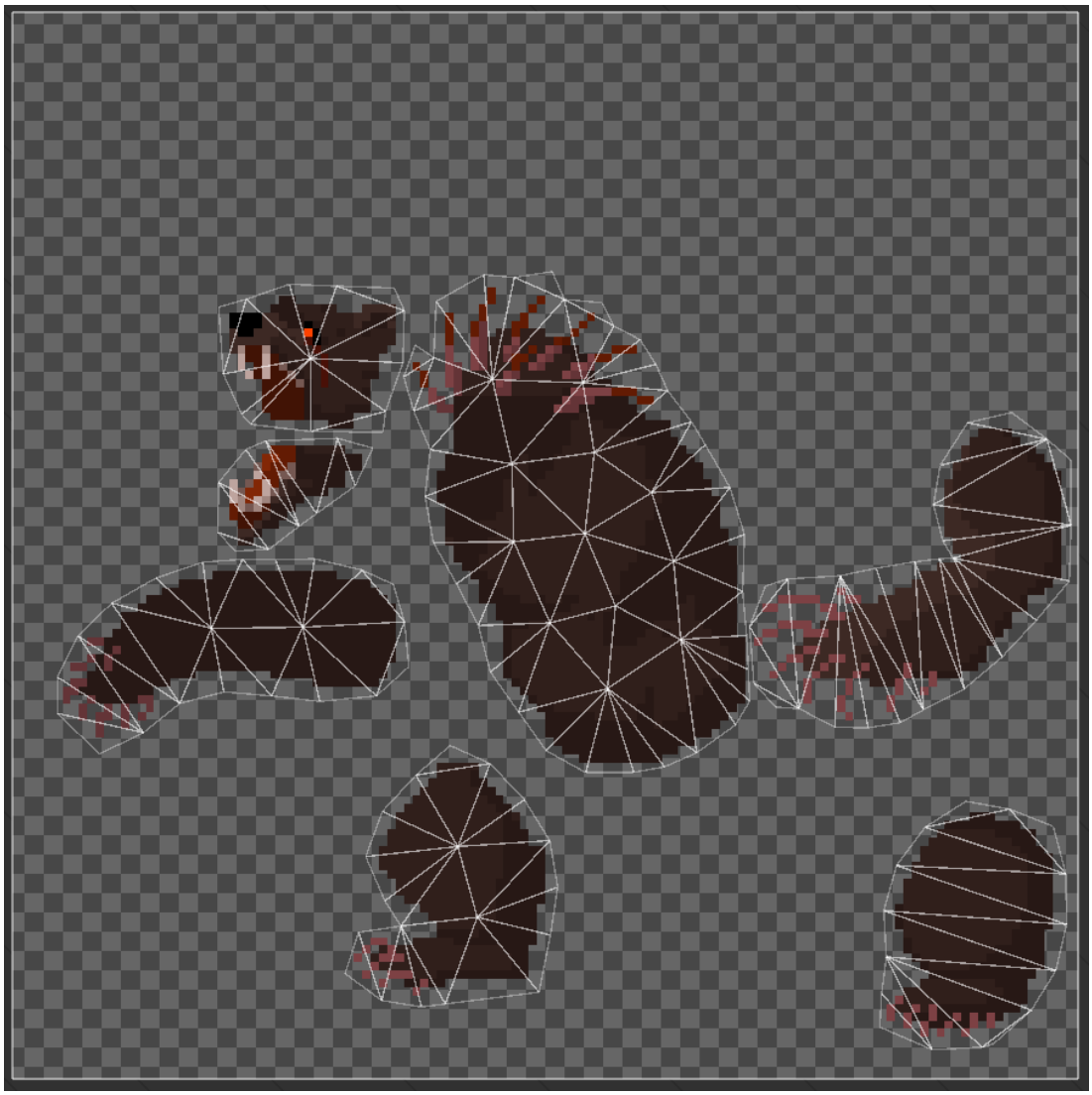

Figure 8. Bearspike's geometry.

Next a bone structure was built on the bear. The building started from the hip bone (red in Figure 9) and from there a spine was built. Legs and arms were built next and all had three bones to control the bear as naturally as possible. The jaw and skull got their own bones to ensure the bear's mouth could be opened and closed.

The body parts were also assigned a different order to ensure the left leg and arm would always be in front of the torso and the other limbs. Without the order,

they would clip through each other during the animations, making the enemy hard to understand.

