Learning to Play, Playing to Learn: An Integrated Design Approach for Learning Experiences in Video Games

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Abstract

This paper outlines an approach for task and challenge design in video games to integrate the learning experience with the playing experience in systematic and testable ways. After introducing basic game-based learning processes in the context of an updated flow model, the approach is outlined from assembling learning outcomes (typology) to applying a learning organization (taxonomy) to creating learning opportunities (tasks and challenges), which can then be empirically tested during development by, e.g., methods of rational level/rational game design.

Keywords: *game design, game-based learning, challenge design, task design*

1. INTRODUCTION

While academic research into learning and teaching with video games traditionally focuses on games that are specifically designed for educational purposes, there is also a growing corpus of research that attests to the high learning and teaching potential of commercial video games for an expansive range of topics [1][2][3][4][5]. The reason is that to win or beat a game or play it well, players need to overcome challenges, and to overcome challenges, players need to learn all the time. Under this premise, the motivation to play equals the motivation to learn.

2. LEARNING IN GAMES

Along an updated version of the flow model, this section introduces both the basic nature of the game-based learning process and the basic set of conditions that define the player's learning experience.

2.1 Learning through constant challenge

To motivate players to keep playing and learning, a game must provide the just-right amount of challenge at all times. This just-right amount of challenge is not identical with a game's baseline challenge. The baseline challenge depends on the target audience; it can be very low, like most idle games [6][7], or very high, like most bullet hell games [8]. The just-right amount of challenge is built upon this baseline challenge. The flow model [9], originally developed by Csíkszentmihályi Mihály and subsequently expanded upon by himself and others, is probably the best-known and most widely applied model to support the right amount of challenge across learning processes.

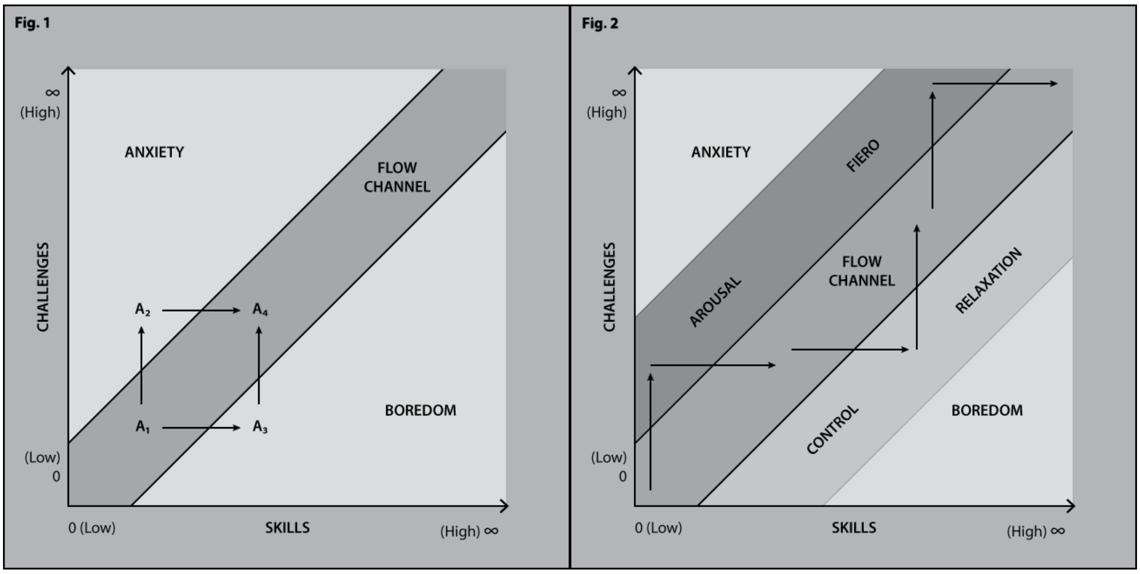

Figure 1: Adapted from: Csikszentmihalyi Mihaly. *Finding Flow: Psychology of Engagement with Everyday Life*. New York: Basic, 1997.

