Συνέδρια της Ελληνικής Επιστημονικής Ένωσης Τεχνολογιών Πληροφορίας & Επικοινωνιών στην Εκπαίδευση

Τόμ. 1 (2023)

13ο Πανελλήνιο και Διεθνές Συνέδριο «Οι ΤΠΕ στην Εκπαίδευση»

Recreational On-line Games and School Achievement in Adolescence: A Systematic Review and Meta-analysis

Margarita Karpouzi, Aspasia Serdari, Maria Samakouri

Βιβλιογραφική αναφορά:

Karpouzi, M., Serdari, A., & Samakouri, M. (2024). Recreational On-line Games and School Achievement in Adolescence: A Systematic Review and Meta-analysis. *Συνέδρια της Ελληνικής Επιστημονικής Ένωσης Τεχνολογιών Πληροφορίας & Επικοινωνιών στην Εκπαίδευση*, *1*, 179–186. ανακτήθηκε από https://eproceedings.epublishing.ekt.gr/index.php/cetpe/article/view/7266

Recreational On-line Games and School Achievement in Adolescence: A Systematic Review and Meta-analysis

Margarita Karpouzi[1], Aspasia Serdari[2], Maria Samakouri[2]
karpouzi.margarita@gmail.com, aserdari@yahoo.com, msamakou@med.duth.gr
[1] Psychologist, MSc Social Psychiatry, School of Medicine, Democritus University of Thrace
[2] Associate Professor of Child and Adolescent Psychiatry & MSc Social Psychiatry, School of Medicine, Democritus University of Thrace
[3] Professor of Psychiatry & MSc Social Psychiatry, School of Medicine, Democritus University of Thrace

Abstract

In the present study, we examined the effect of online games on school achievement during adolescence through systematic review and meta-analysis. The systematic review included 50 articles while 15 studies were selected for the meta-analysis. All studies covered the years 2012-2022 and described a sample of 217689 participants who used video games for recreational purposes and recorded the frequency of engagement. Initially, it was shown that the frequency of engagement with online video games, especially shooter games, has an effect on all age groups of adolescents but the effects are not dramatic. At the same time, it was shown that while excessive online gaming can hinder academic achievement, video games alone can promote skill acquisition and bring about positive academic outcomes. Interestingly, it is thanks to video games that a narrowing of the gap has emerged between men and women in terms of digital reading (Rasmusson & Åberg-Bengtsson, 2015).

Keywords: on-line gaming, school achievement, adolescence.

Introduction

People have easy access to a variety of games via laptops and smartphones thanks to the internet. As accessibility increases the frequency of gaming, people spend more time on games (Yıldırım & Şen, 2019). Adolescents are known to be particularly vulnerable to problematic internet game use (Lopez-Fernandez et al., 2013) due to their immature cognitive control during this period (Kuss, Griffiths & Binder, 2013). There are the following main types of online games: Local and Wide Area Network Games (LAWN) and Massively Multiplayer Online Role Playing Games (MMORPG) (Kuss & Griffiths, 2012). Adolescents are known to be particularly vulnerable to problematic internet game use (Lopez-Fernandez et al., 2013) due to their immature cognitive control during this period (Yates, Gregor & Haviland, 2012).

Previous studies have demonstrated reduced sleep time and daytime fatigue associated with the presence of televisions, video game consoles or internet-enabled computers in the bedroom (Nuutinen et al., 2013). Delayed Sleep-Wake Disorder has been associated with negative consequences during the day (daytime sleepiness, fatigue (Micic et al., 2016) and ultimately, tardiness to school, absenteeism, dropout, and poor academic performance (Saxvig et al., 2012). Academic achievement indicates the knowledge acquired and skills developed in the school subject, usually determined by test scores and conceptually defined as the knowledge acquired and skills developed in the school course (Kumar &Lal, 2014).

