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The Effect of Video Games Towards the Students' Academic Performance

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***Abstract*— Video games, originating in the mid-20th century, have become a major cultural phenomenon. Recently, about so many people, mostly young and mobile gamers, play video games. Despite their popularity, video games face controversy over potential negative impacts, such as promoting violence and harming academic performance. However, research on the correlation between gaming and academic performance is inconclusive. Some studies suggest a negative impact, while others find no significant effect. This study re-examines this relationship among university students in Tangerang using various statistical methods. The research process includes data collection via a questionnaire, followed by normality tests (Shapiro-Wilk Test and QQ Plot), the Kruskal-Wallis Test, and concluding with the Spearman Correlation Test. The results showed a p-value of 0.6376 and a rho value of -0.04767789, indicating no significant correlation and weak negative correlation. The scatterplot also supports this with widely dispersed data points. Therefore, we conclude that no significant correlation exists between time spent playing video games and students' GPA in the Tangerang area.**

***Index Terms*— *correlation; GPA;* video games; statistics.**

I. INTRODUCTION

Video games are an exciting byproduct that emerged from the rapid development of technology in the 20th Century. The first video game was made in 1958, a simple tennis game displayed via an oscilloscope as a screen. The game was known as tennis for two, where two players would be playing tennis on the screen [1]. Video games would then continue developing as time progressed, with Spacewar! Emerging in 1962 [2]. However, video games at that time had not yet entered popular culture the way it has now. It wasn't until the late 1970s and early 1980s that video games became the cultural phenomenon it is. It can be attributed to the fact that home systems became more widely available to the general populace by that time, allowing people of all ages to play in the comfort of their own homes [3]. Thus, that period became known as the golden age of video games, where video games began to see massive commercial success and influence within popular culture. Even today, video games remain massively popular worldwide, and the number of players continues to grow as time passes. As of 2023, it is estimated that the number of active video game players worldwide is around 3 billion. Most video game players are young, making up more than half of the world's active players. The smartphone is the most popular platform on which people play video games, with an estimated 1.93 billion mobile video game players worldwide [4].

However, despite its popularity, video games have been subject to societal controversies. Public perception of video games is mixed, with many holding positive or negative views. Most of the negative perceptions towards video games are based on the beliefs that video games are a waste of time and energy, are the cause of violent behavior, and can lead to addictions [5]. In addition, video games have also been viewed as negatively impacting academic performance. Numerous studies have claimed that the time spent playing games negatively affected students' grades. These studies found that the time spent playing video games negatively correlated with student's academic performance and thus concluded that video games negatively impact grades. Interestingly, however, video games have also been found to bring many positive benefits despite people's negative perceptions towards them. A study conducted in 2022 by IEEE found that playing video games, specifically in the strategy genre, can improve problem-solving and communication skills [6]. Video games have also been found to help improve mental health, and they are used to help patients as a tool for therapy [7]. Video games have also been found to help children improve their social skills, as they encourage collaboration in problem-solving through in-game challenges. It creates an opportunity for people, especially children, to socialize and develop their social skills while playing [8].

There is mix opinion between researchers in this area. Some believes that there is negative correlation between the time spent on video games and academic performance, while others believes there is no significant correlation. A survey conducted in 2022 estimated the Correlation between the time spent on video games and the Grade Point Average (GPA) of students in Universiti Teknologi Mara and found an association between playing video games and lower academic achievement to some degree [9]. A similar

research conducted in 2023 also came with a similar conclusion, where the findings indicate a negative correlation between the time spent on video games and the student's academic achievement measured in GPA one Eastern European country [10]. On the other hand, one research study concluded that there was no significant correlation between playing video games and lower student grades. Other study also found that non-gamers in Saudi Arabia still achieved slightly better grades than their gamer counterparts [11].

So, at this point, different area shows different results whether the correlation is significantly negative or not significant. Therefore, this study tries to retest this condition with varying subjects of research. The new subjects are university students in Tangerang area. Thus, this study will employ several statistical methods to determine whether video games correlate with student academic performance in Tangerang.

II. Literature Review

A. The Shapiro-Wilk Test

The Shapiro-Wilk test is a statistical test used to evaluate whether a sample of data comes from a normally distributed population [12]. In this test, the data are sorted, and the test statistic W is calculated to measure how well the data conform to a normal distribution using Equation (1).

$$W = \frac{\left(\sum_{i-1}^{n} a_i X_{(i)}\right)^2}{\sum_{i-1}^{n}(X_i - \bar{X})^2} \quad (1)$$

X(i) is the ordered sample values and the sample mean. $\bar{X}$ is the sample mean, and a_i is the weights that depend on the sample size n and the expected values of the order statistics of a standard normal distribution.

