Knowledge Representation Schema of the Gameplay

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ABSTRACT

Gameplay is the term used to define the way the players interact with the game. This paper is to present a schema for gameplay to understand the interactivity and inherent states that exist in the playing of a game. The knowledge representation schema of the gameplay is proposed based on the Function Behaviour Structure (FBS) ontology. This schema shows the significant difference between the gameplays based on conflict and competition type of interactions. The proposed schema focuses on the states involved in the gameplay and the transitions between the states. Some games allow the players to play in the same game world, and some in a separate game world. So, the schema is applied under various scenarios, simultaneous/sequence gameplay, and the game world to understand the interaction between the players and with the game.

Keywords
Gameplay, Game State, Winning State, Competition, Conflict

INTRODUCTION

A game is a well-structured kind of play; people usually play for entertainment. A game is a system defined by rules that serve as the game's boundaries by limiting what is allowed and what is not (Stenros 2016). The players must achieve a defined goal to win the game. The goal is fundamental to the game, and they represent the game's winning condition (Arjoranta 2019). There are many definitions of games in the literature. This paper considers the definition of a game as “A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome.” (Salen and Zimmerman 2004). The rules govern the player's interactions with the game and produce the gameplay. The game's nature is changed, and researchers use games in various fields such as education, marketing, and health care. When the games are used in non-gaming contexts, the philosophy of the gameplay is still a relatively underdeveloped topic (Duarte and Battaiola 2017).

According to the MDA approach, the games have three layers: mechanics, dynamics, and aesthetics (Hunicke et al. 2004). The game designer creates games by creating the

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game mechanics. These mechanics include rules, properties of the game objects and their relation, rewards, and penalty. The players can interact with the game using the game mechanics, which produces the game's dynamics (Imre Hofmann 2019). This interaction between the players and the game is called gameplay. The players play the game to achieve the goal defined by the game designer only by using the game mechanics. So, game mechanics is the tool of gameplay. The game's aesthetics are the emotions or the experience created in the player as they interact with the game mechanics.

The game is defined by its mechanics because it is different for each game. As the mechanics are different, the gameplay is also different for each game, but similar patterns are observed based on which games are categorized, like role-playing games, first-person shooting games, etc. These categorizations are done based on game mechanics. Similarly, gameplay can also be categorized based on the pattern of interactions among the players and with the game. The game mechanics are the decisions game designers make, and gameplay is the decisions players make by applying the game mechanics. The game designer can tweak the mechanics based on the dynamics, which is nothing but the gameplay. So, only game mechanics is not enough for a game designer to design an effective game. Understanding the interactions in games is also important for game design.

The gameplay involves many complexities, such as the transition between the states involved in the gameplay and the interaction among the players and with the game. The proposed representation schema can help to understand the gameplay and the interactions involved in the gameplay. The proposed representation focuses on games with a quantifiable outcome, and later, this schema will be extended to open-ended or exploration games. This paper discusses the definitions and representations of gameplay from the perspectives of different authors. This paper presents a schema to understand the gameplay from the player's perspective. This schema is applied in various scenarios to understand the inherent processes that take place in the gameplay.

GAMEPLAY

The authors interpreted the term gameplay from different perspectives in the literature. There is no universally accepted definition of gameplay. According to Sid Meier, a game is a series of choices the player makes to win the game (Rollings and Morris 2004). Each choice a player takes in the game increases or decreases the probability of winning. Gameplay is also defined as the interaction of the players with the game world and among the players. The interactions occur when they follow the rules of a game and experience its system through play (Salen and Zimmerman 2004). The gameplay is not generated from the beautiful visual characters but from the technology. It comes from the interaction between the players and the game world. Whenever the player takes action in the game, the opponent player responds to that action, and this cycle continues until one of them achieves the game's goal. One player's actions affect other players, which is a kind of interaction between players in the game. The game world will respond to every action that takes place in the game by the player. These actions and responses are the interactions that occur between the players and the game world or game system. Here the game world is an artificial setting that includes game objects, a board, a virtual world, non-player characters, etc. The authors also defined gameplay as one or more causally linked series of challenges and actions that allow the player to overcome the challenge (Adams 2014). According to this definition, the gameplay is the relationship between the challenge and the actions taken by the player.

Based on these definitions from the literature, the gameplay is the actions, interactions, game objects, and challenges that make a rewarding, engaging experience for the player. According to the authors, meaningful gameplay emerges when the player interacts with the game world. As mentioned before, the game world or the other players respond to each player's action. So, the series of actions and responses are the ‘events’ of interaction through which gameplay emerges.