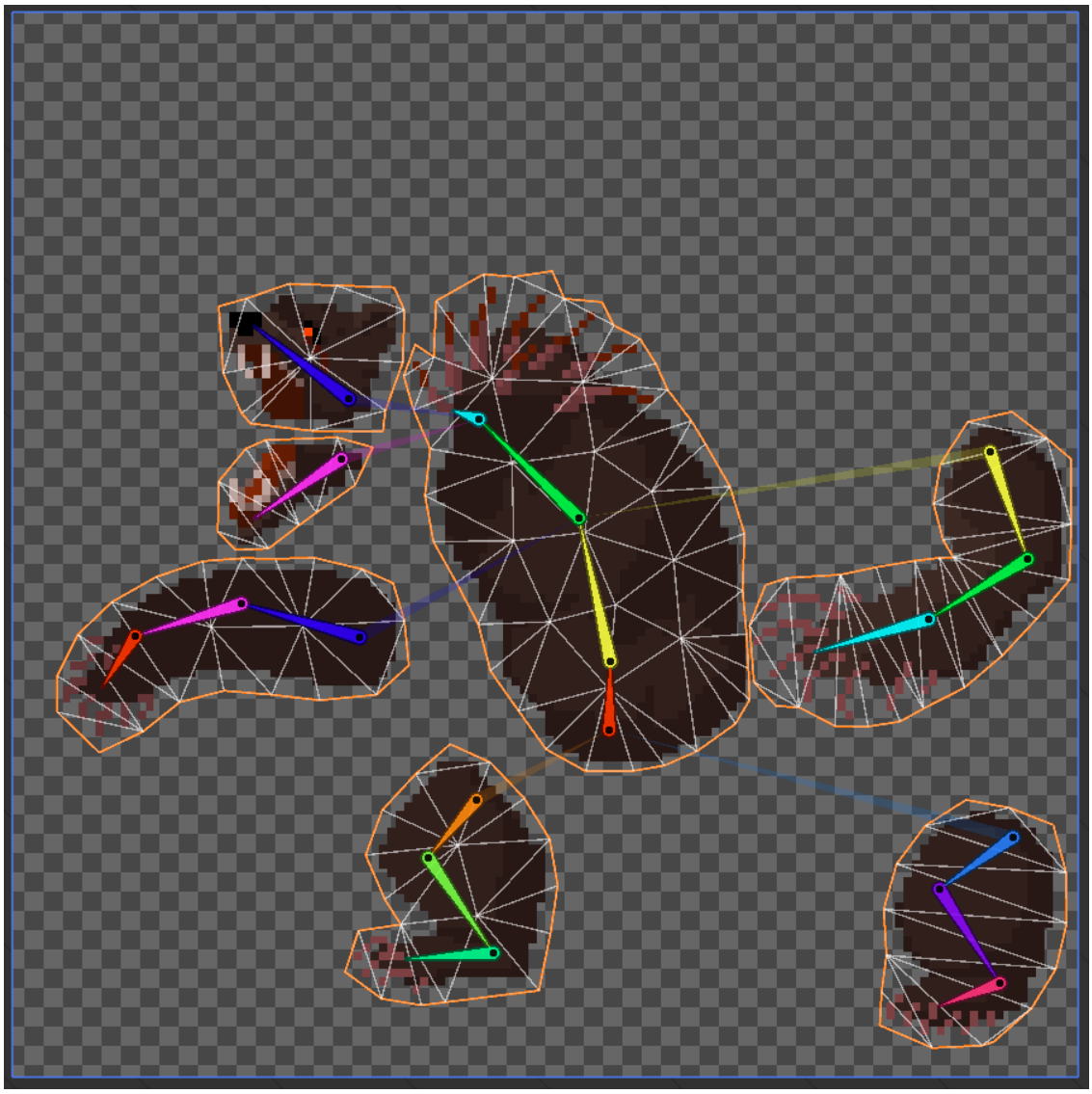

Figure 9. Bones of the skeletal Bearspike.

And last, the body parts were assigned weights. The weights determine the area a certain bone will affect, which gives the skeletal animation its whole purpose. Each bone has its own colour and that same colour correlates the area the said bone affects (Figure 10).

