Designing an Emotive Avatar for a Grammar Game - A Case Study of Engagement and Performance Development

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ABSTRACT
This paper describes the design of a 3D running game with educational content. The goal of the game is to teach children capitalization in German. Sentences are presented to the children in increasing order of difficulty, determined by the syntactic structure of the sentences. Words within sentence were presented decaptialized and the children had to select the words that should have been capitalized. The game design uses an emotional avatar along with speed factor in order to motivate the children to play longer and improve their performance. 20 children played the game with the avatar and 16 children played the game without the avatar. A qualitative feedback was collected via an online survey. In addition, their performance profile was logged and analyzed. Based on the data, we report some trends that indicate increased engagement and performance. These indicators can be used for improving user-dependent, adaptive design for the player.

ACM Classification Keywords
D.2.2. User interfaces: K.8.0. Games

Author Keywords
Educational Game; Avatar; Emotion; Performance; Adaptivity; Personalization; Interaction; Motivation; Game-Based Learning

INTRODUCTION
When designing games, it is relevant to look at design frameworks that allow us to guide and judge design, motivation, and learning. A research and practice model [8] or Foundations of Game-Based Learning by Plass, Homer and Kinzer [14] provide such a model with a comprehensive view encompassing affect, motivation, cognition and socio-cultural aspects of the game as it is embedded into its application environment. In the past, we have applied this model to an existing game [1]. But key ideas to a new game were born during the reading of this paper as outlined below. While there are many dimensions to take into account in game design, this paper focuses on Henry (the chicken runner) and Sam(i) the "feedback" avatar. Plass et al. offer four pillars of engagement in their model that have served as a guideline during the design of Henry run.

In: J. Arnedo-Moreno, C.S. González, A. Mora (eds.): Proceedings of the 3rd International Symposium on Gamification and Games for Learning (GamiLearn'19), Barcelona, Spain, 22-10-2019, published at http://ceur-ws.org

Affect
Affect relates to the emotional engagement of the player with the game, through visuals or music as an example. We chose exaggerated humor embodied in an avatar to get the player to laugh. Rather than sounding out a fail sound, the avatar should get exasperated and even fall over backwards with horror at the performance of the player. Emotion, fun, joy and even frustration, can influence learning in a positive way [13, 9].

Motivation
Gamification approaches to motivation often result in a level and points system. Games on the other hand offer "fun death" upon failure with the key being the ability to start over as many times as the player wishes, the goal is to reach the next more difficult level to get a bigger challenge. The storyline is that the player helps the runner so that the avatar doesn't have to be annoyed anymore. The motivation of the player is therefore to make the avatar happy and the runner good. The reward system follows a cognitivist model (good performance of a friend) rather than a behaviorist model (points) [7].

Cognition
According to Plass et al., cognitive factors entail some of the following:

- context of skills application
- skills meaningful outside of game and transferable
- scaffolding through personalization

- formative and immediate feedback
- content representation
- mechanics aligned with learning goals
- mapping gesture to features of content

The skills (German orthogrphay) are directly meaningful outside of the game. The personalisation results from the distance and speed with which the runner travels. Feedback is both immediate and formative. Any mistakes in the game are immediately corrected and available for the player to contemplate before the next task. Gestures in the game result in the direct capitalization of the word, even though the gesture itself is not related directly to the meaning.

Socio-cultural

The final pillar of engagement leads to an often forgotten component of the world surrounding the game itself. In the design we chose, even the runner in the game and the avatar are already friends that the player is helping out. Future work would have to spend more analysis on how the customization of the avatar and runner could help engagement though social interaction with avatar and runner or other players.

The goal of the presented work is to show the following:

1. Using an emotional avatar should engage players for longer
2. Using an emotional avatar should result in returning players
3. Increased playtime should result in higher skill level

THE GAME

One of the most significant problems German school children face is the concept of capitalization that does not exist in many other languages. In German, nouns are capitalized. In addition, even a verb or an adjective can become nominalized. Wrong capitalization is one of four most frequent spelling errors that persists even for adults [2]. The advent of careless spellings in modern media as well as the use of automatic spell checks may decrease children's awareness even further.