Other than working on definitions, a few researchers also developed models for gameplay. Tom Heaton represented gameplay as a circular model focusing on video games with two fundamental components: the game and the player (Heaton 2006). According to him, the game is a system with which the player interacts; anything that is not the player is a part of that system, including other players. But according to the definitions, the interaction between the players is also a part of gameplay. The interaction between the game and the player is shown using input and output channels. But the processes involved in the gameplay are more than input and output channels. Researchers also represented gameplay, including rules, actions, environment, and gameplay bricks (Raies et al. 2014), but did not discuss the interaction between the players. Researchers also represented the gameplay by dividing it into two parts, play as hereness and game as thereness. They tried to represent the bridge between game and player activity in three levels framework (Juel Larsen and Kampmann Walther 2020). This representation is more oriented towards the relation between gameplay and the game. They discussed the shifting states between game mode and play mode but does not articulate the processes involved to shift and how these transitions happen between game and play.

A series of processes take place to make an action in the game from the player’s perspective. The gameplay involves states, and the transition from one state to another is an interaction with the game. This paper discusses the inherent interactions and other complexities in the gameplay with the Winning state, Plan of action and Game state (WPG) schema. Game designers can use this schema to represent and analyse different gameplays under different scenarios.

GAMEPLAY AS A DESIGN PROCESS

In gameplay, the players play the game with incomplete information because the game's behaviour is uncertain and dependent. Players can only guess the reaction of the game world or the opposing players, but they do not know the exact response. So, in the case of games, the game mechanics designed by the game designer enables the players to start their gameplay and allow them to achieve the goal based on information gathered during gameplay. As the designers make the design decisions based on the requirements to design an artifact or object, the players also make gameplay decisions based on the game object’s positions and the game rules to achieve the goal. So, the gameplay is similar to the design process, and the players are the designer.

The players design their own gameplay based on rules for achieving the winning condition. This gameplay design process can be analysed using an ontological approach. Gameplay is similar to the design process but not a regular design process. So, an ontological approach is required to understand and interpret the gameplay and develop a representation schema that can be used to analyse the type of gameplay. Function Behaviour Structure (FBS) Ontology is adopted among the existing frameworks of the design process because this framework provides a design prototype that enables a designer to start designing with incomplete information and allows adaptations based on the information gathered during the design process.

WPG SCHEMA

The WPG Schema is developed based on the FBS ontology. The FBS ontology has been used to design objects and design processes in several design disciplines, including engineering design, architecture, construction, and software design. Design representations are divided into three high-level categories by Gero's schema for design knowledge: function (F), behaviour (B), and structure (S) (Gero 1990). In order to fulfill a design requirement, the FBS ontology was initially established to represent designed things in terms of their structure, working, and purpose (Gero and Kannengiesser 2003). A designed object's structure (S) is composed of elements with attributes and relationships between them. The attributes derived from its structure, by which it accomplishes function, infer behaviour (B). Moreover, in simple terms, Function (F) is the purpose of the designed object. It is then extended from the representation of design objects to the representation of various processes (Gero and Kannengiesser 2007). In order to explicitly capture the importance of situated cognition or situatedness in designing, the placed FBS framework was later developed as an extension of the FBS framework. However, this work does not dive into the specifics of situated cognition, instead the research work focus on the functional, behavioural, and structural factors and processes involved.

The FBS ontology defines three groups of variables: function variables, structure variables, and behaviour variables. It represents the design with a causal relationship between function, behaviour, and structure. The eight processes connect these variables. They include formulation (1), synthesis (2), analysis (3), evaluation (4), documentation (5), and three reformulation procedures (6,7,8) for design iterations with a range of variable values. These processes are said to be expected for all designing. The three groups of variables are changed into one another through these processes (Gero and Kannengiesser 2007). The FBS ontology gives a model representing the design process at different states. Other design frameworks are described as separate stages connected to each other, but the process involved in transferring the variables from one stage to the next stage is not transparent. The design process has been structured around several distinct tasks that are based on the FBS ontology. The FBS ontology is helpful because a sensible choice of commitments enables the focus on gameplay elements that we think are important. Because the complexity of the gameplay is so overwhelming, this focusing effect is a crucial component provided by this ontology.

By adopting this framework, the knowledge representation schema obtainable with it can be utilized for gameplay. Here the knowledge representation refers to the technical problem of encoding human knowledge and reasoning into a symbolic language that enables it to be processed by information systems. Knowledge representation has three components (i) the representation’s fundamental conception of intelligent reasoning, (ii) the set of inferences the representation sanctions, and (iii) the set of inferences it recommends. In the case of single-player games, this framework is adaptable, but in games with two or more players games, the players interact with each other either simultaneously or in sequence. In such games, a parallel framework can be proposed to represent a game state that enables a player to plan the following action with predictions of the opponent's moves and allows adaptations based on the action taken by the opponent during the game.