I. Kazanidis, A. Tsinakos (Eds.), Proceedings of the 13th Pan-Hellenic and International Conference "ICT in Education", International Hellenic University, Kavala. Greece, 29 September – 1 October 2023. ISSN: 2529-0916, ISBN: 978-618-83186-8-7

Methodology

Systematic Review Methodology

The aim of the study was to examine how online games effect school achievement during adolescence. For this reason we applied systematic review and meta-analysis. A systematic review of existing literature was applied according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) model (Moher et al., 2009). The following databases were used for the review: Pubmed, Scopus, Heal link, Wiley on line Library, Google scholar, Oxford Academic and Springer. At the initial stage, the keywords of the topic were defined: 'online gaming', 'on-line gaming', 'school achievement', 'adolescence'. Then terms related to 'online gaming' were searched for, such as 'internet gaming disorder', 'online games', 'problematic internet use', 'online games addiction'. Similarly for school performance, terms such as "academic achievement", "school performance", "achievement motivation", "cognitive skills" were searched. As limited sleep affects school performance we also searched for the effect of online games in adolescence and the effect of sleep on school performance.

In particular, the search was conducted using the advanced research method. Each term was searched separately focusing on qualitative search rather than quantitative search. After the search, the AND term was used between the search terms so as to increase specificity and the OR term was used to increase sensitivity. After the necessary search, search filters such as date of publication and language were set. Articles were saved after the abstract or article was read. The collection period of the articles was September 2021-June 2022.

The studies were collected based on whether they met the following criteria. They must have been published in the last decade 2012-2022. They should study online games. Games were excluded if they involved educational games designed solely to reinforce specific cognitive skills. To study the relationship between online games and factors related to school performance either directly, such as the development of cognitive skills of memory, attention, concentration of math skills, and indirectly with sleep or truancy. The studies included in our study also had the criterion of being in the English language and sample age 10-19.

Meta-Analysis Methodology

After completing the literature review we went on to meta-analysis of 15 studies that correlated the frequency of use of online games with school performance in adolescents. The studies were divided into three groups according to the ages of the participants: 1) primary school students aged 10-12 years, 2) secondary school students aged 13 to 18 years, and, 3) young adult students aged 19-22 years. The publication error in this analysis was estimated using the funnel plot Figure 2.

All studies described a recreational computer user sample and recorded frequency of engagement or addiction to online games. The study samples consisted of adolescents, who played video games online via desktop computer (PC) or mobile phone (smartphone).The total sample consisted of 217,689 participants. The specific studies were chosen because they could be analyzed statistically as similar analyses had been used to conduct the correlation coefficients. In this meta-analysis, the random effects model (DerSimonian & Laird, 1986) was preferred over the fixed effects model, because the studies used differed in a variety of characteristics resulting in heterogeneity.

The study was classified as "low risk" (-) in terms of identification bias (Bleich, et al., 1988). The effect size of the correlation between the continuous variables of academic performance and the time spent by participants in online games was calculated through the Pearson

correlation coefficient provided by each study. Specifically, the Pearson correlation coefficient r and sample size (N) were obtained from each study included in the review. A two-tailed p value (p=0.05) was set as the threshold for statistical significance of the results. Statistical analysis was performed with SPSS v.28.

Results

Review Results

Initially, 94 studies were collected after they were screened based on the title, the abstract of the article, and through the literature reviews of other studies. Of these studies, 50 were finally selected. From the literature review, a negative association between addictive tendency on internet or computer game use and academic performance was confirmed. This means that the more a student engages in video games, the lower the academic achievement (Penaso & Gaylo, 2019). It has also been found that greater non-academic use of ICT (information and communication technologies) is negatively related to academic performance of high school students (Salomon & Ben-David Kolikant, 2016). This is concurred by Burušić, Šimunović & Šakić (2021), arguing that greater engagement in activities with a more recreational than educational character may be associated with worse academic performance in STEM. It has even been found, by Kuss & Griffiths (2012) that heavy or excessive use of online games is a significant negative predictor of mathematics achievement (Güzeller & Akin, 2014). These long hours of online gaming was found to contribute to a student's likelihood of failure (Cortes et al., 2012). However, not everyone who regularly plays online video games is an excessive user.

Regarding the beneficial effects of video games, researchers Granic, et al. (2014), described that they have been shown to promote a wide variety of cognitive abilities. It needs to be mentioned first that executive function skills have been shown to be involved in academic learning and performance (Best, 2014). In terms of spatial skills these appeared to be enhanced primarily by those who played shooting games which clearly resulted in subjects performing higher in academic subjects that may have been designed for the same domain (Granic et al., 2014). In the study by Bavelier et al., (2012), it was found that shooting game players allocated their attention and filtered irrelevant information more effectively. Some of the major findings on the benefits of play include greater brain volume and plasticity (Kühn et al., 2014), greater ability to transfer skills from play to real-life situations, such as eye and hand coordination, memory skills and visual acuity (McDermott, Bavelier & Green, 2014).

