



Review

More than skills: A novel matching proposal for multiplayer video games[☆]Nadja Stroh-Maraun^a, Daniel Kaimann^{a,*}, Joe Cox^b^a Paderborn University, Faculty of Business Administration and Economics, Warburger Str. 100, D - 33098 Paderborn, Germany^b Faculty of Business and Law, Richmond Building, Portland Street, Portsmouth, PO1 3DE, UK

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ABSTRACT

Multiplayer video games are high-involvement products with multiplatform and multiplayer characteristics which aim to enhance player retention by optimizing the matching of teams in accordance with their skills and attributes. However, relatively little academic research has been conducted into the ways in which player attributes can be used to optimize the formation of teams in multiplayer video games. Our study addresses this deficiency in the literature by analyzing a dataset from a popular online multiplayer game that includes historic behavioral data of 6.9 million players participating in 862,664 unique game rounds. We analyze the observable factors associated with longer duration of participation in each round, finding that player retention improves in the presence of player-versus-player combat, variety and heterogeneity. We also show that player retention diminishes as a result of the absence of particular role or vehicle use within a given round. Based on the findings of the analysis, we develop a novel approach called nested matching to assign players to teams with an optimal mixture of skills and inherent and complementary attributes.

1. Introduction

The video game industry represents one of the most significant components of the global entertainment market. According to the Entertainment Software Association, consumers in the US spent more than \$23.5 billion on game content, hardware and accessories in 2015, an increase of \$1.1 billion since 2014. Contemporary video game titles (e.g. the Call of Duty franchise) also exceed lifetime sales revenues of all-time movie blockbusters such as *Star Wars* or *Lord of the Rings*. Additionally, video games are no longer merely consumed by adolescent males. The Entertainment Software Association also claims that the average gamer in the US is currently 38 years of age, and has been playing video games for about 13 years. Adult female gamers are also shown to represent around twice the proportion of gamers made up by boys aged eighteen or younger [1].

Modern video games are high-involvement products with multiplatform and multiplayer characteristics which aim to deliver long-term entertainment and, consequently, long-term happiness to consumers [2]. This directly results in the retention of consumers, which is often seen as more preferable and profitable than acquiring new ones. Jolley et al. argue that retention can be measured by the duration of time a consumer continues to buy from a company [3]. Rust and Zahorik add that retention can be viewed as the propensity for a consumer to stay

with a brand over time [4]. To improve player retention beyond the short term, producers attempt to efficiently and effectively match participants in multiplayer video games into teams and thus customize the video game experience around aspects of the player such as preferences, playing style and skill level [5]. Consequently, this study addresses three key research questions related to enjoyment, matching and retention of multiplayer video games:

- (i) Which observable, round-level characteristics affect player retention?
- (ii) What are the individual habits and skill levels that affect the efficient matching of players?
- (iii) What type of matching algorithms are most efficient in optimizing player retention?

We address these research questions through a multi-stage analysis approach. First, we analyze the factors associated with round-level player retention in multiplayer video gaming using a unique dataset provided by the Wharton Customer Analytics Initiative (WCAI) and a major international video gaming company. The dataset relates to a popular online multiplayer game and consists of individual player and round-level observations relating to 6.9 million players participating in 862,664 unique game rounds. Following extensive empirical analysis,

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we find evidence that players who utilize a wider variety of different roles and vehicles, as well as those who achieve a higher kills per second ratio, tend to participate in a greater proportion of the overall duration of any given gameplay round. Second, based on these findings, we develop an approach to player matching that balances the relationship between heterogeneity and homogeneity of player skills, demographics and other attributes to maximize the average proportion of played round completed by players. We use this as a basis for the efficient allocation of players to teams and thus for improving player retention measured by the average proportion of round completed by consumers.

2. Literature and hypotheses

Matching players to form teams in multiplayer settings is an emergent topic in the video gaming literature. Using 200,000 randomly selected and individual game rounds, Myślak and Deja show that the possibility of winning a round is increased by 65% in instances where perfectly matched teams compete against imperfectly matched teams [6]. The literature on matching (sometimes referred to as match-making) mainly focuses on the matching of players into homogenous groups according to their skill level. Buchanan-Oliver and Seo argue that player experience and behavior depend on the interaction with game objectives and rules, which are likely to be affected by variations in consumer skills and abilities [7]. To enhance a player's game experience, various studies have therefore suggested that "best fitted" game rounds should contain similarly skilled players [8,9]. For example, various studies argue that to balance the game and thus create a challenging, non-frustrating experience, the probability of winning should be equal for all players [9,10]. Véron supports this argument, suggesting that different skill levels would lead to monotonous game sessions due to the superiority of one team [11]. Thus, there exists a consensus in the literature that matching systems should match players according to similar skills.

