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Research on User Behavior Analysis and Operational Optimization of University Metaverse Platforms—An Empirical Analysis Based on SUESMC Server

Yuxu Liang, Mo Li*
Shanghai University of Engineering Science, Shanghai 200000, China
*Author to whom correspondence should be addressed.

Abstract: With the proposal of the concept of "university metaverse" in recent years, Minecraft, as a youthful metaverse creation platform, has gradually attracted the attention of major universities. Taking the SUESMC server as an example, this paper analyzes player behavior using MDA theory and the difference-in-differences method based on Plan plugin data and questionnaire results. The study finds that although offline activities can promote user growth, the retention rate significantly declines after the activities; in addition, user needs are obviously differentiated. Social players are the core of community stickiness, while achievement-oriented and exploration-oriented players are lost due to resource monopoly, homogeneous gameplay, and lagging map updates. Based on this, the study proposes optimization strategies in three aspects: mechanism, operation, and technology, including feasible strategies such as phased guidance, dynamic resource refresh, high-frequency activity iteration, and AI application, providing some practical references for the construction and operation of university metaverse communities.

Keywords: Minecraft; Metaverse; Behavior analysis; MDA theory; Difference-in-differences method

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1. Research background and significance

1.1. Research background

Minecraft, a sandbox game and digital creation platform renowned for its high degree of freedom, has gradually evolved into an innovative output platform under the concept of "Campus Metaverse" in recent years [1]. However, many Minecraft servers operated by universities are currently facing multiple challenges in resource updating and community management. These servers are mostly maintained by student clubs, so they are restricted by technical limitations and academic pressures, making it difficult to continuously update content [2].

This study focuses on the SUESMC server, which is based on the Minecraft platform and is one of the campus metaverse projects developed by student clubs of Shanghai University of Engineering Science. Club technicians are responsible for the daily maintenance of the server and regularly write plugins to update content based on player feedback; club members mainly use their spare time for creation, such as building virtual campus scenes to attract freshmen during

club recruitment activities. However, this server operation model that is extremely dependent on student manpower has led to periodic fluctuations in player activity [3]. Therefore, this study aims to seek scientific and effective optimization methods for the SUESMC server through relevant theories and data analysis, achieve refined server operations, balance the exploration and guidance mechanisms for players, and solve the problem of sustainable development while breaking through human resource limitations.

1.2. Research significance

This study, based on the MDA theoretical framework, explores the mismatched relationship between game design and player behavior, providing theoretical support for the operation of community-type game servers [4]. By analyzing the imbalance in mechanics, dynamics, and aesthetics, it reveals the root causes of operational dilemmas in university self-built servers, and proposes that balancing player behavior guidance and autonomous exploration can be achieved through systematic adjustment of the three-layer relationship, offering a theoretical basis for the sustainable development of university servers. Meanwhile, combining the practice of university student associations operating Minecraft servers, this study analyzes the coupling relationship between their management models and virtual community construction[5], verifying the organizational advantages of university associations in the construction of metaverse platforms. Aiming at the problem of uncoordinated technology and management faced by university associations in the construction of metaverse platforms, this paper further explores how to transform the technologically empowered virtual space into a digital community ecosystem through the design of a scientific operation mechanism, so as to provide key methodological support for university associations to explore a lightweight and sustainable metaverse construction model.

2. Analysis methods and data collection

2.1. Analysis methods

2.1.1. Descriptive statistical analysis

This study integrates player behavior data and questionnaire survey results to construct a multi-dimensional dataset for descriptive statistical analysis. Descriptive statistics include calculating the mean, standard deviation, skewness, and kurtosis of indicators such as online duration and DAU (Daily Active Users), as well as frequency statistics and cross-analysis of structured questions in the questionnaire to build a semantic network of player needs. The retention rate analysis is based on original log data, calculating the next-day, 7-day, and 30-day retention rates and drawing curve charts. The analysis methods include distinguishing between new and old users, removing outliers, and comparing retention differences among different player groups to reveal the common characteristics of user needs[6]. The retention rate curve shows the phased fluctuations in the user lifecycle, providing support for subsequent analysis and strategy optimization.