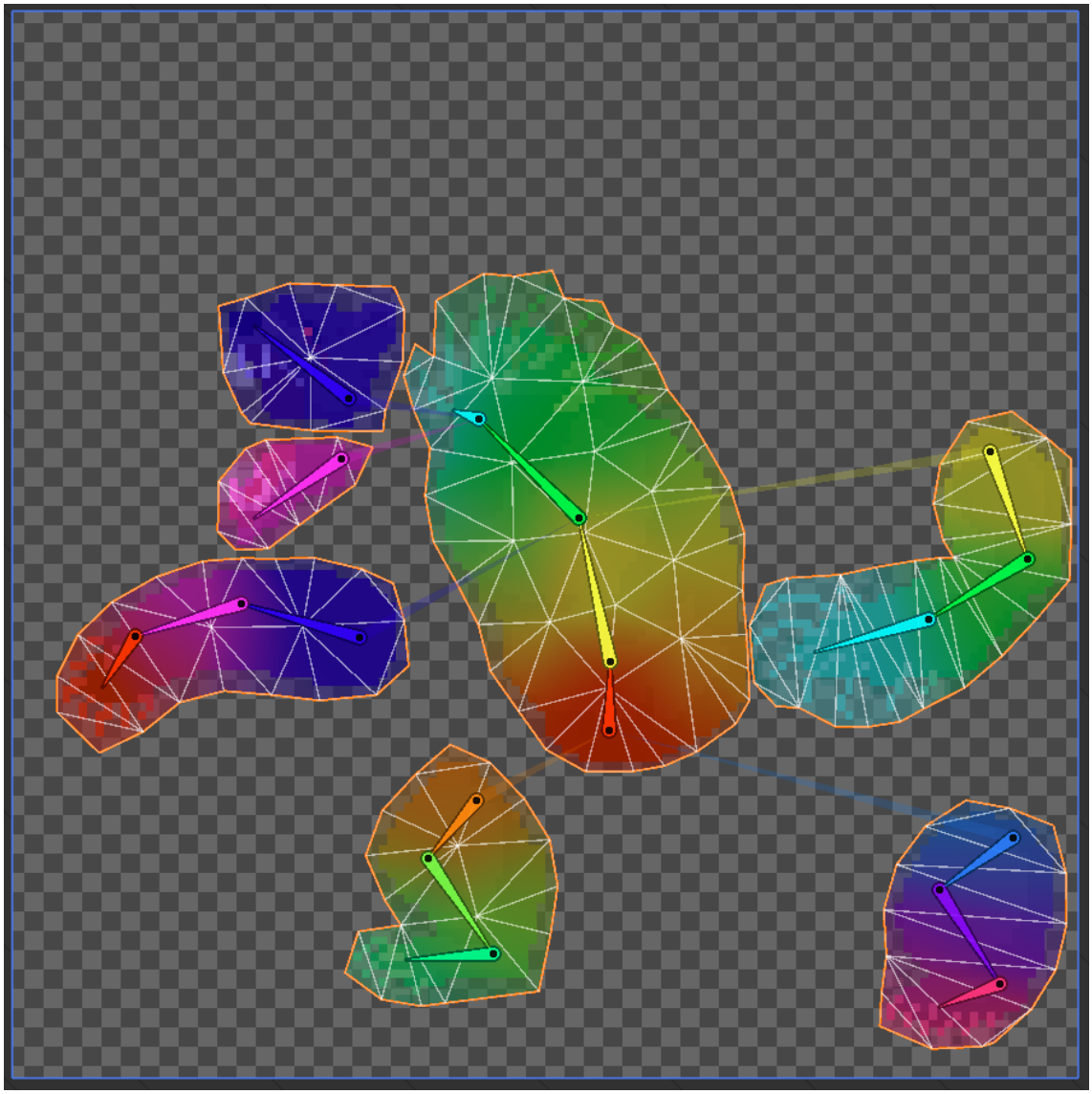

Figure 10. Weights of the skeletal Bearspike.

With the bones and weights determined, the body parts were attached in the same manner the Bearspike was drawn (Figures 11 and 12). The skeletal Bearspike was now ready to be animated.

