Academic Performance Predicts Competitive Gaming Talent: A Time-Adjusted OLS Analysis of CS2 Players

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Abstract. This study examines the relationship between academic performance and gamine talent in competitive video games by focusing on competitive game Counter Strike 2 (CS2) and separates practice-time effects from individual ability. Data were collected from 51 male senior-2 students in Haidian District, Beijing, who met minimum equipment and engagement thresholds. Two ordinary least squares (OLS) approaches were applied: (1) an adjusted-dependent-variable method that divides raw performance by a logarithm of game duration term to approximate performance efficiency, and (2) a residual method that first regresses raw performance on logarithm of game duration and then regresses the resulting residuals (the time-adjusted "talent" measure) on academic score. Results show a consistent and significant positive relation between final exam scores and time-adjusted gaming performance. In the adjusted-Y model, the final score coefficient is positive (coefficient = 1.15) and significant ($p < 0.01$), with the model explaining about 20% variance. In the residual approach the relationship remains significant ($p < 0.01$), and the second regression of the model explains roughly 26% of variance. These findings indicate that, beyond practice time, higher academic achievement is associated with greater efficiency or "talent" in competitive gaming. The research findings challenge the simple stereotype linking gaming proficiency to poor academic performance and suggest that cognitive and learning abilities may have cross disciplinary transfers.

Keywords: Academic performance, gaming talent, Counter Striker 2, competitive game.

1. Introduction

In the traditional view of the past few decades, video games have often been seen as the opposite of learning. People often believe that there is a negative correlation between the level of electronic gaming and academic performance. For example, teachers and parents often say that students who excel academically do not play video games, while students with high levels of performance in the field of electronic games are often considered to be not engaged in their studies. The mass media is filled with stories about the impact of electronic and computer games on the brain. The sensational headline claims that electronic games damage the brain [1]. With the continuous acceleration of people's pace of life in modern society, playing video games is no longer synonymous with being idle. On the contrary, it has become the first choice for many teenagers and even adults to relax and unwind. In the United States, 97% of teenagers play video games for at least one hour every day [2]. With the popularization of games in the world, the view that academic performance and gaming level are negatively correlated has also been challenged and questioned. Many students with excellent academic performance not only do not resist video games but also demonstrate above average talent and level in competitive video games after a certain amount of training. Therefore, the relationship between gaming proficiency and academic performance needs to be reconsidered.

In previous studies, although many studies have tried to summarize the relationship between game level and academic performance, there are still limitations. In most studies, researchers mainly focus on educational games and leisure games: for example, the research of Vlachopoulos and Makri covers role-playing, strategy games and virtual experiments [3]. Although these games can well reflect cognitive ability and help students improve their academic resilience and self-regulation ability [4]. However, its relevance to pure competitive level such as reaction time, targeting ability and situation understanding is limited. However, MOBA and FPS games that are rarely discussed in these studies, such as League of Legends and Counter Strike 2, reflects more in whether the game level performed while playing against real people is related to learning ability. Many early studies used students' GPA

as the evaluation standard of students' learning level. For example, Weaver et al. studied the relationship between College Students' GPA and game use [5]. However, GPA is largely affected by the daily performance. Different students have different attitudes towards GPA. Some students take “Pass” as the goal of University GPA, while others have aim on excellence. Therefore, GPA can represent the results of students' learning at the university stage, but it cannot fully represent the learning ability.

This study focuses on how students’ academic performance influences their gaming talent, especially within the context of the competitive online game Counter Strike 2. In contrast to the previous studies, Counter Strike 2 is a typical competitive online game; By using ranking score and rating in CS2, it can be clearly demonstrated the student's ability to learn, understand, and expert video games. The amount of time each student spent playing the game is also included, since the proficiency accumulated over time may conceal the actual ability and talent. In addition, mean value of all grades tested in the final exam of senior 2 Chinese students are taken as an indicator of academic performance. Unlike college GPA, nearly every student in China takes the final of senior 2 as a serious exam, and the exam include Math, Chinese, English, and three other courses chosen from Physics, Chemistry, Biology, History, Geography, and Political science, which measures the student comprehensive learning ability. By investigating the performance of students with different grades in competitive games or fast-paced games, this study aims to more comprehensively understand the situation of modern students and the role of digital games in youth culture, change people's traditional ideas about the relationship between learning level and games, and form a new understanding of the e-sports industry and E-sports players.

