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Chapter 10: Game Literacy and Message Design

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Key Points

- *Game literacy* is an understanding of game mechanics, design principles, and gaming's role in culture.
- Instructional message design techniques, principles, and best practices can be used to contribute to a game's sense of immersion.
- Video games use a variety of mechanics to manage cognitive load including, uncluttered screen layout, multisensory cueing, and narrative tutorial missions to scaffold new players.

Abstract

The popularity of video games with today's learners requires that educators and instructional designers develop *game literacy*, or an understanding of game mechanics and design. The purpose of this chapter is to discuss game literacy within the context of instructional message design and to illustrate how video game designers apply and adapt principles of instructional message design to manage cognitive load through an immersive experience. These techniques include customizing the screen to display only necessary information and signaling changes in gameplay through sound cues and cinematic perspective. Game mechanics that foster germane load include tutorial missions and interface design. Similar to a narrative-driven video game, this chapter is divided into "quests" addressing cognitive load theory in video games. Completing each quest "unlocks" heuristics

derived from both educational research and game design. The chapter concludes with a "Boss Battle" against research gaps and challenges, notably the *expertise reversal effect* in game-based learning.

Press Start

Imagine investing $300-$500 in a machine that will overload your senses for hours at a time. If movie tickets seem expensive, this machine plays interactive movies lasting 40-100 hours for an additional admission price of $59.99. You will be immersed in strange worlds, distant planets, medieval fantasy battlefields, and dystopian cities. This machine will require you to perform complex tasks. Some of these tasks are designed to make you fail. Repeatedly. At first. Until you "git gud" at them. In fact, you may become so absorbed in meeting the challenge that you occasionally forget to eat, sleep, or practice good hygiene.

If none of this makes sense to you yet, then welcome - you have just taken the first step in developing your *game literacy*.

Game literacy is a type of *multiliteracy* (Gee, 2007; Sang, 2017) that includes knowledge of game design and mechanics, an understanding of gaming's role in culture, and the ability to "read" a visual medium such as video games (Chen et al., 2020). The New London Group (1996) coined the term *multiliteracies* to refer to the "increasing complexity and inter-relationship of different modes of meaning" (p. 78), including visual and multimodal design. The premise is that different media possess their own unique design languages, which users must learn to be considered "literate" in that medium. Print literacy is no longer sufficient for the modern world, which is inundated with visual and multimedia messages (Gee, 2007). People who play video games similarly learn a new way of interpreting and communicating information (Gee, 2007).

Chen et al. (2020) identified a lack of research into educators' game literacy, but they suggested that educators with high-level game literacy could critique educational games more effectively, motivate students through well-designed game-based learning activities, and develop stronger relationships with their students who also play games. Educators and instructional designers can develop game literacy through the "connoisseur" model by reviewing the classics in

each game genre, critiquing games, and reading both scholarly works and popular criticism from gaming sites (Dickey, 2015).

A game designer's aim is to create immersive experiences (Hodent, 2018; Schell, 2020), just as instructional designers strive to create immersive learning experiences (Parrish, 2009). McDonald (2009) recommended that instructional designers borrow principles from popular media such as film to inform their practices, rather than try to apply "*traditional message design* and instructional design principles to film production" (p. 112-113, emphasis added). This chapter follows McDonald's recommendation and applies his approach to video games, another popular medium in which there are good examples of specialized principles that can inform instructional design (Gee, 2007). The purpose of this chapter is to discuss game literacy within the context of instructional message design and illustrate how video games adapt principles of instructional message design to manage cognitive load through an immersive, aesthetic experience. Educators and instructional designers can apply these same principles from video games across a variety of game-based and more traditional instructional contexts to motivate learners.

Backstory

It's in the Game

There are a variety of ways in which video games can be integrated into instructional contexts. However, even educators who play games as a hobby can be reluctant to incorporate them into their pedagogy (Alsawaier, 2018). One method is to make the game itself the subject, as did a recent college course that used the western game *Red Dead Redemption 2* as an access point to teach American history (Deveney, 2021). Another method is to use educational games, sometimes called "serious games," which are designed to effect changes in attitudes, behaviors, competencies, knowledge, and skills (Hodent, 2018; Jacobs, 2021). Two well-known examples are *The Oregon Trail* (1985) and *Darfur Is Dying* (2006). A third method is gamification, or incorporating game mechanics to motivate learners through strategies such as competitions, points, and badges (Alsawaier, 2018). A recent meta-analysis of gamification studies concluded that these strategies hold promise, but suggested that they

have not yet been used to full effect to foster higher-order learning activities (Sailer & Homner, 2020). Furthermore, gamification has been criticized for being too reliant on external rewards and extrinsic motivation (Hodent, 2018; Kapp, 2012).

While much of the research on game-based learning has focused on strategies, games are popular largely because of the sense of immersion in their virtual worlds (Dickey, 2015). One approach to understand immersive game design is to view it through the lens of instructional message design. Message design has evolved from principles governing the visual presentation of instructional content to encompass the entire sensory and learning experience. Instructional message design has been defined as visual patterns, words, and images that impact learning or behavior (Fleming & Levie, 1993). For Seels et al. (1996), the focus on the visual presentation aspects of instructional message design distinguished it from instructional strategies. Larson and Lockee (2013) noted the historical emphasis on visual design but expressed the need for a more expansive, multisensory approach that included the design of virtual worlds and "aural, tactile, and olfactory messages" (p. 210). The increased focus on the entire sensory experience in instructional message design coincides with the increasingly multisensory experience of video games and augmented/virtual reality (Fisher et al., 2019).

