

Collect That Coin: Efficacy Testing of Platformer Game Mechanics With Adult Learners

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Abstract: Digital serious games for adult learning have become a more prominent topic for research in recent years, yet platformer genre games for learning remain underexplored. Despite this, many adults enjoy platformer games for entertainment which presents the question of what about platformer games makes them less prominent in adult education learning games. Platformer games often focus on simple mechanics such as *collecting* and *race to the finish* which map well to lower-order learning but require more effort to map to higher-order learning. To address this case, we rapidly designed and developed a 2D platforming game prototype called *Biomes Rescue* for use in a large general-education undergraduate Geography course. The game follows an Indiana Jones-style character who collects and aligns items to different biomes by evaluating items collected. The problem follows the slime-like creatures: the enemy representing pollution that has impacted Earth's biomes. Three biomes have been disassembled by the enemies and the player must rescue all four biomes by critically thinking about the characteristics of each. We actively tested and adjusted *Biomes Rescue* over the last three years and focus this case on the latest implementation, which addresses the alignment of game mechanics to higher-order learning and Knowles principles of Andragogy combined with games-based learning. We hypothesized participants would have an unbalanced view of the dexterity-centered mechanics tied to fun more so than learning. Our mixed-methods exploratory study aims to understand what mechanics connect to fun and to learning from the learner's perspective using a quiz score - a newly added measure, and Likert scale ratings on Enjoyment with open-ended feedback. Data analysis consisted of thematic analysis and group differences on the quiz scores. This study holds implications for designing platformers for adult learners with an understanding of the differences in game mechanics application for engaging critical thinking.

Keywords: Game-based learning, Andragogy, Platformer games

1. Introduction

Games in adult education take many forms from board and card games to role-playing and strategy games. These game types and genres often provide complex systems of dynamics and mechanics that drive an alignment to higher-order thinking. However, other genres are less prominent in adult education, specifically platformers. Adult learners present unique challenges with games-based learning (GBL). The needs of adult learners often require focus on a variety of avenues to take and draw conclusions in a more self-directed manner (Merriam et al., 2017). As such, simple dynamics within a game such as a platformer game, remain an understudied genre within adult education. Limited studies on the use of platformers often focus on user experience and perceived learning with adult learners (Nasikun et al., 2017). Older studies on adults playing platformers for entertainment suggest the genre is popular (Zelinski & Reyes, 2009). In understanding that adults generally enjoy platformer games, it is unclear as to why they are not as prominent within adult GBL. We believe the underlying design of the platformer being driven by simple core dynamics such as *collecting* and *race to the finish* (Boller & Kapp, 2014) suggests the genre is suited for younger learners. Despite this, gameplay features like jumping, items, and enemies with a constant sense of challenge and frustration that impacts dexterity and visuospatial awareness are deemed enjoyable (Pedersen et al., 2009). Ultimately, the aforementioned mechanics map well to lower-order learning but require more effort to map to higher-order learning. The paucity of studies on the use of platformers with adult learners forms a need to understand the underlying nature of the genre and its implications for education.

Over the last three years, we created a prototype of *Biomes Rescue* using an iterative evaluation approach (Symborski et al., 2017). This case presents our third round of testing the game prototype at the University of Missouri in the United States. The game prototype, referred to henceforth as a game, assists undergraduate college students enrolled in an introductory geography course. The game's design requires students to identify key pieces of course content, relate the content to the game's goal, and demonstrate their resulting knowledge to proceed. Learning becomes essential to gameplay completion. Based on the intent of the game, we focused on understanding the role of platformer mechanics that relate to adult learning needs. The following sections

discuss adult learning with games and platformers and the design of the current version of *Biomes Rescue* with the mixed-methods study design. We conclude with points about student perceptions of game mechanics and the alignment with principles of adult learning.