Figure 2: Adapted from: Csikszentmihalyi Mihaly. *Finding Flow: Psychology of Engagement with Everyday Life*. New York: Basic, 1997. Integr. research from Qin, Hua, Pei-Luen Patrick Rau, & Gavriel Salvendy. "Effects of Different Scenarios of Game Difficulty on Player Immersion." *Interacting with Computers* Vol 22, Issue 3. May 2010. 230–39; Lazzaro, Nicole. "Games and the Four Keys to Fun: Using Emotions to Create Engaging Design." AIGAdesign, 2016. https://www.youtube. com/watch?v=EEmNRRRqgNc

Fig.1 shows the flow model's basic mechanics. "A" represents "Alex," who is learning to play a game. Alex wants to avoid both anxiety and boredom because neither are positive experiences. To avoid these negative experiences, Alex's only available choice, barring the decision to quit playing altogether, is to return to the flow state. Thus, Alex is highly motivated to do just that. For game design purposes, this translates into the general task of providing well-crafted tiers of challenges with difficulty levels that increase in systematic ways. *Fig.2* shows a version of the flow model that incorporates research into player motivation and player emotion. Player motivation, by means of "immersion," is more likely to be sustained when difficulty levels are raised not continuously, but in up-and-down patterns [10]. These up-and-down patterns yield advantages on both sides of the flow channel. One the one hand, it unlocks the emotion of "fiero," the overwhelming feeling of accomplishment that includes emotions like triumph, pride, or relief [11][12], which can only be experienced when, at the beginning of the task, the difficulty level is perceptibly above the player's current skill level. On the other hand, the player can find relief in between and enjoy hard-won increments in proficiency by falling back to "control" and then to "relaxation." Both control and relaxation, for a time, are perceived as positive experiences by players, particularly at higher skill levels [13].

2.2 Defining the learning experience

To design and control both a game's baseline difficulty and its just-right amount of challenge over the course of the game, six conditions need to be considered that define the player's learning experience. These conditions are the *skill spectrum*, *skill threshold*, *skill maximum*, *skill progression*, and the *difficulty preferences* and *density preferences*.

The skill spectrum defines what the player needs to learn over the course of the game in terms of skill, knowledge, understanding, and attitude. These components are discussed below. The skill threshold—a term commonly used for a game's minimum requirements in player skills, often also called skill floor—defines how hard it is to start playing and enjoying the game. While this condition is closely connected to the game's baseline challenge, it cannot be solved for all potential players, however well-known and well-researched the game's target audience is. Besides difficulty, familiarity with game types also needs to be considered [14]. Generally, the threshold design challenge largely disappears when the opening levels are interesting for reasons other than difficulty. The skill ceiling—a term commonly used for the game's attainable levels of mastery, often also called skill maximum—defines whether players can keep learning and become better at playing the game indefinitely, or if, from a certain skill level on, further learning no longer makes a difference. The skill progression condition distributes difficulty levels over the course of the game and its dramatic units, from the skill threshold to the skill ceiling, if there is one. These can be plotted as learning curves, also discussed below. Then, there are the game's difficulty and density conditions. The difficulty condition defines if, how, and at which degrees of freedom players can select, adjust, and actively pursue different levels of difficulty—both as presets and through actions and decisions during gameplay, both with or without dynamic difficulty adjustment [15]. The density preferences, finally, determine how many challenges the player will be confronted with at any one time. Besides other design strategies, this condition is often adjusted in consonance with actual player behavior during gameplay [16].

3. TYPOLOGY: LEARNING OUTCOMES

As stated, the skill spectrum defines what the player needs to learn over the course of the game. While this condition is commonly called skill spectrum, it comprises not only skill, but knowledge, understanding, and attitude. This section introduces these four components of the skill spectrum and discusses why learning outcomes should take precedence during the design process over the creation of tasks and challenges.

3.1 Skill, knowledge, understanding, and attitude

To design learning outcomes for a game effectively and efficiently, these outcomes should be structured according to a qualification typology. This paper suggests a broadened KSA model [17] which distinguishes between *skill*, *knowledge*, *understanding*, and *attitude*.