The player uses a chicken "Henry" to move in the game and pick answers in an endless run. When the correct word is picked, it is capitalized in the sentence shown. For example a sentence like "Auch jede möwe und jede biene ist da." is shown and the player has to pick "möwe" and "biene" as they have to be capitalized (see Figure 1). The game contains 123 sentences sorted by difficulty. The difficulty reflects sentence complexity. The goal of this game is to practice the concept and automate it through speed and increasing difficulty of sentences. In order to compute difficulty measures of a sentence a dependency parser is needed. For this purpose, spaCy, an open-source natural language processing (NLP) library written in Python, was chosen. Given a sentence, it can return CoNLL-U formatted encoding of a sentence that includes tokenization, Part-of-Speech (PoS) tagging and dependency parsing [10]. Given the above resulting information, the difficulty level can be computed. From past research, we know that sentences with embellishments such as adjectives and adverbs are difficult for children [12]. In addition, the use of cases adds to sentence complexity as they represent objects. The number of nouns directly relates to the complexity of the task of identifying them. A higher count of verbs directly indicates complex sentences. By squaring the value, we place exponential emphasis on higher weighted areas. The sentences are then sorted by their difficulty level. Indirectly, the measure reflects sentence length. We count the number of occurrences in a sentence of the following (weight of count in parenthesis): nouns (2), verbs (including auxiliary) (2), adjectives (1), adverbs (1), datives (1), genitives (1), accusatives (1), and nominatives (1). In addition, the maximal distance across all nouns to the root of the sentence, counting the steps through the dependency tree to the root, is noted and is associated with weight value of 2. The square of each count is then multiplied by the weight and summed up to result in the difficulty measure of the sentence. (This measure can be data-driven in future work.)

DESIGN OF FEEDBACK

The player is provided with feedback using three methods: Emotion, visuals, and information.

Emotions

The current design of the game has a single environment which is a forest scenery. The sentence is placed at the top of the scene and originally the question was placed at the bottom. The on-going score is added to the top left of the scene. The avatar "Sam" is added to the scene (see Figure 1.

Figure 1: Game Scene

Sam has five emotional expressions that are designed to provide feedback to the player, namely: Idle, happiness, sadness, "fun death", and stop. The default emotion is in idle position. On expressing happiness, a sound effect of kids cheering "yaay" is played. While on expressing sadness and stop, a sound effect of a sudden buzz is played to indicate something wrong happened. "Fun death", includes a sound effect of hitting the ground due to Sam's falling.

When Henry makes a mistake, Sam expresses sadness. He expresses it using both a facial expression and a gesture. He raises his eyebrows while his head moves downwards and his hand is moving towards his mouth. This indicates to the player that something was wrong and the player might be encouraged to fix the situation or check the sentence for the given correction in order to avoid the same mistake later on. When Henry selects the correct answer, Sam jumps with happiness and has a wide smile to transfer this feeling to the player (See also Figure 2).The additional emotion of "fun death" is an exaggerated emotion of the reaction "falls over backwards", where Sam faints with exasperation. It occurs after repeated mistakes committed by the player. The intend of fun death is humor to increase engagement and focus while providing the feedback that there is room for improvement in the player's performance. This emotion places two 'X's in Sam's eyes and a tongue to indicate fainting as he falls to the ground. After a short period he returns to upright position. Figure 3 shows Sam in his execution of "fun death" manoeuvre.

