## WorderFall

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### Abstract

WorderFall is a single player educational spelling game designed for children in the 3rd to 9th grade levels in order to test their mental acuity of managing multiple words. Racing the clock, the player advances through the game as they answer the questions accurately. Each level progressively gets harder by adding more wrong possible answers. There is nothing wrong with having a game that tests people's mental acuity and improves it. This is a game that requires players to outpace the timer. Since the questions get harder as you score points, we ensure that players can find replay value in pursuing the highest scores possible.

WorderFall is available online now at this site:

http://blankgamesonline.com/worderfall/game.html. It requires the use of Javascript and uses a game engine library known as perlenspiel to represent the game logic.

In this report, I discuss how WorderFall represents all the core elements of an "educational game", the benefits that it offers to students, and the ways that the gameplay departs from traditional educational games and how it makes WorderFall more accessible. Then there will be a segment explaining the algorithms that were used to generate gamelogic, followed by a segment with screenshots and figures. At the end, I will talk about the feedback I've gotten from players with dyslexia and whether or not we found the game to be helpful.

### Introduction

Ever since the invention of computers, we have been able to automate basic human work functions at a rising rate. Granted that we now rely on computers for banking, data analysis, even social interaction, it makes sense that we would find a way to automate more complicated functions over time, such as medical diagnosis, legal analysis and education. Christopher Thomas Miller, in his book Games: Purpose and Potential in Education, provides a strong argument for using games in education. He describes "an explosion of growth ... in educational gaming...due to the increased advancement of digital games and the fact that the Net or Digital Generation has literally grown up surrounded by the idea of gaming." (Miller 2008). Not only are games useful in education, the implementation of computer science in our education curriculum serves another purpose. The United States has to be able to compete with other nations that have advanced their STEM and computer skills beyond that of their own (Shaffer). Games make learning fun so kids will want to play and learn without even realizing they are learning. Therefore, utilizing computer science to write games that help children increase their vocabulary, also promotes their computer skills.

The purpose of this project is to design and create an educational game. There are many different ways to interpret the term educational game. Some may even argue that all games could fall under this category because every game requires the players to do something. By playing any game for a period of time, the player will gradually get better at completing the function the game asks of them. Obviously, some would argue that there are functions that serve no real practical purpose for people to improve at, so in this sense the game goals presented to the player should be based on traditional educational concepts. In this way, players could improve at math, reading, spelling, and knowledge retention while simply playing a game that repeatedly asks them to perform functions related to those subjects.

#### Background

To talk about how WorderFall is meant to educate players, we must first define response time, reading comprehension, and dyslexia.

Response time is the time it takes for your brain to process something and commit to an action. We know the response time for visual stimulus for college aged students averages 190ms but ranges from individual to individual.(Jain) There is a certain limit to how fast your brain can get the signal through it itself and to your hand. The question for this game to try and answer is whether or not you can shorten the path it needs to take for telling words apart.

Reading comprehension is a difficult to define term that refers to the level of ability someone has in being able to decipher text and understand its meaning. (Elleman). A 2019 paper discussing the research of reading comprehension and how it pertains to teaching and policy talks about how reading comprehension can be framed as "the product of word decoding and linguistic comprehension." Here "word decoding" is meant to pertain to how individuals are able to construct words in their mind from letters. After mastery of the word decoding is achieved through practice, linguistic comprehension, knowledge of words and grammar, tends to play a bigger role in a reader's ability to understand complex texts; however, early in development, word decoding actually plays a larger part in reading comprehension as seen in individuals who struggle with dyslexia.

Dyslexia is a term used to describe disorders that interfere with an individual's abilities to spell and decode words. (Sandman-Hurley) This

interference with understanding words stems from the brain's inability to differentiate letters well in words. If you google "Dyslexia worksheets" you'll tend to see a lot of challenges pertaining to filling in letters, word jumbles, and word reconstruction. Education for young dyslexics involves helping train their mental ability to decode words so that they can improve how quickly they can read or spell words.

With all this in mind, we can loop back to WorderFall which is meant to inhabit all of these elements within its design. By training response time, the brain is put into reaction mode for answering guestions. This coupled with the word decoding challenge is meant to help players decoding skills by trying to focus on *speed*. While other activities, such as reading, accomplish this growth as well, it is much harder for students to focus on elongated sessions of something that they struggle with. Meanwhile, Worderfall allows players to easily see their progress in their own personal achievements of getting better, and does so by encouraging players to test themselves with gameplay that incentivizes improving skill until all levels of the game are clear. It's not perfect and there could be a lot of improvements, but the intentions of design are to mimic the tools that are commonly used to combat dyslexia and it should be interesting to see how students, both non-dyslexic and so, might improve at the art of word decoding.