Studies in the United States have reported that adolescents spend over 11 hours per day using modern electronic media such as computer/internet and computer games, which is more than the amount of time spent in school or with friends (Paulus, et al., 2018). In addition, excessive Internet use and increased use of computer games have been found to cause addiction and can cause severe functional impairments in the daily lives of children and adolescents (Drummond & Sauer, 2016).

With Borgonovi's (2016) findings, our hypothesis that low or controlled use of online games will not have an effect on school performance is not supported. Borgonovi (2016), argued that moderate game use may promote positive outcomes for students. From Bevelier & Davidson's (2013) research, the positive effect of game use related to the cognitive functions required for academic success only occurs when game use is casual. Conversely, when use is frequent then familiarity is affected and therefore the benefits are limited (Bevelier& Davidson, 2013).

Regarding the beneficial effects of video games, in terms of spatial skills these appeared to be enhanced primarily by those who played shooting games which clearly resulted in subjects performing higher in academic subjects that may have been designed for the same domain (Granic et al., 2014). Adachi & Willoughby's (2013), longitudinal study showed that the more adolescents reported playing strategic video games (such as role-playing games), the more improvements were evident in self-reported problem-solving skills in the following year.

Meta-Analysis Results

Regarding the first group aged 10-12 years, Farchakh, et al., (2020) found that there is a negative correlation between academic achievement and problematic use of online games in children aged 10-13 years ($r=-.160$, $p<.001$). Schulz van Endert (2021), found that more use of online games predicted overall school grades. Ramirez et al., (2021), studied 2440 students aged 10-13 and found a negligible effect of frequency of video game use on academic performance ($r=-.060$, $p=.003$).

In the second group, adolescents aged 13-18, Brunborg, Mentzoni, and Frøyland (2014), analyzed data from two samples with a total of 1928 Norwegian adolescents aged 13 to 17 years. The surveys included questionnaires on video game use, video game addiction, depression, binge drinking, academic performance and behavioral problems. Time spent playing video games was found to be slightly negatively correlated with academic performance in both samples ($p<.05$).

Lastly, the third group of students aged 19-22, included studies such as a prospective study of Kwok et al. (2023), in a small sample of 15 students in Hong Kong demonstrated that more time in online games leads to significantly lower academic performance ($r =-.520$, $p<.001$). Additionally, Schmitt at al. (2015), investigated the pattern of video game use and video game addiction among 477 male college freshmen and found that video game addiction was negatively related to course grade point average ($r=-.120$, $p=.019$) with a high little effect. Also, Ventura et al. (2012), showed that there is a negative correlation between academic performance and shooter games ($r =-.140$, $p<.05$). Xu et al. (2019), also showed a negative and weak correlation between the time students spend on online video games and their performance ($r =-.101$, $p<.05$), while Yurov et al. (2014), found no significant effect of online game frequency on academic performance ($r =-.063$, $p>.05$) of 113 American students.

We observe a slight asymmetry with the study by Kwok et al. (2021), showing significantly larger effect sizes compared to the other studies. Interestingly, this asymmetry is due to publication error in the studies on young adult students and not in the studies on a secondary school sample. There are three (3) studies for 10-12 year old students and seven (7) for secondary school students (less than 10 per subgroup) therefore the resulting charts do not have optimal reliability for drawing conclusions (Figure 1.).

Additionally, Table 1. presents the effect size estimates as obtained for each subgroup of the analysis. Specifically, for adolescents aged 10-12 years, three studies were included with an overall statistically significant negative and weak correlation coefficient ($r=-.116$, $p=.010$) meaning that school performance decreases as time on online video games increases, but this reduction is small. Studies for this age group show moderate heterogeneity ($I2=65.6\%$). Of course, this conclusion cannot be generalized to the population as there are only three studies (95% CI prediction from -.1.068 to +.837).

For adolescents aged 13-18 years seven studies were included with a statistically significant negative and weak correlation coefficient ($r=-.150$, $p<.001$) meaning that school performance decreases slightly as time spent on online video games increases. This conclusion can be

generalized to the population with a 95% confidence interval for the correlation coefficient from -.250 to -.049. Studies on this age group show high heterogeneity (I2=87.9%).