2. Background

2.1 Adult Learning and Game-Based Learning Principles

Knowles' assumptions tell us that adult learners differ from younger learners (Dantus, 2021). Compared to younger learners, adult learners want independence or self-direction (self-concept) and the experience that they bring to the classroom (adult learner experience). Additionally, their desire to link their learning to what they can do with the knowledge they gain (readiness), their focus on how they can use the new knowledge to solve problems (orientation to learning), and their primary intrinsic motivation help differentiate adult learners from younger ones (motivation to learn) (Horsley, 2010). In his updated work, Knowles (1984) explained his four guiding principles for adult learners: 1) Involvement in instruction planning and evaluation, 2) Action-driven Experience with the ability to fail, 3) Relating to immediate needs, 4) Problem-oriented for greater transfer of knowledge.

Following the idea of a triadic worldview towards andragogy (Dantus, 2021), we view Knowles' principles through Games-Based Learning (GBL). More specifically, we combine the principles of andragogy with Gee's principles of empowered learning such as Co-design - where the player's involvement is active rather than passive. Similarly problem-solving through Well-Ordered Problems leads players through a problem rather than through content. Finally, in strategies, there is Meaning as Action where content and meaning are built into a problem to add to the relevance. (Gee, 2005).

2.2 Platformer Games

Platformer games - also known as *run and jump* games - present action through interaction with an avatar jumping and dropping around obstacles. Movement within a platformer game occurs in all directions (e.g. up, down, left, and right) compared to other genres that keep players on the ground and allow for movement along the X and Z axes (Pedersen et al., 2009). The typical platformer game often focuses on singular core dynamics to support the win state of a game such as race to the finish (e.g. racing against other players or time) or collecting (e.g. accumulating points, items, or power-ups) (Boller & Kapp, 2014). However, platformers can be more sophisticated in their design, incorporating puzzles that require combined cognitive development. For instance, jumping and landing onto specific platforms requires rapid processing speed alongside visuospatial planning that coordinates with a player's dexterity to execute a given task (Zelinski & Reyes, 2009). Incorporating learning into the action-heavy genre requires building on the strengths of such mechanics as collecting and puzzles.

3. Method and Materials

We rapidly designed and developed the third iteration of a 2D platforming game prototype called *Biomes Rescue* for use in a large general-education undergraduate geography course. The game follows an Indiana Jones-style character who must collect and align items to different biomes by evaluating the items' descriptions once collected. The game focuses on the first content covered within the undergraduate geography course, distinguishing biomes. This content assists students in identifying key characteristics (i.e., environmental controls) of different biomes to associate with cultural and environmental issues discussed later in the course. The context of the problem within the game incorporates representative slime-like creatures, sludglings. This enemy within the game loosely represents the pollution within Earth's biomes. Within this game, the player explores four biomes, where the sludglings have disassembled three of them. Players must reconstruct the three incomplete biomes by critically thinking about the characteristics of each to reassemble them while not being caught by the sludglings. Our current iteration of this game focuses on the alignment of game mechanics to higher-order learning and Knowles principles of Andragogy. Informed by earlier results, we hypothesized that participants would have an unbalanced view of the dexterity-centered mechanics tied to fun over learning.

3.1 Study Design

Our study uses a mixed-methods exploratory approach to establish connections between game mechanics to fun and learning (Creswell & Plano Clark, 2011). To conduct this study, we posed the following research question: How does a platformer engage learning in adult players? and the sub-question: How do adult players align platformer mechanics to learning?

Our framework driving the analysis and interpretation stems from an alignment of Gee's principles with Knowles's Principles of Adult Learning. The Allure Framework operationalizes Gee's principles as game mechanics that can be manipulated through the design of a game. This combination of mechanics within the Allure Framework connecting with the different Andragogy principles provides a framework for how adult learners perceive the impact of the game's mechanics on their learning.

3.1.1 Variables

We focused on using the simple and complex mechanics for game-based learning as categorized by the Allure Framework (Bisz & Mondelli, 2023) for the independent variable. These mechanics provide a way for students to interact with the learning content within the game. The two main complex mechanics behind *Biomes Rescue* are evaluating information to categorize it with *Classify the Pieces* and analyzing facts to find a similar relationship with *Concentration*. The key simple mechanic in both of these is *Random* as the players are presented with the information in a nonlinear way. For our dependent variable, we focused on learning outcomes from an external quiz question as well as a set of 5-point Likert Scale questions on Enjoyment.