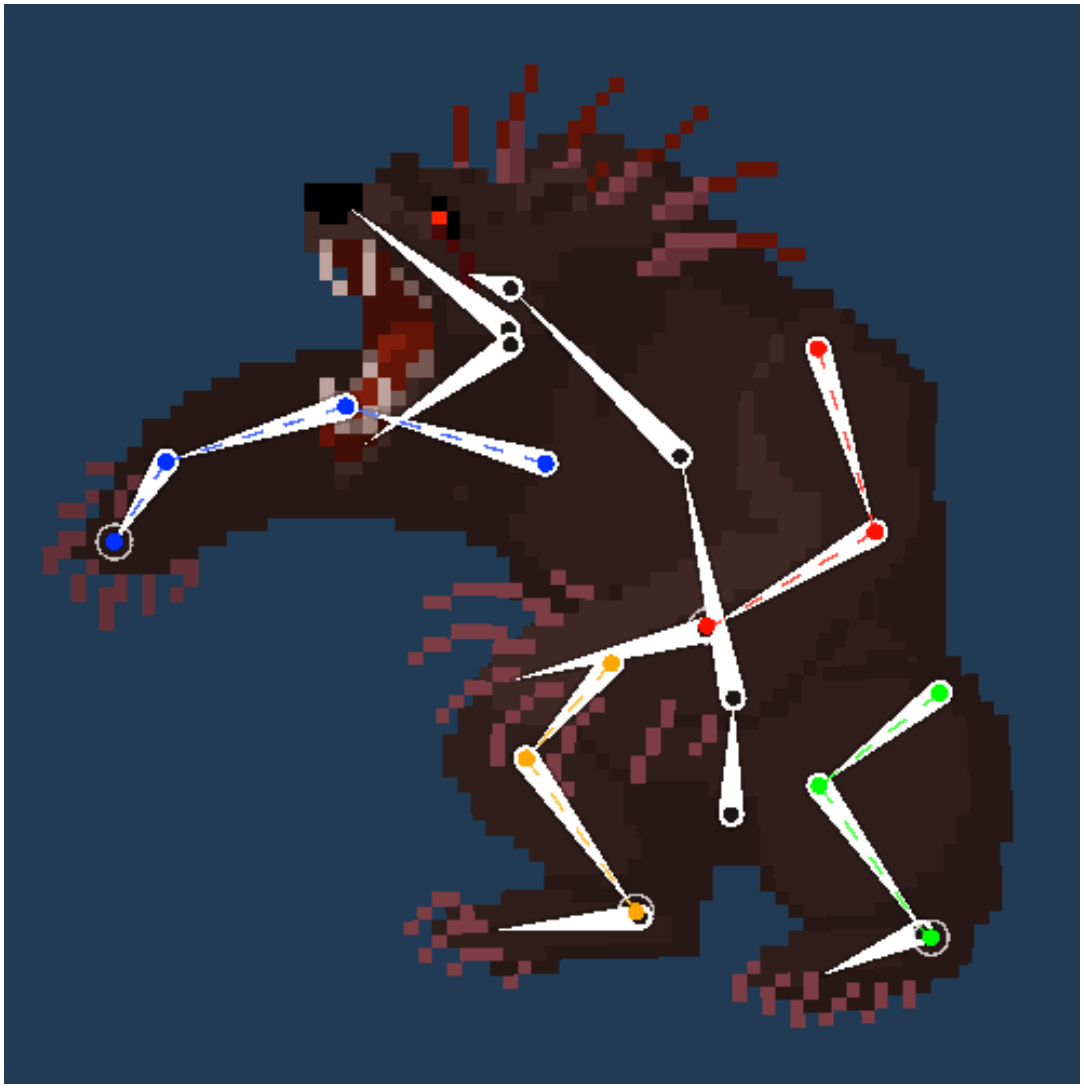

Figure 11. Skeletal Bearspike's main pose.

Figure 12. Spritesheet Bearspike on the left, skeletal Bearspike on the right.

The skeletal animation for Bearspike was done by using Unity's own animation controller. Bearspike's limbs could be moved however necessary into different keyframes that defined the position we wanted the enemy to go from the idle pose or previous keyframe. Unity itself calculated the individual sprites' positions between these keyframes, producing an animation where each part of the animated character moved and rotated smoothly from one position to another. The skeletal animation was made to resemble the sprite animation as closely as possible to ensure the difference would only be the animation method and not the movements. This would eliminate the possibility of one animation having a clearer indication of movement and thus being more favoured.

The differently animated bears were now assigned to their own dungeons; Dungeon A held the sprite animated Bearspikes and Dungen B held skeletal-animated Bearspikes. From the main menu of the video game a participant could now go straight to Dungeon A or Dungeon B, without knowing beforehand what the difference in the dungeons would be.

4 Research Methods

The intent of the researcher was to perform an A/B test for a group of people to clarify how they perceived the different animations, whether or not they saw the difference between the two and if they had any preference over them. The aim was to gather quantitative data by letting the players fill out a questionnaire, but every player was encouraged to give verbal feedback during their playing as well as leave written comments at the end of the questionnaire.

The test was mostly performed in the ICT-City-campus of Turku University of Applied Sciences, but some participants who were unable to come to the campus but expressed their interest to participate to the research were tested at their homes with their home computer. The researcher was always present during the test to ensure the testing went according to plan and no outside distractions would bother the testing.

For three days, a stand (Figure 13) was set up in the centre of the first floor near the dining area and random passerbys were invited to participate in the research by playing the games. The video game was downloaded on two different laptops with similar specs and was thus playable for two people at the same time. As the dungeon map used was dark, moveable walls were pulled around the players to block the noise and excessive lighting from the lightsources around the room to minimize the outside distractions.

Figure 13. The testing setting during the first day of testing.

Overall, 50 volunteers were gathered and in this research they are referred to as participants. Every other participant played Dungeon A first and Dungeon B second while others played Dungeon B first. This was to minimize the bias of the first dungeon experience being scarier and more unfamiliar, giving the second dungeon an advantage of being more approachable and thus more enjoyable.

The game consisted of two identical dungeons called Dungeon A and Dungeon B. The only difference between the dungeons was the enemy animation: in Dungeon A, the enemies were animated with a sprite animation method and in Dungeon B, the enemies were animated with a skeletal animation technique.

Before the participants started playing the game, they were given instructions and tips of the game: how they moved their character, how they used the weapons, where the dungeon was set, how they should progress in the map and what they were supposed to do. Everyone was also specifically asked to pay attention to the enemies: how they moved, how they acted, how they made the player feel and how they fit into the scene.

Each participant was given a task to kill all the enemies in their dungeon. Figure 14 shows a participant playing one of the dungeons. Participants who killed the first three enemies fast (approximately within 3 minutes) were encouraged to progress higher in the tower the dungeon was set on until they reached the top floor or wished to change dungeons. If the participant's character died, they were encouraged to try again until they got at least one enemy killed or they themselves didn't want to continue playing. All of the participants were asked to progress as far in the second dungeon as they had in the first dungeon.

Every participant was also allowed to quit the testing at any point if they so wished or they had no time to play the second dungeon. These participants didn't get to fill the questionnaire and thus their opinions have not been counted for this research.

After the first dungeon was completed or 10 minutes had passed, the participants were asked to play the other dungeon. They were given the same task of killing all the visible enemies and progressing as far as they had in the previous dungeon.

Figure 14. An anonymous participant playing the game.

After both of the dungeons had been cleared, the participants were given either “A first” questionnaire or “B first” questionnaire, depending on which dungeon they had played first to correctly label their preferences. The questionnaires had identical questions in the same order.

At first, the participants were asked profiling questions, such as their age, gender and whether or not they have actively participated in video game

development. Some of their video game preferences were also asked and the proximity of hours they play video games per week. Three key questions were asked at the end, and they were the following:

Which dungeon experience did you prefer?

Which dungeon had better-looking enemies?

Which enemy animation did you prefer to look at?