Cognitive Overload

Early arcade-style video games such as *Donkey Kong* (1981) and *Super Mario Bros.* (1985) used fairly simple game design. The player would try to meet an objective within a game world limited to a single screen or level, often involving jumping from platform to platform. The complexity lay in the external constraints the game placed on the player: time limits, number of "lives," and side-scrolling levels that compelled the player in one direction and often pushed them into obstacles. Before video games were ported to early gaming consoles like the Atari and Nintendo, they were designed to take quarters at the arcade. They were difficult, but through repeated practice, and a lot of quarters, one could eventually learn to beat them by timing their actions just right. (Today's professional gamers often revisit arcade classics and try to challenge themselves through "speedrunning," or conducting the fastest, most efficient playthrough). By contrast, newer games, which cost $60 (or 240 quarters), have

already secured the player's money. These games are instead designed to teach players how to play through scaffolding and problem-solving (Gee, 2007). Many newer games encourage exploration, experimentation, and replay. Failure does not equal "Game Over."

As game technology has grown more advanced and realistic, which enables designers to tell stories and create entire virtual worlds (Dickey, 2015), games have evolved into increasingly complex, multisensory experiences with various interlocking systems (Fisher et al., 2019). Players can interact meaningfully with non-player characters (NPCs) or other human players online. They can see the impact of their actions on the game world, bringing prosperity or ruin with their decisions. Some role-playing games (RPGs) and strategy games have entire political and economic systems that players must learn to navigate. Consequently, many elements of modern video games are designed to reduce extraneous cognitive load to focus players' attention on the gameplay and narrative (Hodent, 2018).

Cognitive load theory (CLT) posits that a learner's working memory is dependent on the complexity of the material and the number of interactional elements (Sweller, 2020; Sweller et al., 2019). Effective instructional design facilitates the transfer of knowledge from working memory to long-term memory (Sweller, 2020), where information is stored for later retrieval. Long-term memory possesses much greater capacity because of the ability for learners to store large amounts of information as *schema*, or mechanisms for mental organization and retrieval (Sweller, 1988). Sweller et al. (2019) distinguished three types of cognitive load that can impact the transfer of information from working to long-term memory: *intrinsic*, *extraneous*, and *germane load*. Intrinsic load is determined by both the complexity of the material and the learner's prior knowledge and experience. Extraneous load is determined by how the information is presented and the demands it places on the learner's working memory. Effective message design will reduce extraneous load whereas poor design will increase it and divert the learner's essential cognitive processing resources away from the intrinsic difficulty of the content. Sweller et al. (2019) have refined the definition of germane load as the reallocation of cognitive processing resources *away* from extraneous load and *towards* intrinsic load.

Mayer and colleagues have developed a set of principles derived from extensive empirical research for managing cognitive

load in multimedia learning environments. These include principles for reducing extraneous load (the *coherence*, *signaling*, and *contiguity* principles); managing intrinsic load (the *pre-training* and *segmenting principles*); and fostering germane load (the *personalization* and *embodiment principles*), such as the use of pedagogical agents (Mayer, 2017). Although the principles of multimedia learning were developed and tested using studies in online instructional contexts, Mayer (2017) advocated for future research examining whether these principles apply equally in media such as serious games as well as augmented and virtual reality.

However, many popular video games have already adapted principles of multimedia learning to manage cognitive load and create more engaging experiences for players. These techniques include customizing the screen to display only necessary information (the coherence principle); signaling changes in gameplay through sound, cinematics, or perspective shifts (the signaling/cueing principle); allowing players to compare gear stats quickly (the spatial contiguity principle); providing mission briefings to alert the player to key opportunities (the pre-training principle); and dividing the narrative experience into quests that can be conducted at the player's convenience (the segmenting principle). The opening tutorial mission found in many video games represents a well-known strategy for managing cognitive load and scaffolding new players with germane load. Video games have many more potential applications beyond improving hand-eye coordination, as has been commonly noted.

Pause Menu

Similar to a modern narrative-driven video game, the remainder of this chapter is divided into three "acts" on how video games manage cognitive load for players and scaffold them to success. Each act consists of quests, which open with a concept, principle, or theory of message design and multimedia learning; explain how and why video games use these design principles with specific examples; and then conclude with heuristic "skill unlocks" for educators and instructional designers derived from educational research and game design. "Leveling up" by unlocking new skills is an essential mechanic in many video games (Van Eck et al., 2018). The grand

finale confronts current research gaps and challenges with a "Boss Battle" against the expertise reversal effect (Sweller et al., 2019).

This chapter assumes nothing about the reader's familiarity with video games and game design. Terminology will be defined in context. The more accessible term "player" is used instead of "gamer" to highlight the connection with "play" as a general learning activity (see also Salen & Zimmerman, 2004; Sutton-Smith, 1997; Vygotsky, 1934; 1978). Brief descriptive case studies of popular narrative-driven games in the action, adventure, and role-playing (RPG) genres will be used to illustrate the relevant principles of instructional message design (interested readers are encouraged to visit YouTube to see gameplay examples in action). It is worth noting that the best-selling games each year are frequently first-person shooters (FPS) and esports. These genres will not be represented as thoroughly here - not because they lack instructional value but because other genres better illustrate certain principles of message design. The focus on certain genres underscores the wide variety of video games and gameplay experiences.

Tutorial Mission

A significant contribution video games have made to our understanding of cognitive load and the implications for players is the development of the tutorial mission. A tutorial mission is the introductory level of the game that scaffolds the player by reducing the difficulty, providing hints when necessary, and enhancing their sense of competence through easily achievable objectives (Alexiou & Schippers, 2018). Effective tutorials introduce players to the fundamental mechanics that will prove most useful later in the game when developing generalizations or problem-solving (Gee, 2007). Tutorials are often short but exciting missions and may serve as the beginning of the game's narrative or start in the middle of the action (*in media res*). Rather than teach a complex mechanic superficially through a tutorial mission in which players do no more than "Press X to Jump," effective tutorials invest the player in a meaningful and contextual story mission (Hodent, 2018). Players learn the game's core mechanics within the context of its narrative and are motivated to do so by the compelling action.

There are variations of the tutorial mission that leverage different cognitive load effects, notably the worked example and faded example effects (Sweller, 2020). Worked examples reduce element interactivity and provide learners with the rationale for each step in a problem-solving procedure. According to Sweller (2020), worked examples with explicit explanations are more effective for novices than requiring them to solve problems. Tutorials may first demonstrate for the player how to complete a task and then ask them to perform the task. There may be required criteria for successful completion before the player can advance. Some games periodically return to the tutorial mission format throughout the game to introduce new game systems and mechanics, which reinforces previously learned skills through consolidation (Hodent, 2018) and distributed practice (McCrudden & McNamara, 2018).