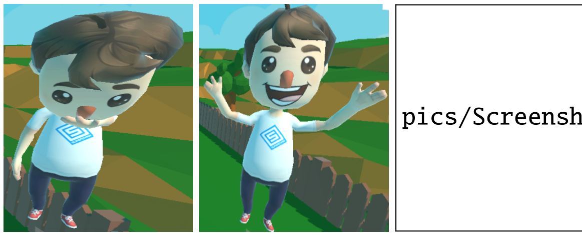

Figure 2: Sam's sad and happy and stop expressions

Figure 3: Sam's Fun Death

Finally, when Sam realizes (by number of mistakes made) that the player doesn't know how to play, he stops Henry and shows the player a panel of grammar instructions as depicted in Figure 4. After spending as much time as the players chooses with the instructions, they can restart the game from the beginning. The panel contains the informative feedback, that explains the rules explicitly to the player. In this case, the explanation has grammatical rules for capitalization.The emotion chosen for Sam as he stops the player, is an exaggerated version of "stop, what in the world are you doing? Let me explain it to you once again before you keep messing up even more" without so many words. The face has an angry expression and the hand is raised to stop the player from running around like a crazy person with no idea of what they are doing. It is intended to be humorous.

Visual and Informative Feedback

Both correct and incorrect answers are displayed in the sentence at the top as the player runs past the words in the game: Correct choices for words that should have been capitalized are changed to capital and displayed in green. In contrast, any missed or wrongly picked word turn red and their spelling is not changed (see also Figure 5). A performance bar was added to indicate how good the player's performance is. It starts with 50% at the start. It increases and decreases with correct and faulty answers respectively. As it falls below 30% it turns

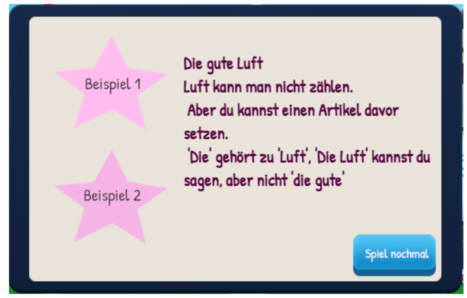

Figure 4: Instruction panel with example sentence with a rule to apply when checking for capitalization (In this example: "if you can add an article to the word, then it should be capitalized")

red. The game speed depends on this performance bar. As a result, the difficulty level is increased for high performers to encourage skill automation. It also prevents boredom for good players and faster movement towards more difficult sentences. As such, the speed is individual and adaptive to the player. Last but not least, a panel showing the final score and a button to play again is shown when players stop the game.

Figure 5: Example word color change for a runner who might have reached word "jede".

UI ADJUSTMENTS

Initial informal evaluations of the UI focused on understanding children's first reaction to the game and verifying their interest and understanding of the humor. Feedback was collected regarding the game and design. Their improvement and ideas were collected and dislikes noted. Furthermore, it was important to test their understanding of the game interface for playing since there are no instructions at the beginning. The feedback was collected through observations as they played and through questions that were answered directly while interviewing all of the participants together to encourage each other to respond thoroughly.

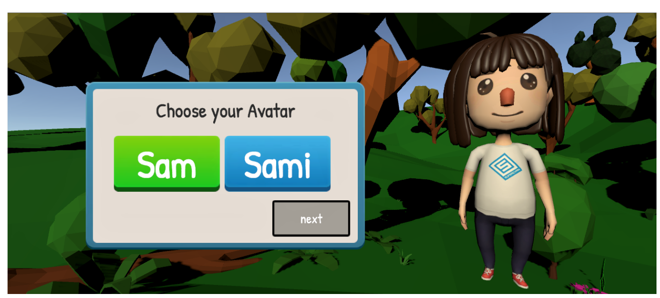

Figure 6: Avatar selection

Changes

The following changes were made due to the feedback.

