

Diegetic Connectivity: Blending Work and Play with Storytelling in Serious Games

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ABSTRACT

In this exploration of serious game design, we posit that, too often, fun and play require compromise in terms of task. Addressing this challenge, we articulate a story-driven approach to single-player serious game design called “diegetic connectivity,” where task, mechanics, and story are tightly bound through conceptual relationships and aesthetic presentation. To explore the challenges and opportunities of this approach, we present a purpose-built second language acquisition (SLA) game called *Arena*, and discuss results from a preliminary mixed-methods study directed at motivation, engagement, and task outcomes. Finally, we discuss some of the critical aspects of diegetic connectivity, as well as opportunities for future research.

Author Keywords

Gamification; Serious Games; Game Design; Diegesis; Story; Mechanics; Task; Second Language Acquisition

ACM Classification Keywords

K.8.0 Games

INTRODUCTION

Gamification – the use of game elements in non-game contexts – can be a powerful way of motivating, engaging, and promoting desired behaviors in players [1]. Because of its usefulness and versatility, gamification has made its way into a variety of disciplines and contexts, from educational games and citizen science to marketing and politics.

A common approach to gamification is the application of points, badges or leaderboards to non-game tasks. There have been many successful games that use such methods, e.g. *fold.it*, *Phylo*, *Cropland Capture*, and *EyeWire* among others. However, this approach is not without limitations.

Points and achievements are just one element of game design. They are metrics for noting progress more than fostering motivation and engagement per se [2]. In addition,

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points are most often used to foster competition in games designed around communities of players. However, Bartle [3] noted four player types, only two of which were especially social in nature. Too strong a focus on progress metrics and competitive communities can make it easy to overlook other engaging game design tools like story, aesthetics, and variable rewards [4, 5]. Yet these are powerful ways to make gamified experiences feel, for lack of a better term, like “real games.”

In this research, we propose an alternative approach to gamification that eschews “metric” and competition focused design in favor of “diegetic connectivity,” where story, world, and aesthetic presentation tightly bind mechanics to purposeful tasks and vice versa. We posit that a story-focused mindset can help designers to overcome the non-trivial challenge of integrating complex, tedious tasks with play, resulting in beneficial outcomes such as enhanced player motivation, engagement, and task performance. This approach may be especially useful in single-player, entertainment-focused games directed at players who remain unmotivated by points, badges, leaderboards, and communities. This suggests the first of two overarching research questions:

RQ1: *How can we characterize approaches to gamification that go beyond “metrics” to motivate and engage participants in meaningful, single-player experiences?*

We are interested in exploring this question both conceptually and practically. The second half of this paper describes the design and evaluation of a “serious game,” *Arena*, built with diegetic connectivity in mind. *Arena* is a second language acquisition (SLA) game set in a science fiction universe. Our exploratory evaluation of *Arena* is loosely directed at a second research question, drawing upon a mix of qualitative and quantitative data to show both the limits and opportunities of the diegetically connected approach to serious game design:

RQ2: *How does diegetic connectivity influence motivation and engagement in terms of play and task?*

CONCEPTUAL DEVELOPMENT

Gamification

The term “gamification” is controversial, having gained a reputation as “exploitationware” in the eyes of some designers [2]. The term sometimes disparagingly refers to competitive scoring “metrics” such as points, thinly layered

onto otherwise unaltered tasks, and this approach is often criticized as ineffective or even malicious [2, 6, 7].

Not surprisingly, many researchers have coined new terms to capture design thinking that is about more than just metrics and tasks [7], including “meaningful play” [8], “games with a purpose” [9], “serious games” [7], and more. These terms are highly contextualized, but describe approaches, often including additional elements such as story, that may enhance player engagement, improve task outcomes, or prolong play [6, 7, 10, 11].

The term “serious game” is of particular interest to us, denoting “the design of full-fledged games for non-entertainment purposes,” [6]. The phrase “full-fledged” captures something qualitatively different about this term vs. the metric and competition focus of “gamification.” It encompasses a more complete perspective, including story and aesthetics, possibly in a single-player context.

On the other hand, the word “serious,” derived from the military traditions of sand table simulation [12], implies that potentially “unserious” aspects of game design – zany characters, dramatic stories, and fantastic worlds – need not apply. Yet modern entertainment video games, “full-fledged” games, specifically draw upon these playful elements to create fun and motivating experiences. As designers, we consider such tools to be essential.

Neither “gamification” nor “serious games” fully articulates our real intent: to produce full-fledged entertainment experiences that nonetheless accomplish something practical. We want to produce “real games,” the kind that might find success in the mainstream game marketplace. This is no small feat, made more difficult by our desire to inject concrete tasks, likely to be difficult or uninteresting, into otherwise enjoyable games. Tasks, laden with detailed requirements, rules, and controls, can often spoil play. However, we see story as a subtle and powerful tool for bridging this challenging divide.

Diegetic Connectivity

We use the term “diegetic connectivity” to describe our approach to serious game design, a mindset more than a model. Diegetic connectivity helps us to understand how a “full-fledged” serious game is really a set of relationships between task, mechanics, and story. Story is our critical tool in this approach. It is used to strengthen every relationship in the game, making each one meaningful and cohesive.