3.2 Measures

To capture data for our research questions, we used a short survey and quiz. The survey collected basic demographics, a three-item set of Likert Scale questions on Enjoyment adapted from Davis (1989), and two open-ended questions. The enjoyment scale included items such as "I found viewing the interactive media on the Biome Rescue game fun" and had a moderate Cronbach's Alpha of 0.68. The quiz following gameplay consisted of three questions. Each question was rated eight points. The quiz tested students on their knowledge of biomes in general (Question 1) and knowledge about biomes within the game (Questions 2 and 3). Given that the students had received instruction on biomes in week 3, we designed the assessment to register both active recall of prior knowledge and new knowledge obtained through the gaming experience. Due to incompleteness, only questions one and two were included in the analysis. Our two open-ended questions asked students to indicate their likes and dislikes about the game and the potential for further development including improvements.

3.3 Participants

We recruited participants from enrollment in an introductory undergraduate world regional geography course taught each spring at the University of Missouri. There were 124 students enrolled in the course, of whom 21 were in the Honors section. 78 students enrolled as participants in the study through an informed consenting mechanism on the Canvas LMS and provided feedback on their game experience through an ungraded survey. Of the 78 students, we have freshmen (n=6), sophomores (n=26), juniors (n=21), seniors (n=25), and honors students (all levels) (n=18).

3.4 Game Mechanics

To capture data about the mechanics within the game prototype, we identified the key mechanics of the design and connected them to the Allure Framework's categorization of simple and complex mechanics for game-based learning (Bisz & Mondelli, 2023). This allowed the examination of student feedback across categories of mechanics to provide meaningful connections between learning and engagement.

Biomes Rescue incorporates the simple mechanic *Random* as the players collect and match clues to biomes in a nonlinear way. *Random* is a key component of the complex mechanics present, *Classify the Pieces* and *Concentration*. Specifically, the players collect key characteristics, or clues, dispersed across all four biomes, then evaluate which clues match each biome. Three of the biomes are incomplete, making some clues unavailable until others have been correctly placed. This requires players to move nonlinearly through the levels joined by the hub world.

The simple mechanic *Rival* occurs through the challenge of defeating the SludgeKing and his minions, and the dexterity challenge. In particular, the desert biome presents the highest level of challenge with the risk of falling into quicksand while dealing with sludglings. This *Role* associated with the player is that of Missouri Joe, a wildlife conservationist. The guiding narrative is built into the role, focusing on action within the game levels over deeper storytelling.

The most notable *Reward* is biome construction. Players must build the platforms in levels to progress through the game. The game rewards players by giving them more exploration of the biomes. Players receive instant feedback in the form of a pleasant "squish" sound when jumping on a sludgling and a coin collection sound when

collecting a clue. The player's character also blinks and loses hearts when encountering a sludgling without defeating it. Additional feedback includes earning points every time they defeat a sludgling. If the player squishes each sludgling exactly once and hits the SludgeKing three times to defeat him without restarting, the score adds up to a "perfect" 100 after winning the boss battle.