To make sure the participants didn't need to remember the letters of the dungeons, the answers in both of the questionnaires were simply "the dungeon I played first" or "the dungeon I played second". The participants were guided to their correct questionnaire by the researcher, depending on which of the dungeons they had played first. The researcher always kept a book of the participants' dungeon playing order.

Lastly, the questionnaire also contained an optional answer box where the participants were able to write their thoughts and insights of their experience and possibly share other comments if they so wished.

The questionnaires were made in Google Forms, and they included identical questions and information.

The players were given a QR-code so they could fill the questionnaire using their own mobile devices. If the player couldn't use their own phone, they were allowed to fill it using either the testing computer or researcher's phone. Each player was advised to fill the questionnaire immediately rather than later to ensure everything they had experienced of the game was fresh in their memory and the results would be as accurate as possible.

The data from the questionnaires was later transmitted to Excel and differenced from each other so that it was possible to distinguish the Dungeon A and Dungeon B preferences from each other: If a participant filled "A first" questionnaire and preferred the dungeon they had played second, this meant they preferred Dungeon B.

5 Results

50 people answered the questionnaires, and all of their answers were gathered on Excel and sorted accordingly (Table 1). As the questionnaires specified which dungeon the players had played first and second, all of their answers were sorted into one table. It should be noted that the question “Preferred Dungeon Experience” only had three answer options, A, B or Both.

After inspecting the results, we can see that Dungeon A, which contained the sprite animation, has been the preferred one regarding the preferred dungeon experience and enemy animation. However, upon closer inspection, it was clear that the second key question gained more uncertain answers. The spread between the A and the B was almost equal, while 19 people out of 50 answered that they saw no difference between the two.

Table 1. Number of participant responses according to their preferences.

	A (sprite animation)	**B (skeletal)**	**Both/No preference**	**Saw no difference**
Preferred Dungeon Experience	20	11	19	
Better-looking Enemies	12	13	6	19
Preferred Enemy Animation	22	12	4	12

The question “Which of the dungeons had better-looking enemies” was aimed to be more of a trick question, but after the testing had finished the question was determined to be worded poorly. The question should have been worded differently, as in the end, the enemy in both of the dungeons was the same bear-like entity, with the only difference being the animation and the technique used in the animation. It was possible that the players tried to spot major

differences between them and thus were unable to see any differences between the due, leading to the option “I saw no difference” getting the majority of answers. To avoid confusion, the question should have been worded differently, for example “Which dungeon enemy appealed to you more as a whole”, rather than asking about the looks of the enemy. For this reason, the question was ruled out of the analysis and will not be viewed further. The other two key questions (“Which dungeon experience did you prefer?” and “Which enemy animation did you prefer to look at?”) were analysed more closely.

The profiling questions were used to determine how different backgrounds and features affected answering the remaining key questions. These included answers based on age, gender, video game development history, weekly video gaming hours, familiarity with pixel art and dungeon crawler game [likeability]. All of those were inspected, but only three of them awarded interesting results worth noting and those were the players’ gender, time used for gaming and familiarity with pixel art video games.

While age was an interesting factor and thought to bring contrast between the answers, there was no great difference between them. The majority of the players were in their twenties (35 out of 50). Out of 50 participants, there was not a sufficient representation of other age groups to draw any meaningful conclusions.

The video game development history also seemed not to bring any worthwhile difference between the answers. Out of 50 players, 13 had actively participated in video game development, but their answers didn’t differ from the overall answers. The only difference was the lack of uncertainty – the developers were able to spot the difference between the animation techniques and thus have a clear preference between the two dungeons.

The question regarding the players’ dungeon crawler likeability was also ruled out of the results, as it was deduced to be irrelevant for the answers. Whether or not a player would like dungeon crawler games, they could still enjoy either of the animation styles and have preferences. The only thing that it may have

affected was the overall enjoyment of the game testing, but a person could still like dungeon crawler games and dislike the style and vice versa. The question overall brought no difference to the answers and was not inspected further.

Below are three tables of answers for the question “Which dungeon experience did you prefer?” with the profiling questions of gender, video game consumption per week and familiarity with pixel art. The answers have been simplified and combined for the results, meaning that if a person answering to the “A first” questionnaire selected the answer “the dungeon I played second”, they mean Dungeon B, as that is the dungeon they played second and thus their answer is counted for Dungeon B.

Below in Table 2 are the answers to the question “Which dungeon experience did you prefer” with the results divided based on player’s gender. It was noticed that there is no big difference in answering between the genders, although Dungeon A which had the sprite animated enemies was bit more preferred than Dungeon B.

Table 2. Preferred dungeon experience by gender.

> Gender	**A (sprite animation)**	**B (skeletal)**	**Both**
Man (n=28)	10	6	12
Woman (n=18)	7	4	7
Other/No answer (n=4)	3	1	0

The people who play over 3 hours of video games have clearer preferences over their liked dungeon, while people who play less than 3 hours or not at all rather answered they liked both of the dungeons equally (Table 3). Dungeon A still was the preferred dungeon out of the two.

Table 3. Preferred dungeon experience by gaming hours per week.