Task: The Serious Objective

Serious games are organized around tasks: real world, “serious” objectives that are the important outcomes of the system. Tasks are rarely seen as inherently motivating or engaging, else why bother to build a game? It is the *combination* of task and play that provides an extra incentive to achieve real world outcomes [1, 6, 7, 11, 13].

The challenge of task is to find ways to mitigate that which is demotivating in order to enhance what is motivating. One

tool for this is mechanics, the rules that define how players work toward game or task objectives [4].

Mechanics: The Rules of Play

Many, though not all, game mechanics capitalize on a short-term neurocognitive process called reinforcement learning (the so-called “dopamine loop”), which enhances engagement through dopamine release and uptake in the brain [14-16]. Reinforcement learning relies upon environmental triggers to inspire curiosity and motivate players to act in anticipation of variable rewards. A player’s ability to reinvest such rewards into the game creates endogenous value [4], propelling players through additional such trigger-action-reward-reinvestment cycles [14]. One goal of designing for this process is to help players achieve a “flow state,” [17] where the passage of time is forgotten and immersion is complete [4, 5].

Game rewards are valuable to players only insofar as 1) they have real meaning outside the game *or* 2) the game itself is designed so that it creates endogenous value, making rewards meaningful inside the world of the game [4]. Points, badges, and leaderboards have real world meaning for some players – those who enjoy competition or have an intrinsic interest in the task. For many others, however, these metrics have no real world value. All too often, they are also not contextualized to the game world in a way that gives them endogenous value.

Story: Meaning, Context, and Value

A good story includes an interesting narrative, fascinating characters, and vivid worlds, structured to entertain and evoke emotion through plot, character arcs, and rising/falling action [18]. Crafting a compelling story is a non-trivial art form, and so story is an often overlooked tool for serious game design, especially in the realm of so-called “gamification.” Yet stories are fundamental to human nature, and story is a mechanism through which games can inspire curiosity, fulfill emotional needs, create meaningful connections, and foster intrinsic motivation [10, 19-22]. One additional compelling aspect of story is fantasy, the evocation of, “mental images of physical objects or social situations that are not actually present,” [19].

In serious games, fantasy comes in two varieties: exogenous and endogenous [23]. Endogenous fantasy tightly binds task to story. For example, in a physics learning game, players might be asked to perform real fuel calculations in order to launch a rocket. Exogenous fantasy is a less integrated approach, where fantasy content is used primarily as feedback for unrelated tasks. For example, players might add 2+2 in order to launch the rocket [10]. Endogenous fantasy is generally considered to be more motivating than exogenous fantasy.

Connections: Diegesis

Diegesis is a term that is used to draw distinction between things that are of the story and things that are not [24-26]. Any

game element that is rooted in the story world is considered diegetic; similarly, anything that is not part of this world is considered non-diegetic, instead existing as part of the “real” world of the player. In film and television, diegesis is often explained with an audio example. The on-screen radio playing a classic hit is diegetic because the characters in the scene can hear it; it is part of the story world. The bombastic film score, set in time to the screen action, is non-diegetic; it is not part of the story world at all [27].

In games, diegesis can be expanded to include other elements. For example, a health bar hovering over an enemy spaceship is non-diegetic, a mechanism for conveying feedback to a player. The same feedback could be conveyed diegetically by instead showing increasing amounts of smoke and fire as the enemy ship takes damage. Interestingly, the health bar can be transformed into diegetic feedback through clever use of story. By, for example, granting the player an augmented reality heads-up display, the health bar feedback can be made part of the story world and its existence cohesively justified.

We see diegesis as useful for addressing three design challenges in serious games: 1) justifying the existence of tasks inside a play environment, 2) creating endogenous value for rewards, and 3) incentivizing task outcomes through mechanics.

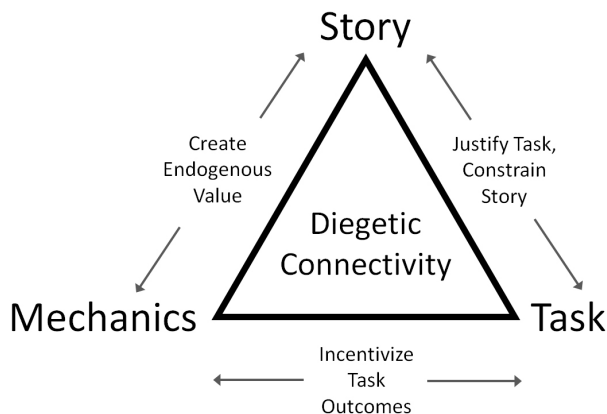


Figure 1. Diegetic connectivity is a perspective on serious game design where story is used to cohesively connect disparate aspects of the game to improve player motivation, engagement, and task outcomes.

Story can help tasks to feel seamlessly integrated into the world of the game. Designers can provide reasons for the task to exist and justifications for why it should be undertaken through clever use of narrative structure, characters, and the game world itself. At the same time, task necessarily shapes story. For example, a citizen science game featuring a taxonomic classification task could present this as a repair activity, where the player must restore damaged records in a ruined archive [28].

