The Relationship Between Videogame Use, Deviant Behavior, and Academic Achievement

Concepcion, L., Nales-Torres, M., & Rodriguez-Zubiaurre, A. The relationship between videogame use, deviant behavior, and academic achievement among a nationally representative sample of high school seniors in the United States. *American Journal of Educational Research, 4*(16), 1157-1163. **Link to Paper**; **Link to Data**

Introduction/Motivation

The paper's primary research question was: does the amount of daily videogame use (hours) predict academic achievement (grades) among United States high school seniors? The authors' secondary research question was: does deviant behavior (a composite of several delinquent behaviors) moderate the aforementioned link? From 2009-2013, high school seniors from over 130 high schools were surveyed annually. The research questions were motivated to assess whether videogame play has a harmful influence on teenagers' academic performance, and if so, whether families and schools should make more stringent restrictions on teenagers' videogame play. Furthermore, there is a potential that videogame play more strongly affects teenagers who are concurrently engaging in deviant behaviors, like theft or drug use. Perhaps targeted interventions at videogame play restrictions would only be effective for these students. If significant associations are found, this may compel deeper causal research and potential parenting or policy recommendations that include a limit to daily videogame use, requirements for videogames to issue warnings around daily videogame play, or specific interventions like increased funding for after-school programs. These interventions would target at-risk youth to limit both exposure to deviant behavior and potentially to videogames as well. Before these recommendations are made, it is important to assess whether there is actually a relationship between videogame use/deviant behavior and academic achievement.

Stakeholders

The two main groups identified as the most important stakeholders for this research are policymakers and the education community at large. Policymakers include administrators, legislators, and sometimes teachers. The education community at large includes parents, students, and researchers. Each stakeholder has their own perspective and motivation when it comes to this study on the effects of games and deviant behavior on academic achievement. Six stakeholder perspectives are discussed below.

Teachers

Teachers are in the classroom with the students and are responsible for providing a well-rounded education. Therefore, teachers would be interested to know the effects deviant behavior or videogames have on students because this could change the way they teach. If deviant behavior had a negative correlation with grades, then they may pay more attention to certain students. If videogames had a positive correlation with grades, then they may consider incorporating videogames in their teaching.

Administrators

The role of administrators is to make sure that their school is meeting standards within education and mediate between teachers, parents, and students. They keep track of their students' success rates, and their academic achievement (specifically grades) may affect school funding.

Legislators

Legislation has significant impacts on education (e.g., curriculum formation, standardized testing requirements, school procedures). The results of this research could have an impact on the future of education, from the way it is taught, how it gets taught, and who gets taught.

Parents

Parents play an important role in their children's education. They are invested in their child's achievement and want the best education possible for them. They can get involved in the school's community by joining the Parent Teacher Association and can influence their children's schools. These results may affect parenting practices at home, as well as how they view the effectiveness of their children's school system.

Students

Students are the main beneficiary of this study. They are the ones whose grades are being studied. This research could change the way they are being taught in school and what their lives at home look like in terms of leisure activities and downtime.

Researchers

Education researchers are interested in improving the education system for students and assessing different methods of teaching and learning. This study could propel further research on various topics: the impact of videogames on other forms of academic achievement (e.g., school engagement), the potential moderating effect of videogame type (e.g., violent vs. educational), the deviant behaviors most commonly displayed by youth today, and so on.

Partnership Issues

We gained access to the data by downloading the publicly-accessible Monitoring the Future (MTF) datasets from 2009-2013 from the University of Michigan Inter-university Consortium for Political and Social Research. This secondary dataset analysis did not involve an active partnership, but potential follow-up studies would likely require partnerships with schools. For example, if a follow-up study assessed the relation between other out-of-school behaviors and academic achievement, surveys or interviews could be administered in schools, as this would be the easiest way to reach a large number of high school seniors. Given this human subjects research of minors in an educational setting, IRB approval would be required.