Case Study: "A Rock and a Hard Place"

Uncharted 2: Among Thieves (2009) opens *in media res* (Latin: "in the midst of things") with an intriguing, disorienting cinematic cutscene starring intrepid adventurer Nathan Drake, the protagonist players met in the previous game. Drake seemingly sits upright in an abandoned train car, looks at his hands and says, "That's *blood*...that's *my* blood...that's a *lot* of my blood." The growing awareness that he (and by extension, the player) is bleeding profusely from the abdomen immediately piques the player's interest as well as several pressing questions. However, those questions will need to wait because debris suddenly flies across the screen and smashes open the rear door of the train car, revealing the ground far below. Drake is not sitting upright at all, but suspended horizontally in mid-air, and soon follows the debris through the rear door himself and ends up clutching a railing (see Figure 1). The game's camera zooms out and we see a flaming train wreck high in the mountains, the last two cars hanging jackknifed over a cliff. At this point, the player takes control of Drake.

Figure 1
Tutorial Mission from Uncharted 2: Among Thieves *(2009)*

Throughout the mission, the player must navigate Drake to safety by climbing pieces of the hanging train car. The camera pans around as Drake traverses from the side of the train to the undercarriage to keep the player's perspective centered. Just as Drake reaches a gap, the tutorial flashes "Press X to jump" as just-in-time information. Falling debris will periodically set the player back to heighten the stress and introduce additional mechanics ("Hold L in the direction you want to swing and press X to jump"; see Figure 2). Jumping and swinging are two essential skills that players will use throughout the entire game to climb and navigate obstacles. Later in the game, the player will learn to drive vehicles and use weapons, but the tutorial mission is solely focused on these basic survival skills in a suspenseful context rather than presenting irrelevant mechanics (Hodent, 2018). The level gives the player the illusion that they are

racing against time as the train lurches ever closer to falling off the cliff, but the lurches are scripted to occur as the player reaches various mini-checkpoints and are in fact pushing the player toward successful completion. These mini-checkpoints are signaled by both visual and audio cues (Hodent, 2018; Mayer, 2017). The opening tutorial concludes with Drake running through the last train car as it slides off the mountain, making a desperate leap and then collapsing in exhaustion after he crawls to safety. The player can empathize.

Figure 2
Relevant, Just-in-Time Instruction During the Tutorial Mission

Consider how this level has motivated the player through contextual, meaningful action (Hodent, 2018) while simultaneously managing their cognitive load in beginning a new game. Only essential information about basic navigation has been presented in accordance with the coherence principle (Mayer, 2017). The seamless shifts in camera perspective that continuously center the player's view eliminate the need to mentally rotate the screen as they navigate their way around each side of the train. Mentally rotating objects increases the time necessary to perceive them correctly (Shepard & Metzler, 1971), and when hanging from a train car, there is precious little time to expend on extraneous cognitive load. Players receive both visual and audio cues of imminent changes in the game environment, such as smashing glass and machine parts that creak, wobble, and threaten to break as Drake uses them for leverage. In only five minutes, the

tutorial mission has invested players in an exciting mystery, introduced the core game mechanics of climbing and traversal, and taught them skills that will save their (Drake's) life later in the game.

Act I: Reduce Extraneous Load

Quest: The Coherence Principle

Multimedia learning is more effective when extraneous and irrelevant material are removed (Clark & Mayer, 2016; Mayer, 2017). To compensate and reduce extraneous load, many modern games remove unnecessary elements from the visual display. In deciding which systems and Heads Up Display (HUD) elements to incorporate, Hodent (2018) recommended that game developers focus on a few core pillars and mechanics. These mechanics should be challenging to the player because they serve the game's purpose, but extraneous elements and onerous navigation should be removed. Older games often featured various meters on the screen, such as a prominent health bar in the upper left corner. In newer games, taking damage is often revealed not by a draining health bar that draws attention away from the enemy, but by tunnel vision effects such as a red heartbeat and nerve pattern around the edges of the screen or a gradual fading to gray (Figure 3). In *Elder Scrolls V: Skyrim* (2011), the relevant meters for health, magic, and stamina are only displayed when those resources are consumed.

Figure 3
Damage Indicator from Call of Duty 2 *(2005)*

Quest: The Signaling/Cueing Principle

Highlighting essential information through typeface, arrows, spotlights, or callouts leads to more effective learning in multimedia environments (Clark & Mayer, 2016; Mayer, 2017). A special type of signaling/cueing in works of fiction is the *motif*, a repeated pattern, image, sound, or symbol. Motifs can draw learners' attention to essential information or act as cues to connect pieces of information (Taeger, 2020; Taeger & Yanchar, 2019). The use of narrative motifs follows the Gestalt principle of similarity, in which the learner will seek patterns and repetition to orient themselves; motifs also adhere to the principle of previous experience, in which learners will interpret information within the context of prior learning (Lohr, 2008). Each time a motif appears, it further consolidates the learner's understanding (Hodent, 2018). Narrative events in games are often connected through motifs, which can be illustrated in instructional contexts through recurring examples and ideas (Parrish, 2009).

In the specific context of game design, Hodent (2018) discussed the "priming effect," or signaling an imminent change in the game environment through visual cues. This can draw the player's attention

more quickly to a threat or a point of interest. Video games use signaling/cueing techniques of various salience, including arrows, sound/musical cues, haptic/tactile cues, and perspective shifts. Stealth-based games, in which the player's objective is to remain hidden and blend in with their surroundings, cue the player that they are being detected with an indication arrow in the enemy's direction. Once their cover has been blown, the player might notice a dramatic musical change to signal a shift from exploration to combat mode (Hodent, 2018).