Story is also a tool for creating endogenous value, especially for mechanic-driven variable rewards. Unlocking new chapters of the story itself can be one type of reward,

but other opportunities abound: the player avatar might be upgraded and enhanced in ways that connect meaningfully to the story and world, a game economy can be developed where players may purchase or trade items, or action-oriented mechanics like exploration and combat may provide story-justified moments of excitement and intrigue. Connections between story and mechanics abound in well-designed entertainment games. In serious games, story can also be used to forge connections between mechanics and task. For example, story-driven quests could encourage players to exercise second language reading comprehension skills in conversations with other game characters.

Connections between task, mechanics, and story can be made in many ways, including through textual explanation. However, aesthetics, the visuals and sound of a game, are especially noticeable to players [4], and we view this presentational layer as especially important for forging diegetic connections. Visual motifs and themes such as character and world design, iconography, and even the details of menus and feedback all help to convince players that tasks are an integral part of the story, far more than just busywork to be completed in order to “get on with the fun.”

Outcomes: Motivation and Engagement

We see diegetic connectivity as important, not just because it has the potential to smoothly integrate tasks into single-player, entertainment-oriented serious games, but also because this approach may actually enhance player motivation and engagement, as well as task outcomes.

There is a spectrum of motivation, ranging from extrinsic to intrinsic. Extrinsically motivated individuals are moved to act because of some desirable outcome, while intrinsically motivated individuals act for the pleasure and satisfaction that the action itself provides [19]. Intrinsic motivation is often viewed as the more compelling of the two, though more difficult to create due to its highly individual, contextualized nature from person to person [29].

Psychological research has demonstrated that purely extrinsic rewards can have a negative effect on intrinsic motivation [30, 31], potentially negating the effectiveness of “metric” based scoring mechanisms in serious games. Alternatively, the more intrinsically motivated a player is to do a task, the more likely desired goals will be met [19, 30].

Motivation is usually seen as a necessary pre-requisite for engagement [32, 33], which is equally important in games, serious or not. Engaged individuals that are fully involved demonstrate a certain persistence to work through spontaneous difficulties (not found in individuals that are not engaged), and exhibit “higher levels of sustained interest in the activity or the instructional content of the activity,” [19, 21, 34].

Diegetic connectivity creates opportunities to foster task engagement by raising and then satisfying player curiosity, an instinctual human behavior arising from a desire to seek information that will reduce uncertainty [35]. Stories in

games raise dramatic questions, and thus curiosity, by providing places, situations, skills, and characters that players know little or nothing about. Uncertainty has been noted as an important motivating element of games [36], normally mitigated only after effort by the player to overcome challenges and obstacles of various kinds [4], including mechanically induced obstacles that also increase dopamine release and uptake [14-16]. By tightly integrating task, mechanics, and story, we anticipate enhanced player uncertainty, curiosity, motivation, and engagement, not only with respect to the non-task aspects of serious games, but also with respect to tasks themselves.

System Overview

Empirically studying diegetic connectivity will be a long-term, multi-faceted process for us. Starting out on this avenue of research, we developed a purpose-built serious game, *Arena*, and conducted a preliminary mixed-methods study directed at user perceptions of our design approach, motivation, engagement, and short-term learning effects. In this section, we describe the design of *Arena*. In the next, we describe our exploratory study methods and findings, as well as some of the future work they point to.

Arena is an SLA game set in the distant future, an age of space colonization and technological advancement. The game takes place on a colony planet where the local language is Spanish. This world is controlled by a local crime family who use a dangerous AI technology, the *Spider*, to cement their hold on power.

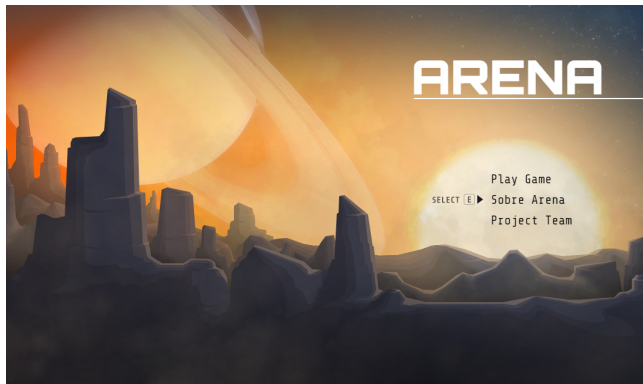


Figure 2. Language is an important part of *Arena* from its first moments. Here, menu choices show Spanish and English, e.g. “About *Arena*” changes to “Sobre *Arena*” when selected.

Players take on the role of Brock Springer, a military officer who is called from Earth to help his sister Emily. Emily’s husband has been murdered and her life is in jeopardy. She needs Brock’s help.