B. QQplot

Q-Q Plot (Quantile-Quantile Plot) is a graphical tool used to compare the distribution of sample data with a particular theoretical distribution, such as the normal distribution, by displaying the quantiles of the sample data against the quantiles of the theoretical distribution [13]. The primary purpose of the Q-Q Plot is to visualize how well the sample data fits the theoretical distribution, helping in checking the normality or fit of the data to another distribution. To read a Q-Q Plot, look at the X-axis, which shows the quantiles of the theoretical distribution, and the Y-axis, which shows the quantiles of the sample data. The diagonal reference line represents the perfect theoretical distribution. If the sample data follows the theoretical distribution, the points on the plot will be close to the reference line. Deviations from this line indicate differences in distribution; for example, points that form a concave curve indicate a thicker-tailed sample data distribution, while a convex curve indicates a thinner-tailed one. Thus, the Q-Q Plot helps identify the fit and deviation of the sample data distribution to the theoretical distribution.

C. Kruskal-Wallis Test

The Kruskal-Wallis test is a non-parametric statistical test used to determine whether there are significant differences between three or more groups of data that are not necessarily normally distributed [14]. Unlike ANOVA, which requires the assumption of normality, this test uses the ranks of the data to identify differences in medians between the groups. This test is beneficial when the data are ordinal or interval data do not meet the parametric assumptions. To read the results of the Kruskal-Wallis test, the test statistic H is computed and the resulting using Equation (2).

$$H = \left(\frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i}\right) - 3(N+1) \quad (2)$$

Where N= is the total number of observations.Ri is the sum of ranks for the i-th sample, n is the number of observations for the i-th sample, and k is the number of samples.

D. Spearman's Correlation Test

Spearman's Correlation, or Spearman's rank correlation coefficient, is a non-parametric statistical measure used to assess the strength and direction of the relationship between two variables based on their ranks [15]. It is an alternative to Pearson's Correlation and is useful when the data is not normally distributed or is ordinal. Spearman's Correlation does not require the assumption of normality. It can handle data that does not meet the parametric assumptions, making it very suitable for analyzing ordinal data or outliers. To read the Spearman Correlation results, consider the Spearman correlation coefficient value ρ, computed using Equation (3).

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \quad (3)$$

Where ρ which ranges from -1 to 1. A value of ρ close to 1 indicates a solid positive monotonic relationship, while a value of ρ close to -1 indicates a strong negative one. A value of ρ close to 0 indicates the absence of a monotonic relationship. In addition, the p-value is used to test the statistical significance of the Correlation.

III. Methods

The step by step research processes are shown in Fig. 1. The research is started with data collection through a Questionairre. Afterwards normality test consisit of The Saphiro Wilk Test and QQ Plot. Afterwards Kruskal Wallis Test. Ended with Spearman Correlation Test.

This study combines two distinct research methods: qualitative research and quantitative research. According to Creswell, qualitative research explores and understands the individuals or groups attributed to a social or human problem [16]. Qualitative research aims to answer 'what,' 'how,' or 'why' something happens instead of 'how many' or 'how much' [17]. Quantitative research, however, values breadth,

statistical descriptions, and generalizability. In other words, it values the use of more numbered data that can be measured by statistics and processed using mathematical procedures. Thus, using a mixed research method that utilizes both qualitative and quantitative aspects allows for a more in-depth analysis of a particular problem by measuring the quantitative data and validating it with qualitative data [18].

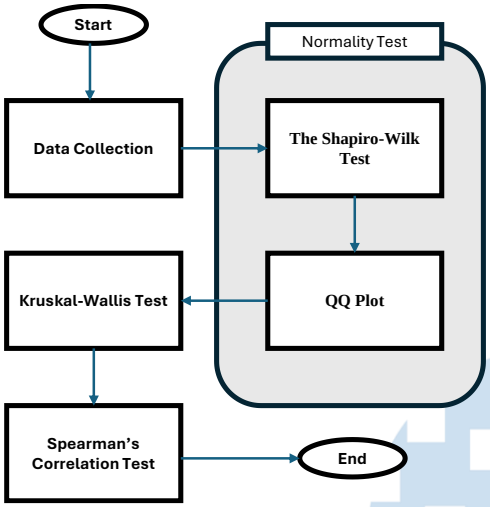

Fig. 1. Research Processes

A. Data Collection

To thoroughly analyze whether video games impact university students' academic performance, we first need to obtain data from them. To do this, we created a questionnaire containing questions that ask for general information, information about the games the respondents play, and information regarding the students' grades.