Skill is a repeatable, observable performance, judged against proficiency, expertise, competence, and similar criteria. Knowledge comprises recall and recognition of facts and procedures. Understanding is the ability to comprehend abstract concepts and complex processes and apply knowledge in new and different circumstances. Attitude, finally, denotes changed or adapted behavior. The practical differences between these components can be briefly illustrated along the game of Go. Being able to win matches is skill. Knowing the difference between *gote* and *sente* is knowledge. Being able to reliably tell good *shape* from bad shape is understanding. Attitude, finally, is to advance from more passive play to *kiai* [18]. All four components, as this example shows, have only weak dependencies, if at all. That way, they structure the design process for learning outcomes without impeding on imaginative configurations and creative freedom. Nor need these four components be balanced in any way—which of them are used, and how frequently they are used, should solely be a function of the game's type and intended playing experience.

3.2 From outcomes to tasks and challenges

Subordinating the design of tasks and challenges for the player to the design of learning outcomes might not seem intuitive. Thus, to demonstrate that the design process will benefit from this approach and produce interesting and relevant tasks and challenges in systematic ways, its four basic steps will be outlined and illustrated with a final boss example.

First, based on the game's target audience, its type, and its intended playing experience, everything the player needs to learn over the course of the game to master or win the game is assessed and categorized according to the applied typology, in this case skill, knowledge, understanding, and attitude. As a second step, each learning outcome is broken down into individual learning objectives: the skill increments the player has to learn; the pieces of knowledge the player has to acquire; the individual insights that will lead to understanding; and the build-up of experiences that lead to changes in attitude. Optionally, this step can be supported by a learning taxonomy for richer details, to be discussed below. Then, in a third step, these learning objectives are plotted as learning curves and distributed, piece by piece, across the game's dramatic units. During the fourth and final step, all these individual learning objectives are turned into learning opportunities for the player in the form of specific tasks and challenges that match their respective dramatic units' contexts, requirements, and intended playing experiences.

To illustrate this process, a cliff that seems impossible to scale is assumed to be the final boss in a game. In the first step, everything the player needs to learn to be able to accomplish this task is assessed and subsequently broken down into learning increments. For example, using a grappling hook is a skill increment; judging which holds will probably break and which are safe is a piece of knowledge; appraising the cliff on the whole to calculate a reasonable route is understanding; charging difficult stretches aggressively with a series of combos instead of advancing slowly and hesitatingly is an attitude change. These incremental learning events are then plotted over the game's dramatic units as learning curves and then attached to engaging tasks and challenges for the player. Approaching the design process in this manner, every single task and challenge the player encounters is relevant for the intended playing experience, testable, and shaped in accordance with the game's overall structure.

4. TAXONOMY: LEARNING ORGANIZATION

Optionally, the design process introduced above can be supported by a learning taxonomy to add both variety and depth to the playing experience. Two different taxonomies are outlined in this section, Gardner's Multiple Intelligences model and Bloom's taxonomy.

4.1 The taxonomies of Gardner and Bloom

Both Gardner's Multiple Intelligences model [19][20][21] and Bloom's taxonomy [22][23][24] are viable choices to support task and challenge design. While there are substantial differences between these two models, the most important factors for the purposes of game design are that Bloom's taxonomy is more empirically sound [25] and Gardner's model is more easily applicable. Accordingly, Bloom's taxonomy is by and large a better choice for the design of educational games, especially those intended for the classroom. For non-educational game design, Gardner's model is by and large the better choice because it is readily adaptable to game design methodologies, yet still sufficiently detailed and sufficiently comprehensive.

4.2 Applying learning taxonomies to the design process

Learning taxonomies classify and organize learning objectives into specific categories to structure these objectives and assess learning outcomes. For the design process, taxonomies assist in recognizing the complexity of individual tasks so that learning opportunities can be designed more judiciously; they support the playtesting process by making the assessment of player progress toward skill, knowledge, understanding, and attitude more precise; and they enrich the playing experience through tasks and challenges that are more engagingly complex, more diverse, and carefully calibrated.

