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Enhancing Player Engagement in Games using Design Patterns

Prof. Ganesh Shelke[1], Prof. Mahesh Bhandari[2], Kanhaiya Sulay[3]
Department of Information Technology, Vishwakarma Institute of Technology, Pune,India

Abstract: ***The video game industry is one of the fastest growing and most competitive areas of creative activity, and the challenge of keeping players involved far beyond the initial digital experience and decreasing player churn continues to be one of the consistent concerns of developers. Many games acquire players quickly, but struggle to keep them engaged over long times due to the absence of a plan that creates an ordered, systematic approach to player retention. In this paper, we maintain that there can be a practical and efficacious design related solution to decrease player churn by creating an ordered approach through the use of game design patterns that have been well justified in the game design or player interaction literature.***
Looking directly at patterns and their potential for fostering player psychology, motivation and interaction a more careful scripted application of patterns has profound implications on player experience building engagement. Illustrating in this article how patterns can facilitate or formalize the developers efforts to create more orderly approaches to engagement increases the experience and provides better opportunities to create more meaningful, rewarding - fun gameplay. Ultimately, the use of game design patterns provides opportunities to create more engaging, interactive and immersive experiences that greatly contributes to player satisfaction and long term engagement.
Keywords: Player Engagement, Game Design Patterns, Psychology, Motivation, Video Games, Game Development, Game Engine, Unity, Retention.

I. INTRODUCTION

Growth potential and a competitive developer market go hand-in-hand within the video game industry. Indeed, new technologies have made it even easier for studios to use advanced tools in graphical development, complicated gameplay design, and creating complex virtual worlds. Today's games very often boast marvelous graphics and years of hard work in programming, technical work, and advanced game mechanics. Even as developers and studios make high-quality games, and technology and tools help them build rich experiences, a pressing issue appears in both the community and industry: how long can players be expected to stay interested in the game? The majority of titles manage to catch attention at first, when they are new, but interest often turns into boredom shortly after. This gap suggests there is a serious problem in game design. Game designers know how to build goals, novel ideas, and systems, yet players play for shorter and shorter lengths of time. One major reason for the decline in interest is the inconsistent and unstructured approach to keeping players engaged in current game design. Most design grids or development practices do not provide a complete model of how players think, feel, and act over time. Without clear strategies to outline and apply game mechanics and how they connect to human motivation and engagement, even the best experiences and technologies will fail to create emotional and cognitive engagement. This study tells about how the use of proper design pattern can contribute in enhancing the player engagement in game. When proper design patterns are used it also helps developers for adding new features dynamically in already existing game.

II. LITERATURE SURVEY

In science research on games and software engineering, there are two streams of interest: (1) game design patterns and their impacts on gameplay; and (2) software design patterns and systems, in addition to adaptive techniques, that offer maintainable and flexible implementations while also having features that could potentially increase engagement.

A. Foundations: design patterns (games & software)

Similar interactive structures and mechanics that creators use to create consistent, meaningful features of gameplay are called game design patterns. The work of Björk & Holopainen makes game design patterns useful and provides a language for discussing gameplay interactions while also demonstrating how game design patterns shape player experience and affordances. Björk and Holopainen have received citing support for their work to describe interactions as feedback loops, reward structures, pacing structures and so on. [2]

Furthermore, the classic software engineering "Gang of Four" book describes several patterns of object-oriented design (Observer, State, Decorator, Command, Strategy, etc.) that address shared implementation problems (e.g., create flexibility, loose coupling, extensible) in a software system. Patterns and patterns are the language developers use to build those games features discussed from a game-design perspective. Some of their principles (e.g., "program to an interface") may make it easier for developers to extend game mechanics without fragile code changes, which is an important need to iterate gameplay for increased engagement. [1]
Takeaway: Game design patterns describe what interaction to add for engagement; software patterns describe how to implement that interaction clearly so it can be turned and extended.

B. Methods of Engagement: Gamification, and Reward Mechanisms

There exists a large body of empirical research, as well as work exploring gamification elements (points, badges, leaderboards, feedback loops), and their effects of motivation and engagement. According to the literature review by Hamari et al, an evidence synthesis of different empirical literature, gamification generally has a positive effect on engagement although they vary in their effect depending on context and implementation. This means that simply adding game elements is likely to improve engagement - however, only if those design elements support the players goals and context. [6]
To sum up: merely adding gameful elements is not enough, those elements must be supportive of gameplay flow and accompanied by strong implementation to avoid the participant being taken out of an immersion experience.