2. Method

2.1. Dataset Praparation

This study uses online Excel sheet to collect data information for calculation, and the core data includes game level, game time, and learning ability. Due to the hard-core content and strong competitiveness of CS2, almost all players are male. The remaining female players often have the behavior of being organized by experts in the process of playing, so female players are not included in this study. At the same time, CS2 is highly competitive and has short TTK (time to kill), so there are certain requirements for players' computers and peripherals. During the survey, it was found that many players were using office computers or laptops to play. These computers generally have low performance and cannot achieve a high frame rate and stability; There are also some players who do not have sufficient game peripherals (mouse, keyboard, headset). These factors limit the players' ability to play at their real level in the game, and the improvement brought by peripherals has a strong diminishing marginal return effect [6]. Therefore, the basic threshold must be set for the player's equipment, but it is not necessary to be reflected in the subsequent regression calculation. The respondents in this study met the following conditions: male; Senior 2 students in Haidian District, Beijing; Study normally and take the exam seriously; Enjoy playing CS2; It has been more than one year since the first exposure to CS2; At least 20 Ranking games will be played this season; The computer can stably run CS2 at 1080p image quality 144hz, and the total price of peripherals is higher than 500 yuan.

Combined with the above reasons, the investigation sheet of this study includes the following contents. 1. perfect world arena S20 season ranking score: perfect world is the official agent of CS2 in China, and its perfect world arena has more than 9 million players. Its ranking mode is more competitive than CS2's official match and has better anti cheating. 2. perfect world arena S20 season rating: rating is a comprehensive measure of players' performance in the game, including average number of Kills Per Round (KPR), average number of Deaths Per Round (DPR), Average Damage per Round (ADR), and impact (i.e. influence on the situation) [7]. 3. Game duration: how many hours players have played in total. 4. final score: the final exam of senior two of the public high school in Haidian District, Beijing is set by the Haidian Education Commission, and everyone has the same

exam questions. 5. whether the equipment meets the standard: the same as above. 6. whether the recent game duration meets the standard: the same as above.

A total of 65 groups of data were finally collected in this survey, and additional verification was carried out for the data containing unreasonable values, such as game duration greater than 2, 000 hours and rating greater than 1.3. After eliminating invalid data and outliers, 51 groups of data were retained.

2.2. Model and Formula

The study assumes that there is a certain degree of positive or negative correlation between students' academic performance and their performance in competitive video games, and this relationship can be isolated and analyzed under the premise of controlling variables such as game duration.

In the previous data collection process, this study has already controlled variables such as gender, age, and gaming devices, so there is no need to mention them again. According to Bediou et al.'s paper, there is a linear relationship between individual game performance and the logarithm of practice frequency, that is, performance follows a logarithmic function over time [8]. Therefore, $T = \log_{10} Time(hours)$ will be used as the control variable for time in the regression model [9]. According to the update of HLTV, the new Rating calculation method is adapted to the gaming environment of CS2, which can reflect the comprehensive performance of players in the game while satisfying the feature of mean equal to 1 [7]. So, $L = RankingScore \times Rating$ is adopted by the linear model as a comprehensive score that reflects the player's level.