Modern game controllers provide haptic/tactile cues by rumbling or vibrating, such as when the player takes damage or drives a vehicle over rough terrain. Some games also use haptic cues when players near an objective or point of interest. This mechanic is often used as a character's mind's eye, enhanced senses, or "instinct." In *Red Dead Redemption 2* (2018), players can use treasure maps to find buried gold and valuables. The maps provide the player with visual clues only (no specific map points or place names), but once the player arrives in the general area, the controller will begin to vibrate. The closer the player gets to the treasure, the more intense the vibrations.

One of the more dramatic visual cues noticeably occurs in third-person perspective games and borrows a cinematic convention. These games often follow the protagonist from a just-behind (*The Witcher 3: Wild Hunt*, 2015) or over-the-shoulder perspective (*Batman: Arkham City*, 2011). The game's "camera" is placed at either a neutral or a slightly high-angle shot (Figure 4). When the player encounters enemies, however, the camera thrusts the protagonist forward into an extreme long and high-angle shot, showing the player their full surroundings, enemies, and the magnitude of the threat that they are facing (Figure 5).

Figure 4
Over-the-Shoulder Perspective in Batman: Arkham City *(2011)*

Note. Notice the just-in-time instructions at the bottom of the screen. The Bat Signal in the distance indicates the next objective in the game.

Figure 5
Perspective Shift During Combat Mode in Batman: Arkham City *(2011)*

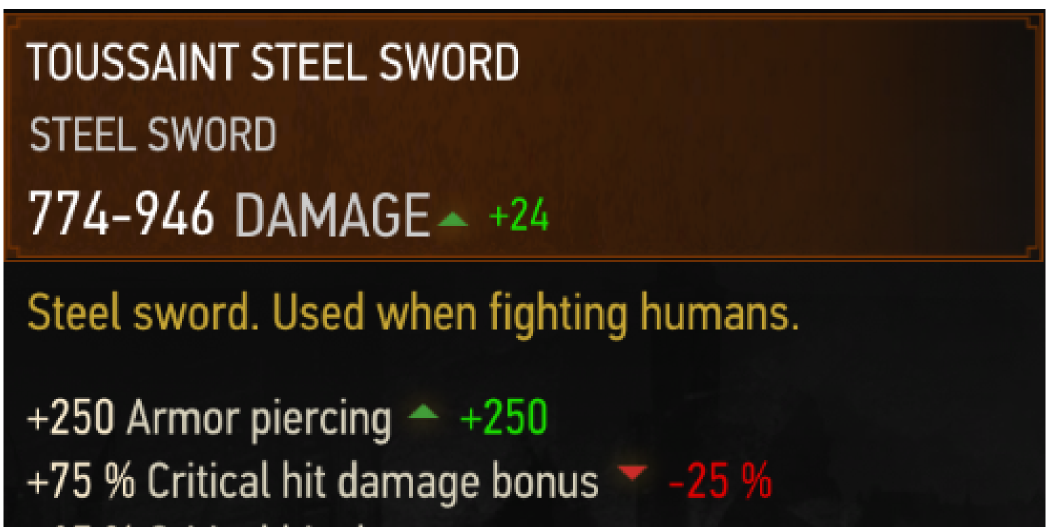
Quest: Spatial Contiguity and the Split-Attention Effect

Placing corresponding text and graphics in closer proximity to each other reduces extraneous load (Clark & Mayer, 2016; Mayer, 2017) and avoids the split-attention effect, in which learners must

mentally integrate two separate sources of information (Sweller et al., 2019). The spatial contiguity principle is useful in games in which players need to compare the stats for two similar items in their inventory. For example, if a player wanted to compare two swords for their speed and damage stats, they might need to equip one sword, jot down the various stats, and then repeat the process with the other sword. To streamline this process, many games use an inventory interface that allows the player to compare currently equipped items against other items of the same type in their inventory. Differences between the two items are displayed through bar graphs or colored up/green and down/red arrows (Figure 6). These contiguous visual displays indicate whether changing items would be an upgrade or downgrade in the player's overall gear strength.

Figure 6

Gear Stats Comparison from The Witcher 3: Wild Hunt *(2015)*



New Skills Unlocked: Extraneous Load Heuristics

Instructional Designer (Lvl. 1)	Use instructional motifs to highlight key concepts and connect ideas (Parrish, 2009; Taeger, 2020; Taeger & Yanchar, 2019).
Message Designer (Lvl. 1)	Integrate multiple sources of information into a single screen/page to avoid the split-attention effect (Sweller et al., 2019). Give the learners a way to compare information as easily as they compare gear stats.
Game Designer (Lvl. 1)	Provide just-in-time information when the learner needs it to complete an authentic task rather than overwhelm them with irrelevant information (Mayer, 2017).

Act II: Manage Intrinsic Load

Quest: The Pre-training Principle

Learners comprehend a multimedia lesson better when they receive pretraining in key concepts and elements (Clark & Mayer, 2016; Mayer, 2017). A comparable function in video games is the "loadout screen" in first-person shooters (FPS) and other action games. In these games players are usually limited to carrying only a few items from their inventory, which requires careful planning and selection. The loadout screen displays the mission map and other potential points of interest to help players develop a strategy before starting the mission. Another example occurs in the *Hitman* series, in which players control globetrotting assassin Agent 47. Each mission opens with a mission briefing by Agent 47's handler, Diana Burnwood. Diana introduces the mission's targets, backstories, and a few areas of interest in the environment that the player can exploit, always concluding with, "I'll leave you to prepare." Armed with this intel, the player then selects a limited number of items that may prove

useful during gameplay. The player is free to explore and adapt during the mission itself, but the pretraining briefing directs their attention to mission objectives and effective strategies to complete them. The mission loadout structure encourages higher-order thinking by requiring players to analyze the mission's parameters and then synthesize and evaluate potential strategies.