The population that is the subject of this research is university students in Tangerang. Sampling is selecting representative elements from a given population [19]. In other words, we collect data from a small sample – which may include a few members – that represents a larger population. In this research, the data is collected from a sample of 100 respondents of university students. This study's sampling methods include purposive random sampling to active students only. The respondents are randomly selected from the population, guaranteeing minimal sampling bias. Google Forms is a free online form tool provided by Google that can be used to create a wide range of forms. This tool allows users to customize the contents of their form, as well as determine the theme, and even the ability to set the form as a graded quiz. These forms are also easy to share, requiring only a link to access and fill them. The information gathered from these forms can then be placed neatly into a spreadsheet, which makes it easy to retrieve and process.

The R language is a programming language primarily used for statistics. R enables users to conduct statistical analysis and import, export, and visualize the data from the analysis results [20]. The R programming language is modified and run within its dedicated programming environment known as R Studio. Using R in R Studio, we can run several different statistical tests on the data we collected. Furthermore, we can create visualizations of the statistical analysis done in R.

B. Normality Test

The Shapiro and Wilk test determines if the numerical variables within this study are distributed normally. It is chosen because its popularity and frequently used in statistical research [21]. The resulting p-value decides whether to reject or accept the null hypothesis that the data are normally distributed. As shown in Table I, a low p-value (0.05) indicates that the data are not normally distributed, so the null hypothesis is rejected.

TABLE I. SHAPIRO WILK TEST DECISION TABLE

p-value	Hypothesis	Decision
> 0.05	Ho is not rejected	a normal distribution
≤ 0.05	Ho is rejected	not a normal distribution

A quantile-to-quantile plot, or a Q-Q plot, is a graph used to test between the empirical or observed distribution and a variable's theoretical or expected distribution [18]. In other words, the Q-Q plot is used to visualize the observed and predicted data distribution. A Q-Q plot is helpful in visually analyzing if a piece of data is distributed normally.

C. Kruskal-Wallis Test

The Kruskal-Wallis test is practical when trying to compare the mean of two variables. The Kruskal-Wallis test was chosen over other statistical tests for several reasons. The Kruskal-Wallis test can be applied to data that is not normally distributed [22]. This test is suitable for small sample sizes [23]. The null hypothesis states that the medians of all groups are the same, while the alternative hypothesis states that at least one group has a significantly different median. As shown in Table II, if the p-value is less than the significance level of 0.05, then the null hypothesis is rejected, indicating a significant difference in medians between the groups.

TABLE II. KRUSKAL-WALLIS TEST DECISION TABLE

p-value	Hypothesis	Decision
> 0.05	Ho is not rejected	There is no significant difference in medians between the groups.
≤ 0.05	Ho is rejected	a significant difference in medians between the groups.

D. Spearman's Correlation Test

Spearman's Correlation Test helps determine if there is an association between categorical and

numerical variables [24]. This Correlation can be measured between two numerical variables in which the distribution of both is unknown or is not distributed normally. It is chosen beuase its popularity in correlation testing [25]. As shown in Table III, if the p-value is less than the significance level of 0.05, then the relationship between the two variables is considered statistically significant.

TABLE III. SPEARMAN'S CORRELATION TEST DECISION

p-value	Hypothesis	Decision
> 0.05	Ho is not rejected	the relationship between the two variables is not considered significant.
≤ 0.05	Ho is rejected	the relationship between the two variables is considered significant.