We selected the details of our story and world carefully, drawing upon our understanding of both task and mechanics. From a standpoint of task, we wanted a game environment that could deliver modern Spanish while still leveraging the motivational qualities of fantasy [19]. In terms of mechanics, we also wanted the creative freedom to include common entertainment game mechanics such as combat, but in a way that felt fun and exciting, rather than

out of place or even uncomfortable, as in a more contemporary setting. Finally, we wanted a world that could be presented through aesthetics in a visually dramatic way. We wanted to forge diegetic connections using visuals and sound whenever possible. A futuristic science-fiction setting and plot allowed us to accomplish these goals.

Task: Spanish Language Vocabulary Matching

Arena’s task is vocabulary matching, a mini-game that begins when players converse with non-player characters (NPCs). Conversations contain English passages that further the game narrative and world of *Arena*. Spanish words appear in each passage, and players must translate them in a timed matching game. Diegetically, we justify this matching mechanic with the *Spider* story element: Brock is suffering the side effects of a parasitic AI embedded in his brain. This *Spider* makes him physically stronger, but also weakens his mind. He is losing his knowledge of Spanish, and the player must help him “remember” his fading vocabulary.



Figure 3. The *Spider* is a critical story element, used to justify both language activities and play mechanics.

Though not a task per se, players also encounter additional vocabulary passively as they explore. This vocabulary is presented through titles and in some game art assets, understandable through context clues but requiring no active work from the player. These words are diegetic, e.g. the label “puerta cerrada” (locked door), and players may choose to cognitively engage with them or not.



Figure 4. Vocabulary is typically presented in diegetically motivated matching tasks, e.g. story plus mechanics.

We included these two modes for language interaction to explore how story alone vs. story and mechanics together can motivate players to engage with tasks in a diegetically connected serious game.



Figure 5. Some vocabulary is presented only in passing, e.g. story only. Here, the phrase “puerta cerrada” (locked door) is presented without an associated activity.

Arena's task is based upon Psycholinguistic SLA theory, which suggests that individuals learn a second language through goal-based, communicative activities. Success is dependent on authentic encounters with a comprehensible form of the target language. Players must be exposed to the target language within contexts where they can negotiate meaning through rich interactions [37, 38]. In this way, task underpins all our decisions about conversations and communication goals in *Arena*.

Mechanics: The Spider and Venom

Players must balance the physical power of the *Spider* against the need to communicate in Spanish. This balance is accomplished by managing a critical game resource: venom. Venom reduces the time given during vocabulary matching tasks, making them more challenging. It is gained when players use the *Spider*, diegetically representing the *Spider*'s increasing hold on Brock.



Figure 6. The Spider can be deployed to explore narrow crawl spaces, jump over chasms, and more.

The *Spider* is represented by a drone device that the player can deploy into the game world. The *Spider* can do things

that Brock cannot, such as accessing small areas or fighting enemies. It can also be upgraded to become more powerful.



Figure 7. The Spider is also used to fight enemies in combat, clearing the way for further exploration. Using the Spider increases Venom, an important game resource.

The *Spider*'s abilities have endogenous value in the context of *Arena*'s world. They allow the player to clear obstacles more quickly and for less venom cost. When these rewards are used wisely and venom is managed correctly, the player can take fun liberties with the *Spider*. However, if venom or rewards are mismanaged, Brock may completely lose his memory, and the game will end in defeat.

METHODS

“Diegetic connectivity” is a complex design mindset that can be operationalized and studied in a wide variety of ways. Recognizing this, we use the remainder of this paper to report a preliminary and exploratory empirical evaluation of *Arena*. Our intention is not to make strong claims about the diegetic connectivity approach, but rather to illustrate its use and to elaborate upon its potentials and challenges.

For this exploratory investigation, we recruited a small number of participants to play *Arena* and respond to a series of questionnaires about their experience. We also administered Spanish pre- and post-tests to evaluate task outcomes (learning effects) after exposure to the game.

Participants

Participants (n=30) were recruited from computer science courses at a mid-sized undergraduate liberal arts college in the northeastern United States. 17 participants were male, and 12 were female. Ages ranged from 18 to 25, with a mean and median age of 21.

Given our interest in gamers as potential beneficiaries of single-player experiences like *Arena*, we recruited from computer science courses in anticipation that these participants might identify as gamers. Many computer science students are passionate about games, pursuing this interest both as gamers and as student game developers [39]. We asked participants to respond to the statement “I consider myself a gamer” in our demographic survey. 12 participants agreed strongly with this statement, 13 somewhat agreed, and 5 did not agree at all.

Environment and Equipment

This study was run in one of two quiet computer labs reserved for the purpose. Participants were brought to one of the labs in small groups (between 1 to 5 participants at a time); they participated in the study individually and at their own pace. The lab computers were 2013 iMacs running OSX Yosemite version 10.10.5, with a 2.7 GHz Core i5 processor and 8 GB of memory. *Arena* is a browser-based game built with the *Phaser* Javascript game engine API. It was run in the Google Chrome browser for this study.

Procedure

Participants took a demographic survey and a Spanish pre-test to evaluate their familiarity with a targeted set of Spanish vocabulary words. Following these initial surveys, participants played *Arena* for about 20 minutes. Language activities in the game were instrumented to capture player performance for later analysis.