Figure 7: Example screenshot from Game Introduction (translated to English for this paper)

- A female avatar (Sami) was added as suggested by most participants in all evaluations. The player chooses the avatar he/she wants (Figure 6).
- To personalize the avatar, more color and texture options were provided for the T-shirt selection. The player chooses between pink, blue, white and polka dots.
- The progress-bar constituted a source of misunderstanding since it does not indicate progress but performance. Since the performance coincides with speed, the caption was changed to "speed X m/sec", where X denotes the current value. The bar now visualized the speed and is easier to interpret.
- Since the majority of the participants had requested a change in the instructions panel, the original long text instruction was replace with two example buttons that the players can choose to listen to as often as they want. On clicking the examples buttons, an audio is played reading this example.
- Some participants had difficulty to read both the sentence and its question. The question was moved directly below the sentence at the top of the scene. The light green color previously employed was replaced with a much darker version to increase visibility, taking into account color blind issues.

Additions

In addition to the above changes, new ideas were added.

- Getting the players to feel the game and to know the story behind, it is very important to increase motivation and enhance perception. A skip-able introduction supports the story after the player chooses his avatar. Here, an exhausted Sam(i) is shown with Henry. Sam notices that the player has arrived on the scene and asks the player why it took so much time to arrive. Afterwards, the avatar introduces himself and that he is helping Henry the chicken to learn German but he is really tired from all the running and Henry's mistakes. So he asks the player to help make Henry learn and win. Notice the indirection built into the story of whose performance is on the line. The players themselves are here to help Henry the chicken rather than learn themselves. The intend is to lower the pressure on the player. This approach has the potential to create a relationship with the avatar or Henry during a joint effort to be accomplished to increase the motivation and engagement for the game (see also Figure 7).
- Furthermore, as suggested, we have added the "Chicken Dance" as it is popular worldwide to most of the kids. This animation occurs when the player gets the correct answer several times. We have also added a part of the song to it. This animation plays fast so that makes it funnier too. The fast speed is due to short timing between player's choices in game. This animation is also accompanied by a facial expression of a wide smile to express great happiness to motivate the player (see Figure 8).
- The avatar's idle status was substituted with a running backwards animation that indicates that the avatar is running with Henry. This animation increases the fun factor because Sam running backwards looks hilarious, especially as Henry speeds up.

Figure 8: Chicken Dance

DATA ACQUISITION

Two versions of the game were deployed as browser games with and without the avatar. Each version of the game is followed by a questionnaire. The research question is whether the avatar will lead to longer playing times and an increased return rate to play more. The presence of the avatar would have a positive impact on learning, assuming longer play-time improves performance.

	w/o Sam	w/ Sam
participants	16	24
age groups	from 7 to 14	from 7 to 14
gender	6 males & 10 females	9 males & 15 females
number of log files	6	11
sentences logged	37	151

Table 1: Metadata of participants. All players where from Egypt, upper middle to higher class social standing and from private international schools.

Data

The data acquired for analysis were from the two surveys and from game logs. Each sentence and word that the player encountered was logged along with correctness. The participants had different German background knowledge. The participants who had more than average German knowledge were 50% in the without Sam evaluation and 62.5% in the with Sam evaluation. The number of log files are less than number of participants because some participants encountered internet connection problems and some closed their browsers quickly that the logs were not posted. The score and time was computed from the log files.

ENGAGEMENT EVALUATION

In order to understand engagement, a survey was designed according to theoretical derivation of questionnaire sections as described further in [1] and based on previous related work by [14, 4]. A short review of the motivation behind each section of the survey is given here for completeness.

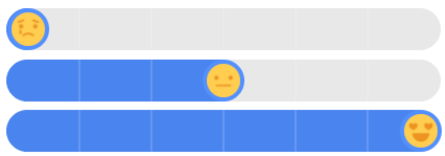

Figure 9: Child-friendly Likert scale (jotforms)

As shown in Figure 9, the design of the surveys is child-friendly for easier understanding and enjoyment of filling it. We have added the answers to choose from in pictures and smiley faces for the Likert scale. Apart from meta data, the following topics were sections in the survey. Together they indicate engagement: Basic needs, self-efficacy, cognition, flow, and affect.

