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The Effects of Self-Learning Generative AI NPCs on Player Game Immersion and Loyalty: The Mediating Role of Game Immersion

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Abstract. With the growing use of generative artificial intelligence in digital games, whether AI-driven non-player characters (NPCs) can improve player experience and further shape continued play intention has become an important question for game design and user research. This study examines whether self-learning generative AI NPCs influence game loyalty through game immersion. A quasi-experimental between-subjects design and a retrospective questionnaire were used to compare players who had interacted with self-learning generative AI NPCs in the past three months with players who had only interacted with traditional scripted NPCs. Based on 195 valid responses, the AI NPC group reported significantly higher game immersion and game loyalty than the traditional NPC group. Mediation analysis using PROCESS Model 4 further showed that game immersion significantly mediated the relationship between NPC type and game loyalty. The findings suggest that the value of generative AI NPCs lies not only in the technology itself, but also in whether adaptive and natural interaction can enhance immersion and thereby relate to continued play and recommendation intention. Given the non-random grouping and self-reported data, the findings should be interpreted cautiously.

Keywords: self-learning generative AI NPC, game immersion, game loyalty, player experience, mediation effect

1. Introduction

As of June 2023, the number of online game users in China reached approximately 550 million [1]. Against this background, whether players are willing to remain engaged with a particular game remains a central issue for game design and user experience research. Among the many factors that may affect retention, NPCs are important because they support narrative progression, provide task feedback, and help maintain a sense of game world presence. Their interaction style may therefore be closely related to player immersion.

Traditional scripted NPCs usually rely on predefined dialogue trees. Players select from fixed options, and NPCs respond according to predetermined scripts. This design is stable and controllable, but its interaction boundaries may become apparent after repeated play. With the development of large language models, some games have begun to introduce generative AI NPCs. In

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LLM-driven dialogue games such as Vaudeville, players can communicate with NPCs in natural language, and NPCs may adjust their responses by referring to prior interactions [2, 3]. Previous studies have shown that open-ended NPC dialogue may expand interaction space, although it can also produce memory failures, irrelevant responses, or character inconsistency [2]. Liu found that an AI-enhanced version of a text game increased willingness to continue playing compared with a traditional version [3]. Galingana and Cagadas reported that free-input NPC dialogue in a visual novel context improved immersion more than fixed dialogue options [4]. Yu et al. also suggested that GPT-based anthropomorphic NPC characteristics may influence satisfaction and loyalty through immersion [5].

In online game research, game loyalty generally refers to players' tendency to continue playing a game and maintain a positive attitude toward it. Choi and Kim linked online game loyalty with critical design factors [6], while Su et al. found a significant relationship between flow experience and loyalty in mobile games [7]. Game immersion refers to a state in which players are highly involved in gameplay and temporarily reduce awareness of the external environment [8]. Ding et al. found that game customization influenced loyalty both directly and indirectly through immersion, with the indirect effect accounting for about 31.2% of the total effect [9]. Zhang's study on role-playing online games also treated continued play, recommendation, and positive evaluation as key expressions of loyalty [10]. These studies suggest that game design features may first influence immersion and then shape continued play and recommendation intention.

Although existing work indicates that AI NPCs may change player experience, two gaps remain. First, many studies focus on player comments, technical implementation, or single AI NPC experiences, while fewer studies compare AI NPC experiencers with traditional scripted NPC experiencers at the individual level. Second, limited research has measured game immersion and game loyalty simultaneously and tested whether immersion explains the relationship between NPC type and loyalty. Therefore, this study treats NPC type as the independent variable, game immersion as the mediator, and game loyalty as the dependent variable.

In this study, self-learning generative AI NPCs refer to NPCs supported by generative AI that can dynamically adjust dialogue content, behavioral logic, and interaction style according to player input and interaction history [2]. The study does not directly measure technical parameters of NPC systems; instead, grouping is based on whether participants had actually experienced this type of NPC in the previous three months. Game immersion was measured with the five-item scale by Choi and Kim [6], and game loyalty was measured with the five-item scale by Zhang [10]. Based on the above literature, three hypotheses were proposed: H1, players in the self-learning generative AI NPC group will report higher game immersion than those in the traditional scripted NPC group; H2, players in the self-learning generative AI NPC group will report higher game loyalty than those in the traditional scripted NPC group; H3, game immersion will mediate the relationship between NPC type and game loyalty.