Quest: The Segmenting Principle

Content with high intrinsic load is easier for learners to process when segmented into more manageable, self-paced chunks (Clark & Mayer, 2016; Mayer, 2017). One way in which video games segment content is through quests or missions. Narratives in video games, especially in the RPG and adventure genres, use a variety of quest types to tell the story. Educators and instructional designers can adapt the structure and conventions of quests for their message design (Dickey, 2015). Quest types include "fetch/FedEx quests," "escort quests," and "boss battles." In a fetch quest, players are tasked with retrieving an item in the game world and possibly delivering it to another location (Dickey, 2015). Games can sometimes string together several fetch quests to build a larger item that the player needs to complete an objective. Fetch quests are effective at introducing players to a new area and building confidence because they tend to be easier than other types of quests, but they also become tedious when overused (Dickey, 2015). An analogous activity in educational contexts would be asking learners simply to find and retrieve information with little variation.

In an escort quest, players protect a non-player character (NPC) and escort them to another location, usually attacked by enemies at several points along the way. Players assume a more expert role and assist the NPC in achieving their objective, but players often dislike these quests because NPCs are not always well-programmed to defend themselves or be helpful (Cerny, 2015). However, educators and instructional designers do not need to program competent NPCs; instead, they can consider how learners may use their newly acquired skills to help others, further consolidating these skills.

A boss battle is often the culmination of a larger quest line in which players must confront an enemy or guardian using the items and skills they have acquired throughout the game to that point. Bosses grow progressively more difficult, requiring players to

problem-solve and use combinations of both learned and newly acquired skills. Boss battles resemble summative assessments in that players must demonstrate their learning in a new and challenging context.

The length of modern video games, some of which can take dozens of hours to finish the main storyline, has required developers to consider pacing and segmentation more carefully. Depending on the game's complexity, there can be a significant initial downgrading of players' abilities if there are long intervals between play sessions, which can be discouraging for players who have already invested time in learning to play (Hodent, 2018). The challenge is to design the game to accommodate a range of gaming habits, and there is evidence that longer intervals between play sessions may lead to deeper learning of the game's systems through the principle of distributed practice if the game continually reinforces its core mechanics (Hodent, 2018; Kapp, 2012; McCrudden & McNamara, 2018). McCrudden and McNamara (2018) found that distributing learning activities, study, and retrieval practice over time was more effective than "cramming." Hodent (2018) recommended teaching the game's most complex features over time through iterations, reminders, and consolidation. After the player learns one complex skill, they will continue practicing as they learn the next, consolidating the initial skill as they do so. The repetition also helps the player develop schema to interpret the game (Hodent, 2018) and other games using similar mechanics.

Distributed practice's implications for message design includes how best to present previously learned material efficiently but comprehensively such that learners/players can pick up where they left off. One method games use to remind players about previously learned material is to provide quick tips, tutorials, and narrative flashbacks during loading screens (Hodent, 2018). As games have grown more technologically advanced, loading screens have increased in duration, which developers have leveraged as learning and narrative devices (Avard, 2019).

New Skills Unlocked: Intrinsic Load Heuristics

Instructional Designer (Lvl. 2)	Remind learners of information and help consolidate learning between lessons with narrative flashbacks or helpful hints (Hodent, 2018).
Message Designer (Lvl. 2)	Adapt the pre-training principle (Mayer, 2017) into a "mission loadout" briefing to prepare learners before a lesson by highlighting key features and strategies that will enable them to be successful.
Game Designer (Lvl. 2)	Turn an instructional intervention into quests, culminating in a "boss battle" (Dickey, 2015).

Act III: Foster Germane Load

Quest: Pedagogical Agents

Pedagogical agents are virtual coaches who assist with learning and may be animated figures, avatars, or recordings of real people (Clark & Mayer, 2016). The pedagogical agent acts as a "beneficial navigator" (Mohammadhasani et al., 2018, p. 2301). Utilizing the embodiment principle, designers should consider using pedagogical agents who speak, gesture, and react like humans (Clark & Mayer, 2016; Mayer, 2017), which also preserves the sense of a social partnership between learner and instructor in online settings (Mayer, 2017). Pedagogical agents are more effective when they follow the personalization principle and speak conversationally and politely (Clark & Mayer, 2016; Mayer, 2017). Pedagogical agents can promote cognitive processing by serving as social cues (Clark & Mayer, 2016; Mayer, 2017), but there is also an emotional element that learners navigate by developing a connection with the agent. Dickey (2015) discussed the use of pedagogical agents in video games to evoke emotional responses from players and build deeper connections.

Players appreciate characters who are helpful (Cerny, 2015) and with whom they can empathize (Schell, 2020).

Characters in the game world must not only fulfill their roles in the narrative, but also serve as “mini-minions” to achieve the designer’s intentions (Schell, 2020). Using a narrative structure can provide a message design strategy for the instructional arc. One popular structure for understanding narrative design has been the Hero’s Journey/Monomyth (see Campbell, 1949), which has been recommended as a framework for both instructional designers (Dickey, 2015; Parrish, 2008; 2009) and game designers (Kapp, 2012; Schell, 2020). The counterparts of pedagogical agents in video games often include archetypal figures from the Hero’s Journey, allies and sidekicks, and anthropomorphic animals or artificial intelligence (AI). In some cases, the pedagogical agent may even assume an antagonistic role, taunting the player while simultaneously teaching them the game’s mechanics. One such example is the AI operating system GLaDOS from *Portal* (2007).

Clark and Mayer (2016) acknowledged that further research was needed to determine if and when pedagogical agents become too distracting or condescending for learners, which gestures are most effective, and which types of learners may benefit most from using agents. Schneider et al. (2018) found that while adding more anthropomorphic features to an agent, such as hair or eyebrows, increased motivation for some learners, it also increased extraneous cognitive load for learners with low prior knowledge. However, Javora et al. (2018) countered that anthropomorphic features may increase visual complexity but not extraneous load because the changes are limited to one element. Furthermore, Javora et al. argued, anthropomorphism creates “characters,” which can assist learners with recalling the information presented as a story fragment or narrative. Li et al. (2019) concluded that pedagogical agents who used specific pointing gestures led to more effective learning in accordance with the cueing/signaling principle. Li et al.’s findings corroborate Cerny’s (2015) recommendations to make AI sidekicks useful by having them react to the players’ actions and reveal solutions when appropriate. In Mohammadhasani et al.’s (2018) study on the use of pedagogical agents with students with Attention-deficit/hyperactivity disorder (ADHD), students who worked with “Koosha” (Persian for “diligent”)

demonstrated significant improvements in both learning and motivation.