> Gaming hours per week	**A (sprite animation)**	**B (skeletal)**	**Both**
None or less than 3 hours (n=17)	5	3	9
From 3 to 14 hours (n=13)	7	2	4
Over 14h (n=20)	8	6	6

When inspecting the results based on familiarity with pixel art, it was noted that A was the preferred one out of the two, but the option “Both” was also popular (Table 4). It was surprising that the people who haven’t played much pixel art games or those with a lot of experience with them seemed to be equally liking more A or both, while those with a few pixel art video games seemed to prefer more A rather than both or just B.

Table 4. Preferred dungeon experience by familiarity with pixel art.

> Familiarity with Pixel Art	**A (sprite animation)**	**B (skeletal)**	**Both**
0-1 pixel art games played (n=10)	3	2	5
2-4 pixel art games played (n=14)	7	3	4
Over 5 pixel art games played (n=26)	10	6	10

Below are three more tables with the same profiling, answering the key question “Which enemy animation did you prefer to look at?”.

Based on gender, men have a strong preference of Dungeon A's sprite animation, while women's opinions are more equally distributed between the options. Women were more likely to not see the difference between the animations.

Table 5. Preferred enemy animation by gender.

> Gender	**A (sprite animation)**	**B (skeletal)**	**Saw no difference**	**No preference**
Man (n=28)	15	6	5	2
Woman (n=18)	4	5	7	2
Other/No answer (n=4)	3	1	0	0

Based on gaming hours per week, the results show that people who play less than three hours of video games per week were more likely unable to see the difference between the dungeons, while people who play more than three hours of video games saw the difference and generally preferred Dungeon A's animations over the Dungeon B's animations (Table 6).

Table 6. Preferred enemy animation by gaming hours per week.

> Gaming hours per week	**A (sprite animation)**	**B (skeletal)**	**Saw no difference**	**No preference**
None or less than 3 hours (n=17)	4	3	8	2
From 3 to 14 hours (n=13)	7	3	2	1
Over 14 hours (n=20)	11	6	2	1

When it comes to familiarity with pixel art, people who have played multiple pixel art video games saw the difference between the animations and had clear preferences (Table 7). With none or only one pixel art game played, the players were more likely to have no preference or not spot the difference. Generally, out of the two animation styles, sprite animation was clearly more liked in all of the groups.

Table 7. Preferred enemy animation by familiarity with pixel art.

> Familiarity with Pixel Art	**A (sprite animation)**	**B (skeletal)**	**Saw no difference**	**No preference**
0-1 pixel art games played (n=10)	3	1	4	2
2-4 pixel art games played (n=14)	7	4	3	0
Over 5 pixel art games played (n=26)	12	7	5	2

In addition to quantitative results, the participants were given an option to open their thoughts straight to the researcher or give comments in the questionnaire. Based on the gathered comments, the general consensus of the qualitative answers is that while Dungeon A enemies matched the rest of the style, Dungeon B enemies were nicer to look at, but the skeletal animation felt out of place and too over-animated.

6 Discussion

The hypothesis formed prior to the testing was that the people would generally prefer the Bearspikes animated with sprite animation rather than the ones animated with skeletal animations. It was also thought that people will notice the animations styles being different and that people with experience in video games and in pixel art video games would without exception prefer sprite animated enemies.

Out of all the results, people preferred Dungeon A over Dungeon B in all categories. The experience was better in Dungeon A or both dungeons were equally good. The enemy animation was clearly better in Dungeon A, meaning that in a pixel setting, pixel art sprite animation works better than skeletal animation. Some people wished to discuss their answers after finishing the questionnaire or answer in the writing box at the end of the questionnaire, and it was clear that the preferences depended on people themselves too: one person said that the enemy attacks were better indicated by the sprite animation while another participant said the opposite. It is important to remember that the favoured animation can also depend on stylization preferences: while skeletal animation is a faster way to animate, in pixel setting it can look uncanny and weird, but this could also be a desired effect in a horror style video game.

Based on the feedback received, the enemies felt slow and “laggy” in Dungeon A. People who preferred Dungeon B told that in their opinion, the skeletal animations were more beneficial in the game style and setting, while Dungeon A animations - even if fitting to the art style of the game - felt out of place in the fast-paced game. The so-called jumpiness of the sprite animation was labelled to be an unwanted effect in a dungeon crawler. People who preferred Dungeon A didn’t like the style mismatch in Dungeon B, which has more movement due to skeletal animation. Interestingly though, some of them also pointed out that it looked more interesting and captivating.

When looking at the results to the two key questions, Dungeon A with the sprite animations stands out as the most preferred one. While the people might have

preferred both or had no major preference between the two dungeon experiences, Dungeon A was generally more preferred. When the only difference between the dungeons was the method, the enemies were animated with, it is safe to say that the people felt the difference and preferred the sprite animated enemies over the skeletal animated enemies.

People regardless of their gender have their own preferences, but within these participants, men seemed to prefer the enemy animations in Dungeon A over Dungeon B animations while women were less likely to spot the difference between the animations. The reasoning behind this might be that the men answering to the questionnaire also played more video games compared to the women participants. Both men and women seemed to also enjoy both of the dungeon experiences and the answer “I liked both [of the dungeons] the same amount” was almost as popular as the Dungeon A.