2. Methodology

2.1. Research design

This study adopted a quasi-experimental between-subjects design with a retrospective questionnaire. Because participants entered groups based on their existing game experience, random assignment was not conducted. Instead, participants were categorized into an experimental group or a control group according to the type of NPC they had actually interacted with in the previous three months. The operational definitions are shown in Table 1.

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The independent variable was NPC type, the dependent variable was game loyalty, and the mediator was game immersion; the measurement instruments and scoring methods are summarized in Table 2. H1 and H2 were tested using independent-samples t tests, and H3 was tested using Hayes PROCESS Model 4 [11].

Table 1. Operational definitions of the experimental and control groups

Group	Operational definition
Experimental group	Participants who had interacted with at least one self-learning generative AI NPC in a game in the past three months, such as an LLM-driven dialogue game including Vaudeville
Control group	Participants who had mainly interacted with traditional scripted NPCs in the past three months and had not experienced the above type of self-learning generative AI NPC

2.2. Participants and sampling

Convenience sampling was used. The questionnaire was distributed through Wenjuanxing and shared in AI NPC-related communities, general game player groups, and student networks. The original target was at least 120 valid questionnaires, with approximately 60 participants in each group. In total, 195 valid responses were obtained, including 82 participants in the experimental group and 113 in the control group. Inclusion criteria required participants to be at least 18 years old, to have played digital games with NPC interaction in the past three months, and to recall a specific NPC interaction experience. Responses that failed screening questions, failed the attention check, or showed clear response regularity were excluded.

2.3. Measures

The first screening question asked whether participants had interacted with an AI-driven NPC that changed responses according to their previous dialogue or behavior in the past three months. Participants answering "yes" were assigned to the experimental group. The second screening question asked whether participants had mainly interacted with traditional scripted NPCs and had not experienced the above AI NPCs. Eligible participants entered the control group. The NPC perception scale measured perceived adaptiveness, naturalness, memory, and variability of NPC interaction and was used as a manipulation check.

Table 2. Variables, measurement instruments and scoring methods

Variable	Type	Measurement instrument	Scoring method
NPC type	Independent variable	Screening questions and a self-developed NPC perception scale with five items	Binary grouping; NPC perception rated on a 7-point Likert scale
Game immersion	Mediator	Online game immersion scale by Choi and Kim [6]	Five items, 7-point scale
Game loyalty	Dependent variable	Online game loyalty scale by Zhang [10]	Five items, 5-point scale

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Table 2. (continued)

Control variables	Covariates	Self-developed demographic and gaming background questions	Age, gender, weekly game time, gaming experience, and main game genre

2.4. Procedure

The questionnaire followed this order: research information, demographic questions, NPC type screening, recall of a representative NPC interaction, game immersion scale, game loyalty scale, and an attention check. Participants were asked to recall a specific NPC interaction before completing the immersion and loyalty items so that their responses focused on an actual game experience rather than a general impression of games.

2.5. Data analysis

Data analysis was conducted using SPSS 26.0. Descriptive statistics, reliability analysis, and the manipulation check were conducted first. H1 and H2 were tested using independent-samples t tests with Cohen's d reported. H3 was tested using PROCESS Model 4, with NPC type coded as 0 = traditional scripted NPC and 1 = self-learning generative AI NPC. Bootstrap sampling was set to 5,000. When control variables showed group differences, ANCOVA was conducted as a supplementary analysis. The significance level was set at two-tailed $\alpha = 0.05$.

2.6. Design limitations

This design has several limitations. First, the study used a retrospective questionnaire and non-random grouping, so the findings mainly indicate associations rather than strong causal effects. Second, NPC type was classified based on self-report, which may involve differences in understanding and recall bias. Third, games featuring self-learning generative AI NPCs are still developing, and the representativeness of the experimental group remains limited.