For teenagers and young adults aged 19-22, five studies were included with a statistically significant negative and weak correlation coefficient (r=-.106, p<.001) meaning that academic performance decreases slightly as time spent playing online video games increases. This conclusion can be generalized to the population as the 95% confidence interval for the correlation coefficient passes 0 (from -.153 to -.058). The studies for this age group do not show heterogeneity (I2=0.4%).

Overall the relationship that results from all 15 studies between school performance and frequency of online games is negative and weak (r=-.135, p<.001) which means that school performance decreases slightly as the time spent by students increases adolescents in online video games and is a generalizable result to the population (95% CI of prediction -.223 to -.046). The studies on all adolescents show high heterogeneity (I2=83.9%). It should also be noted that the homogeneity test between the subgroups showed that there is homogeneity in the three subgroups (p=.128) with the result that we have the indication that the effect of the frequency of playing online video games is slightly negative and weak in all age groups adolescents.

Limitations

The process of searching and analyzing the existing literature showed that there is a great heterogeneity in the research in terms of the research object, the sample, as well as the method chosen. This would be important to be taken into account by the researchers, so that there is the possibility of obtaining data suitable for further analysis and generalization in the future. Perhaps, it would have been more reliable to prefer instruments measuring academic achievement rather than just participant self-report questionnaires.

Conclusions

In order to conclude, there is a positive effect of the use of games related to mental functions, which are required for academic success, when the use of games is occasional. This evidence suggests that while excessive online gaming may hinder academic performance, video games alone may promote skill acquisition and produce positive academic outcomes.

Our findings concur with research results in Turkey (Şahin et al., 2016) suggest that game addiction may not be responsible for poor academic performance. Students with low academic performance may have poor time management skills unlike other students whose performance was not affected by the time allocated to the game and the type of games played (Penaso&Gaylo, 2019).These abnormalities in their schedule may affect their academic performance in general.

Therefore, there is a need to investigate other parameters that may influence the association with video games and lead to a decrease in academic performance. Research is needed to determine whether the cognitive skill acquired in a game can affect performance on academic tasks that require the corresponding skill. More specifically, whether and to what extent video games teach problem-solving skills and whether these skills generalize to real-world settings needs further investigation.

References

Best, J. R. (2014). Relations between video gaming and children's executive functions.

In *Learning by Playing* (pp. 42–53). Oxford University Press.

Bavelier, D., & Davidson, R. J. (2013). Brain training: Games to do you good. *Nature, 494*, 425– 426. https://doi:10.1038/494425a.

Bleich, A., Brown, S.-L., Kahn, R., & van Praag, H. M. (1988). The Role of Serotonin in Schizophrenia. *Schizophrenia Bulletin*, *14*(2), 297–315. https://doi.org/10.1093/schbul/14.2.297

Borgonovi F. (2016). Video gaming and gender differences in digital and printed reading performance among 15-year-olds students in 26 countries. *Journal of adolescence, 48*, 45–61.https://doi.org/10.1016/j.adolescence.2016.01.004

Brunborg, G. S., Mentzoni, R. A., &Frøyland, L. R. (2014). Is video gaming, or video game addiction, associated with depression, academic achievement, heavy episodic drinking, or conduct problems?,*Journal of Behavioral Addictions, 3*(1), 27-32. https://doi.org/10.1556/jba.3.2014.002

Burušić, J., Šimunović, M., & Šakić, M. (2021). Technology-based activities at home and STEM school achievement: the moderating effects of student gender and parental education. *Research in Science & Technological Education, 39*(1), 1–22.

Cortes, M. D. S., Alcalde, J. V., & Camacho Jr, J. V. (2012). Effects of computer gaming on High School students' performance in Los Baños, Laguna, Philippines. *国際公共政策研究, 16*(2), 75-88.

Der Simonian, R., & Laird, N. (1986). Meta-analysis in clinical trials. Controlled clinical trials, 7(3), 177–188. https://doi.org/10.1016/0197-2456(86)90046-2.