Quest: Instructional Interface Metaphors

An instructional interface metaphor presents information, menus, and navigational cues using a format familiar to the learner (Lohr, 2008). For example, the Home button in many interfaces is symbolized by a house icon, a comforting navigational cue to return to a more familiar place (Cheon & Grant, 2012). Computer desktop interfaces use the *folder* metaphor as an easily recognizable navigation system that also shows relationships between parts (*subfolders* and *files*) and the whole (Hodent, 2018; Lohr, 2008). Other common instructional interface metaphors include *outlines*, *desktops*, and *syllabi* templates. These metaphors are effective because they rely on the Gestalt principle of experience (Lohr, 2008) and existing schemas to which the learner can incorporate new information about what to expect and how to navigate an online course, website, or application.

In video games, the interface metaphor design aims for deeper immersion into the game world (Schell, 2020). Types of interfaces vary depending on the game's genre, and some genres require more substantial interface design (Dickey, 2015). An adventure game may store a player's item inventory in a virtual backpack (Dickey, 2015; Hodent, 2018), whereas RPGs often have more detailed interfaces for the various game systems such as inventories, collected documents, and quest logs (Dickey, 2015). Some games have highly customized interfaces to match their aesthetic. In *Red Dead Redemption 2* (2018), for example, players use a Sears & Roebuck-style catalog to purchase items from general stores (Figure 7).

Figure 7

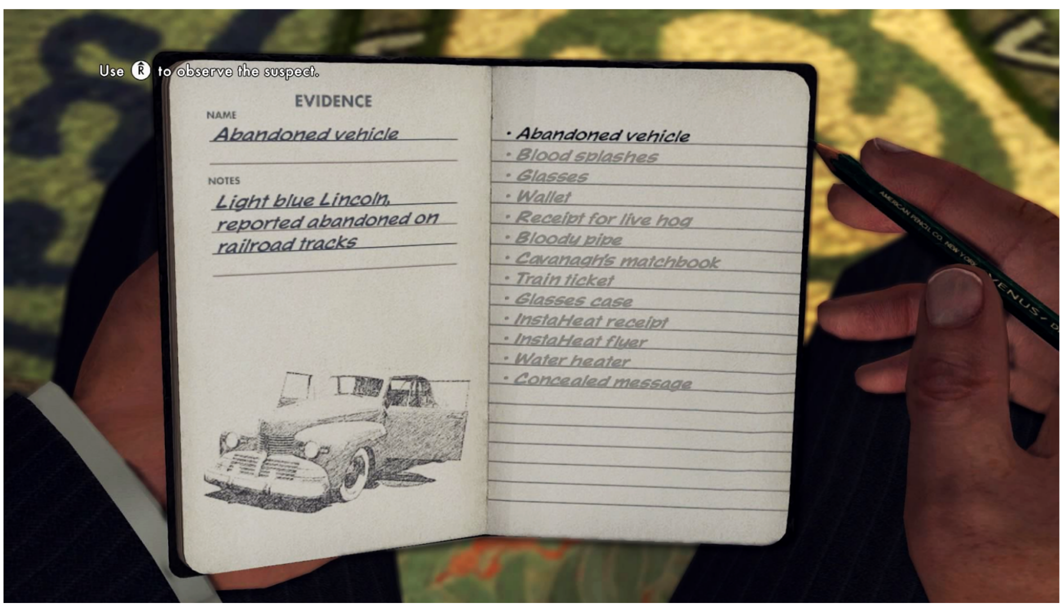
Comparison of the Game Catalog with a Sears & Roebuck Catalog

Note. The video game interface (top) removes much of the text clutter and increases the size of the salient details such as item name and price. It preserves the aesthetic of the original (bottom) but in a more readable format.

The core function of the game interface is to provide essential just-in-time information to the player. Players can typically pause the game at any time and consult the world map, item inventories, skills, controller schemes, and other options and settings. Frequently used interfaces, such as the world map or item inventory, may be accessible during the game with a single button. In the detective game *L.A. Noire* (2011), protagonist Cole Phelps keeps records of his investigations, clues, witness testimonies, and sketches in a notebook throughout the game. Players open the notebook with a single button to determine their next objective and to confront suspects with any evidence they have collected. The notebook contains records of both completed and active investigations, so players can return to previous cases to inform their decisions. The game's notebook drives the storyline and serves as a seamless interface for tracking history, progress, and items (Figure 8).