As mentioned earlier, the gameplay is similar to the design process but is not a routine design process. This allows reinterpreting function, behaviour, and structure representations in the context of gameplay as follows.

Winning State (W): A player's end goal is to win the game. The winning state is derived from the rules. All the players in the game will play to achieve the goal by following the rules.

Game Plan (P): It is defined as the plan of action, driven through strategy (Dor 2018), skill (Stevens and Young 2010), knowledge (Noemí and Sedano Hoyuelos 2014), and chance. In the case of chance/randomness, the players do not have control over it, but the progress in the gameplay depends on it (Roberts et al. 1959). The game plan has two stages in this schema: the expected game plan includes the intermediate goals and plan of action derived from the winning state. The derived plan is the plan that is derived from its Game State (G) to lead to the winning criteria.

Game State (G): Describes the game components and their relationship (Juul 2004). It captures the play at every specific moment. The outcome of the gameplay or game is derived once the game state reaches the winning condition.

Seven processes link together these three states of gameplay. These processes, which are claimed to be expected for all gameplay, are formulation (1), synthesis (2), analysis (3), evaluation (4), documentation (5), and two reformulation processes (6,7) for gameplay iterations. These processes are responsible for transforming three states of the gameplay into each other. The role of each process and the transformation are discussed below under different scenarios.

Single-player Games

Single-player games are designed for only one player or played in the single-player mode. The competition or conflict in single-player gameplay is created by a computer rather than a human opponent. Single-player games include competition with limitations like timer, lives, or player. These games also have a conflict with the non-player characters/game world and with the self.

In FBS ontology, there are three types of reformulations. Type 1 is a structural reformulation where the structure is modified, type 2 is a behavioural reformulation, and type 3 is functional reformulation. The proposed WPG schema consists of only two types of reformulations. Type 1 is game state reformulation, where the players modify the game state, and type 2 is game plan reformulation, where the player modifies the expected plan of winning state based on the game state. The player does not reformulate the winning state in gameplay because it is derived from the rules and the game designer defines it.

Examples: Candy Crush Saga (King 2012), Pacman (BANDAI NAMCO Entertainment 2013), etc.

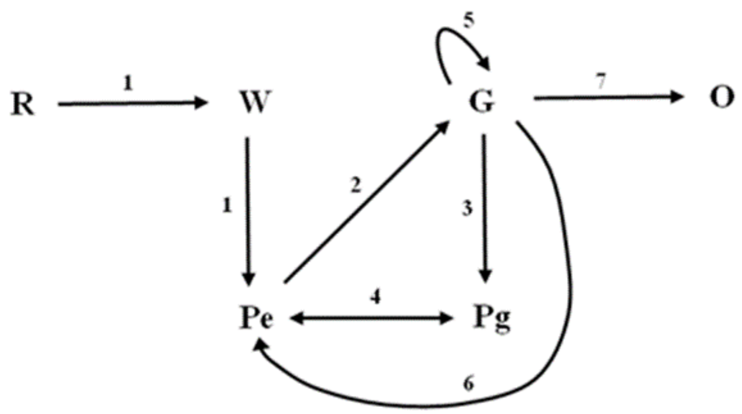

Figure 1: WPG Schema for Single-player Games.

R = Rules	G = Game State
W = Winning State	O = Outcome/Result
Pe = Expected plan to win the game	→ = Transformation
Pg = Derived plan from the current game state	↔ = Comparison

1. Formulation: transforming rules into winning state space (R → W) and then into an expected plan to win (W → Pe).
2. Synthesis: generates game state based on expectations of the winning plan/strategy (Pe → G).
3. Analysis: derives plan from the generated game state (G → Pg).
4. Evaluation: compares the expected winning plan with the plan derived from the game state (Pe ↔ Pg).
5. Reformulation type 1: modifies the game state space based on a reinterpretation of the game state (G → G').
6. Reformulation type 2: modifies the expected winning plan state space based on a reinterpretation of the game state (G → Pe').
7. Outcome: After achieving the winning criteria (G → O), the outcome is produced.

Candy Crush

1. Formulation: The rules of the game candy crush are interpreted by the player as the winning state (R → W) includes collecting n number of candies. The player thinks of a plan that is expected to achieve a winning state (W → Pe). The plan consists of matching required candies and getting candies adjacent to the required candies.
2. Synthesis: A game state is changed (Pe → G) based on the expected game plan, which includes changing the positions of the candies.
3. Analysis: After the game state (G) is changed, the plan can be derived based on that game state (G → Pg). This may include any kind of achievement or loss, score, and progress toward getting the required candies.
4. Evaluation: The derived state of the game is compared against the expected winning state to assess whether the achieved candies are equal to the required candies to win (Pe ↔ Pg).
5. Reformulation type 1: The player modifies the game state space by changing the positions of the candies based on a reinterpretation of the positions of the candies in the game state (G → G').