Several potential collaboration issues could be involved, such as concerns related to study implementation, confidentiality, and data sharing. First, teachers may feel that the study implementation detracts from instructional time, and students may feel a survey is cumbersome. Second, school districts may worry about how student data will be stored and how to protect student confidentiality. As such, it is critical that the research team first builds trust by explaining past studies, research aims, and data collection and storage processes. Researchers should

develop a rigorous data storage process that is anonymized, backed up, and encrypted to ensure confidentiality. Students may also have concerns about parents or teachers reviewing their results, which makes it critical that researchers emphasize that only the research team will see their individual results. Students who refuse to participate in the study should have their requests honored. Finally, school districts may be concerned about data sharing and the reputational effects if negative information is revealed (e.g., high marijuana use). Stakeholders opposed to data sharing may worry about what the survey results will say about schools and students. Regarding research outputs like articles and reports, researchers should be clear about how the geographic region and school size will be made public. However, the individual state and district will not be shared so as to make identification more difficult (but, it is important to note, identification is likely to still be possible to some extent). In addition, studies may shed light on areas where schools are failing students (e.g., math preparedness) or issues that students may not want adults to see (e.g. more deviant behavior than expected). These may lead to policy changes that could be necessary to drive positive social change, such as teacher training. However, these policies could also be potentially costly, such as stricter academic standards, or detrimental to students, such as increasing police presence in schools.

Data/Methods and Research Question Match

Data Origin

MTF is a nationally representative survey of students attending private and public high schools across the United States. Each year, MTF uses multiple phases of random sampling (i.e., geographic regions, schools in those regions, classes in those schools) to obtain samples of 15,000 high school seniors. Data collection occurs in the classroom during school hours. To replicate the methods of Concepcion and colleagues (2016), we aggregated cross-sectional data by combining the 2009-2013 datasets. We could not reproduce the original authors' weighted sample due to the lack of information, so we instead used the full available sample of 71,773.

Measurements/Survey Items

Academic Achievement. We assessed academic achievement using the question: "Which of the following best describes your average grade so far in high school?" Values ranged from 1 (grade of 69% or below) to 9 (93-100%). We computed descriptive statistics (M = 6.53; SD = 1.82; skewness = -.60; kurtosis = -.13), which aligned with those found by the original authors (M = 6.54; SD = 1.91; skewness = -.61; kurtosis = -.25). The mean roughly corresponds to a B.

Videogame Use. Students self-reported how many hours per week they spent playing "electronic games on a computer, TV, phone, or other device," with answer choices ranging from "none" to "9 or more." Our descriptive statistics (M = 4.05; SD = 2.29; skewness = .54; kurtosis = -.51) mostly matched those computed by the original authors (M = 4.23; SD = 2.37; skewness = .48; kurtosis = -.65). The mean score roughly corresponds to 3-5 daily hours of videogame use.

Deviant Behavior. We computed a composite score by summing students' self-reported frequency engaging in the following seven behaviors: stealing < $50, stealing > $50, stealing vehicle parts, trespassing in buildings, intentionally damaging property, marijuana use in schools,

and police arrests. Concepcion et al. (2016) created this measure based on frequent deviant traits reported by FBI crime reports. The original authors used principal component analysis (PCA) regression weighting to produce their composite score, but without a detailed description of their procedure, we created a sum composite score. Similarly, our deviant behavior measure was strongly skewed (ours = 2.88;original = 5.40) with high kurtosis (ours = 10.53;original = 39.19).

Sample Representativeness

MTF uses an extensive, multi-stage random sampling procedure to obtain a nationally representative sample; however, several issues persist that may limit representativeness. First, schools and parents must consent to the research, and there may be important differences among students in non-consenting schools or households. Second, students complete the MTF survey in class, and it is possible that this setting may produce less truthful responses (e.g., dishonesty with self-reported grades) compared to if the study were conducted elsewhere. Third, small high schools could be underrepresented in the data given the school-focused random sampling method. Finally, Concepcion and colleagues (2016) did not consider the nested nature of these data in their analyses, so school-level variance may not be accounted for in these analyses.

Research Design, Causality, and Disconnects

MTF is a cross-sectional survey. It is not a randomized controlled trial nor longitudinal, so we do not control for other factors that could explain effects and cannot claim causality.