After play, participants took a game experience survey to capture their reactions. We asked a variety of open-ended response questions about *Arena* and also adapted the Game Experience Questionnaire from IJsselsteijn et al. [40] and the NASA Task Load Index (NASA-TLX) [41], which measures mental demand, temporal demand, performance, effort, and frustration on a scale from 0 to 100. This initial evaluation reports primarily on the qualitative responses.

Following the game experience survey, participants were asked to take a Spanish language post-test with the same vocabulary as the pre-test taken before playing *Arena*. We also report on this short-term learning outcome data.

LIMITATIONS

We acknowledge a number of important limitations to this study. It was conducted under controlled conditions, and with a small sample, imposing artificiality and limited statistical power. In addition, our design is quasi-experimental; we are not comparing *Arena* to other serious games or other language-learning activities. As such, we can say little about diegetic connectivity as compared to other design approaches. As such, we report our findings primarily as a baseline for future inquiry.

In the future, we see many possibilities for manipulating and studying various diegetic approaches in *Arena*. For example, we foresee adjusting the game's mechanics, task structure, and story presentation, thereby enabling us to dissect and study the various relationships that make up a diegetically connected game. We also hope to compare various versions of *Arena* – on user experience and task outcomes – to other serious games. And we recognize that our current analysis of learning effects in *Arena* is limited; the effects we report in this study are short term, based upon a limited test vocabulary. In future work, we expect to measure learning effects (and their decay) over time, introduce listening comprehension exercises, and explore the usefulness of *Arena* as a supplement to other instruction. In short, we see this current study as the beginning of long-term exploration, and report it as such.

RESULTS

We asked participants about 1) what aspects of *Arena* influenced their interest in playing, either positively or negatively, 2) what aspects of *Arena* influenced their interest in learning Spanish, either positively or negatively, 3) whether they would continue to play and why, 4) suggestions for improvement, 5) feelings of fatigue during play, and 6) if they had any additional comments.

Note that these questions do not ask specifically about task, mechanics, or story because we were interested in collecting open feedback from players to inductively explore the impact of different *Arena* elements. All the same, several themes related to diegetic connectivity strongly emerged.

Player Experience: Story, Mechanics & Aesthetics

Participants noted the importance of story, mechanics, and aesthetics in terms of motivation and engagement. These elements of *Arena* are, of course, easily noticed; it is still useful to acknowledge that players viewed them as an overwhelmingly positive influence on their play experience.

Example Statements About Story, Mechanics, and Aesthetics

1. STORY: The story of the game really interested me, and kept me wondering how things would progress throughout the game. The NPCs were fun-looking and added to the atmosphere of the world, which overall made the experience really nice.
2. STORY: The story was interesting! I'm curious to find out what happened to his [the player character's] sister's husband.
3. MECHANICS: The mechanics were pretty fun as well. I enjoyed becoming the spider and fighting enemies to unlock a new level.
4. MECHANICS: The leveling up of the ammo system made me want to continue playing to see what kind of ammo I could get in the future.
5. AESTHETICS: The environment was absolutely gorgeous. The sound design was very engaging, and the environment as a whole was quite immersive.
6. AESTHETICS: The game art was really, really amazing, I kept wanting to look at all of it and it really set the sci-fi mood of the game. The music also piqued my interest because it was very intense, and it made me want to play and find out what was the mystery/action.

Table 1: Story, mechanics, and aesthetics were seen as important individual elements of the *Arena* play experience.

Players specifically noted how story enhanced their sense of wonderment and curiosity, driving them to continue exploration and play. Players also referenced the role of variable rewards, e.g. reinforcement learning, as a mechanism for motivating their actions in the game. Unsurprisingly, visuals and sound were seen as an important aspect of the overall experience. They were noted as motivators because of the way they created a sense of immersion, atmosphere, and mystery.

Player Experience: Task

Virtually all participants expressed interest in learning a second language (40% were somewhat interested, 43% interested, and 10% extremely interested), suggesting that second language learning is generally considered desirable

and worthwhile. However, 20 participants (67%) indicated that they were not currently learning a second language, and only 4 participants (13%) indicated that they were. 6 participants (20%) did not answer this question. For our participants, then, the desirability and perceived benefits of learning a second language did not seem to translate into concrete action. It is beyond the scope of this study to understand exactly why this is, but we do suggest that the mismatch between perceived value and concrete action is fertile ground for a game such as *Arena*; we designed *Arena* specifically to explore how playful diegetic connections might impact this player-learner “enthusiasm gap.”

Example Statements About Task Contextualized by Story

1. I have attempted to learn Spanish on multiple different occasions in the past with very little success. I have taken Spanish classes and also used Rosetta stone, but my lack of interest has always prevented me from really getting into it and putting in the effort required. This game had a really nice environment that was fun to explore, so it captured my attention more than something like a lesson or a virtual exercise does.
 2. There was some kind of reason behind why the character needed to know Spanish.
 3. [Arena] increased my interest [in learning Spanish] with the need to defeat that arrogant spider.
 4. The conversations were great to help understand and learn Spanish.
 5. Being story driven definitely was a key part. Additionally, gaining an understanding allowed me to progress more efficiently (actual reward for learning). I also wanted to continue along with the game itself and that meant successfully understanding what the words meant.
-

Table 2: Players perceived how story contextualized the Spanish language tasks in the game, giving them purpose and presenting them in a way that made coherent sense within the world of the story.