6. Reformulation type 2: The player modifies the expected winning plan state space by trying to get the powers like a bomb by matching five same candies based on a reinterpretation of the game state (G → Pe’).
7. Outcome: Produces the outcome after achieving the winning state (G → O), including the score of required candies.

Two-player Games with Conflict

Two-player games are designed for only two players, or games played in the two-player mode. A computer or a human opponent creates conflict in two-player gameplay. The player's actions depend on the actions of the opponent player, and the actions of the opponent player affect the player (Sasupilli M and Bokil P 2022). The schema is similar to the single-player game, but it includes a parallel schema for the opponent player to represent a game state that enables a player to plan the next moves with predictions of opponent moves and allows adaptations based on the action taken by the opponent during the game. The players in conflict-based games always play in the same game world because the actions of the players affect each other. But the flow of the processes is different in simultaneous gameplay and sequence gameplay in the same game world.

Simultaneous gameplay in the same game world

In simultaneous gameplay, both players change the game state simultaneously. In the case of the Supreme Duelist Stickman (Neron’s Brother 2018), both the players try to attack each other simultaneously to pin down. The rules are represented as R because they are common for players ‘a’ and ‘b’. The winning state is similar to both the players, but there is a difference. In the case of a wrestling game, player ‘a’ has to pin down player ‘b’ to win and vice versa for player ‘b’. So, the winning state of player a is represented as W_a and player b as W_b. The expected plan of winning state and derived plan of the game state is also represented for player ‘a’ as Pe_a and Pg_a and player ‘b’ as Pe_b and Pg_b. Here the game state is common for both players because both players modify the same game state, which creates conflict (Sasupilli M and Bokil P 2022). The actions of player ‘a’ affect player ‘b’ and vice versa because both players modify the common game state. But the processes involved in the representation are numbered in the same order for both players because these processes occur simultaneously in the gameplay.

Examples: Castles (2 Player Games by App Holdings 2015), Supreme Duelist Stickman, etc.

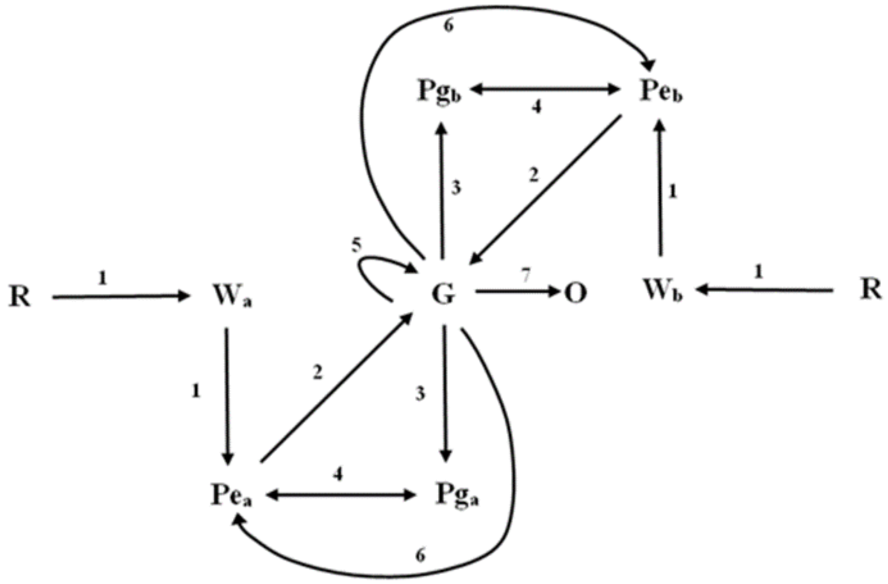

Figure 2: WPG Schema for Two-player games with conflict and simultaneous gameplay.