### Motivation

Originally I was interested in making a game that taught students computer science skills. With this in mind, I wrote a treatment for a game that caused me many many headaches and felt like it was going nowhere fast. It involved trying to make a game that allowed players to make their own games. This idea quickly became insurmountable as the amount of functionality in the game engine I was using was just not able to accommodate executing custom code at runtime without some serious custom compilation and routing.

Taking this into account, I decided to take another run with a much simpler game that involves reading and spelling to improve students' abilities to decode words.

I have personally seen play testers improve at this game. They start sometimes a bit confused, but when they stick with it, they get better and better with every round. The fact that the skill this game requires of the player aligns with the exact kind of skills that impact reading comprehension means that improvement in the game is likely to improve actual reading skill. I never actually got to the stage where I could organize a formal study through my school due to the COVID-19 pandemic. I decided to just run my tests online with some participants who fall under my core target demographic: Gamers. The goal is to provide gamers with dyslexia and young students still developing their reading skills a game that can be used as a tool to improve their personal reading skills. The theory being that gamers will be able to force themselves to improve over a shorter time period.

This relates to a conversation I had with my friend. He's a strange typist. He uses a resting position of WASD and doesn't touch type, but he manages to hit a typing speed of 90-110 WPM. I asked him if he does a lot of typing tests, on a hunch, and he revealed that he had done at least 50 typing tests over the last 5 and a half years. Obviously this is just an anecdote and not really a straight fact, but I concluded that gamers, like my friend, have really good results with sparse practice with skills that they try to improve with testing.

### **Methods**

- a. Main goal: To create a game that tests players word decoding abilities
- b. Project objectives
  - 1. A question generator
  - 2. Incentivizes players to answer correctly
  - 3. Correct answers will raise difficulty
  - 4. Higher difficulty leads to repeat playthroughs

### c. Design Summary



Basically I needed a way to display words. This was step one.

Perlenspiel has a function that lets you put a character on a location in the main grid, and I wrote a function that takes in a string and a starting coordinate and enters a word in that location. Then we could display words easily.

Next step was to create a question. This was a much more complicated problem. I decided that the simplest answer would be to make the question something that could be generated by a computer. Like a math problem. So by making the problem (Select the word that is exactly one letter off), we are essentially showing the kids math problems that they can process like regular word problems. Using a list of words and some functions that collect and randomly distribute the sets of 2 off words and 1 off words randomly into the answer pool, we can consistently generate solvable and novel questions. Hooray!

Now that that's done, we need to add something to help control the pace of the player. Ideally for the mental improvement to happen, we'd need the player to always be in a state where they are trying to answer quickly. Naturally we would need a timer. This timer will serve as a way to incentivise players into answering the questions quickly. A count function in the game will loop every 5 milliseconds and will decrease the number that gets written to the top left of the screen. When the timer hits 0, the game ends and the player is shown a game over screen.

With the timer finished, the score mechanism was easy to implement. +10 points for every correct answer, -10 points for a wrong one. I decided to also add an incentive for correct answers via the timer. Hitting a wrong answer will nick the players time, while getting a correct one will give them some back. The thinking here is that the rate at which players can get answers will decrease as the difficulty rises.

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Next, is the dynamic difficulty. I wanted this game, from the beginning, to be something that rises in challenge. Otherwise the endless gameplay would get repetitive and boring and the player would not improve. I decided the best way to make the game harder would be to slow the player down by force. To do this, the number of answers rises, as the player starts to do better. This serves two important purposes. One, the player is challenged to find the needle in a bigger haystack, forcing them to become better at reading the longer lists of words for the right answer. Two, it's very simple to implement a higher answer count, since the function for finding the 2 letter off words gets all of them before randomly selecting wrong answers.

Finally, we have the epitome of this game, the music. Perlenspiel has some built in SFX that include some instruments. So I wrote a little diddy that gets more complicated as the player progresses. It was meant to offer more incentive to players to repeat their playthroughs, since it's something that unlocks as they play the game, but it has the added benefit of being in sync with the game's clock so players can use it to get into a rhythm with their answers.

Screenshots of the game can be seen in figures 1, 2, and 3.

### **D.** Testing

To test Worderfall's effect on students ability, we must design a plan of action to undergo testing.

Considering that WorderFall deals with word decoding and aims to help improve such skills. We would want to conduct a test that can determine whether or not playing WorderFall can improve word processing in both children with and without dyslexia. To test this we would need to collect data that can represent reading comprehension and ability. This can be achieved by timing the subjects to read a segment of text and getting a baseline for their reading ability in words per minute. Once we have this preliminary data for the subjects, the testing can move on to the next phase.