IV. RESULTS AND DISCUSSION

A. Questionnaire Result

Table IV shows the categorical variables, while Table V figures numerical variables. For the preferred game platform, among the respondents, 50 preferred mobile, 49 preferred PC/laptop, and only one preferred console, which shows a nearly equal preference split between mobile and PC/laptop among the respondents, with the console being less popular, suggesting that most respondents prefer gaming on more accessible platforms. For the preferred Genre, 33 respondents play shooters, 27 play Multiplayer online battle arena (MOBA) games, 8 play role-playing games (RPG), 7 play racing games, 6 play action-adventure games, 5 each play battle royale and puzzle games, 3 play strategy games, and 1 respondent each plays arcade games, gacha games, fighting games, rhythm games, sports games, and tower defense games. It means that shooters (33%) and MOBA games (27%) are the most popular genres among the respondents, followed by RPGs and racing games. It reflects the various interests of the respondents. For the time spent playing video games (TimeGame), the average (mean) amount of time spent playing video games daily is 4.05 hours, with the median time spent on gaming being 3 hours each day and the most frequently stated time spent playing video games (mode) is 2 hours per day. It means there's a range in video game playtime, with the majority spending around 2-3 hours per day gaming. For the time spent studying (TimeStudy), the average (mean) time spent on studying per day is 4.03 hours, with the median study time being 3 hours each day, and the most frequently stated time spent studying (mode) is 2 hours daily. It shows a similar pattern to time spent on gaming (TimeGame), with most respondents studying for about 2-3 hours daily. For the current Grade Point Average (GPA), the respondents' average (mean) GPA is 3.4923, while the median GPA is 3.56. The most frequently stated GPA (mode) is 3.0, which shows that most respondents have a GPA around 3.0, with the average being somewhat higher at 3.49.

TABLE IV. CATEGORICAL VARIABLES

Data	Category	Frequency
Game Platform	Mobile	50
	PC / Laptop	49
	Console	1
Genre	Shooters	33
	MOBA	27
	RPG	8
	Racing	7
	Action-Adventure	6
	Battle Royale	5
	Puzzle	5
	Strategy	3
	Arcade	1
	Gacha	1
	Fighting	1
	Rhythm Game	1
	Sports	1
	Tower Defense	1

TABLE V. NUMERICAL VARIABLES

Data	Mean	Median	Mode
The Time Spent for Playing Video Games (TimeGame)	4.05	3	2
The Time Spent for Studying (TimeStudy)	4.03	3	2
Current Grade Point Average (GPA)	3.4923	3.56	3

B. Normality Test

The Shapiro-Wilk Test for Normality is used to determine if the numerical variables of a sample are distributed normally, and the Q-Q plot is used to visualize the empirical and theoretical distribution of a given data. In this study, the numerical variables include the time spent playing video games (TimeGame), the time spent studying (TimeStudy), and the GPA of each respondent. The following is the format for the hypotheses for these three data sets.

Ho_1: TimeGame data has a normal distribution. Ha_1: TimeGame data does not have a normal distribution

Ho_2: TimeGame data has a normal distribution. Ha_1: TimeStudy data does not have a normal distribution

Ho_3: GPA data has a normal distribution. Ha_1: GPA data does not have a normal distribution

The Shapiro-Wilk test result is in Table VI. All p-values are far below the significance level of 0.05, meaning that all variables significantly deviate from a normal distribution. Normality Test Result

From QQ plots in Fig. 2 to 4, it is also confirmed that those variables are not normally distributed as too many residues occur outside the area. Their points on the plots are not close to the reference line.

TABLE VI. SHAPIRO-WILK TEST RESULT

Variables	p-values	Status
TimeGame	1.39e-07	not a normal distribution
TimeStudy	1.273e-05	not a normal distribution
GPA	3.807e-05	not a normal distribution