Farchakh, Y., Haddad, C., Sacre, H., Obeid, S., Salameh, P., &Hallit, S. (2020). Video gaming addiction and its association with memory, attention and learning skills in Lebanese children. *Child and Adolescent Psychiatry and Mental Health, 14*(1).https://doi.org/10.1186/s13034-020-00353-3

Granic, I., Lobel, A., & Engels, R.C. (2014). The benefits of playing video games. *The American psychologist, 69* (1), 66-78 .https://doi.org/10.1037/a0034857

Güzeller, C. O., &Akin, A. (2014). "Relationship between ICT Variables and Mathematics Achievement Based on PISA 2006 Database: International Evidence."*Turkish Online Journal of Educational Technology 13*(1): 184–192.

Kühn, S., Gleich, T., Lorenz, R. *et al.* Playing Super Mario induces structural brain plasticity: gray matter changes resulting from training with a commercial video game. *Mol Psychiatry 19,* 265–271 (2014). https://doi.org/10.1038/mp.2013.120.

Kumar, R., & Lal, R., (2014). Study of Academic Achievement in Relation to Family Environment among Adolescents. *International Journal of Indian Psychology, 2* (1), doi:10.25215/0201.074, DIP:18.01.074/20140201

Kuss, D. J., & Griffiths, M. D. (2012). Online gaming addiction in children and adolescents: A review of empirical research. *Journal of Behavioral Addictions, 1*(1), 3–22. https://doi.org/10.1556/jba.1.2012.1.1

Kuss, D.J., Griffiths, M.D. and Binder, J.F. (2013) Internet Addiction in Students: Prevalence and Risk Factors. *Computers in Human Behavior, 29,* 959-966. https://doi.org/10.1016/j.chb.2012.12.024.

Kwok, K. O., Li, K. K., Wei, W. I., Tang, A., Wong, S. Y. S., & Lee, S. S. (2021). Editor's Choice: Influenza vaccine uptake, COVID-19 vaccination intention and vaccine hesitancy among nurses: A survey. *International Journal of nursing studies, 114*,103854. https://doi.org/10.1016/j.ijnurstu.2020.103854

Lopez-Fernandez, O., Freixa-Blanxart, M., & Honrubia-Serrano, M. L. (2013). The problematic internet entertainment use scale for adolescents: prevalence of problem internet use in Spanish high school students. *Cyberpsychology, behavior and social networking, 16*(2), 108-118.https://doi.org/10.1089/cyber.2012.0250.

McDermott, A. F., Bavelier, D., & Green, C. S. (2014). Memory abilities in action video game players. *Computers in Human Behavior, 34,* 69–78. https://doi.org/10.1016/j.chb.2014.01.018.

Micic, G., Lovato, N., Gradisar, M., Burgess, H., Ferguson, S., & Lack, L. (2016). Circadian melatonin and temperature taus in delayed sleep-wake phase disorder and non-24-hour sleepwake rhythm disorder patients an ultradian constant routine study. *Journal of Biological Rhythms, 31*, 387–405. http://dx.doi.org/10.1177/ 0748730416650069

Moher, D., Liberati, A., Tetzlaff, J., &Altman, DG. The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: *The PRISMA Statement. PLoS Med 6*(7): e1000097.https://doi:10.1371/journal.pmed1000097

Nuutinen, T., Ray, C., &Roos, E. (2013). Do computer use, TV viewing, and the presence of the media in the bedroom predict school-aged children's sleep habits in a longitudinal study? *BMC public health, 13,* 684.https://doi.org/10.1186/1471-2458-13-684.

Paulus, F. W., Ohmann, S., von Gontard, A., & Popow, C. (2018). Internet gaming disorder in children and adolescents: a systematic review. *Developmental medicine and child neurology, 60*(7), 645–659. https://doi.org/10.1111/dmcn.13754.

Penaso, M. V., & Gaylo, D. N. (2019). Interactive Online and Offline Games: Their Influence to The Mathematical Aptitude of Secondary School Learners. *International Journal of Scientific & Technology Research. 8*, 6.

Ramirez, M. D., Besser, A. C., Newsome, S. D., & McMahon, K. W. (2021). Meta-analysis of primary producer amino acid δ15N values and their influence on trophic position estimation. *Methods in Ecology and Evolution, 12*(10), 1750–1767.https://doi.org/10.1111/2041-210x.13678

Rasmusson, M., & Åberg-Bengtsson, L. (2015). Does performance in digital reading relate to computer game playing? A study of factor structure and gender patterns in 15-year-olds' reading literacy performance.*Scandinavian Journal of Educational Research, 59*(6), 691–709. https://doi.org/10.1080/00313831.2014.965795

Sahin, M., Gumus, Y. Y., & Dincel, S. (2016). Game addiction and academic achievement. *Educational Psychology, 36*(9), 1533-1543.