People with over 3 hours of gaming per week had clearer dungeon experience and enemy animation preferences than people with less or no gaming hours. One reason for the people who don’t play video games being unable to see the difference between the enemy animations can be the pressure of the testing situation. When observed, the participants with no gaming history showed more signs of nervousness and awkwardness when playing the game than those who play video games more often. Some participants even told the researcher that they only focused on keeping their player character alive and desperately killing the Bearspikes rather than paying attention to the looks and the feel of the game and entity’s looks themselves. These people were also more likely to enjoy both of the dungeon experiences. On the contrary, it was observed that the people who play video games more often were more comfortable in gaming during the testing situation and thus viewed the elements more critically. When the enemy appeared on their screens and started chasing them, they had time to pay attention to the enemy's characteristics. Some even ran circles around the enemy and vocally commented on their observations.

Even though more gaming hours indicated clearer preferences, there were still people with many gaming hours who were not able to pick their preferred

dungeon or animation style. The reason behind this can again be the stressful testing situation. Even if person would play a lot of video games, the hours might be spent on completely different games such as turn-based RPGs, resource-management games or other games where the player isn't required to act fast or control mouse and keyboard at the same time. In that case, the experienced players paid more attention to learning the game mechanics and game progress rather than in how they perceived the enemies.

With little to no experience with pixel art video games, the players were more likely to enjoy both dungeon experiences and have no preference between the two enemy animations. Many of these people didn't see any difference between the animations. In their case, the reason might be that the style is simply new and unfamiliar to them, and thus they have nothing to compare the style to. One of the players with no experience in pixel art video games exclaimed that they noticed the two dungeons had something different in them but couldn't pinpoint what it was.

In contrast, people with more familiarity with pixel art video games were more likely to see the difference, and many preferred Dungeon A and its sprite animated Bearspikes. Skeletal animations are rarely if never used in traditional pixel art video games, so people were expecting to see familiar sprite animations in the test game as well. When everything else is traditional pixel art graphics and the enemies aren't, it contradicts with the player's expectations which in turn could break the immersion and bring the player discomfort (Pass, 2025).

On the other hand, the style of the animation in the game is more than just a financial decision; breaking the expectation can also be a stylistic choice. In the last part of the questionnaire, people were able to give free feedback, and some wrote that while the smooth skeletal animation felt out of place in the otherwise rough pixel art setting, it stood out in an uncanny way, enchanting the horror element of the game. This can give a reasoning for the number of people preferring Dungeon B.

Animation is a style choice, but above anything it will determine the feel of the gameplay. The participants preferring Dungeon B could have felt that the enemies felt slower and “laggy” with sprite animation, which suits the style of the pixel art video game but might be an unwanted effect in an action-based dungeon crawler where speed determines your success. In their opinion, the skeletal animations were more beneficial in the game style and setting, while sprite animations, even if fitting to the art style of the game, felt out of place in the fast-paced game. Skeletal animation is smoother due to computer-driven movement having higher FPS than sprite animation and it was evident in the dungeon selected to the test. The style choice now comes to the decision, what kind of players the style decision will benefit more; those who like the style of the art, or those who like the style of the genre.

However, better flow of the animations doesn’t fully determine a better animation. Participants also said that the enemy attacks were better telegraphed in the sprite animation which is important in action games. If the player cannot understand when the enemy’s attack is landing, they are more likely to get hit without knowing the reason and the gaming experience might not be as enjoyable. As each of the frames is drawn individually in sprite animation, the attack indication can be edited to be cleaner and more precise while also being aesthetically pleasing to the eye. The sprite animation in Willow Guard’s case connects the enemies to the game world’s style and makes the dungeons look coherent, which is one of the reasons sprite animations were chosen to be used. Skeletal animation on the other hand is faster to edit, and for a games with customizable character skeletal animation offers more room to changes without a need to edit hundreds of sprites one by one. It is pertinent that both of these methods have their benefits and disadvantages.

6.1 Study Limitations

It should be noted that pixel art, like any art, is subjective and can be made and interpreted in multiple ways (Lee, 2020). A skilled artist can achieve a desired look in multiple different methods and vice versa. Even if the artist and game

developers would be satisfied with their work, the players might not. In this research the researcher was more familiar with sprite animation, which possibly made the sprite animation artistically more polished and precise, giving it an advantage over skeletal animation.

Another study limitation for this research is constantly evolving technology. During the making of this research, a few new applications were published and artificial intelligence evolved to be even more accurate in generating art. This research also focused on 2D art, but there are ways to implement 3D characters in 2D games by pixelating them. While those topics were not covered in this thesis, they should be noted as possible methods.

Before the research method was finalised, there was a consideration to only show participants two different gameplay videos instead of letting the participants themselves play the game. While this would have allowed more people to participate and let the nervous, non-gaming participants focus on the animations more, it could have been overall boring experience to the participants and given indecisive results due to participants losing interest. Animations on a character that stays still on the screen might also look different on a character that is moving on the screen, meaning that just showing videos could have been a defective research method.