The data we used from MTF included videogame use, deviant behavior, and academic achievement. However, the measurements or survey items used may not reflect the concepts that we care the most about in this study. First, academic achievement was measured via student self-reported grades, which may not be accurate. Even if grades are accurately reported, they may not give the full picture of students' academic achievement — for example, graduation rates or school engagement may also be relevant. Second, videogame use was captured via self-reported hours of play per day, which again may not be accurate. Even if videogame use is accurately reported, other aspects of videogame use could be relevant, such as the type of game played. Third, deviant behavior was measured via a composite score of students' self-reported frequency of engaging in delinquent behaviors. However, the behaviors seem oddly put together. Is it fair to combine "stealing vehicle parts" and "marijuana use" as a proxy of deviant behavior?

The research question does have implications for broader policy and practice objectives. First, understanding whether videogame use predicts academic achievement may guide teaching and parenting practices, as they may increase or decrease videogame use. Second, understanding the role of deviant behavior for academic achievement may have implications for school policies, such as police presence in schools.

There is a risk of misinterpretation of the study results. For example, the original authors found that videogame use positively predicted academic achievement, although the effect was incredibly small. Teachers or parents could interpret this to mean that they should universally promote videogame use. However, there is not enough information on the types of videogames played (e.g., violent vs. educational), which may be important for the effects of videogames. As another example, the original authors found that deviant behavior did not predict academic

achievement, nor did it moderate the link from videogame use to academic achievement. However, given the questionable measurement of deviant behavior in this study, these findings do not necessarily mean that deviant behavior does not have an effect (perhaps even a causal effect) on academic achievement. Ultimately, the small proportion of variance explained means that we should interpret these results with great caution. Even if we were confident that the results were trustworthy, the study was published in 2013. Modern changes related to videogames (e.g., interactive elements) and academics (e.g., emphasis on grades) may limit generalizability. To mitigate the risk of study misinterpretation, researchers should be very clear about the limitations of their study and avoid overstating results.

Reproducibility

Reproducing analyses from a large, multi-year, cross-sectional study was challenging. View the Technical Appendix for instructions on how to access our code. We produced the opposite findings from the original authors using the same analyses and data. Several factors may have led to this failure to reproduce. First, we encountered difficulties with dataset retrieval and merging. The authors combined five years of cross-sectional data. Variables were spread across three sub-datasets within each year, resulting in 15 total datasets. Each came in different file formats (e.g., .sav, .csv, .rda), so each dataset required a unique load-in approach.

Second, we encountered a host of issues related to variable creation. Variables had different names across the 15 spreadsheets (e.g., academic achievement had three names that differed both across and within years), and the predictors were only included in a few sub-datasets per year. Fortunately, we kept track of the variables with the searchable online codebook. Also, the "deviant behavior" variable was a single composite score created using PCA regression weighting of seven variables. The authors did not clearly specify the PCA procedures or the variables used. For example, for "marijuana use," it was unclear if we should have used the variable related to school, use in the last year, or use in the last month. We resolved this issue by choosing the school-related variables given the paper's focus on academic performance.

Third, we encountered issues with the statistical analyses. The authors used a weighting procedure to reach a sample size of 67,822. However, with no information about this procedure, we used the full sample of 71,773. The actual correlations and regressions were straightforward; however, our analyses produced the opposite findings from the paper, as shown in Tables 1 (authors' correlations), 2 (authors' regressions), 3 (our correlations), and 4 (our regressions). The authors found a significant positive relation between videogame use and academic achievement. This relation was significant and negative in our data, and we found another significant negative relation between deviant behavior and academic achievement). Ultimately, no regression models explained much variance in academic achievement (authors' $R^2 = .004$, our $R^2 = .001$). Given the small original effect, a minor change in our sample or methods may have influenced the findings.

Both the authors' and our results should be interpreted with caution — if at all. Based on the authors' results, readers may conclude that we should encourage videogame use. Our results entail the opposite conclusion. Given the miniscule effects, likely neither study is trustworthy.

Table 1. Correlations Among Key Study Variables (N = 12,383)

	Deviant Behavior	Academic Achievement
Videogame Use	.04	.05
Deviant Behavior		-.00

*$p < .05$.

Table 2. Results of Hierarchical Regression Analysis

	Step 1	Step 2	Step 3
Videogame Use	.05*	.05	.05
Deviant Behavior	–.02	.05	
Videogame Use x Deviant Behavior			–.08
R2	.003*	.003	.004
ΔR2	.003*	.000	.001

Notes. Dependent variable is academic achievement. Standardized coefficients are shown.
*$p < .05$.