3. Results

3.1. Sample characteristics and control variable tests

A total of 195 valid responses were obtained, including 82 participants in the experimental group (42.1%) and 113 in the control group (57.9%). The age difference between groups was not significant (experimental group $M = 29.63$; control group $M = 29.09$), $t(178) = 0.70$, $p = 0.488$. Weekly game time, gaming experience, and main game genre also showed no significant group differences ($p > 0.05$). Gender composition differed significantly between groups, with 30 female participants in the experimental group and 18 in the control group, $\chi^2(1) = 9.84$, $p = 0.002$. Therefore, gender and other control variables were included in supplementary analyses(Table 3).

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Table 3. Comparison of control variables between the experimental and control groups

Variable	Experimental group	Control group	Test statistic	p
Age (years)	M=29.63, SD =5.33	M=29.09, SD =5.52	t(178) = 0.70	0.488
Gender (female/male)	30/52	18 / 95	$\chi^2(1) = 9.84$	0.002
Weekly game time	M =2.44, SD =1.12	M=2.42,SD=0.99	t(161)=0.09	0.927
Gaming experience	M=4.17, SD =0.90	M=4.03,SD=0.96	t(181)=1.07	0.284
Main game genre	See Table 4	See Table 4	$\chi^2(4) = 6.91$	0.141

Table 4. Distribution of main game genre by group

Game genre	Experimental group n (%)	Control group n (%)
Role-playing games (RPG)	17 (20.7%)	17 (15.0%)
Action-adventure	28 (34.1%)	28 (24.8%)
Simulation/management	18 (22.0%)	24 (21.2%)
Strategy	13 (15.9%)	24 (21.2%)
Shooter/competitive	6 (7.3%)	20 (17.7%)

3.2. Reliability and manipulation check

Reliability analysis showed that Cronbach's α values for game immersion, game loyalty, and NPC perception were all above 0.91 (Table 5), indicating good internal consistency. The manipulation check showed that NPC perception was significantly higher in the experimental group (M = 5.48, SD = 0.76) than in the control group (M = 2.25, SD = 0.58), $t(144) = 32.23$, $p < 0.001$, Cohen's d = 4.88. This indicates that the two groups differed clearly in perceived NPC interaction features.

Table 5. Reliability coefficients of the scales

Scale	Number of items	Cronbach's α
Game immersion	5	0.92
Game loyalty	5	0.91
NPC perception	5	0.94

3.3. Hypothesis testing

H1 tested the group difference in game immersion. The experimental group (M = 5.26, SD = 1.16) scored significantly higher than the control group (M = 3.61, SD = 1.39), $t(189) = 9.03$, $p < 0.001$, Cohen's d = 1.27. H1 was supported.

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H2 tested the group difference in game loyalty. The experimental group (M = 3.81, SD = 0.91) scored significantly higher than the control group (M = 2.76, SD = 1.00), $t(183) = 7.59$, $p < 0.001$, Cohen's d = 1.08. H2 was supported.

H3 tested the mediating role of game immersion. PROCESS Model 4 showed that the indirect effect was significant, ab = 1.033, 95% CI [0.808, 1.253], and the confidence interval did not include zero. The direct effect was small, $c' = 0.015$. H3 was supported (Table 6).

Table 6. Mediation effect of NPC type on game loyalty through game immersion

Path/effect	Coefficient
A path (NPC type-game immersion)	1.651
B path (game immersion-game loyalty)	0.626
Total effect c	1.049
Direct effect c′	0.015
Indirect effect a × b	1.033
95% CI of indirect effect	[0.808, 1.253]

3.4. Supplementary tests with control variables

After controlling for age, gender, weekly game time, and gaming experience, ANCOVA showed that the main effect of NPC type on game immersion remained significant (B = 1.681, SE = 0.191, t = 8.79, $p < 0.001$). The main effect of NPC type on game loyalty also remained significant (B = 1.053, SE = 0.144, t = 7.29, $p < 0.001$).

A gender subgroup analysis was conducted to further examine whether gender imbalance influenced the main results. Among male participants, the experimental group scored higher than the control group on both immersion (M = 4.97 vs. M = 3.79) and loyalty (M = 3.53 vs. M = 2.90), $p < 0.001$. Among female participants, the experimental group also scored higher than the control group on immersion (M = 5.77 vs. M = 2.66) and loyalty (M = 4.29 vs. M = 2.04), $p < 0.001$. These results indicate that the main differences were consistent within both gender subgroups.