C. Systems that adapt and difficulties in tuning (dynamic difficulty)

Dynamic Difficulty Adjustment (DDA) represents an explicit approach that seeks to keep players in the "flow" zone (neither bored or frustrated and in the proper zone) by adjusting challenge when they are playing (real-time). Hammit's work "Hamlet" has successively illustrated both theoretical requirements to DDA, as a system-level approach to engagement, as well as some explicit guidelines for practice systems-level approach to engagement, as well as some explicit guidelines for practice implementation implications. They found that DDA can have a higher levels of engagement with play if the DDA is well-designed, and challenge is balanced through the systems preservation of perceived fairness. A recent review of DDA and experimental papers illustrates algorithmic DDA and and AI personalization design with AI-based engagement. [8]

D. Empirical research and recent studies finding connections tying patterns to engagement

Empirical research has largely focused on adventure-style level progression, patterns of level design, adventure play, and measures of audience engagement while focusing on contemporary indie games or mobile games. The studies provide insights into how induced adventuring, modes of play that are largely repeated encounters, explorations of engagement, precise patterns of level design, integration patterns of play and engagement contribute to audience engagement. These studies ultimately demonstrate adventuring patterns while exploring engagement levels, game play patterns utilizing clear loops to engage players in games, and layer skill development of play while conveying meaningful systems of progression. This research easily builds further support for the declaration of order and structure in games that utilize a pattern-based structure in the levels of design present in game play as an engagement among the gaming category or genre. [9]
The previous literature indicates that both game design patterns and software design patterns are relevant to player engagement. Gamification and adaptive difficulty have been shown to empirically increase motivation, but there is limited work that connects software design patterns (Observer, State, Decorator, and so on) with observational measures of engagement. This is the motivation for this work in the study reported in this paper.

III. METHODOLOGY

This study investigates how software design patterns can influence player engagement in video games through a qualitative and analytical approach. This includes the identification of relevant design patterns, the linking of these patterns to psychological mechanisms of engagement, and the examination of examples from commercial games where these patterns can be clearly identified. The focus of this research is to understand concepts and apply design patterns in such a way as to achieve higher engagement, motivation, and retention by studying existing games rather than creating prototypes.

1) Step 1: Choosing Relevant Game Design Patterns

The first step is to select software design patterns that can impact player engagement. Each of these pattern has its own significance in terms of game development.

Observer Pattern: This pattern helps to provide immediate feedback and response to the player. Helps to keep player motivated and engaged in game. This pattern also helps to track the achievements of the player in the game.
State Pattern: This pattern helps to update player states and powers in real time. Example if player is in air state it cant jump, similarly if player is in water state it cant shoot the bullets through gun, all these actions and protocols are possible through the use of state design pattern.
Decorator Pattern: This pattern helps to add-on new features and powers to the player in real time progress. This keeps player motivated and engaged as he gets to see the constant rise in his progress through real time power increments.

2) Step 2: Mapping Design Patterns to Engagement Mechanisms

In the second phase of the study, the study links the functionality of each design pattern, to psychological and behaviorist ideas that drive engagement. This phase is relevant for ensuring that a technical understanding of each pattern is also related to human motivation, emotional engagement, or cognitive flow.

Observer Pattern → Instant Feedback and Motivation

Games built on the Observer pattern notify players immediately when there is a change, update, achievement or failure. Instant feedback links closely to concepts within reinforcement learning and motivational psychology. Players remain more alert, engaged, and motivated to keep engaging in a game at the moment when relevant and timely feedback is given.

State Pattern → Dynamic Difficulty and Flow-preservation

The State pattern prevents a player from changing to a state that elevates the level of challenge. Managing progression, difficulty level, and game state offers frequent opportunities for a player to remain in a state of "flow," or balance of challenge and skill as a player has the ability to adjust their chosen mode to achieve a desired level of challenge. As the player improves, when the difficulty level matches the player's improvement, frustration and boredom are lessened, ultimately increasing engagement and long-term retention.

Decorator Pattern → Feature Extensions and Opportunities for Replayability

The Decorator pattern offers developers the ability to incorporate features (new items, abilities, or enhancements) into gameplay that keeps the gameplay experience new and fresh without reconstructing or designing new features within the game application. Creating new features and gameplay adds activities for players to return, experiment with novel strategies, and return to a game over and over again. The incorporation of new feature opportunities can increase retention of the gameplay experience.