Table 3. Reproduced Correlations Among Key Study Variables (*N*=?)

	Deviant Behavior	Academic Achievement
Videogame Use	.02	-.04*
Deviant Behavior		-.01*

*$p < .05$. *N* range from 9,988 to 68,292 due to differential missing data.

Table 4. Reproduced Results of Hierarchical Regression Analysis

	Step 1	Step 2	Step 3
Videogame Use	-.03*	-.02*	-.04*
Deviant Behavior		-.04*	-.05*
Videogame Use x Deviant Behavior			.00
R^2	.00*	.01*	.01*
ΔR^2	.00	.01	.00

Notes. Dependent variable is academic achievement. Standardized coefficients are shown.
*$p < .05$.

Modeling

The original study examined the relation between videogame use and academic achievement, as well as the potential moderating effect of deviant behavior. The authors believed that students who regularly use videogames and engage in deviant behavior would experience low academic achievement, while videogame use would not affect the academic achievement of students who do not engage in deviant behavior. To test the hypothesis, Concepcion et al. (2016) conducted correlational and hierarchical regression analyses. The analyses were straightforward and well-executed, but more clarity on the analysis process and code could have been helpful.

We are skeptical about the deviant behavior variable and suspect that the authors may have run several analyses that were not reported. For reference, the seven variables included in the deviant behavior measure were: stealing < $50, stealing > $50, stealing vehicle parts, trespassing in buildings, intentionally damaging property, marijuana use in schools, and police arrests. While MTF did not include an established, validated measure of deviant behavior, the authors' choice of variables seems piecemeal. We suspect that they may have tested several variations of the deviant behavior measure before settling on the final iteration.

Additional Analyses

We ran five additional analyses not covered by the authors: 1) regression analysis using deviant behavior to predict academic achievement, 2) hierarchical regression analysis using videogame use, marijuana use, and their interaction to predict academic achievement, 3) descriptive statistics conditioned on data collection year and school region, 4) hierarchical regression analysis using videogame use, data collection year, and their interaction to predict academic achievement, and 5) hierarchical regression analysis using videogame use, school regions, and their interactions to predict academic achievement. View the Technical Appendix for instructions on how to access our code.

Analysis 1: Regression Analysis with Deviant Behavior Predicting Academic Achievement (Table 5). We found a significant negative relationship between deviant behavior and achievement. However, the effect was so small that it barely explained variance in academic achievement. We may (very cautiously) infer that adolescents who reported having more deviant behaviors may report slightly lower grades than those who have less deviant behaviors.

Analysis 2: Hierarchical Regression Analysis with Videogame Use, Marijuana Use, and their Interaction Predicting Academic Achievement (Table 6). Due to the piecemeal nature of the deviant behavior measure used in the study, we wanted to explore whether a single behavior could moderate the relation from videogame use to academic achievement. We selected marijuana use due to its higher prevalence than other behaviors like stealing vehicle parts. We hypothesized that students who frequently use videogames and frequently use marijuana in school would experience low academic achievement, whereas videogame use would not affect the achievement of students who do not regularly use marijuana in school. We mirrored the original authors by using a three-step hierarchical regression to test our hypothesis. In Step 1, videogame use significantly negatively predicted academic achievement but explained negligible variance (replicating our findings from Step 1 of the reproducibility analyses in Table 4). In Step

2, marijuana use in school significantly negatively predicted academic achievement, but this explained only a very small amount of additional variation in academic achievement (ΔR^2 = .002). Although the effect is small, marijuana use explains more variance in academic achievement than the original deviant behavior measure. In Step 3, we found no significant interaction and no additional explained variation in academic achievement (ΔR^2 = .00). Contrary to our hypothesis, marijuana use in school did not moderate the effect of videogame use on academic achievement, which does mirror the original findings and our reproducibility analyses.