Basic Needs

Basic needs are the essential fundamentals of the human beings for survival and well-being and an important prerequisite for learning [5]. It was shown that learning in an environment where failure has disturbing consequences is burdensome and decreases efficiency of learning process [3]. For a learning environment, basic needs can be described as the need for basic safety not as the need for food and water. The learner faults are accepted through the learning process as a normal path to achieving learning objectives. One of the advantages of learning games over classroom learning is that they allow friendly or funny failures.The purpose of the following questions is to ensure that the player enjoys playing the game and feels comfortable with making mistakes.

- It's okay to make mistakes at school.
- It's okay to make mistakes in the game.
- In school I like to take part in exercises.
- I enjoy learning in school.
- I enjoy learning in games.

Self-Efficacy

A person's self-image is a result of combination of some or all of the following four factors. Self perceptions also depends on how other perceive us and our own interpretation of other's opinion [15]. There is classically known direct positive correlation between our self-perception and our performance [18]. The questions are intended to capture self-efficacy with respect to reading skill (an important partial skill of this game).

- I like to read.
- I'm good at German.
- My parents think I'm good at German.
- My teachers think that I am good at German.
- I'm good at this game.

Cognition

It has been shown in various science fields that learning through games boost the educational benefits in term of enhancing the learning progress [16, 17]. To be certain that our game achieved this goal, we asked to define the extent of agreement to the following statements in both surveys in form of Likert scale statements.

- I learn upper and lower case in this game.
- I make less mistakes in writing when I get good in this game.
- I talk to others about the questions in this game.

Flow State

Flow is initiated when an individual reaches a state of effortless concentration and enjoyment and is exceedingly productive while feeling happy. It happens when someone's skills are completely focused on winning a manageable challenge [6, 11].

The questions are designed to capture flow with the following survey questions by asking about the four states of ability and difficulty, in other words, boredom, stress, ease and difficulty and normalizing it against their feeling of fun.

- The game is fun.
- The game is too easy for me.
- The game is too difficult for me.
- Henry has gotten better in the game.
- The game bored me.
- The game stressed me out.
- I'll play the game again.
- Were you good with upper and lower case before?

Affect of Game

Liking the game details is important so that players choose to play this game. So we asked about the agreement of the statements in Table 2. And at the end of the surveys, we added an open paragraph question to let the participants add their comments and suggestions about the game.

Without Sam	With Sam
• I like Henry the chicken. • I like the music. • I want Henry the chicken to win. • I'm enjoying the egg race.	• I want to help Sam(i). • I want to help Henry the chicken. • I wonder what Sam(i) wants to do next. • I was able to help Henry. • Sam(i)was happy in the end. • Sam(i) is funny. • Did you have the same feelings as Sam(i)? • Sam bothers me while I play. • Sam helped me.