Story had three strong impacts: 1) it enhanced curiosity, 2) it captured attention, and 3) it created meaning. For some players, the world and environment of *Arena* felt qualitatively different from typical learning environments, enhancing motivation and engagement. For others, the story established concrete goals and activities, with similar results. Story, in addition to making the *game* better, seemed to make the *task* better as well.

Example Statements About Task Contextualized by Mechanics

1. The fact that every time I missed a word brought me closer to 'dying' in the game made me want to know more of the Spanish.
 2. Blending Spanish words into the English text makes their meaning easy to figure out using context, which I found helpful.
 3. The Spanish mechanic felt like it fit within the game, and didn't feel forced; sure, I was learning stuff, but it still felt like a normal game.
 4. There was a sense of punishment within the game when you were wrong and there was a will to learn (or memorize) the words in order to succeed.
-

Table 3: Players also perceived how game mechanics (rewards, punishments, and rules of play) contextualized the Spanish language tasks, giving them endogenous value within the world of the game.

Psychological effects such as reinforcement learning and reward loops also gave players an enhanced feeling that the task itself had value; the task was the mechanism by which they could make progress and participate in enjoyable play activities as they unlocked progress in the world, e.g.:

Example Statements About Reward and Punishment Mechanics

1. Gaining an understanding [of language] allowed me to progress more efficiently (actual reward for learning). I also wanted to continue along with the game itself and that meant successfully understanding what the words meant (punishment for being wrong could lead to game over).
 2. I never really saw the effects of venom, but I assumed it was bad from the tutorial text so I was motivated to learn the Spanish needed to get 100% on all the Spanish interactions and reduce venom.
 3. The leveling up of the ammo system made me want to continue playing to see what kind of ammo I could get in the future.
-

Table 4: *Arena* includes several interconnected reward and punishment systems, including venom (a resource that must be managed) and weapon upgrades. These systems are tied to task in various ways, and are also framed by the story and world of the game.

In many comments, participants indicated that the relationships between story, task, and mechanics in *Arena* were critical for fostering engagement with the game. Furthermore, these relationships also enhanced engagement with the task, giving it purpose (e.g. “There was some kind of reason behind why the character needed to know Spanish.”) and meaning (e.g. “I also wanted to continue along with the game itself and that meant successfully understanding what the words meant.”).

In their comments, participants also discussed how the *cohesiveness* of the experience was important. *Arena* felt “unobtrusive,” and like a, “normal game.” Participants also recognized *Arena* for its “fun,” “atmosphere,” “education,” and “interactivity,” and for its ability to overcome the difficulties of learning a second language. This is the blending effect of diegetic connectivity, a mindset that gives designers permission to forge playful and entertaining connections between otherwise disparate elements.

Example Statements About Work and Play in *Arena*

1. *Arena* taught Spanish in an unobtrusive way that is part of the gameplay rather than just sitting down and learning from flashcards. I liked that the language learning aspect seemed more conversational than memorizing.
2. The atmosphere of the game was a lot more intriguing than most educational games. It took a different approach going for a thriller sort of game rather than a game plot for young children.
3. The story was pretty interesting, as was the prospect of being able to learn Spanish in a way that was actually fun, unlike most language learning games.
4. I found the story engaging, which made the game easy to continue playing.
5. I did like this game and it did increase my willingness to learn Spanish, simply because playing five minutes of it made me feel it has the potential to be more educational and interactive than any high school class I ever took.

6. Learning another language has always been of interest. The problem, however, is that it's never been one of my strong suits (simply memorization / classroom doesn't work for me). Video games seemed like a great alternative to try.
7. I thought that it was a very interesting game that matched learning and entertainment nicely. Learning new languages have been difficult for me and I thought it would be a fun new way to try and learn.

Table 5: The connections between story, mechanics, and task, including the way these are presented through aesthetics, create a whole greater than the sum of the parts. Many participants reflected upon the way games like *Arena* can go beyond traditional educational tools to contextualize learning activities in new and engaging ways.

Learning Effects

Pre- and post-tests were used to capture participant knowledge of 23 vocabulary words that appear in *Arena*. Recall our interest in story and mechanic driven tasks vs. story only tasks. 16 words were included in “story plus mechanics” tasks. The remaining 7 words were shown to players in passing, usually as part of pop-up information bubbles providing information about the story and world.

The pre- and post-tests asked participants to type a Spanish translation for a provided English word. Participants were reassured that they need not use special characters (e.g. ñ, á, é, í, ó, ú, etc.) so as to avoid confounds from using US standard keyboards. Words were randomized to avoid ordering effects.

We used a coding process to produce a final grade for each test, akin to coding techniques used in content analysis [42]. Three coders individually graded the language pre- and post-tests, coding answers as correct (1) or incorrect (0).