4. Discussion

This study compared players who had experienced self-learning generative AI NPCs with players who had only experienced traditional scripted NPCs. The results showed that the experimental group reported significantly higher game immersion and game loyalty than the control group, with large effect sizes. Mediation analysis further showed that game immersion significantly mediated the relationship between NPC type and game loyalty, while the direct effect was small. Thus, the relationship between NPC type and player loyalty was mainly reflected through immersion experience.

The findings are consistent with previous studies on AI NPCs and game immersion. Cox and Ooi found that LLM-driven NPCs expanded the interaction space between players and NPCs, although memory failures and inconsistent responses remained concerns [2]. Liu reported that adding AI NPCs improved gameplay evaluation and willingness to continue playing [3]. Galingana and

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Cagadas also found that free-input NPC dialogue improved immersion in visual novels [4]. The present study extends these findings by showing that AI NPC experiencers reported not only higher immersion but also higher loyalty.

This study also extends the "game design feature-immersion-loyalty" pathway. Previous research has shown that online game loyalty is related to continuing play and positive attitudes [6], and that flow or immersion experience is closely associated with loyalty [7]. Ding et al. found that game customization indirectly influenced loyalty through immersion [9]. Unlike character appearance or equipment customization, self-learning generative AI NPCs change dialogue style and interaction logic. Nevertheless, both represent game design features that may first affect immersion and then influence loyalty-related attitudes.

Theoretically, this study provides an empirical perspective centered on player experience. Discussions of AI NPCs often focus on technical feasibility, dialogue generation, or player comments. Recent work on LLMs and games also suggests that the value of LLM-based game applications should be assessed in relation to player experience, narrative interaction, and long-term engagement [12]. By comparing two groups of players and testing a mediation model, this study shows that the value of AI NPCs should be evaluated not only by whether they generate more text or simulate human-like dialogue, but also by whether they enhance player involvement and whether such involvement is linked to loyalty.

From a game development perspective, the value of self-learning generative AI NPCs should not be understood merely as making NPCs "more human-like" or increasing the amount of dialogue. The key issue is whether they can stably enhance players' immersion in the game world. If NPCs can respond to player input, maintain character consistency, and show memory of important interactions, players may be more likely to continue playing and recommend the game. However, AI NPCs should be applied cautiously. LLM-driven NPCs may show unstable memory, irrelevant responses, or character drift [2]. If open-ended responses frequently depart from the plot or ignore earlier player input, immersion may be weakened. Developers should therefore prioritize character consistency, contextual memory, narrative boundaries, and safety control rather than simply pursuing open dialogue.

5. Conclusion

Based on 195 valid questionnaire responses, this study compared players who had experienced self-learning generative AI NPCs with players who had only experienced traditional scripted NPCs. The AI NPC group reported significantly higher game immersion and game loyalty than the traditional NPC group. PROCESS Model 4 further showed that game immersion significantly mediated the relationship between NPC type and game loyalty. The results remained significant after controlling for age, gender, weekly game time, and gaming experience. By comparing two groups of players and testing a mediation model, this study shows that the value of AI NPCs should be evaluated not only by whether they generate more text or simulate human-like dialogue, but also by whether they enhance player involvement and whether such involvement is linked to loyalty. From a game development perspective, the value of self-learning generative AI NPCs should not be understood merely as making NPCs "more human-like" or increasing the amount of dialogue.

Overall, the findings support the pathway of "NPC interaction type-game immersion-game loyalty". Self-learning generative AI NPCs may enhance immersion through more natural and adaptive interaction, and immersion is further associated with continued play and recommendation intention. This study extends the game design feature-immersion-loyalty model to the context of generative AI NPCs and provides preliminary evidence for understanding how AI technology relates

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to player experience. However, because this study used non-random grouping and self-reported data, and because NPC type was mainly classified based on player recall, the findings should be understood as correlational evidence. Future research may use controlled experiments, behavioral data, and larger samples to further examine the effects of AI NPCs on immersion, loyalty, and actual retention behavior.

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