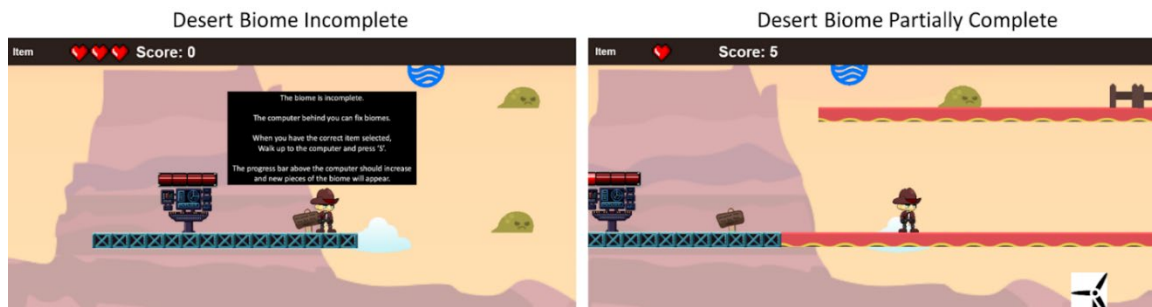


Figure 1: Example of Random and Reward mechanics in an incomplete biome

3.5 Procedure

The world regional geography course comprises 15 weeks of instruction with 50-minute lectures that meet twice a week. In week 12 of the 15-week course, the students were asked to bring their laptops to the lecture session and play *Biomes Rescue* for at least fifteen minutes at the beginning of class. The link to the game was embedded in the instructions for an ungraded survey in the Canvas LMS, which also included the informed consent document and the survey questions. After fifteen minutes passed, the instructor distributed a hard-copy quiz. Students were encouraged to keep playing the game before completing the quiz for an additional fifteen minutes or until they completed the game, whichever came first. After submitting the quiz, students were invited to take the voluntary feedback survey in Canvas. After class, the instructor graded the assessments and linked those scores to each student's survey results using a numerical identifier to preserve student anonymity.

3.6 Analysis Plan

To address our research questions, we incorporated a combined thematic analysis with non-parametric tests to confirm and detect relationships. Specifically, we open-coded using an Inductive and Deductive process (Fereday & Muir-Cochrane, 2006) to formulate two categories. Using Axial Coding on our two categories (Williams & Moser, 2019) along with a Fisher's Exact Test, we examined relationships between Adult Learning Assumptions and Game Mechanics discussed by the students. Significant Mechanics from the Fisher's Exact Test were put into a Mann-U Whitney test for our Learning Quiz Score and the variables from our Likert scale questions.

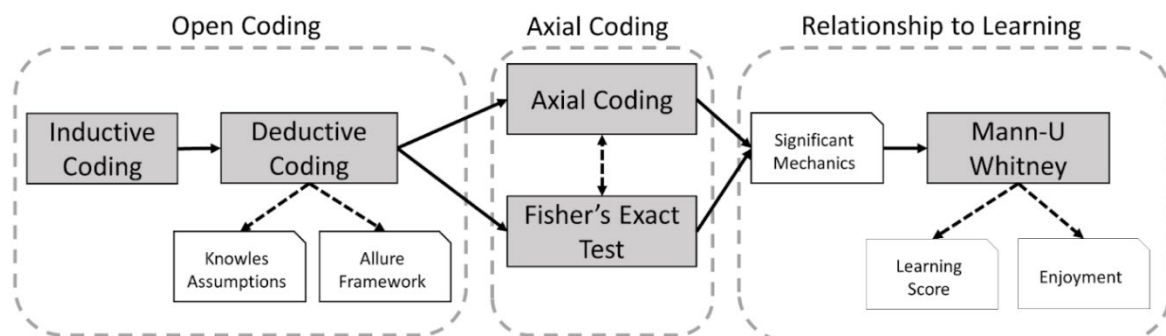


Figure 2: Analysis process for Mixed Methods Exploratory Approach.

4. Results

Overall, *Biome Rescue* was considered fun, engaging, and enjoyable. As one participant stated, it "was very fun and made me want to keep playing." The most commonly mentioned concern was the difficulty of the game. Many wished there was a way to regenerate lives or wanted checkpoints with a way to save the game so that they did not lose all progress after three chances. Participants mentioned the frustration they felt when they did not complete the challenge initially due to difficulty while others specifically mentioned enjoyment from the dexterity challenge.