3) Step 3: Example Case Studies from Existing Games

The next step is the analysis of popular video games that demonstrate, in practice, how design patterns are applied. Such examples will provide a means to explain how these design principles function within the game-playing experience.
Candy Crush (Observer Pattern) Feedback is immediate in Candy Crush to show when the player actually reaches a certain milestone, be it earning rewards or unlocking new levels. These instant updates can trigger a dopamine response, creating a cycle of temporary feedback that encourages players to keep progressing.
Temple Run (State Pattern): Temple Run differentiates between different states of progression within its endless runner genre. The more the player runs, the tougher it gets. There are a number of states of play: normal running, power-up state, and escaping near death. These changes create excitement and maintain the flow of the game.
Puzzle Games (Decorator Pattern): Most often, puzzle players are given power-ups or boosters that infuse variety into their gameplay intensity, such as bombs, hints, or special abilities. These additions enable players to enhance their experience, use new strategies, and stay more engaged without changing core puzzle game mechanics.

4) Step 4: Analytical Discussion of Engagement Impact

Once you have identified and mapped patterns to principles of engagement, you would next conduct a detailed analysis of how each design pattern contributes to engagement metrics, such as the following:
Motivation: Patterns such as Observer enhance intrinsic and extrinsic motivation through reward and feedback systems.
Retention: State and Decorator patterns foster long term retention by establishing a structure of progression, or 'fresh' gameplay experiences of the same general nature.
Replayability: Decorator patterns improve replayability by allowing players to experience relevant modular feature expansions that best encourage the act of replaying.

5) Step 5: Tools, Resources, and Implementation Notes

The final stage is dedicated to describing the tools and resources used to engage students in documenting patterns and to visualize the structural relations among them. Given that this study is on a conceptual and analytical level, no live coding or in-game coding was required.

Documentation Tools: MS Word, Google Docs

Diagramming Tools: Draw.io, Lucidchart, or MS Visio, UML diagrams

Examples of Representation Techniques: UML class diagrams, sequence diagrams, state diagrams, and pattern interaction charts.

IV. RESULTS AND ANALYSIS

Looking at the design patterns in game development, they are important to retain gamers on their site. By applying software design patterns in video game developments, the designers have been able to introduce playing mechanics that are flexible, interactive, and easy to maintain, thus leaving users with great experiences.

A. Observer Pattern

The Observer pattern is very often implemented to provide event-driven feedback systems. Candy Crush applies the Observer pattern in order for players to be informed in real time that they have completed a level, received rewards, or achieved milestones. Such feedback incentivizes players to continue playing, increasing engagement and play session length. The Observer pattern also decouples the notification system from game logic. It will make it easier for the developers later to add new features in the future.

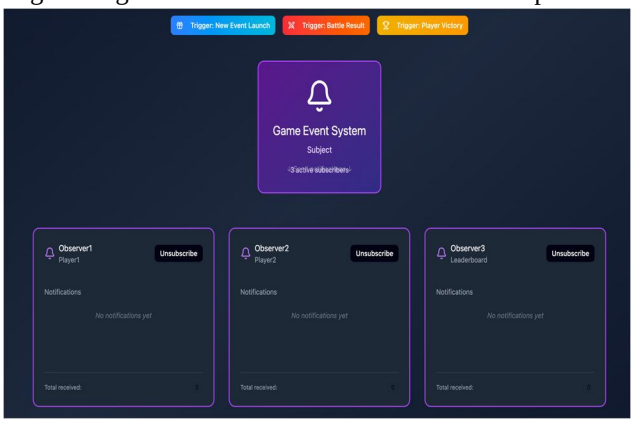


Fig 4.1(a) In game Observer Design Pattern UI

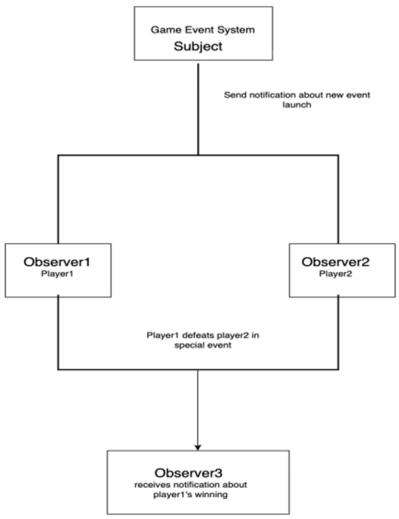


Fig 4.1(b) Concept Observer Design Pattern

B. State Pattern

Management of game states is all about maintaining engagement, difficulty, and excitement in their proper balance. A good example of the State pattern is Temple Run, which increases the level of challenge as the player advances. In a game, the developers try to create an appropriate learning curve as the advancement of a game takes place. This learning curve should prevent players from getting bored during easier challenges and also avoid frustrating them tremendously when the challenges get tough. State pattern allows to implement physical-state protocols dynamically in game.