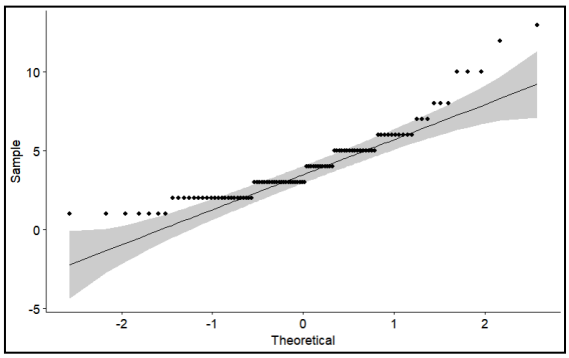

Fig. 2. Q-Q Plot for TimeGame

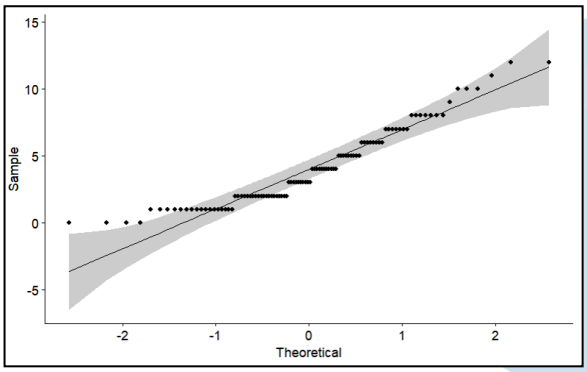

Fig. 3. Q-Q Plot for TimeStudy

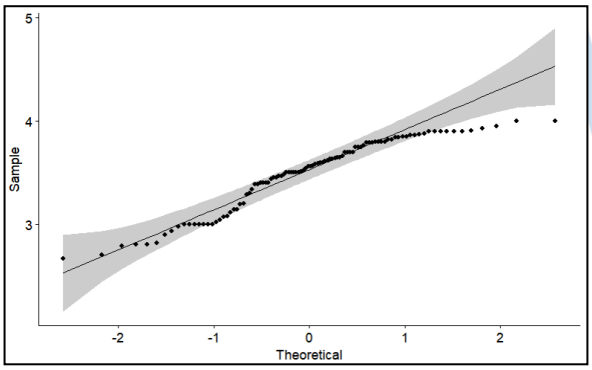

Fig. 4. Q-Q Plot for GPA

C. *Kruskal-Wallis Test*

Since the variables are not normally distributed, we apply The Kurskal-Wallis test as a non-parametric alternative to the one-way analysis of variance (ANOVA) test. The test measures the association of an independent categorical variable with a dependent numerical variable by comparing the mean values of both. In this study, we compare the categorical variables of 'Genre' and 'Platform' with the numerical variable 'TimeGame. The hypothesis formats are:

Ho_1: There is no significant difference in medians between Genre and TimeGame. Ha_1: There is a significant difference between Genre and TimeGame.

Ho_2: There is no significant difference in medians between Platform and TimeGame. Ha_2: There is a significant difference between Platform and TimeGame.

The results of the Kruskal-Wallis test towards the categorical variable of Genre with the numerical variable of TimeGame in Table VII show a p-value of 0.01672. The p-value is less than the significance level of 0.05, suggesting a significant association between the two variables. Thus, based on the test results, we can conclude that there is a significant association between the video game genre and the amount of time spent playing video games. For the variable Platform with TimeGame, we obtain the p-value of 0.0007408, suggesting a significant association between the two variables. Therefore, based on the test results, we can conclude that there is a significant association between the platforms used for playing video games and the time spent playing them.

TABLE VII. KRUSKAL-WALLIS TEST RESULT

Variables	p-values	Status
Genre and TimeGame.	0.01672	a significant difference
Platform and TimeGame.	0.0007408	a significant difference

D. *Spearman's Correlation Test*

In this study, we conducted Spearman's Correlation towards two numerical variables: TimeGame and GPA. Followings are the hypothesis format:

Ho: the relationship between TimeGame and GPA is not considered statistically significant.
Ha: the relationship between TimeGame and GPA is considered statistically significant.

Based on Spearman's Correlation in Fig. 5, we obtain the p-value of 0.6376 and the rho value of -0.04767789. The p-value is more significant than the significance level of 0.05, indicating no significant correlation between TimeGame and GPA. Additionally, the rho value supports the statement as it means a weak negative correlation between the two variables.

```
        Spearman's rank correlation rho

data:  data$TimeGame and data$GPA
S = 174596, p-value = 0.6376
alternative hypothesis: true rho is not equal to 0
sample estimates:
       rho
-0.04767789
```

Fig. 5. Spearman's Correlation Results

Furthermore, we can observe from the Scatterplot in Fig. 6 that the data points are significantly scattered, deviating from the theoretical distribution line. It further supports the argument that the two variables are not significantly correlated. Therefore, based on Spearman's Correlation and the scatterplot, we can conclude that no significant correlation exists between the Time Spent for Video Games and students' GPA.