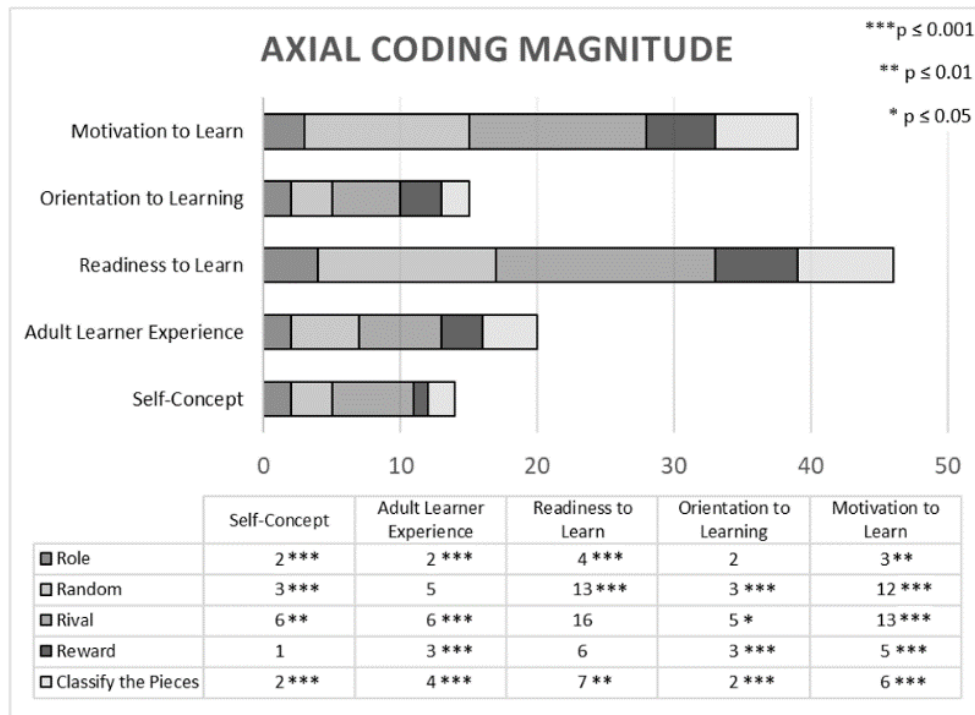


Figure 3: Graph showing axial coding magnitude between game mechanics and Knowles Assumptions with supporting significant relationships identified using Fisher's Exact Test

Participant comments about the narrative, such as “it was charming,” showed that they enjoyed the aspects of *Role* encountered in *Biomes Rescue*. While the participants enjoyed the *Role* present in the story, they also wished that the narrative more succinctly integrated the learning objectives of the game and conveyed more information about each biome. There was a desire to connect more with their previous experience in the course and have the narrative presented in a way that was more applicable to the game. In line with this sentiment, some participants called this a “missed opportunity,” saying that the narrative should “[lay] out the goals of the game more explicitly” and that “more specific information about the biomes and objectives when entering the biomes would be helpful.” Those who felt that the game did involve a connection with their previous experiences had positive comments about liking the platformer style, the game feeling nostalgic, and being relevant to them.

The aspects of *Rival* were pleasing to some participants. One participant stated, “I liked the difficulty added with the slimes and stuff, it did just enough to keep me on edge and enjoy the experience.” Other participants commented variations of “it was fun stomping on the sludge monsters.” Another participant said, “I liked the final boss fight at the end of the game.” However, almost half of the participants wished the game was less frustrating, stating that the game was too difficult. For example, one participant stated, “I think it was a little unforgiving and difficult, because it was easy to die and it restarted the whole thing.” Another participant stated, “The game was fun, but my biggest complaint is the fact you cannot get more lives, and that the quicksand one-shots you. It makes it very frustrating when you have to restart completely.” Other participants were more direct about this complaint, saying, “the fact that there are no checkpoints was brutal, I'd like it more if you didn't go all the way back to the start when you died”.

There were both positive and negative comments about the *Random* aspects of the game. Every *Classify the Pieces* comment was also coded as *Random*, but not every instance of *Random* mentioned involved *Classify the Pieces*. Some participants enjoyed the nonlinear progression of biome exploration, but many participants felt that the lack of direction on which biomes to enter and in what order “complicated” the game. This is often what participants were referring to when they indicated a desire for “more guidance” in the game, and was the most common complaint with a preference for pedagogical learning over andragogy. Somewhat contrary to Knowles' principle that adult learners desire independence and self-direction, more students wanted further guidance on where to go and what to do in what order than commented on enjoying the agency and exploration that the game provided. Two participants mentioned they would have preferred to play the game as homework so that they could take their time exploring and figuring things out on their own without the time constraints of the class session, indicating a preference for self-direction of gameplay.