R = Rules
W_a = Winning state of player 'a'
W_b = Winning state of player 'a'
Pe_a = Expected plan to win the game of the player 'a'
Pg_a = Derived plan from the current game state of the player 'a'
Pe_b = Expected plan to win the game of the player 'b'
Pg_b = Derived plan from the current game state of the player 'b'
G = Game State
O = Outcome/Result
→ = Transformation
↔ = Comparison

Supreme Duelist Stickman

1. Formulation: The rules of the Stickman game are interpreted by the player as winning state ($R \rightarrow W_a$) ($R \rightarrow W_b$), including defeating the opponent by making him lose lives. The player thinks of a plan that is expected to achieve a winning state ($W_a \rightarrow Pe_a$) ($W_b \rightarrow Pe_b$). The plan includes which weapon to use and how to attack the opponent and defend.
2. Synthesis: Based on the expected game plan, a game state is changed ($Pe_a \rightarrow G$) ($Pe_b \rightarrow G$), including defending himself from the opponent and attacking the opponent.
3. Analysis: After the game state (G) is changed, the plan can be derived based on that game state ($G \rightarrow Pg_a$) ($G \rightarrow Pg_b$). This may include any kind of achievement or loss of energy, score, or progress toward the game compared to the opponent.
4. Evaluation: The derived state of the game is compared against the expected plan of the winning state to assess whether the used weapons and power is useful enough to win ($Pe_a \leftrightarrow Pg_a$) ($Pe_b \leftrightarrow Pg_b$).
5. Reformulation type 1: Both the players modify the game state space by attacking the opponent using his powers based on a reinterpretation of position and tricks of the opponent in the game state ($G \rightarrow G'$).

6. Reformulation type 2: The player modifies the expected winning plan state space by changing the weapons or using different powers based on a reinterpretation of the game state (G → Pe_a') (G → Pe_b').
7. Outcome: Produces the outcome after achieving the winning state (G → O), including one of the players having to lose all his lives.

Sequence gameplay in the same game world

In sequence gameplay, both players change the game state one after the other. In the case of chess, both players move their game components one after the other. In this schema, the representation of rules, winning state, expected plan, derived plan, game state, and outcome are the same as simultaneous gameplay. But the sequence of the processes that take place in the gameplay is different for sequence gameplay.

The processes of player 'a' are represented with the subscript "a" and the processes of player 'b' are represented with the subscript "b". The process of Synthesis is to generate the game state based on the expected winning plan. This process occurs only once, that too for player 'a' because after setting up the game, player 'a' generates the game state, and then player 'b' directly derives the plan interpreted from the game state and compares it with the expected winning plan and modifies the game state. The process synthesis does not occur for player 'b' because that is done by player 'a', so player 'b' will only reformulate the game state. In the case of chess, player 'a' generates the game state by moving his soldier, and then player 'b' interprets the game state before modifying the game state. Even in carroms, all the coins will be at the center of the board and the player 'a' will strike first to generate the game state, and later, it is modified by the player 'b'. The player who serves first generates the game state based on the expected winning plan, even in tennis.

Examples: Chess, Carroms, Ludo, Tennis, etc

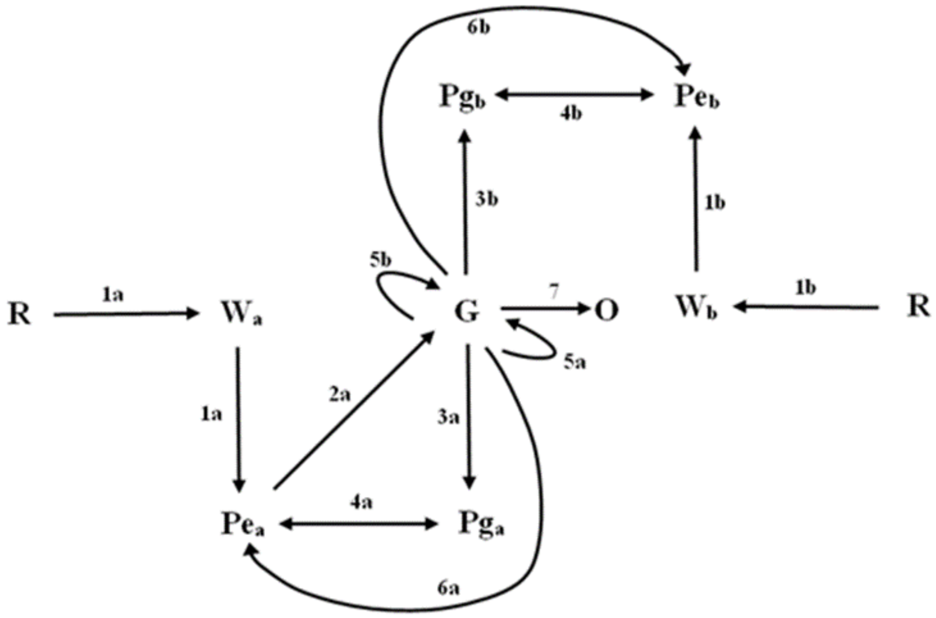

Figure 3: WPG Schema for Two-player games with conflict and sequence gameplay.