2.1.2. Difference-In-Differences (DID) analysis

This study employs the Difference-in-Differences (DID) method to evaluate the direct or indirect impacts of online-offline activities on the server ecosystem of SUESMC [7]. Through a natural experiment design, users who participated in the activities are designated as the experimental group, while non-participating users serve as the control group. The observation period is divided into pre- and post-activity phases using the activity implementation time as a node, thereby isolating the confounding effects of time trends and individual heterogeneity to quantify the independent role of the activities.

2.2. Data collection

2.2.1. Data collection via Plan plugin

This study uses the Plan plugin to collect behavioral data of Minecraft server players, recording indicators such as login duration and DAU (Daily Active Users) with precision to the minute and unique identity codes[6]. The data covers the

period from September 2024 to February 2025, capturing the temporal changes in player behavior, which provides a solid foundation for studying the impact of community activities and content updates [8].

2.2.2. Data collection via questionnaire distribution

To evaluate the operational quality of the SUESMC server and user needs, the research designed and distributed the Minecraft University Club Server Satisfaction Questionnaire to server players. The questionnaire included 17 structured questions and 4 open-ended questions, encouraging users to freely elaborate on personalized needs and optimization suggestions [9]. It aimed to understand users' gaming purposes and evaluations of the server's core indicators. Finally, 117 valid samples were recovered, providing a basis for subsequent quantitative analysis and server improvement.

3. Analysis results of user behavior

3.1. Analysis of objective behavioral data

3.1.1. Characteristics of players' online duration and retention rate

This study uses the Plan plugin to collect players' behavioral data from the SUESMC server from September 2024 to February 2025, and analyzes the characteristics of online duration and retention rate. The average daily online duration of 367 registered players is 1.8 hours, with the highest proportion in the 1-2 hours interval. The retention rate curve shows that the next-day retention rate is 73.55%, which drops to 67.75% on day 7 and 55.92% on day 30. It significantly decreases from day 2 to day 20 and from day 40 to day 60, while remaining stable from day 20 to day 40 and after day 60[8]. It is worth noting that the 30-day retention rate of players with an average daily online duration of more than 2 hours is 28.57%, which is significantly higher than that of players with less than 1 hour of average daily online time, indicating that user activity is closely related to long-term retention.

3.1.2. The short-term impact of club activities on activity level

To study the short-term impact of club activities on activity level, this research uses server log data and employs the Difference-in-Differences (DID) method to evaluate the effect of club activities on players' activity level. Taking the "Hundred Clubs Battle" recruitment event as the policy timing point, players who logged in during the event are defined as the experimental group, while players of the same period who did not participate are set as the control group, constructing a panel data framework. The model includes time dummy variables, treatment group dummy variables, and interaction terms to quantify the independent effect of the event.

Analysis shows that the average daily online duration of players in the experimental group significantly increased, with an average increase of 0.86 hours compared to the control group after the event. The average daily number of active users in the experimental group increased from 32 to 89, a 278% increase, while the control group only increased from 15 to 18. The completion rate of mini-game tasks among players in the experimental group increased by 25% during the event, with no significant change in the control group [9].

Table 1. Regression Results of the Difference-in-Differences (DID) Model

Variable	Coefficient	Standard Error	p-value	95% Confidence Interval
Time Dummy Variable	0.12	0.05	0.021	[0.02, 0.22]
Treatment Group Dummy Variable	0.34	0.11	0.002	[0.12, 0.56]
Interaction Term (Policy Effect)	0.86	0.28	0.003	[0.30, 1.42]
Adjusted R^2	0.672	-	-	-

3.2. Analysis of subjective experience data

Based on 117 valid questionnaires, this study depicts the user profile of the SUESMC server from two dimensions: demographic statistics and behavioral patterns. The results show that males and freshmen are the main user groups of the server. Behavioral characteristic analysis reveals a polarization in user login frequency, with the proportion of high-frequency freshmen users significantly higher than that of other grades. The online duration is mainly 1-2 hours, and deep users are mostly concentrated in architectural creation and PVP (Player vs. Player) gameplay. Through the Kruskal-Wallis test and Dunn's post-hoc test, grade has a significant impact on user login frequency and online duration.