Test	Judgments	# Disagreements	Rate of Disagreement
Pre-Test	690	32	4.6%
Post-Test	667	17	2.5%

Table 6: Rate of disagreement for language test grading.

Disagreements were resolved using a “majority rules” approach, where the final grade per word was assigned based on the grade given by the two raters who agreed.

We used paired two-sample t-Tests to investigate whether there was a significant difference in the mean grades for pre- and post-tests for “story only” words and “story plus mechanics” words. One participant failed to submit a post-test and was omitted from analysis.

t-test: Paired Two Sample for Means (Story plus Mechanics)

	Pre-Test	Post-Test
Mean	3.483	5.035
Observations	29	29
t Stat	-4.396	
P(T<=t) two-tail	0.000	

Table 7: Players actively interacted with 16 words in diegetically motivated translation activities (story plus mechanics). The difference in means from pre- to post-test was significant to $p < 0.000$, showing a strong short-term learning effect.

We found a significant learning effect ($p < 0.000$) for words in the story plus mechanics category.

t-Test: Paired Two Sample for Means (Story Only)

	Pre-Test	Post-Test
Mean	0.931	0.793
Observations	29	29
t Stat	2.117	
P(T<=t) two-tail	0.043	

Table 8: Seven words were diegetically motivated, contextualized, and seen by players, but were not actively interacted with or translated in an activity (story only). The difference in means from pre- to post-test was not significant, showing no learning effect for these words.

We found no learning effect for story only words, suggesting that story alone does not effectively incentivize players to engage cognitively with pedagogical information. Active engagement through mechanics is important.

This seemingly trivial finding – that active engagement with the language is obviously preferable to passive exposure – nonetheless has important implications for diegetic game designers. The goal of diegetic connectivity is the smooth and cohesive blending of story, mechanics, and task, but our (admittedly limited) findings about learning suggest that many tasks, in order to be effective, must also be interruptive. Is it true, then, that task must inevitably spoil play? Or can task interruptions be managed or reframed such that they enhance engagement and promote a state of “flow” [4, 5, 17]? An earlier version of *Arena* helps shed light on such questions.

DISCUSSION

Diegesis and Task: A Four Quadrant Matrix

Our first vision for *Arena* was more radically diegetic than the version we explored in this current study. It was designed around a fully Spanish-speaking world where all game content was delivered in Spanish. Players were granted diegetically-justified translation tools to assist them in navigating this unfamiliar information space.

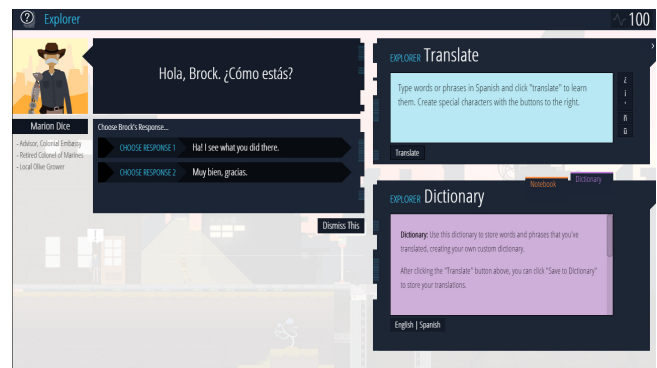


Figure 8. In our first polished version of *Arena*, players interacted with NPCs almost entirely in Spanish. A translation tool called the *Explorer* helped them to make sense of the language... for a cost.

In this early version, we wanted to create a feeling of being “dropped” into a Spanish speaking world, forced to contend with the complexities of language just as one might when living abroad [43]. This approach would create many incentives to work actively and deeply with the target language, in terms of both game mechanics and cognitive

engagement. This would lead – we thought – to enhanced motivation and improved task outcomes. However, through several rounds of informal play testing, we began to see some of the costs of full immersion, especially the cognitive load imposed on players. The full translation activity was fatiguing, spoiling the fun of the game. It incentivized players to skip through language activities and undermined *Arena*'s learning intent [44].

We changed our approach in the version of *Arena* reported here, creating a complex diegetic justification – the *Spider* – in order to deploy a simpler (but more artificial) vocabulary matching task. We relied upon diegetic connections to make this activity feel like a natural part of the game world. The task was greatly simplified and less of an interruption, but presenting it to players was a challenge. We were forced to craft an explanation of the *Spider*, including the harm it does to Brock's language abilities and the ways this harm is translated into game mechanics and task.

We presented this backstory in its entirety at the beginning of the game, when many other details about task, story, and mechanics are competing for player attention. This resulted in confusion for players, e.g.:

Example Statements About Usability in *Arena*

1. I would definitely make sure that the player had a firm grasp of how to play the game before tossing them into the activities. Also maybe the first few Spanish activities could be a little bit easier so that the player has a bit more time to fully understand what they are supposed to do.
2. I found the directions for the matching gameplay a bit confusing. I would also like the option to read a piece of dialogue more than once.

Table 9: Many players noted that the instructions for language matching (the task) were complicated and hard to remember.