In the next phase, the subjects will play WorderFall for 30 minutes. After each round of the game, their score will be recorded. In 30 minutes each subject will have a number of scores. While it is theoretically possible that a subject could end up with one score after 30 minutes (from going so long on one round that they amass a score much larger than any other tests could go against), it is very unlikely for any subject to manage to spend more than a few minutes on a given round. With this in mind, we should be able to see whether or not their scores possess a positive or negative trend. This trend will be useful to compare against the data gathered in the final phase.

In the final phase, subjects will be asked to repeat the first experiment with another segment of text. This new reading data will be compared against the

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subjects original time to determine if their reading ability improves, degrades, or stays the same. The hypothesis for the results of this would be that the subjects that show a trend of improvement at worderfall in the second phase will also show an improvement in the first and last experiments. With this data it is possible to determine whether playing Worderfall correlates at all with an increase in reading ability.

#### Future Work:

If I were to continue working on this project, I would probably focus on adding more word lengths to the game to offer even easier difficulties to help those who really struggle with the game to make it easier to get better. Another possibility would be porting the game to a language that offers more visual freedom so that it could be improved with better visuals to entice players to get higher scores. I believe those elements to be important for improving the universal appeal of games, but not necessary at the stage of development we are currently in. Another possibility for this game would be to add more question types and variety to give the game more moment to moment excitement and challenge. Either way WorderFall has the capability to grow in all sorts of directions and that is a testament to its solid core design.

#### Conclusion

In conclusion, WorderFall is a game that was designed to hone in and improve one skill and seemingly is able to accomplish this task by offering players the opportunity to practice and test themselves. It is not unlike the typing tests that my friend is fond of. Over time, testing a skill will generally improve it, so long as it is clear and evident how the test functions. It's possible that these skills will not translate to actual reading skills, but we cannot prove that either way without more data.

# List of Figures

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### Bibliography

Alt, Mary, Tiffany Hogan, Samuel Green, Shelley Gray, Kathryn Cabbage, and Nelson Cowan. "Word Learning Deficits in Children With Dyslexia." *Journal of Speech, Language, and Hearing Research* 60, no. 4 (2017): 1012-028. doi:10.1044/2016 jslhr-l-16-0036.

- Education.com. "Sight Word Spelling: Game." Game | Education.com. March 26, 2020. https://www.education.com/game/sight-word-spelling-2nd/.
- Education.com. "Sight Words Bingo Game: Game." Sight Words Bingo Game | Game | Education.com. March 17, 2020.

https://www.education.com/game/sight-words-bingo/.

- Elleman,Amy M., Eric L. Oslund. "Reading Comprehension Research: Implications for Practice and Policy - Amy M. Elleman, Eric L. Oslund, 2019." SAGE Journals. https://journals.sagepub.com/doi/full/10.1177/2372732218816339.
- Gee, James Paul. *What Video Games Have to Teach Us about Learning and Literacy*. Palgrave Macmillan, 2008.
- "IXL: Learn Spelling." IXL Learning. <u>https://www.ixl.com/ela/spelling</u>.
- Jain, Aditya, et al. "A Comparative Study of Visual and Auditory Reaction Times on the Basis of Gender and Physical Activity Levels of Medical First Year Students." *International Journal of Applied and Basic Medical Research*, vol. 5, no. 2, 2015, p. 124., doi:10.4103/2229-516x.157168.
- Kaye, Peggy. "Games for Writing: Playful Ways to Help Your Child Learn to Write." Google Books. August 31, 1995.

https://books.google.com/books/about/Games\_for\_Writing.html?hl=&id=9GL1EIHy -vMC.

- Sandman-Hurley, Kelli. *Dyslexia and Spelling: Making Sense of It All*. Jessica Kingsley Publishers, 2019.
- Shaffer, David Williamson., and James Paul. Gee. *How Computer Games Help Children Learn*. Palgrave Macmillan, 2010.
- Tettegah, Sharon Y., and Martin Gartmeier. *Emotions, Technology, Design, and Learning*. Academic Press, 2015.
- "What Is Dyslexia?" Yale Dyslexia. https://dyslexia.yale.edu/dyslexia/what-is-dyslexia/.
- Winton, Alais, and Joe Salerno. *Fun Games and Activities for Children with Dyslexia: How to Learn Smarter with a Dyslexic Brain*. Jessica Kingsley Publishers, 2018.
- Łuniewska, Magdalena, Katarzyna Chyl, Agnieszka Dębska, Agnieszka Kacprzak, Joanna Plewko, Marcin Szczerbiński, Jakub Szewczyk, Anna Grabowska, and Katarzyna Jednoróg. "Neither Action nor Phonological Video Games Make Dyslexic Children Read Better." *Scientific Reports* 8, no. 1 (2018). doi:10.1038/s41598-017-18878-7.