Chess

1. Formulation (1): The rules of the game chess are interpreted by the player as winning state space ($R \rightarrow W_a$) ($R \rightarrow W_b$), including checkmating the opponent by moving game components according to rules. This occurs when the king is under attack or in "check" and every possible move by the king will also put it in check. The player thinks of a plan that is expected to achieve a winning state ($W_a \rightarrow Pe_a$) ($W_b \rightarrow Pe_b$). The plan includes removing the opponent's game components one after the other.
2. Synthesis (2a): Based on the expected plan of winning state, a game state is changed ($Pe_a \rightarrow G$) by the player 'a', which includes changing the position of the game component according to the rules.
3. Analysis (3b): After the game state (G) is changed by player 'a', the plan can be derived based on that game state ($G \rightarrow Pg_b$) by player 'b'. This may include any kind of achievement or loss, positions of the game components and the interconnections between them, and progress toward getting closer to the king of the player 'a'.
4. Evaluation (4b): The current position of the game components derived from the game state is compared against the expected plan derived from winning state space, i.e., player 'a' king has to be under attack ($Pe_b \leftrightarrow Pg_b$).
5. Reformulation type 1 (5b): The player 'b' modifies the game state space by changing the position of one of his game components based on a reinterpretation of the positions of the game components in the game state ($G \rightarrow G'$).
6. Reformulation type 2 (6b): the player 'b' modifies the expected winning plan space by trying to remove other game components of the player 'a' like a horse, soldier, etc., based on a reinterpretation of the game state ($G \rightarrow Pe_b'$).
7. Analysis (3a): After the game state (G) is changed by player 'b', the plan can be derived based on that game state ($G \rightarrow Pg_a$) by player 'a'. This may include any kind of achievement or loss, positions of the game elements and the interconnections between them, and progress towards getting closer to the king of the player 'b'.
8. Evaluation (4a): The current position of the game elements derived from the game state is compared against the expected plan derived from winning state space, i.e., player 'b' king has to be under attack ($Pe_a \leftrightarrow Pg_a$).
9. Reformulation type 1 (5a): the player 'a' modifies the game state space, by changing the position of one of his game elements based on a reinterpretation of positions of the game elements in the game state ($G \rightarrow G'$).
10. Reformulation type 2 (6a): the player 'a' modifies the winning plan state space by trying to remove other game elements of the player 'b' like a horse, soldier, etc., based on a reinterpretation of the Game state ($G \rightarrow Pe_a'$).
11. Outcome (7): produces the outcome after achieving the winning state ($G \rightarrow O$), including one of the player's kings being in check or draw.

Two-player Games with Competition

Two-player games are designed for only two players, or games played in the two-player mode. The competition in two-player gameplay is created externally (Sasupilli M and Bokil P 2022). The actions of the player do not depend on the actions of the opponent player, and the actions of the opponent player will not affect the player because both the player's actions are independent. Still, the outcome of this competition depends on both the player's performance.

The schema is similar to other two-player games, but there will be two independent game states. The players in competition-based games can have the same game world or a separate game world because the actions of the players do not affect each other's gameplay. But the flow of the processes is different in simultaneous gameplay and sequence gameplay in the same game world. In this case, both players change their respective game states. The game state of player 'a' is represented as G_a, and player 'b' game state is represented as G_b. The outcomes derived by both the player's gameplay is compared to know the winner of the game. So, here the outcomes are also represented as O_a for player 'a' and O_b for player 'b'.

The sequence of the processes is the same for both players because there is nothing to derive or interpret from the opposite player's game state even though the player gets to know the opposing player's game state. The representation of a two-player game with competition is the same for sequence gameplay, simultaneous gameplay, same game world, and separate game world.

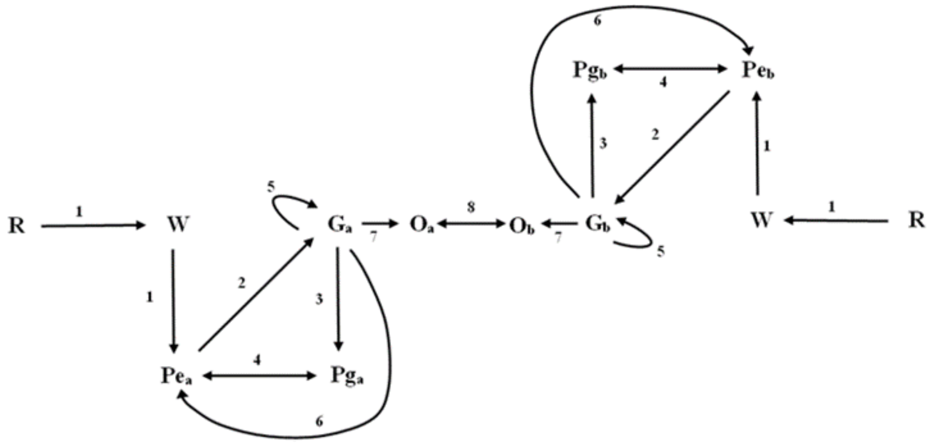

Figure 2: WPG Schema for Two-player games with the competition.