Analysis 3: Descriptive Statistics Conditioned on Year and Region (Table 7). Given that the authors aggregated five years of cross-sectional data, we wanted to examine whether the year of data collection was relevant to the findings, as the nature of videogames may have changed from 2009-2013. We also considered the possibility of regional differences across the United States. We conducted descriptive statistics conditioned on year and region to eyeball potential differences. For year, the means and *SD*s of academic achievement across the five years concentrated around 6.5 and 1.8, respectively. Through this eyeballing, we suspected no difference in academic achievement across years. All groups had moderate negative skewness, indicating a higher concentration of high self-reported grades. All groups had negative kurtosis, suggesting that the data distributions have relatively lighter tails. For region, the means of academic achievement across the four regions fluctuated between 6.3 and 6.7, and *SD*s concentrated around 1.85. The Northeast reported the highest grades, which differed from the West by more than 0.4 points. By examining the boxplots (Figures 1 and 2), we anticipated that region, but not year, may have an effect on academic achievement (tested in Analyses 4-5).

Analysis 4: Hierarchical Regression Analysis with Videogame Use, Year, and their Interaction Predicting Academic Achievement (Table 6). We conducted hierarchical regressions to test the moderating effect of study year. In Step 2, year did significantly positively predict academic achievement (meaning that self-reported grades increased over time). In Step 3, both videogame use and year did not significantly predict academic achievement, nor was their interaction, and it did not explain any additional variance (ΔR^2 = .00).

Analysis 5: Hierarchical Regression Analysis with Videogame Use, Regions, and their Interactions Predicting Academic Achievement (Table 6). In Step 2, all regions tested (Northeast, North Central, South, and West) significantly predicted academic achievement, but it explained only a small amount of variance (R^2 = .006). In Step 3, only the West region significantly predicted academic achievement. All other variables and interactions were not significant, indicating no moderating effect of region.

Table 5. Results of Analysis 1 (Linear Regression Analysis)

	Standardized coefficients
Deviant Behavior	-.01*
R^2	.00*

Notes. Dependent variable is academic achievement. *$p < .05$.

Table 6. Results of Analyses 2, 4, and 5 (Hierarchical Regression Analyses)

	Step 1	Step 2	Step 3
Videogame Use	-.03*	-.02*	-.03*
Marijuana Use		-.17*	-.18*
Videogame Use x Marijuana Use			.00
R^2	.00*	.02*	.02*
Videogame Use	-.03*	-.027*	-3.553
Year		.023*	0.016
Videogame Use x Year			.002
R^2	.00*	.003*	.003*
Videogame Use	-.03*	-.026*	-.021
North Central		-.083*	-.055*
South		-.1*	-.079
West		-.252*	-.217*
Videogame Use x North Central			-.007
Videogame Use x South			-.005
Videogame Use x West			-.009
R^2	.00*	.006*	.006*

Notes. Dependent variable is academic achievement. Standardized coefficients are shown. Analysis 2 reported in the first chunk, Analysis 4 reported in the middle chunk, and Analysis 5 reported in the bottom chunk. *$p < .05$.

Table 7. Results of Analysis 3 (Descriptive Statistics Conditioned on Year and Region)

	2009	2010	2011	2012	2013	Northeast	North Central	South	West
Mean	6.55	6.45	6.49	6.60	6.55	6.70	6.59	6.51	6.33
SD	1.86	1.83	1.84	1.78	1.81	1.74	1.85	1.82	1.87
Skewness	-.62	-.56	-.57	-.64	-.62	-.70	-.63	-.57	-.52
Kurtosis	-.17	-.16	-.22	-.03	-.07	.18	-.15	-.16	-.29