Table 2: Affect Questions

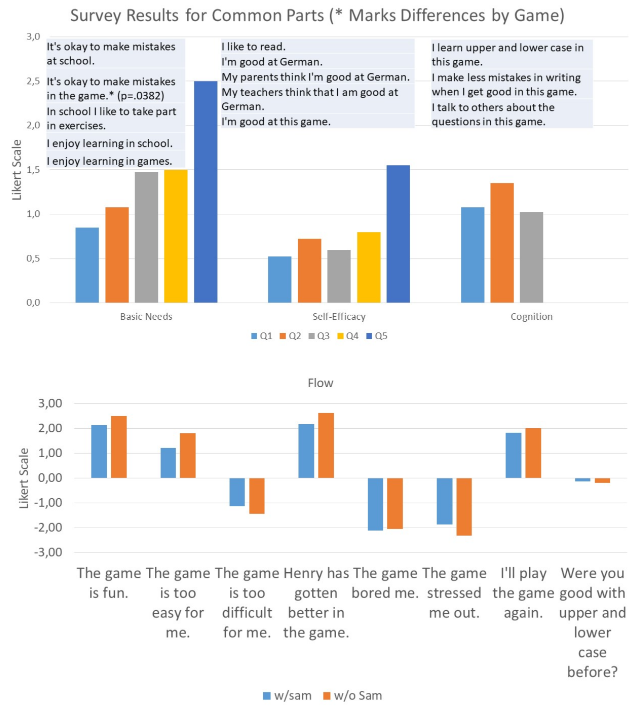

Figure 10: Survey Results

Engagement Results

For both games, the results are depicted in Figure 10. Games motivate children more than regular class time. The only answer where both groups differed significantly (p=.0382), is the question whether it's ok to make a mistake in the game. While the group with Sam was indifferent, the group playing without Sam said that its ok to make mistakes with an average of 2 on the Likert scale. In contrast, making mistakes in the classroom was not significantly different from either group or when compared to the game-play within each group. Answers to the Affect questions lie between 2.3 (I was able to help Henry) and 3.0 (do you want Henry to win?) The set of questions regarding the flow show similarities between the two groups. But the results also show that both games seem to produce a sort of flow. The game was neither too easy nor too hard. It was not stressful and it was not boring. The players feel they improved while having fun and would play again.

After analyzing the results of both surveys, it is clear that the participants like both versions of the game. There seems to be more worry regarding making mistakes in the version with Sam. On interviewing children, why they were worried more in the game with Sam, it seems that they cared when Sam got sad and wanted to avoid his sadness.

PERFORMANCE EVALUATION

Computing Performance

Computing performance can be tricky in a game. In this version, the student has to actively pick words that should be capitalized. Doing nothing should not be rewarded. Table 3 summarizes how speed and performance is computed. While speed depends on the correct and wrong active picks the student makes, the correct performance is computed based on the correct identification of nouns only (ignoring correctly not picked items).

	Student thinks...	
Truth	noun (picked)	not noun (not picked)
noun	speed up +20 Word turns green Word is capitalized performance = picked/nouns[30]	no effect on speed Word is capitalized
not noun	slow down −20 Word turns red	achievable in idle word remains white

Table 3: Determining performance over window of last 30 words seen, speed and visual feedback

Performance Results

Figure 11 shows difficulty vs speed vs correct pick percentage. The red line represents the speed, the green line represents the sentence difficulty (as defined earlier) and the blue line represents the % correct pick of nouns. The graph indicates what we call peaks of performance. We note the following:

- increasing speed produces dip in performance that can be recovered
- increasing difficulty produces dip in performance and speed that is recovered but more slowly

Performance is measured at each peak.

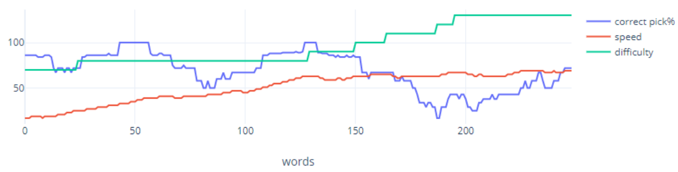

Figure 11: Sample learning curve of a 4th grader

Duration of Play

Based on the log files, the play time can be computed as summarized in Table 4 it can be seen that players with Sam have a tendency to play longer. Comparing the differences of the two distributions a p-value of 0.0941 (> .05) is not quite significant for a 95% confidence interval. Clearly one of the problems is the small number of trials but there seems to be a tendency.

Group	w/o Sam	w/ Sam
Mean	184.50	403.64
SD	210.37	255.74
SEM	85.89	77.11
N	6	11

Table 4: Comparing duration (in seconds) of play

According to the data, all players got faster in speed while playing. High speed results in difficulty of handling the mechanics of the game and thinking about the cognitive task simultaneously. This leads to one of three possibilities:

- The instruction panel pops up in case of continuous decreasing performance that leads to zero valued speed and then player restarts the run (A).
- The player gives up (B).
- The player continues, gets better and faster again (C).