Simultaneous gameplay in the same game world

In competition-based simultaneous gameplay, both players change their respective game states simultaneously. In the case of Chameleons (2 Player Games by App Holdings 2015), both the players tap near their chameleon to thrust its tongue out to eat insects. The player who gets 50 points first is the winner. In this game, both players are in the same world and play simultaneously without affecting the other player's gameplay. In these games, the players keep modifying their respective game states and cannot interfere in other's game states. The outcomes derived from the player's game states are compared to decide the winner.

Examples: Chameleons, Painters (2 Player Games by App Holdings 2015), etc.

Chameleons

1. Formulation: the rules of the Chameleons game are interpreted by the player as winning state ($R \rightarrow W_a$) ($R \rightarrow W_b$) includes collecting 50 points before another player. The player thinks of a plan that is expected to achieve a winning state ($W_a \rightarrow Pe_a$) ($W_b \rightarrow Pe_b$). The plan includes speed, concentration, and how to feed the chameleon by taping as fast as possible to collect points.
2. Synthesis: based on the expected plan of winning state, a game state is changed, including taping around the chameleon ($Pe_a \rightarrow G_a$) ($Pe_b \rightarrow G_b$).
3. Analysis: After the game state is changed, the plan can be derived based on that game state ($G_a \rightarrow Pg_a$) ($Gb \rightarrow Pg_b$). This may include the direction of the insects coming towards the chameleon, points achieved, and progress towards the game compared to another player.
4. Evaluation: The derived state of the game is compared against the expected winning state to assess whether the speed and direction are enough to get the required points ($Pe_a \leftrightarrow Pg_a$) ($Pe_b \leftrightarrow Pg_b$).
5. Reformulation type 1: both the players modify their game state space by taping near their chameleon to thrust the tongue and collecting the points based on a reinterpretation of the direction of insects coming and points collected by another player in the game state ($G_a \rightarrow G_a'$) ($G_b \rightarrow G_b'$).
6. Reformulation type 2: the players modify the expected winning plan state space by changing the direction and increasing the speed based on a reinterpretation of the game state ($G_a \rightarrow Pe_a'$) ($G_b \rightarrow Pe_b'$).
7. Outcome: produces the outcome after achieving the winning criteria ($G_a \rightarrow O$) ($G_b \rightarrow O$), including points collected by the player.
8. Evaluation: The outcome of player 'a' is compared against the outcome of player 'b' to decide the winner ($O_a \leftrightarrow O_b$).

Sequence gameplay in the same game world

In competition-based sequence gameplay, both players change their respective game state one after the other. In the case of snakes and ladders, both the players move their game elements one after the other, but there is only competition between them. In this game, the player who reaches the end wins the game. When one of the players achieves the goal first, the outcomes of both players are compared. Even though this game is played turn by turn, the processes of the players occur in the same sequence, one player after the other player.

Snakes and Ladders

1. Formulation: the rules of the game are interpreted by the player as winning state space ($R \rightarrow W_a$) ($R \rightarrow W_b$), including reaching the end of the game before opposite players by following the dice. The player expects the required number from the dice to achieve a winning state ($W \rightarrow Pe_a$) ($W \rightarrow Pe_b$).
2. Synthesis: based on the expected winning plan, a game state is changed ($Pe_a \rightarrow G$) ($Pe_b \rightarrow G$) by the player that includes based on the expectations from the dice, the player 'a' rolls the dice and changes the game state by changing the position of his game component.
3. Analysis: players derive the plan based on the game state ($G_a \rightarrow Pg_a$) ($G_b \rightarrow Pg_b$). This may include any kind of achievement or loss, the position of the game component, and progress toward getting closer to the end of the game.
4. Evaluation: The current position of the game components derived from the game state is compared against the expected winning plan derived from winning state space, i.e., one of the players reaching the end of the game before other players ($Pe_a \leftrightarrow Pg_a$) ($Pe_b \leftrightarrow Pg_b$).

5. Reformulation type 1: the players modify their game state space by changing the position of their game component based on the number generated by the dice ($G_a \rightarrow G_a$') ($G_b \rightarrow G_b$').
6. Reformulation type 2: the players modify their winning plan state space by expecting to escape from the snake or get a ladder through dice based on the reinterpretation of game state ($G_a \rightarrow Pe_a$') (Gb $\rightarrow Pe_b$').
7. Outcome: produces the outcome after achieving the winning state ($G_a \rightarrow O$) ($G_b \rightarrow O$), including one of the players reaching the end of the game.
8. Evaluation: compares the outcome of both the players to decide the winner ($O_a \leftrightarrow O_b$). In the case of multiple players, time is taken to reach the endpoint of the game.