Participants enjoyed the *Reward* aspects of the game, stating they liked the satisfying ‘squish’ sound when stomping on the Sludglings, the coin sounds when collecting the clues, and the emergence of the animals upon completing a biome. Others wanted there to be higher stakes and more incentive in the game. One participant stated, “It was really easy to cheat my way through by trying every item without really reading it. If I made an improvement it would be to have a consequence for every wrong guess.” Similarly, others mentioned that “it needs to have more motivation for players in order to make a deeper impact” and “there needs to be more of an incentive to actually pay attention to the detail of the game.” Finally, in line with Knowles’ principle of intrinsic motivation for adult learners, many participants mentioned the game was immersive, engaging, fun, novel, and easy to play.

Participants liked the opportunities to problem-solve within the game and wanted more complexity with this type of learning, which coincides with Knowles’ andragogy principle of focusing on how they can use newly acquired knowledge to solve problems. They seemed to enjoy the complex mechanic - *Classify the Pieces* the most. Their comments indicated that they wanted more of this type of learning in the game with more complex mechanics:

...be more effective than just explaining the biomes... something that enhances the information you're receiving... [allow] the lecture to cover the fundamentals and the game to enhance that knowledge... an engaging piece of information to pursue in a game... maybe you find an animal in the wrong biome and have to put it back where it belongs.

These sentiments coincide with Knowles’ principle of adult learners’ desire to link learning to what they can do with the knowledge gained. The students wanted more utilization of learning within the game and more incentive to retain the information. One participant said, “I don’t think the game engages with the topics enough though, and can be ‘brute forced’ by someone who just wants to rush through it.” Along this principle of utilization, some stated they were unsure of their learning and wanted more from the game. “I didn’t always feel like I was learning. I feel like there needs to be some type of quiz or mini game that would help you if you actually paid attention.” Another participant stated the “teaching process is hidden in the game, and you can’t see it obviously.” This participant alluded to wanting the learning to be more overt. Another participant wanted there to be “some kind of worksheet to fill out while playing the game” to reinforce learning and provide access to content outside of the game. These participants wanted the concepts reinforced more, more formative assessment, and more depth to the learning.

Table 1: Mann-Whitney U Test Results on Quiz Score and Enjoyment by Game Mechanic. * indicates significance

Game Mechanic	Quiz Score	p-value	Enjoyment	p-value
Role	264.500	0.761	277.500	0.973
Rival	788.000	0.623	741.500	0.951
Reward	349.500	0.868	510.000	0.010*
Classify the Pieces	67.500	< 0.001*	436.000	0.456

Our Mann-Whitney U tests indicate that learning performance was impacted by the complex mechanic, *Classify the Pieces* while enjoyment was influenced by the simple mechanic, *Reward*, see Table 1. Each mechanic group was generated as a dichotomous variable where 0 represented students who did not indicate the specified mechanic and 1 indicated where comments aligned with the given mechanic. From the plots (see Figure 4), students who discussed aspects of *Classify the Pieces* performed better than students who did not recognize the complex mechanic. However, students who mentioned aspects of *Reward* rated enjoyment significantly lower than students who did not.