Possibility	No Sam	Sam
A: Restarts	3	3.4
B: Gives up	4.6	2.6
C: Recovers	2.6	11.3

Table 5

In Table 5, the normalized numbers of occurrences for each category are computed by dividing the number of occurrences of each by total number of words seen. Given this data, both versions show instruction panel the same number of times. More often participants gave up in the game version without Sam indicating a higher engagement and motivation with Sam. Moreover, the comparison of the numbers of occurrences of players recovering from the setbacks (C) supports their endurance with Sam at a much larger rate.

EFFECTS OF REPEATED PLAY

It is important to see how repeated play affects performance. Additional logs of multiple play for three players are observed. Players 1-3 are girls from different international schools in Cairo, Egypt in grades 2, 3 and 4 at ages 8, 9 and 10 years old, respectively.

Data Description

Each time the performance peaks (as observed and explained in Section 7.3), it is computed for the given difficulty level. Figure 12 depicts the amount of peaks by level for each round of play. Figure 13 shows the duration of play with each new round of play. It can be seen that each round of play leads to a longer session. It can also be seen that with each trial, the child has been able to reach a higher level of difficulty. The players were able to pass the point that they had been “stuck" on in a previous trial and continue on to more difficult sentences with new performance peaks.

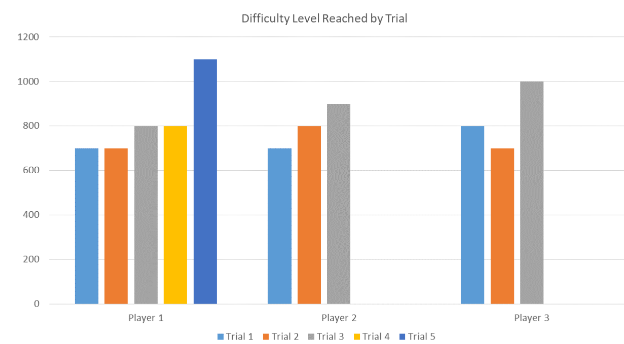

Figure 12: Difficulty Level Reached for Peak of Repeat Players

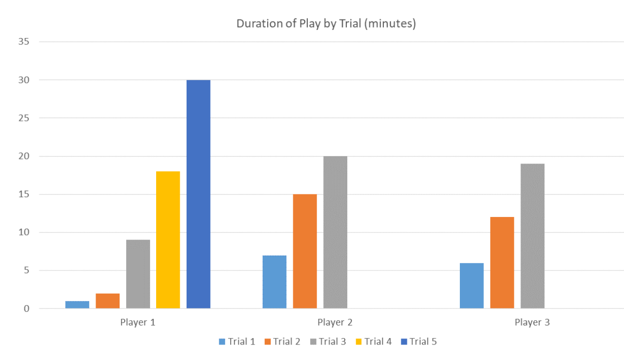

Figure 13: Duration of Game Play for Repeat Players

Learning Curve

As an example of a learning curve, Figure 14 plots performance vs. words seen for Player 2. The blue line represents the first game run, the red line represents the second game run and the green line represents the third game run. The graph is plotting the correct pick performance vs words for the three game runs. The learning curves for the other two players have similar behaviour. From the learning curve exemplified in Figure 14, it can be seen that repeated playing results in improved performance and time of play increases.

Figure 14: Player 2 learning curve

CONCLUSION AND FUTURE WORK

Results are preliminary studies on a first prototype of the game that serves as a data exploration effort to gain clarity on log file collection and interpretation. A large number of players is needed to show the impact of the learning content on skill acquisition and improvement that transfers into writing skills. We plan to deploy the game with undergraduate students and school children learning German for this large-scale analysis.

ACKNOWLEDGMENTS

We would like to thank all the children who have participated in the preliminary evaluation of this game and Sam(i) the avatar.