Figure 8

The Notebook Interface from L.A. Noire *(2011)*

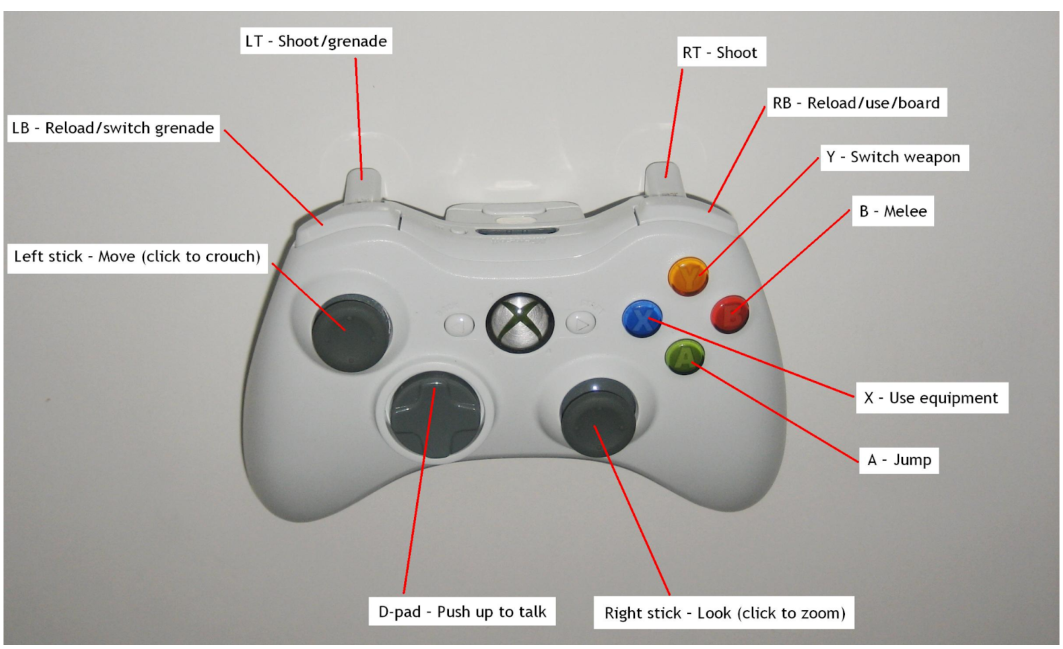


Note. When players select a piece of evidence from the list on the right, Detective Phelps will flip to another page in the notebook with more details. Notice the discreet reminder in the upper left corner that players can look up to observe the suspect's facial reactions and body language.

Effective interface metaphors can assist in schema development (Cheon & Grant, 2012). Just as instructional interface metaphors rely on learners' existing schemas, games likewise use players' prior experiences to present information about their mechanics and systems. Video game designers use common interfaces to help players develop schemas for understanding game mechanics and controls. Control schemes tend to be consistent across genres or in-game activities to capitalize on players' prior experiences and reduce the time needed to teach them the controls (Hodent, 2018). For example, most first-person shooters (FPS) tend to use the same or similar buttons for firing a weapon, crouching, running, and switching inventory items. Playing one FPS and learning the basic controls ensures that players can transfer their knowledge to other FPS games (Figure 9). Players expect similar genres or activities to conform to a standard controller scheme (Hodent, 2018). Using completely different controller schemes and mechanics for different activities introduces too much intrinsic and extraneous cognitive load for players, leading to frustration and negative experiences (Hodent, 2018).

Figure 9

A Typical Controller Scheme for an Action Game



Note. Image Credit: https://upload.wikimedia.org/wikipedia/commons/5/5c/Halo_3_control_scheme.jpg

Effective interfaces reveal the relationships between different parts of a system. An obvious example of using an interface for spatial awareness in games is the world map. Players can access the world map from the Pause menu or consult the mini-map compass in the bottom corner of the screen to get their bearings. The orientation of the mini-map and its relation to the player holds implications for the player's cognitive load. An allocentric mini-map always points North, whereas an egocentric mini-maps shifts in relation to which direction the player is facing (Hodent, 2018). If the mini-map is allocentric and the player is facing South, the player would need to mentally rotate the map 180 degrees to get their bearings. Shepard and Metzler (1971) discovered that participants' reaction times increased in proportion to the number of mental rotations necessary to determine if two presented shapes were the same. Puzzle games such as *Tetris* (1989) use this mental rotation effect to their advantage, often paired with a timer, to increase the challenge and heighten the stress for a player.

Figure 10

Skill Tree from Horizon Zero Dawn *(2017)*

Another example of interface as relationship is the skill tree (Figure 10). As players gain experience, they can spend experience points (XP) to unlock new skills. Unlocking new skills throughout the game is an effective way to reduce the cognitive load for new players and maintain the balance between skill and challenge to help players achieve a flow state (see Csikszentmihalyi, 1990). Branches of the skill tree are usually connected by a broad type of play style, such as Combat, Stealth, and Magic. Skills in each branch are usually linked sequentially or at least clustered by proximity (Lohr, 2008) so that players must work towards more powerful and useful skills by unlocking lower prerequisite skills. Based on their skill tree schema, players expect to unlock skills in a certain order (Hodent, 2018). Similar to how a tree grows, skills unlock from bottom to top (or top to bottom). If a skill tree does not follow this pattern, then the interface must include other visual cues such as contiguity and proximity to show the progression of how skills unlock.

Interface metaphors provide the player with not only information but also feedback in the form of judgment of their skills, rewards for their progress, and motivation for their next challenge (Schell, 2020). Van Eck et al. (2018) drew a parallel between health meters and inventories as types of assessment in which low values could prompt players to improve in those areas. In *The Sims 3* (2009), for example, player needs are represented by meters for attributes such as *Hunger*, *Comfort*, *Fun*, *Hygiene*, and *Bladder*. If the meter changes from *Green/Full* to *Red/Empty*, then the player needs to take appropriate actions to boost the meter back to green. Game designers strive for "juiciness" in their games, or redundant multisensory feedback for players' actions (Hicks et al., 2019; Schell, 2020). Audio feedback is often more "visceral" than visual feedback and can simulate touch more effectively (Schell, 2020, p. 434). Since many game controllers rumble and vibrate, a player may receive visual, auditory, and tactile feedback for their actions simultaneously.

Designers must take care that interface metaphors do not interfere or actively conflict with the intended message through too much juice. Hodent (2018) described a gaming phenomenon known as "red overload." Recall that modern games often present the damage meter through red tunnel vision that encroaches from the edges of the screen. Red also signifies threats because the color tends to contrast well with other colors in a game environment. In games where teams

may be represented by blue and red, in which Team Red will recognize fellow members as red icons, the increasing red overload can interfere with a player's perception of their fellow teammates, incoming threats, and damage. For a comparable instructional effect, imagine a PowerPoint presentation that used red text, red highlights, and red arrows to call the learner's attention to essential information.

When developing an interface metaphor, the designer must also ensure that learners can interpret the metaphor correctly in context. Some computer and media interface metaphors reflect the experience of the programmers rather than that of the users and can be overly technocentric and indecipherable (Lohr, 2008). Learners may not have the requisite experience to make sense of the metaphor or understand how it connects information (Lohr, 2008). Conversely, learners may have the requisite experience to understand the metaphor but misinterpret it in context because it functions differently. For example, a magnifying glass is recognizable for its *search* or *examine* functions, but learners may instead perceive the magnifying glass in its *magnification/zoom* usage (Hodent, 2018).