Such comments reinforce the importance of good usability in computer games [e.g. 45, 46]. They also underscore the challenges inherent to crafting successful relationships between story, mechanics, and task. In addition to creating a believable narrative with emotional impact, diegetic connectivity should produce intuitive functionality at all levels. *Arena* succeeds in many ways, but falls short here.

This struggle ultimately suggested that a more formal understanding of the relationships the task and the rest of the game would be beneficial. We see the possibility of mapping such relationships on two axes: diegetic complexity and task complexity, with various design trade-offs resulting for each combination of diegetic justification and task design.

Low complexity approaches in both axes, like our “story only” approach in the reported version of *Arena*, may be straightforward to justify. Popups that require no active engagement feel very natural and easy to players, just like a purely entertainment-oriented game. However, these seemed to foster too little active engagement (at least in *Arena*) to be successful. Designs with lower diegetic

complexity but higher task complexity (our “immersive” translation approach from the earlier version of *Arena*) or lower task complexity but higher diegetic complexity (our “story plus mechanics” approach) may have greater potential for success, depending on their specific implementation, but require further study. Implementations that are complex in both axes run severe risks of overwhelming players and losing their interest.

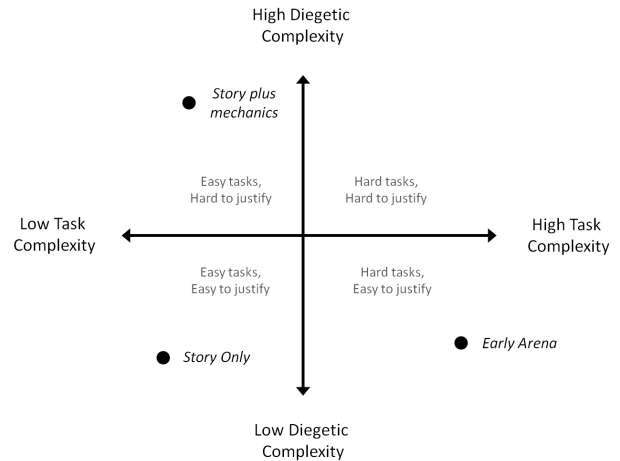


Figure 9. Different diegetic justifications and task implementations may produce different experiences and outcomes for serious game players. This may be further moderated by the task “genre,” e.g. citizen science tasks to produce data may benefit from low task complexity and low diegetic complexity, while learning activities may benefit from higher task complexity.

Task as Motivator

Zhang and von Dran [47] note the importance of “motivators” and “satisfiers” in web and other interactive experiences, suggesting that some features are necessary in order to satisfy user expectations, while others are truly motivating, encouraging users to actively engage with a system. In serious game design, it is sometimes tempting to think of task as something other than a motivator – perhaps even as a demotivator – especially for entertainment minded designers. The entire premise of a serious game, after all, is to convince players to undertake mundane, challenging, or uninteresting activities by promising a playful, fun experience in return.

Our work with *Arena* shows that this view is mistaken. Tasks can, indeed, be motivators, and serious game designers should recognize the task as something unique and special about the systems they design, e.g.:

Example Statements About Language Learning as Motivating

1. It reminded me the importance of learning another language.
2. The fact that it was a game where you could learn or improve on a new language.
3. I'd still like to learn another language.

Table 10. Several participants commented on their interest in learning a second language, showing how the task itself can be a motivator, even if its difficulty is a deterrent to engagement outside of play.

This is to say that diegetic connections should not be thought of as a tool for tricking players or hiding the task from them. Rather, diegetic connectivity is an approach that gives designers a way to acknowledge both the motivating power of the task as well as the limits of that power.

Aspects of a task that seem demotivating, difficult, or boring can be streamlined and diegetically justified in a way that helps to make them feel palatable and even fun; aspects that are already seen as interesting can be foregrounded, used to recruit players and enhance the cachet of the experience. This is true of contexts beyond second language acquisition: the altruistic impulses and inspirations of citizen science, the insights gained from persuasive games, or the pride of contributing to human computation-oriented “games with a purpose.”

CONCLUSION

In this paper, we explored how story can help to overcome some of the difficult challenges presented by the synthesis of task and play in serious game design. Our approach, dubbed “diegetic connectivity,” highlights the importance of strong, story-oriented connections between task and mechanics to immerse players in game worlds that feel cohesive and fun, more akin to commercial entertainment than typical “gamified” experiences.

Our language learning game, *Arena*, was designed with these connections in mind, and we used an exploratory, mixed-methods study to unpack the player experience and task outcomes. Though our work here is preliminary, we nonetheless found that in *Arena*, diegetic connections did indeed seem to enhance players’ self-reported motivation and engagement. Furthermore, quantitative analysis showed how this approach could produce successful task outcomes, while simultaneously raising questions about task design and diegetic presentation.

As a loosely organized approach or way of thinking, diegetic connectivity remains subject to the whims and preferences of individual designers, and there is much work to be done in terms of refinement and study of this approach to serious game design. We see many opportunities to formalize the diegetic connectivity model for serious game design across a wide spectrum of task-oriented experiences, especially when it comes to defining some of the most critical relationships between story, mechanics, and task.

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