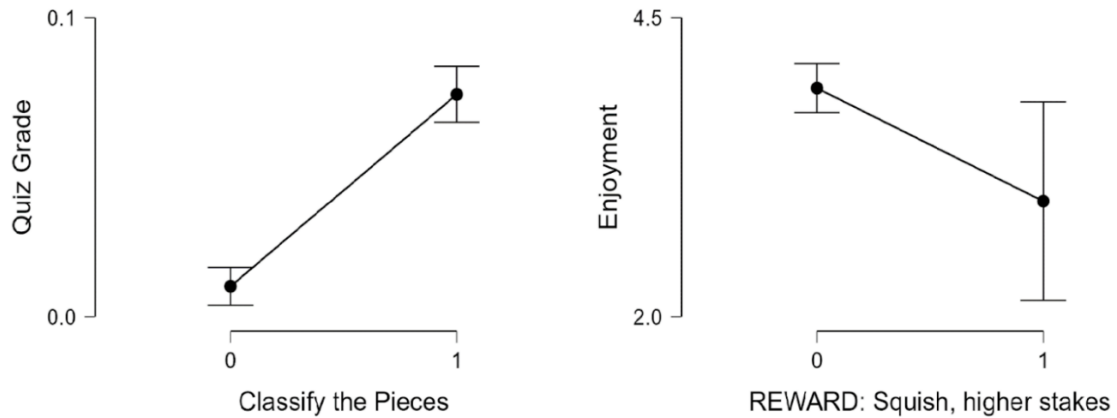


Figure 4: Mann-Whitney U test plots of Classify the Pieces on Quiz Grade and Reward on Enjoyment

5. Discussion

The notion that individual game mechanics could be recognized by adult learners as successful indicators of knowledge construction presents an interesting problem. Based on earlier studies, we hypothesized that enjoyment would connect to the mechanics instead of learning. So, we posed our research question to examine how players recognized mechanics and the relationship to Knowles principles. This relationship provides the basis for understanding learning and how it compares to enjoyment.

In the case of *Biomes Rescue*, the platformer genre game that built on previous years of design and feedback had incorporated complex mechanics with simple mechanics. The intersection of these mechanics seemingly created a more comprehensive way to utilize game mechanics as both an engaging portion of the game, but also as a higher-order assessment to evaluate the different pieces within each biome. This Classify the Pieces mechanic was preferred by adult learners which addresses Knowles principle of making learning problem-based.

How learners engage with learning changes as they age and transition to higher education, yet that transition may take longer in some individuals than others. As the course consists primarily of younger adults, some participants are still transitioning from pedagogy to andragogy. This is evidenced in the comments by the desire for more guidance over figuring out the game for themselves.

Our findings show that adult learners prefer more complex mechanics with higher-order learning. This aligns with Horsley's (2010) findings. Everyone seemed to enjoy *Role* and *Reward* and wanted more of these simple mechanics, but the complex mechanic, *Classify the Pieces*, was most preferred. As for *Random*, most students accepted the nonlinear nature of the biomes as part of the core game mechanic, but students still in transition from pedagogy wanted a more linear gaming experience. *Rival* was the most mentioned in the codes and the least popular due to the challenge presented by the platforming death conditions (Cuerdo & Melcer, 2020). This is likely because participants were frustrated by dexterity challenges not balancing with their platformer game skills. Specifically, player death where all hearts were lost meant starting completely over. We did not ask the participants to disclose their game skill level in the data, but novice gamers or those less experienced with platformer games would be frustrated by this type of challenge rather than delighted (Sun et al, 2018).

The game itself did not include *Rapid*, but this final simple mechanic was inadvertently added due to the time constraints of the class. This addition to the game through external implementation during the lecture period generated a limitation with our learning performance metric. Instead of counting all three questions within the quiz, only two were used. The nature of the two questions was dependent on how far into the game the student was able to get, leading several students to underperform on question two. This added time constraint interacted with the dexterity performance, leading to complaints of the challenge being too high. So, while adult learners are engaged with failure, there is a point when it becomes unenjoyable (Cuerdo & Melcer, 2020).

6. Conclusion

Though platformer games are not as common to adult learning, there is precedence for their use in higher education. As the paucity of studies on using platformer games for adult education drove us to conduct this study, we now have new questions to pose about the type of learning and impact of other gameplay features such as different ways to address challenge. When the design combines simple and complex mechanics, the

resulting engagement can achieve several notable aspects of adult learning. However, the expectation of guidance and overt assessment within a game presents an interesting challenge to align with both andragogical notions of self-guidance while also maintaining the distinction between games-based learning and gamification. Additionally, Knowles' theory of andragogy is relative and is not a one-size-fits-all approach when it comes to adults following the assumptions outlined by the andragogy model (Darden, 2014). Despite criticisms addressing the weaknesses of Knowles' theory of andragogy, the principles have been proven robust for teaching adults and are widely used by researchers today with the caveat that instructors must adapt this method to meet the needs of their diverse learner populations (Dantus, 2021). This leads to additional questions on how to align andragogy to other learning principles to address an increasingly diverse group of learners.