The interface metaphor must present necessary information clearly and unambiguously, using the learner's prior experience as an access point. The interface itself should also not introduce any extraneous load that can interfere with the learner's processing and interpretation of content. Schell (2020) argued that the best interfaces are invisible and foster deeper immersion. The aesthetic and thematic uses of interface metaphors in video games illustrate sound message design principles that can be applied to instructional design. Games thrive on experimentation and a customized interface can reinvigorate the gaming experience (Schell, 2020). While some instructional interface metaphors may be more familiar to learners, consider developing an interface that complements the design's aesthetics and the essential concepts that learners should understand.

New Skills Unlocked: Germane Load Heuristics

Instructional Designer (Lvl. 3)	Provide the learner with a clear navigational path that clearly illustrates the parts in relation to the whole (Lohr, 2008). Meaningful interface design can support schema development in learners (Cheon & Grant, 2012).
Message Designer (Lvl. 3)	Design the learning interface to match the aesthetic and theme of your narrative structure (Dickey, 2015) using a metaphor familiar to your learners (Cheon & Grant, 2012; Lohr, 2008; Schell, 2020).
Game Designer (Lvl. 3)	Create a pedagogical agent as a mentor or sidekick to learners in their learning quest with whom they can build an emotional connection (Dickey, 2015; Parrish, 2009).

Boss Battle: "The Expert"

Although a large body of research has supported cognitive load theory (Petko et al., 2020), there are still gaps regarding the measurement of different types of load, its effects on different types of learners/players, and how it manifests in different game elements. De Jong (2010) challenged whether the three types of cognitive load could be empirically distinguished from each other. Intrinsic load is dependent on several variables, including the learner's knowledge base and element interactivity (Sweller, 2020), which makes total cognitive load nearly impossible to estimate (Hodent, 2018). Game designers extrapolate estimations of cognitive load through UX (user experience) testing that measures eye movement, reaction times, and qualitative survey data (Hodent, 2018). However, qualitative collection techniques such as surveys can be unreliable and physiological tests can be intrusive (de Jong, 2010).

The use of games and gamification strategies may benefit some students to the disadvantage of others without careful, intentional design that accommodates learners with various levels of game expertise. In a study conducted by Lee and Heeter (2017), gaming experts experienced a false sense of understanding when playing an educational game because they relied on their pre-existing schema for game mechanics instead of attending to the educational message and particularities of the new game. One of the major exceptions addressed in cognitive load theory and the principles of multimedia learning is the *expertise reversal effect* (Sweller et al., 2011). Strategies that may benefit learners with little experience may also impose increased extraneous load on experts and consequently diminish their performance (Sweller et al., 2011). In the study, gaming experts with high working memory were less likely to use the game's help functions than their non-gaming counterparts with comparable working memory (Lee & Heeter, 2017). Lee and Heeter (2017) recommended that game designers integrate educational content into the game's mechanics as well as the narrative to ensure that gaming experts direct resources to processing the unfamiliar educational content.

Different game elements may result in different cognitive load effects. Complex, multisensory video games with visual effects, dialogue, sound effects, and musical soundtracks increase perceptual load, or the resources needed to process sensory information (Fisher et al., 2019). Fisher et al. (2019) found that increased perceptual load in the visual or auditory channel increased reaction times within the same modality only, but increased extraneous cognitive load increased reaction times across modalities. Therefore, increased visual load (such as flashing lights or fog) should impact reaction times to visual cues without significantly impacting reaction times to audio or musical cues, which is likely the intention of the increased visual load for the gameplay experience. Extraneous cognitive load, such as reversing the directional controls to convey disorientation, will impact reaction times in both modalities. The speed and pacing of a level can also affect players' perceptions of cognitive load. Petko et al. (2020) identified correlations between the speed of a vertically scrolling educational game with learners' achievement and perceptions of load. Faster pacing led to a perception of increased intrinsic load even though the game's content had not changed, and slower pacing was

considered distracting and increased extraneous load. Petko et al. (2020) suggested that games may be more complex than other types of media and that the results of changing variables such as pacing can be more difficult to predict.

Video games have applied principles of multimedia learning and cognitive load effects to both scaffold and engage players. However, designers must recognize that estimating cognitive load requires analysis of the learners and their prior knowledge. Educators and instructional designers using game-based learning strategies must also be careful to ensure that educational content is delivered through both the game's content *and* mechanics so that learners are neither advantaged or disadvantaged by their level of gaming expertise.

New Game?

Game-based learning and game design does not require any specialized knowledge of programming or technical expertise (Dickey, 2015; Kiili & Tuomi, 2019). Educators can instead consider low-tech and middle-tech approaches (Van Eck et al., 2018). The availability and easy use of flashy visuals in many educational apps can lead to increased extraneous cognitive load, but using a well-designed low-tech option instead can both enhance the message and increase learners' access to it (Larson & Lockee, 2013). Educators and instructional designers can also use principles of instructional message design adapted from video games to enhance more traditional instruction without needing to create materials as visually or interactionally complex as video games.

Van Eck et al. (2018) stated that video games are an effective medium for promoting situated learning and problem solving, but that these benefits were also often oversimplified. Studies have consistently demonstrated that gamification and game-based learning can lead to small, yet significant gains in cognitive, motivational, and behavioral outcomes (Sailer & Homner, 2020). To achieve greater effect sizes from using game-based learning strategies, the answer may lie in shifting our attention from surface-level strategies in video games towards deeper principles of instructional message design by following McDonald's (2009) challenge to the instructional design field to adapt what examples from popular media do well. Instead of

relying on gamification strategies such as points and badges, games can be more effectively used by considering the immersive player and learner experience (Hodent, 2018). An immersive experience is better elicited through careful, intentional use of instructional message design principles that also enable the learner to be more successful.

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