If future research is to be conducted, it would be interesting to animate a player character instead of animating an NPC. The player character can be observed easier and analysed more calmly, as the player character can be viewed also outside of combat. Another suggestion is to test the animations in a different video game genre. While many of the participants were able to play and finish the dungeons, there were multiple participants who were unfamiliar with dungeon crawlers or fast-paced gaming style in general. Those participants had difficulties coordinating the keyboard and mouse at the same time and they got stressed when the combat started. Some people showed visible signs of nervousness during the testing and thus were unable to fully focus on the testing situation. A game with less stress-causing mechanics is advised to be used in future testing.

7 Conclusions

The objective for this thesis was to determine whether the participants in this study would spot the difference between sprite animation and skeletal animation in the pixel art video game. For this to be tested, the participants played two versions of the same video game and answered a questionnaire regarding their preferences. Game developers have wanted to use skeletal animations in pixel art graphics, but this method is rarely suggested, and the idea is often abandoned before it is attempted. Based on the expectations, skeletal animation is exclusively offered as an option for high-resolution art graphics.

The findings in the research indicate that while players prefer sprite animations in pixel art graphics more than skeletal animations, skeletal animation is an option to be considered. The number of players enjoying the skeletal animations in pixel art setting was greater than expected. The number of players unable to spot the difference between the sprite and skeletal animations indicates that there is no reason to avoid skeletal animations in pixel art. It appears that game developers' negative expectations could be the source of why skeletal animation is seldom utilized. It is likely that players will not know the animation is created differently, and in some cases the skeletal animations are better suited to the game than sprite animations. This could be especially true when making serious games or games targeted for non-gamers because using skeletal animations is more beneficial to the company due to it taking less time to make and being easier to edit later. In conclusion, skeletal animations should be considered as a viable animation technique for pixel art graphics.

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A/B test WillowGuard questionnaire – A played first

This questionnaire is for thesis research purposes only. Please note that the results will be analyzed anonymously in the bachelor's thesis done by Maria Hänninen. If you do not wish to participate in the research, you are free to quit at any moment should you wish so. All the data gathered here will be held till the thesis has been published, after which all the data will be erased.

By filling this questionnaire, you confirm that you have played the Dungeon A first and Dungeon B second. If this is not true and you have actually played Dungeon B before playing Dungeon A, please ask Maria to give you different questionnaire to fill.

The first part of the questionnaire will ask vague questions about your age, gender and video game development history.

* Indicates required question

1. **Age**. Please select your age. *
- Under 18
- 18 – 21
- 22 – 25
- 26 – 29
- 30 – 39
- 40 – 49
- 50 or Over

2. **Gender**. Please pick a gender most suitable. *
- Man.
- Woman.
- Other.
- Prefer not to answer.

3. **If you have actively developed a video game before, what was your role?** *

- I have never actively participated in the process.
- Coder/programmer
- Game developer
- Concept artist
- 2D artist
- 3D artist
- VFX artist
- UI/UX designer
- Sound developer
- Producer
- Game tester
- Narrative designer
- Something not listed her

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This part will ask you questions regarding your video game preferences.

4. **How many hours fo you play video games in a week?** *

The video games can be played on computer, on console such as PS5 or Xbox, on hand console such as Nintendo Switch or Nintendo DS or on mobile device like phones or tablets.

- Less than 3 hours a week.
- 3 to 7 hours a week.
- 7 to 14 hours a week.
- 14 to 30 hours a week.
- Over 30 hours a week.
- I never play video games.

5. **How many 2D-pixel art video games have you played?** *

Examples of 2D pixel art video games: Super Mario Bros, Sonic the Hedgehog, Terraria, Stardew Valley, Undertale, Celeste, Habbo Hotel, Pokémon Red, Blue and Yellow, old Flash games from Miniclip etc...

- I have never played 2D pixel art video games.
- I have only seen other people play 2D pixel art video games, either in real life or through streams, videos..
- I have played one 2D pixel art video game.
- I have played a few (2-4) 2D pixel art video games.
- I have played some (5-8) 2D pixel art video games.
- I have played many (+9) 2D pixel art video games.
- I mostly play 2D pixel art video games.

6. **On a scale of 0 to 7, how much do you like dungeon crawler games?** *

Examples of dungeon crawler games: Hades, Binding of Isaac, Darkest Dungeon, Cult of the Lamb, Noita, Diablo...

- 0. I have never played such games
- 1. I strongly dislike them
- 2. I dislike them
- 3. I somewhat dislike them
- 4. I do not like them nor dislike them / I am not sure of my preference
- 5. I somewhat like them
- 6. I like them
- 7. I greatly like them.

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In this part, you will answer questions regarding your thoughts on the game you have just played.

7. **Which dungeon experience did you prefer?** *
- The dungeon I played First.
- The dungeon I played Second.
- I liked them both the same amount.
- I liked neither.

8. **Which dungeon had better-looking enemies?** *
- The dungeon I played First.
- The dungeon I played Second.
- I saw no difference between the two.
- It did not matter to me. / I cannot say.

9. **Which enemy animation did you prefer to look at?** *
- The enemy animations in the First dungeon I played.
- The enemy animations in the Second dungeon I played.
- I saw no difference between the two.
- I had no preference.

10. **Would you like to give any comments, insights or anything else about the enemy animations?**
- *(free answer box)*

Thank you for participating in the research!