References

- Alias, N., Rosman, F., Rahman, M. N. A., and Dewitt, D. (2015) The potential of video game in Malay language learning for foreign students in a public higher education institution. *Procedia-Social and Behavioral Sciences*, Vol. 176, pp. 1020-1027. <https://doi.org/10.1016/j.sbspro.2015.01.573>
- Bisz, J., and Mondelli, V. L. (2023) *The Educator's Guide to Designing Games and Creative Active-Learning Exercises: The Allure of Play*. Teachers College Press.
- Boller, S., and Kapp, K. (2017) *Play to learn: Everything you need to know about designing effective learning games*. Association for Talent Development.
- Cuerdo, M. A. M., and Melcer, E. F. (2020, April) "I'll Be Back": A taxonomy of death and rebirth in platformer video games. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1-13). <https://doi.org/10.1145/3334480.3382863>
- Dantus, S. J. (2021) A triadic worldview? The misconception and bias of universality in Knowles' andragogy. In *Commission for International Adult Education at the American Association for Adult and Continuing Education* (pp. 77-85).
- Darden, D. (2014) Relevance of the Knowles theory in distance education. *Creative Education*, Vol.5 No.10, pp. 809-812. <https://doi.org/10.4236/ce.2014.510094>
- Davis, F. D. (1989) Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, Vol. 13, No. 3, pp. 319-340. <https://doi.org/10.2307/249008>
- Fereday, J., and Muir-Cochrane, E. (2006) Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods*, Vol. 5, No. 1, pp. 80-92. <https://doi.org/10.1177/160940690600500107>
- Gee, J. P. (2005) Learning by design: Good video games as learning machines. *E-learning and Digital Media*, Vol. 2, No. 1, pp. 5-16. <https://doi.org/10.2304/elea.2005.2.1.5>
- Horsley, T. L. (2010) Education theory and classroom games: Increasing knowledge and fun in the classroom. *Journal of Nursing Education*, Vol. 49, No. 6, pp. 363-364. <https://doi.org/10.3928/01484834-20090521-02>
- Knowles, M. (1984) *Andragogy in Action*. San Francisco: Jossey-Bass.
- Merriam, S.B., Caffarella, R.S. and Baumgartner, L.M. (2017) *Learning in adulthood: A comprehensive guide* (3rd ed.), John Wiley & Sons/Jossey-Bass.
- Nasikun, A., Wijonarko, B. Y., Rahman, R. B. A., Persada, A. G., and Wibirama, S. (2017) Virtual Reality-based platformer games development for elevating architectural heritage awareness. *International Journal of Information Technology and Electrical Engineering*, Vol. 1, No. 3, pp. 93-97. <https://doi.org/10.22146/ijitee.33592>
- Pedersen, C., Togelius, J. and Yannakakis, G.N. (2009) Modeling player experience in super mario bros. In *2009 IEEE Symposium on Computational Intelligence and Games* (pp. 132-139). <https://doi.org/10.1109/CIG.2009.5286482>
- Sun, C. T., Chen, L. X., and Chu, H. M. (2018) Associations among scaffold presentation, reward mechanisms and problem-solving behaviors in game play. *Computers & Education*, Vol. 119, pp. 95-111. <https://doi.org/10.1016/j.compedu.2018.01.001>
- Symborski, C., Barton, M., Quinn, M. M., Korris, J. H., Kassam, K. S., and Morewedge, C. K. (2017) The design and development of serious games using iterative evaluation. *Games and Culture*, Vol. 12, No. 3, pp. 252-268. <https://doi.org/10.1177/1555412016673262>
- Williams, M., and Moser, T. (2019) The art of coding and thematic exploration in qualitative research. *International Management Review*, Vol. 15, No. 1, pp. 45-55.
- Zelinski, E. M., and Reyes, R. (2009) Cognitive benefits of computer games for older adults. *Gerontechnology: International Journal on the Fundamental Aspects of Technology to Serve the Ageing Society*, Vol. 8, No. 4, pp. 220-235. <https://doi.org/10.4017/gt.2009.08.04.004.00>