In terms of participation motivation and functional preferences, user motivations show diversification, with "obtaining community certificates/attendance" and "architectural creation" as the main driving factors. The territory plugin is used most frequently, with architectural creation users highly dependent on the territory plugin, and social players using the teleportation plugin more frequently [10]. Spearman correlation analysis shows that there is a significant positive correlation between architectural creation motivation and the frequency of territory plugin use. Multiple linear regression analysis indicates that activity innovation and management response speed have a significant positive impact on the plugin stability score. The results of the Mann-Whitney U test show that the frequency of teleportation plugin use by social players is significantly higher than that of non-social players [11].

In terms of satisfaction evaluation, users are relatively satisfied with the community atmosphere and the response speed of the management team, but give low ratings to the richness of activities and the diversity of game content. The main reasons for user churn are concentrated in the lack of attractiveness of game content and the insufficient stability of plugins. One-way analysis of variance shows that there are significant differences in the ratings of activity richness among different user groups. Multiple linear regression analysis indicates that community atmosphere and plugin stability have a significant positive impact on overall satisfaction.

The improvement demands mainly focus on functional optimization and content innovation, and high-frequency users show a strong willingness to participate in community co-construction. Chi-square test reveals a significant correlation between user types and participation willingness. Binary logistic regression analysis shows that the lack of attractive content and insufficient plug-in stability significantly increase the risk of user churn. In summary, optimizing activity planning and plug-in operation and maintenance, and balancing the experience needs of different user groups have become the key paths to improve the overall satisfaction of the server.

4. Optimization strategies

4.1. Mechanism optimization

This study optimizes the SUESMC server from the mechanism layer, dynamics layer, and aesthetics layer of the MDA theory. On the mechanism layer, a phased guidance system is designed. For example, a tool kit is provided during the novice protection period, and a safe area is defined. Additionally, a task chain is adopted to help players get familiar with the game. Meanwhile, resource balance is optimized by setting dynamic refresh and economic reforms to alleviate resource issues. For instance, scarce resources are set to refresh periodically, and a resource decay mechanism is introduced. On the dynamic layer, design social activities such as cross-school collaborative tasks to promote interaction, and build a social point system to incentivize players to participate in community construction. On the aesthetic layer, the achievement system is reconstructed by introducing repeatable achievements and hierarchical achievements to incentivize exploration, while strengthening the fairness of achievements and the motivation for exploration.

4.2. Operation strategy

The upgrade of operation strategies focuses on activity cycles and content innovation. The activity cycle has shifted from semester-based updates to high-frequency iteration, with monthly theme seasons and weekly mini-activities set up to enhance participation, such as "Construction Season," "Adventure Season," and other events, accompanied by limited-

time gameplay. In terms of content innovation, the linkage between building plugins and the economic system has been realized by introducing the 'FAWE + Economic Plugin' mechanism, allowing players to use in-game currency to purchase regional editing permissions. Meanwhile, a 'Creative Workshop' platform has been established to encourage players to submit design proposals, and the next phase of update content will be determined through community voting.

4.3. Technical support

In terms of technical support, the behavior tree is used to dynamically adjust the game difficulty. Specifically, the monster intensity is adjusted based on behavioral data such as players' online duration and death counts. Meanwhile, automated management tools are deployed to reduce operational pressure. Additionally, lightweight AI applications are explored to optimize NPC interaction logic: differentiated prompts are provided according to players' levels and task progress, and historical data is used to predict hotspot areas of resource consumption, so as to adjust refresh rates in advance or release collection tasks.

5. Research conclusions and prospects

This study focuses on the self-built Minecraft server of universities (SUESMC), revealing key issues in its operation through multi-method research. The study finds that although offline activities can significantly promote user growth, the retention rate declines after the activities, necessitating high-frequency content updates and optimized social mechanisms to extend the user lifecycle. Player needs are obviously differentiated: social players are the core of community stickiness; achievement-oriented players are seriously lost due to resource monopoly and gameplay homogenization; exploratory players are restricted by lagging map updates, and their participation needs to be activated through dynamic map resets and innovative gameplay.

Future research intends to expand from four aspects: first, build a cross - university collaboration ecosystem, explore the resource sharing mechanism of university alliance servers, and promote the construction of an open ecosystem. Second, use AI technology to achieve dynamic content automatic update and reduce the operation and maintenance burden. Third, build a churn warning and personalized recommendation system based on machine learning to improve the retention rate. Fourth, expand the educational attributes of the server and explore a sustainable operation model to strengthen its value as a digital transformation tool.

Disclosure statement

The author declares no conflict of interest.

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