Nevertheless, an ongoing debate exists on how skill ratings should be constructed. In other contexts, the so-called Elo rating is a rating system for chess players that predicts the probability of game outcomes based on skill ratings [12]. This system has been considerably developed and enhanced over time such that it is now used to make similar assessments in a wide range of video games. A particular example of this is the TrueSkill matching system; a Bayesian skill rating system based on the Elo rating which is used on the Microsoft Xbox 360 Live online gaming service [13,14]. A modification of the Elo rating is also used to investigate the matching of players of equivalent gaming skills in the online game *Warcraft III* [15]. Delalleau et al. further suggest that a matching procedure should rely on a multi-dimensional skill level identification to generate more balanced matches in the game *Ghost Recon Online* [9]. This particular study relies on the TrueSkill system as well as other player attributes such as accuracy, number of played sessions or the number of kills, deaths and captures within the game.

A different approach is the Bradley-Terry model which compares pairs and predicts the probability of winning for one of the two individuals [16]. Huang et al. extended the Bradley-Terry model to compare paired teams and provide individual skill results [17]. A similar extension of the Bradley-Terry model is also used to balance teams in the game *Enemy Territory* by reallocating players from one team to the other [18].

Another advanced approach to player matching is proposed after analyzing the online game *League of Legends* where teams ideally consist of players with different roles [6]. The matching system developed by the authors for this game assigns role-specific skill levels for each player and matches together players with similar skill levels in different roles. A similar result is found by Chen et al. who state that players' skills should depend on the base skills of the players, base skills of the role

they are playing and the role-specific skills of the players [19].

Alternatively, Francillette et al. have developed a multilevel matching system whereby players are grouped according to their playing style and they are clustered within a group according to their skill level [8].

Following these studies, we propose that optimal matching of video game players with similar skill levels should create a more challenging and enjoyable game experience and thus maximize the likelihood of player retention within a given round. We therefore formulate the following research hypothesis:

H 1. Greater homogeneity of player skill, as measured by variation in player starting rank, death/kill ratio and non-combat score, positively affects player retention within a given gameplay round.

It should however be noted that a number of the studies cited above show that player matching should not necessarily be undertaken on the basis of skill level alone [9,6,8]. Instead, it is important to recognize that player motivations are multifaceted and are affected by a combination of psychological needs, behavioral patterns and personality traits [20]. Using survey and behavioral in-game data from the game *Fallout: New Vegas*, Chen et al. show that scores and other aggregated features are of limited value in player matching. Instead, they find that in-game behavior such as sequential patterns might help to predict the player's characteristics and that game expertise is a dominant factor affecting the behavior within the game [21]. Nagle et al. model variations in duration of gameplay in first-person shooters according to personality traits, finding that customization and difficulty adaptation around these personality traits have a significant effect on gameplay duration [22]. An effective approach to player matching should take into account a range of further attributes to optimize the construction of teams such as playing styles and specific roles adopted within a team as part of complex in-game strategies [23]. For example, the player experience is strongly influenced by physical proximity to the gameplay server, which affects response time and thus the length of time a player spends waiting to be assigned to a round [11]. Therefore, geographical factors are likely to influence the extent to which players are willing to spend time participating in game rounds where there is high variation in the physical proximity to the gaming server. Further, evidence from the game *Soccerbots* shows that effective matching should be based on the clustering of observed behaviors such as roles and playing styles [24].

Shores et al. also establish that deviant behavior in online social systems affects the retention of other players [25]. More precisely, so-called 'toxic' players encourage higher drop-outs from rounds among fellow players in the game *League of Legends*. A similar argument is made in relation to the game *MechAssault*, where the authors give evidence that players prefer to be matched on the same team along with others that demonstrate the same characteristics as themselves [26]. Riegelsberger et al. therefore asked players to rank other gamers' profiles which contained different attributes and behaviors. They concluded that one player type prefers to be matched to other players who are basically homogenous in terms of skills whereas another player type prefers players with friendly gaming personalities and the last player type prefers pugnacious players. Thus, the alignment of a 'preferred' set of behaviors is likely to represent one desirable feature of an effective matching system, where teams are formed on the basis of characteristics such as variations in player age. Finally, Prugsamatz et al. find consumer attitudes to be the most significant predictor of purchase intentions in the market for video games, particularly distinguishing between 'hardcore' and 'casual' gamers [27]. If players make purchasing decisions on the basis of their attitudes towards gaming, it seems reasonable to also suggest that these same attitudes might also be an important determinant of the gameplay experience when matched with and against other gamers with similar or different attitudes. This

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