This study uses two different OLS regression models: adjusted dependent variable method and residual method. Adjusting the dependent variable method is to use the influence of game duration as the coefficient of the dependent variable, so that the dependent variable changes from game level to game talent. The dependent variable of this method is closer to the individual's performance efficiency or talent, and the model is simple with clear results briefly. The residual method is to first regress the dependent variable of game level with respect to game time and then use the residual after excluding game performance to regress with respect to learning level. This method can clearly demonstrate how the influence of time is eliminated and can test the accuracy of fit of the first step to time (residual distribution), ensuring the exclusion of control variables. The formulas of two methods are as follows.

$$\text{Adjusted Y method: } Y_{i(adj)} = \beta_0 + \beta_1 X_i + \varepsilon_i \tag{1}$$

$$\text{Residual method: } Y_{i(res)} = \gamma_0 + \gamma_1 T_i + r_i \tag{2}$$

$$r_i = \alpha + \beta X_i + \varepsilon_i \tag{3}$$

The above formula contains two different types of symbols, that is, variables and coefficients. $Y_{i(adj)}$, $Y_{i(res)}$, X_i, T_i, and r_i are variables, the explanatory of them are as follows: $Y_{i(adj)}$ is the adjusted dependent variable for i-th student, and it is measured in $RankingScore * Rating/T$; $Y_{i(res)}$ is the dependent variable for i-th student, and it is measured $RankingScore * Rating$; X_i is the senior 2 final grade for i-th student; T_i is the logarithm of the i-th student's game time (based on 10); r_i is the residual of i-th student after removing time, and it is used as the dependent variable after removing the effect caused by game duration. β_0, β_1, γ_0, γ_1, α, β, and ε_i are coefficients, the explanatory of them are as follows: β_0 is the benchmark game level when all explanatory variables are 0 for adjusted Y method; β_1 is the regression coefficient of gaming talent on academic performance for adjusted Y method; γ_0 is the benchmark game level when all explanatory variables are 0 in the regression of gaming level on time; γ_1 is the regression coefficient of gaming level on time; α is the benchmark game level when all explanatory variables are 0 for residual method; β is the regression coefficient of gaming talent on academic performance for residual method; ε_i is the random error term, representing the influence of unobserved factors.

3. Results and Discussion

3.1. Results

The descriptive statistics can be found in Table 1. In addition, Fig. 1 above shows the scatter plot of adjusted-Y method. It shows the distribution of each student's comprehensive game ability score (dependent variable) and final score (independent variable), as well as the OLS best fit line under this distribution. The R^2 of the OLS best fit line is 0.1992; β_1 is 1.1491; standard error is 0.3292; t value is 3.491; and p value is 0.00103. Therefore, under this model, the coefficient of the final score is positive and significant at the conventional significance level (P<0.01). The meaning of the coefficient can be explained as follows: for each unit of increase in the final score, the converted performance score will increase by about 1.149 units on average. The explanatory power of the model is medium, which can explain about 19.9% of the dependent variable variation.

Table 1. Descriptive Statistics

	Sample size	Mean	Median	Standard deviation	Max value	Min value
Ranking score	51	1648.529	1622	315.489	2700	902
Rating	51	1.058	1.06	0.115	1.37	0.81
Game duration	51	1000.51	755	747	3500	152
Final score	51	435.078	432	47.371	558	302

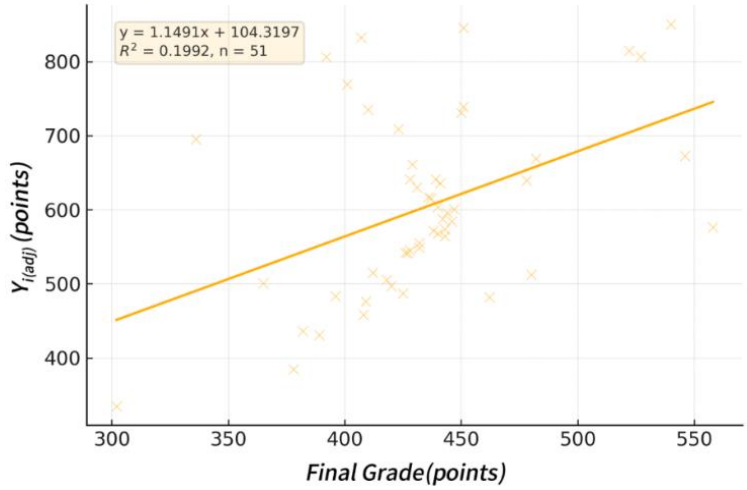

Fig. 1 Scatter plot for adjusted Y method (Picture credit: Original)