Figure 1. Boxplot of Academic Achievement Conditioned on Year

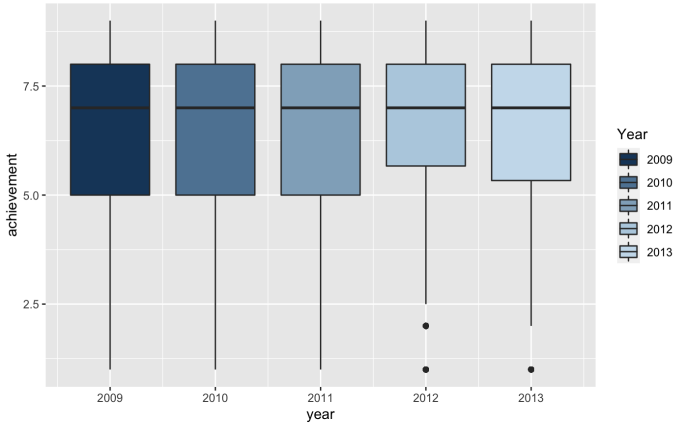
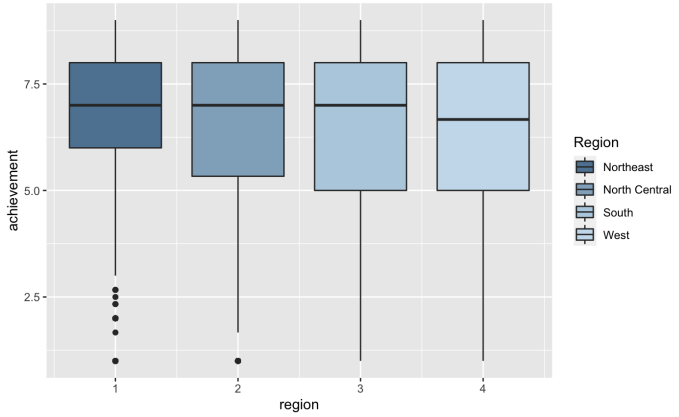


Figure 2. Boxplot of Academic Achievement Conditioned on Region



Social Impact

These results could have a social impact on the future of education and the education community. Results could change the way students are taught, the school curriculum, the roles of teachers and administrators, and policing in schools. In terms of the education community, parents may rethink how they let their children spend time playing videogames and have stricter rules for their children in terms of activities allowed after school or weekends. For students, this could change the way that they learn, interact with their peers, and relax in their home life. Education researchers are also impacted, as this study highlights the need for additional, more nuanced research in this area. Intervention researchers could also investigate relevant programs — for example, if videogame use benefits academic achievement, an intervention could gamify class lessons. Videogame use could also be incorporated into school curricula. Policy changes that could arise from this research could potentially include policing in schools. For example, our reproducibility analyses (but not the original analyses) demonstrated a negative effect of deviant behavior on academic achievement. Despite the miniscule effect size, policymakers could use this finding to advocate for stronger police presence in schools, which could contribute to the school-to-prison pipeline and negatively influence students. As for challenges, there is a need for additional research before any concrete policy or programmatic changes can be made. When it

comes to changes in the school curriculum, there would also need to be more evidence that videogames have an effect on grades. After that, there would need to be buy-in from teachers, parents and students. Adding or reducing school policing would also require buy-in from administrators, teachers, parents and students, as well as careful consideration of the effects of increased police presence in schools.

Conclusion

Through putting together this report, we gained several takeaways. First, there are inherent challenges to reproducing regression and consolidating large, multi-year datasets with unique weighting procedures. Although the datasets were publicly available, the data came in various formats and data cleaning was quite cumbersome. It would have been preferable for the original authors to specify their analytic procedures in more detail. For example, we could not reproduce the PCA regression weighting because the authors did not share their procedure. Second, because of the small, inconclusive effects for the predictor variables and the reliance of just a few survey questions used to operationalize large concepts like academic achievement, we cannot make substantial policy recommendations at this time. This would require more replication, finding significant effects, and more extensive research. For example, qualitative research, such as one-on-one interviews, could provide insights as to the type of games students play and gauge their perspective on how games affect their academics. The research question could also be broadened or narrowed in scope. For example, videogame type or intensity could be more important predictors of academic achievement than simply the hours spent playing videogames. Lastly, we have concluded that descriptive data, especially at the onset of a new research question, can be equally, if not more, informative as running more complex models. When reviewing our data, we noticed that for high achieving students, there was no clear concentration of students playing low hours of games. As such, even before conducting official analyses, we inferred that there may be a weak relationship. This process overall revealed how challenging replicability may be and the need for caution in the face of minimal effects. It would be interesting to understand how related challenges have been addressed in other educational research areas.

Technical Appendix

Please refer to the R markdown file titled "reproducibility_modeling.Rmd" to view the complete code for loading in the datasets, cleaning the data, conducting the reproducibility analyses, and conducting the additional five analyses for modeling.