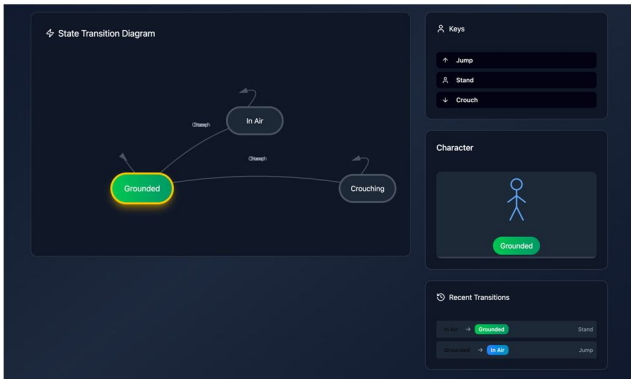


Fig 4.2 (a) In game State Design Pattern UI

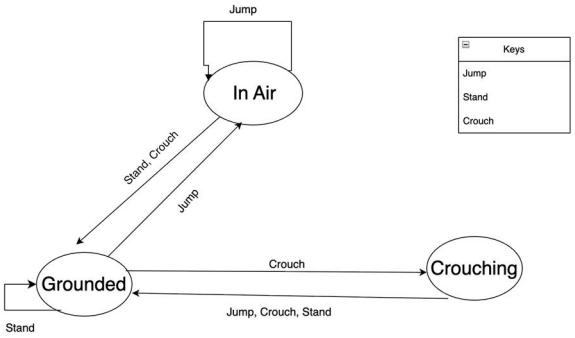


Fig 4.2 (b) Concept State Design Pattern

C. Decorator Pattern

This pattern helps developers to add power-ups dynamically in game as the game progresses player gets to use new powers. Decorator pattern is commonly used power advancement in real-time so that player can maintain their motivation and engagement through the game. This advancements generally includes power-ups, costumes changes, temporary heal-ups.

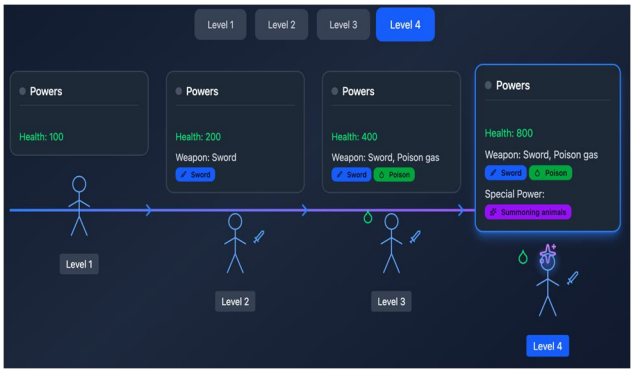


Fig 4.3(a) In game Decorator Design Pattern UI

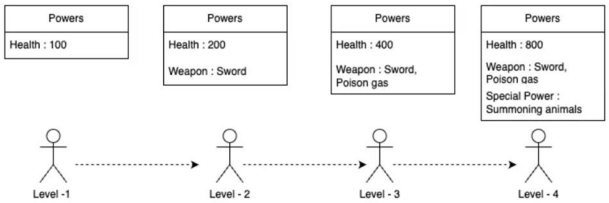


Fig 4.3(b) Concept Decorator Design Pattern

D. Discussion of Overall Impact

If we look on the the overall impact we can notice that proper choice of design pattern choices can directly impact on players engagement in the game. These patterns helps to keep player motivated and engaged through the game. This patterns also improves the overall readability and maintainability of the code structure which further simplifies the code base in much more efficient way.

Pattern	Impact
1.Observer Pattern	Keeps player engaged by showing engaging notification.
2. State Pattern	Allows to make dynamic state-based decisions by allowing or restricting the player from performing particular actions.
3. Decorator Pattern	Increases player motivation by enhancing dynamic power-ups.