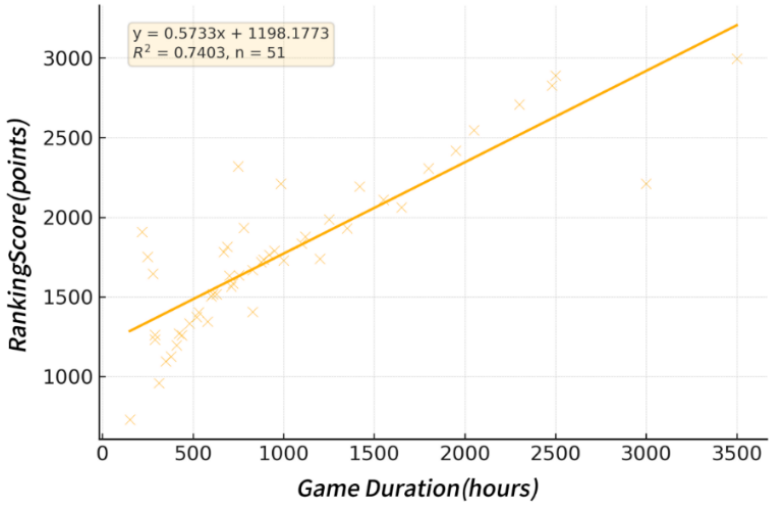

Fig. 2 Scatter plot for the first step for residual method (Picture credit: Original)

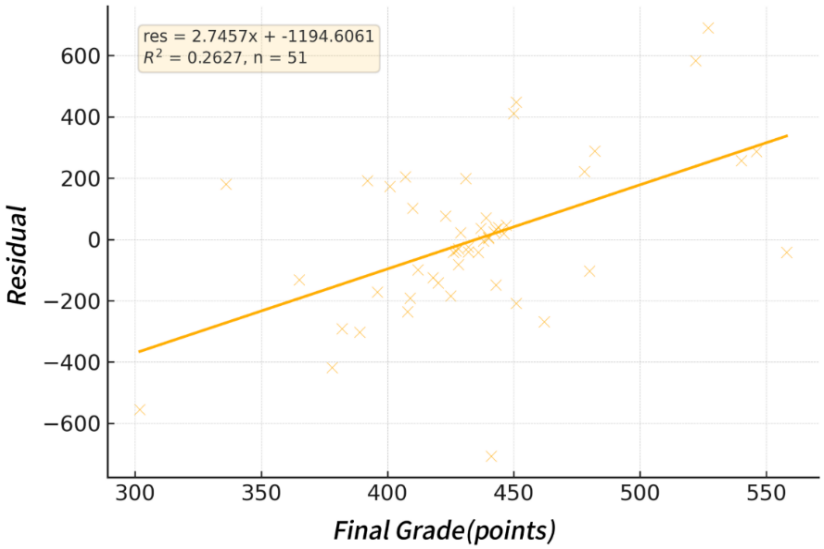

Fig. 3 Scatter plot for the second step for residual method (Picture credit: Original)

Fig. 2 and Fig. 3 above are scatter plots of the two steps of the residual method, which show the distribution of original ranking score to game duration and the residual of it to final grade. The first step eliminates the effect by proficient practiced along playing CS2 for a long time. The residual, that is, the difference between students' present game level and the average level of logarithmic growth measures the real game talent, and the second step is the regression of gaming talent on academic performance. For the first step: the R^2 is 0.7403, and γ_1 is 0.5733. For the more important part, step two: the R^2 is 0.2627; β is 2.7457; standard error is 0.7366; t value is 3.059; and p value is 0.00360. Under the residual method, there is still a significant positive correlation between the residual and the final score after eliminating the game time (P<0.01), indicating that after controlling the effect of practice time, there is still a positive correlation between academic performance and "performance difference after time elimination" (which can be understood as closer to "talent" or "efficiency"). The explanatory power of the model is 0.2627, which can explain about 26.3% of the dependent variable variation. At the same time, the methodology can directly correspond to the research goal of "examining talent after eliminating time".