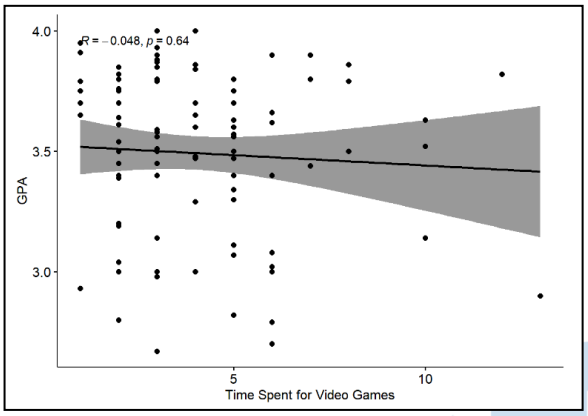

Fig. 6. Spearman's Correlation Scatterplot

E. Discussion

The Shapiro-Wilk tests conducted for the variables 'Time Spent for Video Games,' 'Time Spent Studying,' and GPA yielded p-values below the significance level of 0.05, indicating that these variables are not normally distributed. This result suggests that the assumption of normality, which is crucial for many parametric statistical methods, is violated. Consequently, it is appropriate to use non-parametric statistical methods when analyzing these variables. Non-parametric methods, such as the Mann-Whitney U test, Kruskal-Wallis test, or Spearman's rank correlation, are advantageous in this scenario because they do not assume a specific distribution for the data. They are robust and reliable for analyzing skewed data or data with outliers. Therefore, given the non-normal distribution of the variables, non-parametric methods are recommended to ensure the validity and accuracy of the statistical analysis.

The Kruskal-Wallis tests on the independent categorical variables 'Genre' and 'Platform' concerning the dependent numerical variable 'Time Spent for Playing Video Games' indicate significant correlations. This finding suggests that the type of video game genre and the gaming platform play crucial roles in determining the amount of time students dedicate to gaming. For example, specific genres like role-playing games (RPGs) or massively multiplayer online games (MMOs) might engage students longer than casual or puzzle games. Similarly, different platforms (e.g., consoles, PCs, mobile devices) might offer varying levels of accessibility and immersive experiences, influencing game time.

Based on the findings that video game genre and platform significantly influence the time spent playing video games, students should monitor and balance their gaming time, set specific time limits, prioritize tasks, and choose less time-consuming games. Mindful of their gaming habits can help them make informed choices and improve self-regulation. If managing gaming time becomes challenging, seeking support from peers, family, or counselors can provide additional strategies and accountability.

Spearman's correlation analysis for the variables 'Time Spent for Video Games' and 'Grade Point Average (GPA)' yielded a p-value more significant than the significance level of 0.05. It indicates that there is no statistically significant correlation between the two variables. However, the rho (ρ) value of -0.04767789 suggests a negative but weak correlation between time spent on video games and GPA. While the negative rho value implies that as time spent on video games increases, GPA tends to decrease slightly, the Correlation is weak and not statistically significant.

This lack of significance means we cannot confidently assert that video game time has a meaningful impact on GPA based on this data alone. Several factors could contribute to this weak Correlation. It's possible that moderate gaming does not significantly detract from academic performance for most students or that students who manage their time well can balance both activities effectively. Additionally, other variables not accounted for in this analysis, such as study habits, time management skills, and individual differences in cognitive abilities, could play a more significant role in determining GPA. The weak and non-significant Correlation highlights the complexity of the relationship between recreational activities and academic performance. It suggests that while excessive gaming might have some negative impact, it is not a predominant factor affecting GPA for most students. Further research with a more comprehensive set of variables could provide deeper insights into the dynamics between gaming habits and academic achievement.

V. Conclusion

The Shapiro-Wilk Test for Normality assesses whether numerical variables in a sample are typically distributed. This study's variables include time spent playing video games, studying, and GPA. The test results indicate that all variables deviate substantially from a normal distribution. The Kruskal-Wallis test results show significant associations between the categorical variable Genre and the numerical variable TimeGame, with a p-value of 0.01672, and between Platform and TimeGame, with a p-value of 0.0007408. Thus, video game genre and platform significantly influence the time spent playing video games. In this study, we analyzed the Correlation between TimeGame and GPA using Spearman's Correlation. The results showed a p-value of 0.6376 and a rho value of -0.04767789, indicating no significant correlation, as the

p-value is above 0.05 and the rho value suggests a weak negative correlation. The scatterplot also supports this with widely dispersed data points. Therefore, we conclude that no significant correlation exists between time spent playing video games and students' GPA in Tangerang area.

The finding that there is no significant correlation between time spent playing video games and students' GPA implies that playing video games does not directly affect academic performance. It suggests that factors such as study habits, time management, and individual differences may play a more critical role in influencing GPA. Therefore, concerns that video game time alone might negatively impact academic success may be unfounded, and a more holistic approach should be taken when addressing students' academic performance and extracurricular activities. Besides, considering to analyse respondents' GPA data from several subsequent semesters.

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