REFERENCES

1. Kay Berkling and Roger Gilabert Guerrero. 2019. Designing a comprehensive evaluation method for learning games - a general approach with specific application to iRead. In *Proceedings of the 3rd International GamiFIN Conference, Levi, Finland, April 8-10, 2019*. 94–105. `http://ceur-ws.org/Vol-2359/paper9.pdf`
2. Kay Berkling and Rémi Lavalley. 2018. Automatic orthographic error tagging and classification for German texts. *Computer Speech & Language* 52 (2018), 56–78. `https://doi.org/10.1016/j.csl.2017.11.002`
3. K. Berkling and C. Thomas. 2013. Gamification of a software engineering course and a detailed analysis of the factors that lead to it's failure. *Interactive Collaborative Learning (ICL), International Conference IEEE* 525–530 (2013).
4. Cyril Brom, Filip Děchtěrenko, Vít Šisler, Zdenek Hlávka, and Jiri Lukavsky. 2018. Does Motivation Enhance Knowledge Acquisition in Digital Game-Based and Multimedia Learning? A Review of Studies from One Lab.
5. E. Chew, N. Jones, and D. Turner. 2008. Critical review of the blended learning models based on maslows and vygotskys educational theory. *International Conference on Hybrid Learning and Education, Springer* 40–53 (2008).
6. M. Csikszentmihalyi. 1997. *The masterminds series. Finding Flow: The Psychology Of Engagement With Everyday Life*. Basic Books.
7. Jacquelynne S Eccles, Allan Wigfield, and Ulrich Schiefele. 1998. Motivation to succeed. (1998).
8. Rosemary Garris, Robert Ahlers, and James E Driskell. 2002. Games, motivation, and learning: A research and practice model. *Simulation & gaming* 33, 4 (2002), 441–467.
9. Hans-Georg Häusel. 2016. *Brain view: warum Kunden kaufen*. Vol. 143. Haufe-Lexware.
10. Matthew Honnibal and Mark Johnson. 2015. An improved non-monotonic transition system for dependency parsing. In *Proceedings of the 2015 Conference on Empirical Methods in Natural Language Processing*. 1373–1378.
11. S. A. Jin. 2012. "Toward Integrative Models of Flow": Effects of Performance, Skill, Challenge, Playfulness, and Presence on Flow in Video Games. *Journal of Broadcasting and Electronic Media* 56(2),169–186 (2012).
12. Rémi Lavalley and Kay M. Berkling. 2014. Data Exploration of Sentence Structures and Embellishments in German texts: Comparing Children's Writing vs Literature. In *Proceedings of the 12th Edition of the Konvens Conference, Hildesheim, Germany, October 8-10, 2014*. 241–247.
13. Jan L Plass, Steffi Heidig, Elizabeth O Hayward, Bruce D Homer, and Enjoon Um. 2014. Emotional design in multimedia learning: Effects of shape and color on affect and learning. *Learning and Instruction* 29 (2014), 128–140.
14. Jan L Plass, Bruce D Homer, and Charles K Kinzer. 2015. Foundations of game-based learning. *Educational Psychologist* 50, 4 (2015), 258–283.
15. T. B. Rogers, N. A. Kuiper, and W. S Kirker. 1977. Self-Reference and the Encoding of Personal Information. *Journal of Personality and Social Psychology* 35(9):677-–688 (1977).
16. D. Shaffer, K. Squire, R. Halverson, and J. P Gee. 2005. Video Games and the Future of Learning. *Phi Delta Kappan* 87(2),105-–111 (2005).
17. E. Zhi Feng Liu and P. Chen. 2013. The Effect of Game-Based Learning on Students' Learning Performance in Science Learning – A Case of "Conveyance Go". *Procedia - Social and Behavioral Sciences* 103,1044–1051 (2013).
18. B.J. Zimmerman, A. Bandura, and M. Martinez-Pons. 1992. Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American educational research journal* 29(3),663–676 (1992).