3.2. Discussion

The results show that there is a significant positive correlation between academic performance and game performance. Similar result (R^2, p value) can be observed either by using the direct "comprehensive performance score" regression or by using the residual method to eliminate the practice time and then regression. This means that students with higher academic performance and stronger learning ability tend to be more gifted and competitive in competitive games, which supports the hypothesis that "there is a positive relationship between academic ability and some types of game skills". The significance of the residual method is particularly important: even after the experience/training effect brought by the game duration is eliminated, the relationship between performance and performance is still observed, which supports the view that "talent or ability (rather than pure practice time)" plays a role in explaining performance differences.

Compared with previous studies, the conclusion of this study is consistent with the view that students who study well perform better in education and leisure games [3]. On this basis, this article adds the embodiment of this view in competitive games, as well as the specific quantitative relationship between game talent and learning ability and game time. At the same time, after eliminating the interference factors of time, the students who study well are still more competitive in the game, which corresponds to the articles that emphasize cognitive ability and reasoning ability [4].

This study is the first to explore the impact of academic performance on game level (talent/efficiency) within the framework of "performance score" after excluding game duration, which has the following theoretical and practical value. First, promote the refinement of the

theoretical model: traditional models tend to confuse video game talent with practice experience, but this study uses the residual method to separate the influence of practice time, so that the dependent variable can be more accurately introduced into the concept of talent. This not only follows the modeling idea that the learning curve is logarithmically linear [8], but also conforms to the emphasis on "personal ability" in cognitive transfer theory (such as the impact of positive effect on cognitive performance) [10]. Such methodological logic will help to promote the transformation of game research methods from "behavior quantity" to "individual essential ability". Second, correct the public cognitive bias: for a long time, the bias that "playing games will affect grade" still exists, but this study based on the data found that under the same game practice input, students with better academic performance actually have better performance ability, which not only challenges the stereotype that "playing games is exclusive to students with poor performance", but also provides an empirical basis for rational discussion of the role of games. Third, education evaluation and talent identification: the above results show that individual abilities can be more targeted in the education environment, especially in the field of e-sports, which provides a new consideration standard for the selection of "innate master" by E-sports clubs.

However, this study also has several limitations: measurement error, sample representation, and personal attitude towards ranking score. To begin with, it is common that people will lend their game account to their friend, sometimes because two people need accounts in a specific ranking score interval to play with their friends, sometimes because people want to try their friends' expensive skins; in case of that, the game duration statistics on steam platform is inauthentic, so the data set collects time an estimate duration for each person's pure duration. Second of all, the sample size is relatively small, and all the 51 samples are collected from high school students in Beijing Haidian district. Last, some people consider their ranking score as a serious achievement, but others don't; their personal attitude is unquantifiable, however.

Future research can ameliorate these limitations by following suggestions: spread the online investigation to players all over the world, if possible, to make sure the finding fits all players; try to collect the time duration more precisely; and design a problem set to speculate each person's attitude towards ranking score and add it as a variable.

4. Conclusion

This study examined the relationship between academic performance and gaming talent in Counter Strike 2. The findings indicate that after removing the factor of practice time, there is a positive linear relation between academic performance and gaming talent, suggesting that the previous perception of playing video games and study is biased. These results contribute to the refinement of current model and may inform E-sports clubs of new ways of finding potential experts. While further work is required to address, the study provides a solid basis for future investigations into competitive games.

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