We have discussed the possible benefits of design pattern but it is also equally important to keep in mind that player engagement also depends on other factors of the game like strong ideology, game concept, genre, proper player based according to game concept. Design pattern do takes care of more richer programming experience but it is not only the factor for enhancing player engagement.

V. CONCLUSION

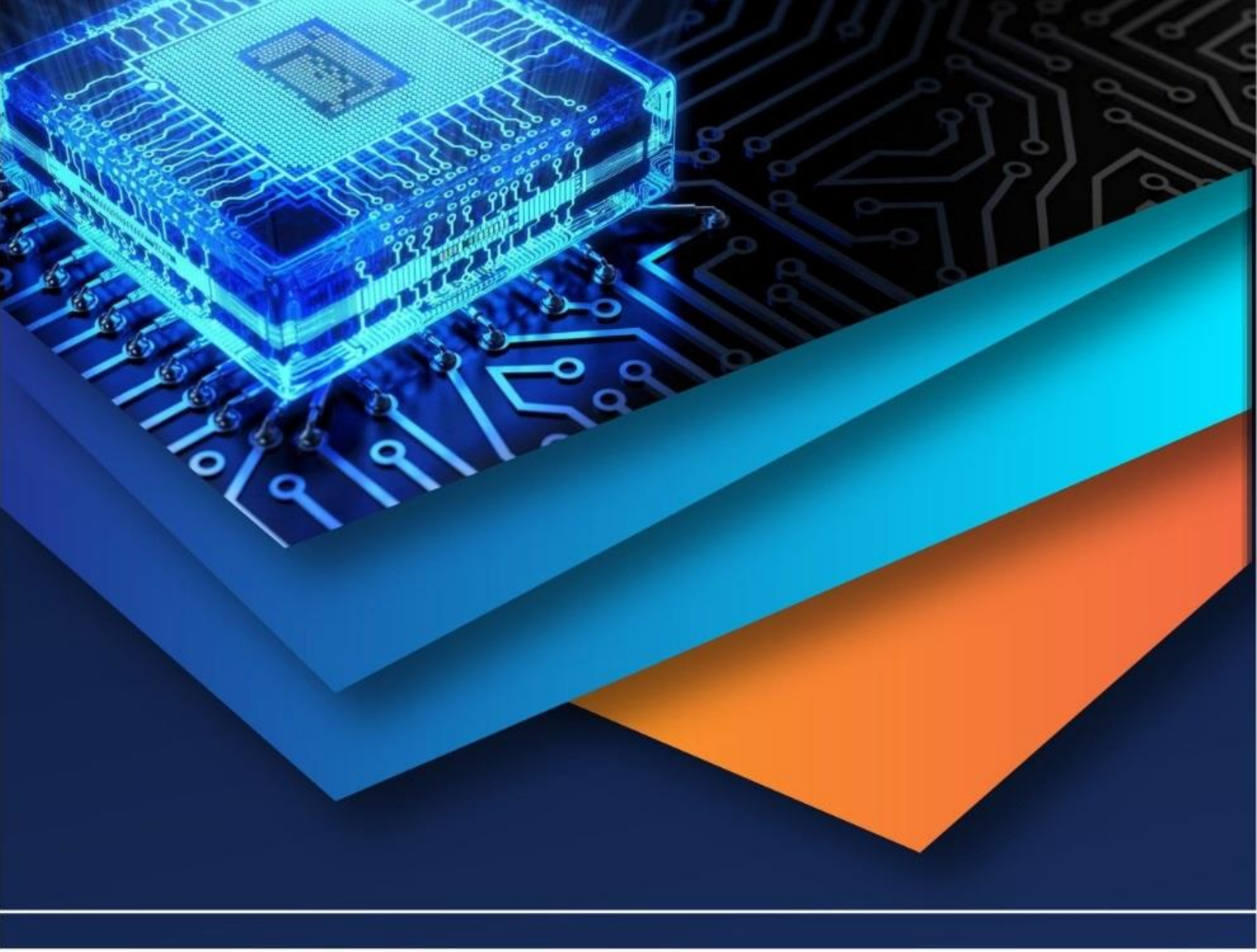
This study tells us that design patterns such as observer, state and decorator contributes efficiently for improving player engagement in games. This also works behind the scenes for the developering to update and maintain the code much more efficiently. Weather its about adding new features or adding new special events in the game it works seamlessly.

Observer, state and decorator design patterns are the most commonly used in game development helping developers to write code in much more efficient way.

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