Bloom's taxonomy differentiates between the cognitive, affective, and psychomotor domain, each with extensive subdivisions—from remembering to creating in the revised cognitive domain; from empathic and emotional awareness to the commitment to values and character formation in the affective domain; and from sensory perception and selection to assembling, executing, modifying, and originating skill- and action-based performances in the psychomotor domain. Gardner's Multiple Intelligences model differentiates between linguistic (verbal) intelligence; musical intelligence; logical-mathematical intelligence; spatial intelligence; bodily-kinesthetic intelligence; interpersonal (social) intelligence; intrapersonal intelligence (understanding of self); and naturalist intelligence (the capacity to make consequential distinctions and recognize patterns). Either model is able to assist in designing learning objectives, preparing playtest setups, evaluating test results, and enriching the playing experience.

5. LEARNING OPPORTUNITIES

Eventually, learning outcomes are transformed into learning opportunities, i.e., tasks and challenges the player must face and overcome to master or win the game.

5.1 Physical, cognitive, and empathic tasks

Explicitly or implicitly, conceptual development generally refers to the three major task categories as player actions, puzzles, and interactive storytelling, or similar. To make the categorization of learning opportunities more compatible with learning outcomes and learning taxonomies, this paper proposes to refer to these categories as physical tasks, cognitive tasks, and empathic tasks. The term “empathic” is selected over “affective” to acknowledge that interactive storytelling, particularly in the form of interactions with non-player characters, focuses less on value and character formation than on empathic and emotional awareness, i.e., understanding the motivations, intentions, and sentiments of non-player characters and other players to solve tasks and challenges.

Physical tasks are primarily connected to skills and knowledge and mainly require control, coordination, and endurance. A physical task can be to defeat an enemy in combat; jump from one moving platform to another; or steer a vehicle through an obstacle course. Cognitive tasks are primarily connected to knowledge and understanding and mainly require memory, analysis, and evaluation. A cognitive task can be to find a way to open a locked door without brute force; line up a row of symbols in the right way to open a crypt; or figure out how troops should be moved to outflank an opponent. Empathic tasks are primarily connected to understanding and attitude and mainly require cognitive, emotional, and compassionate empathy—grasping a character’s emotional state; feeling with that character; and actively helping that character, respectively [26][27]. An empathic task can be, over and above purely strategic reasoning, to grasp a character’s motives or intentions and act accordingly; decide which party to join in a conflict; or consider the consequences of one’s actions not only for oneself, but also for others.

5.2 Task design parameters

With the possible exception of experimental, educational, or art games, the most basic design parameter for tasks and challenges is to make these tasks and challenges solvable for the player. This is primarily a matter of well-designed and meticulously tested learning curves. Another basic design parameter is to ensure that a task or challenge is consistent, both within the immediate context of the dramatic unit it belongs to and the game as a whole, possibly its theme. The third basic design parameter is to make tasks and challenges easily recognizable so that the nature of the challenge is not in itself a challenge, except when intended. As a fourth, but entirely optional, basic design parameter, tasks and challenges can be elastic, i.e., solvable in different ways or at adaptable difficulty levels or both.

5.3 Task modeling and playtesting

The categorization of player action, puzzles, and interactive storytelling into physical, cognitive, and empathic tasks, as proposed by this paper, is conceptually similar to the categorization into physical, mental, and social tasks by what is generally referred to as either rational level design or rational game design [28][29]. Conceptual differences between these two categorization schemes notwithstanding, both are well-suited for the rational level design or rational game design approach. Broken down into its smallest constituents as learning outcomes with their associated tasks and challenges, perhaps even broken down further with the help of a learning taxonomy, the game's entire learning process, from learning curves to the playing experience, can be empirically tested and fine-tuned at every step of the development process.

While the game's learning curves should be perfectly balanced with the game's dramatic structure and other important design elements, the learning curves as such cannot and should not be perfectly smooth, as discussed above in the context of the extended flow model. Instead, they should display both ridges and troughs to facilitate experiences of stress and fiero on the one hand, and relief and control on the other, in consonance with parameters like game type, game length, target audience, and the intended playing experience.

6. CONCLUSION

Working with this integrated design approach, player progress and learning experiences can be seamlessly integrated into the overall design process and the playing experience, all with several layers of control. Every assumption and every decision lends itself to rigorous empirical testing. Individual design decisions always relate back to the game's type and scope, the qualifications and expectations of its target audience, and the intended breadth and depth of the learning experience as an integral part of the gameplay and the player experience as a whole.

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