Sequence and Simultaneous gameplay in the separate game world

In competition-based games, if the game world is separate for both players, then it doesn't matter if it is a sequence or simultaneous gameplay. The processes will be in the same sequence for both players. In the case of tombola (Indian Bingo) ("Tombola Rules", n.d.), the players change their own tickets according to the number picked from the pouch. The players try to complete the house to win the game. There are other intermediate goals also, like completing the row before other players. Even though this game has simultaneous gameplay in a separate game world, the processes of the gameplay take place simultaneously in the same sequence.

In the case of party games, the gameplay can be simultaneous or sequence in separate worlds. For example, in the cup pyramid game, both players build the pyramid with paper cups, and the player who finishes first is the winner. In this game, both players can participate one after the other, and the time taken can be recorded to know the winner. This game can also be played parallelly by having separate tables for the players. In both ways, the process sequence is the same for both players, and at the end, the outcome is compared to declare the winner.

Examples: Cup Pyramid ("Cup Pyramid Rules", n.d.), Tombola ("Tombola Rules", n.d.), etc.

Cup Pyramid

1. Formulation: the game 'cup pyramid' rules are interpreted by the player as winning state space ($R \rightarrow W$), including stacking cups as fast as possible before another player. The player thinks of a plan that is expected to achieve a winning state. The plan consists of the pace and the trick of stacking the cups as a pyramid ($W \rightarrow Pe_a$) ($W \rightarrow Pe_b$).
2. Synthesis: generates game state based on expectations of the winning plan/strategy ($Pe_a \rightarrow G_a$) ($Pe_b \rightarrow G_b$) that includes the position of the cups and progress of the player.
3. Analysis: derives plan from the generated game state ($G_a \rightarrow Pg_a$) ($G_b \rightarrow Pg_b$). This may include falling down the pyramid and progress.
4. Evaluation: The derived state of the game is compared against the expected pace to assess whether the current pace and plan are enough to finish the game ($Pe_a \leftrightarrow Pg_a$) ($Pe_b \leftrightarrow Pg_b$).
5. Reformulation type 1: the player modifies the game state space by adding cups one after the other based on a reinterpretation of the positions of the cups in the game state ($G_a \rightarrow G_a$') ($G_b \rightarrow G_b$').
6. Reformulation type 2: the player modifies the winning plan state space by changing the pattern of placing the cups based on a reinterpretation of the Game state ($G_a \rightarrow Pe_a$') ($G_b \rightarrow Pe_b$').

7. Outcome: produces the outcome after achieving the winning criteria ($G_a \rightarrow O_a$) ($G_b \rightarrow O_b$), including the time taken to finish the game.
8. Evaluation: compares the time taken by both the players to decide the winner ($O_a \leftrightarrow O_b$).

According to the WPG schema, if the players have a common game state to change, then the interaction between the players is in conflict. If the players have an independent game state, then the interaction between the players is competition. Cooperation is also an interaction between the players and one of the gameplays. The WPG schema will be extended to cooperation-based gameplay in the future. The multiplayer cooperative games will have two layers of interaction: Cooperation gameplay between team members and Competition/Conflict between teams. This type of combination interaction is yet to be analysed using the WPG schema.

CONCLUSION

According to the literature, the interaction between the players and the game world is the main focus of the gameplay definition. The series of action and response events is gameplay. We proposed Winning State, Plan, Game State (WPG) Schema based on FBS ontology to understand this 'action and response' event and the gameplay. Some games allow the players to play in the same game world, and some in a different game world. So, the schema is studied and developed under various scenarios, simultaneous/sequence gameplay, and game world. According to the WPG schema, conflict is the intrinsic interaction, and competition is an extrinsic interaction in gameplay. In conflict-based gameplay, both players change the common game state. In competition-based gameplay, both players have separate game states to change. Based on this observation, we can say that conflict and competition are two different gameplays experienced by the players in the game.

The WPG schema can be used to categorize the gameplays. As game mechanics are tools of gameplay, the proposed schema can be used to identify the mechanics used to generate these gameplays. This schema can also be used to analyse the gameplay before the play testing with the actual players. The WPG schema is applied to only single-player games and two-player games in this paper. Cooperation is also one of the interactions between the players. This schema will be applied to cooperation-based games in the future. The combination of these interactions in multiplayer team games is yet to be analysed.

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