Salomon, A., & Ben-David Kolikant, Y. (2016). High-school students' perceptions of the effects of non-academic usage of ICT on their academic achievements. *Computers in Human Behavior, 64*, 143 151. https://doi.org/10.1016/j.chb.2016.06.024

Saxvig, I., Pallesen, S., Wilhelmsen-Langeland, A., Molde, H., & Bjorvatn, B. (2012). Prevalence and correlates of delayed sleep phase in high school students. *Sleep Medicine, 13*(2), 193–199.http://dx.doi.org/10.1016/j.sleep.2011.10.024.

Schulz van Endert T. (2021). Addictive use of digital devices in young children: Associations with delay discounting,self-control and academic performance. *PloSone,16*(6), https://doi.org/10.1371/journal.pone.0253058.

Schmitt, B., Brakus, J. J., &Zarantonello, L. (2015). From experiential psychology to consumer experience. *Journal of Consumer Psychology, 25*(1), 166–171. https:// doi.org/10.1016/j.jcps.2014.09.001.

Ventura, M., Shute, V., & Kim, Y. J. (2012). Video gameplay, personality and academic performance. *Computers & Education, 58* (4), 1260–1266. https://www.learntechlib.org/p/167567/.

Xu, X., Wang, J., Peng, H., & Wu, R. (2019). Prediction of academic performance associated with internet usage behaviors using machine learning algorithms. *Computers in Human Behavior, 98*, 166–173. https://doi.org/10.1016/j.chb.2019.04.015.

Yates, T. M., Gregor, M. A., & Haviland, M. G. (2012). Child maltreatment, alexithymia, and problematic internet use in young adulthood. *Cyberpsychology, behavior and social networking, 15*(4), 219–225.https://doi.org/10.1089/cyber.2011.0427

Yıldırım, İ., & Şen, S. (2019). The effects of gamification on students' academic achievement: a meta-analysis study. *Interactive Learning Environments, 29*(8), 1301–1318.https://doi.org/10.1080/10494820.2019.1636089

Yurov, K. M., Beasley, S. W., Kwak, M., & Floyd, K. S. (2014). The effect of psychological and environmental factors on academic performance of video gamers', *Issues in Information Systems, 15*, 2393–398.

Appendix

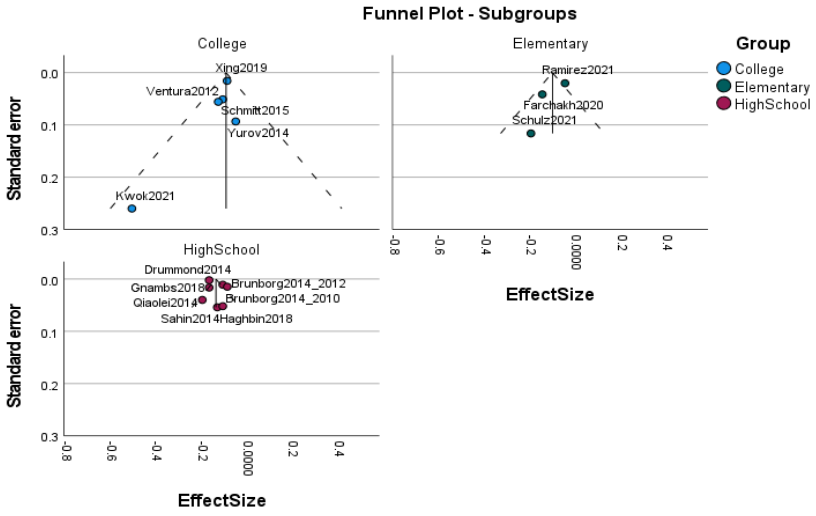

Figure 1. Funnel plot

Table 1. Effect Size Estimates for Subgroup Analysis

					95% CI		95% CI Prediction Interval[a]	
	Effect Size	SE	Z	P	Lower	Upper	Lower	Upper
Elementary	-.116	.0449	-2.573	.010	-.204	-.028	-1.068	.837
HighSchool	-.150	.0165	-9.113	.000	-.182	-.118	-.250	-.049
College	-.106	.0146	-7.255	<,001	-.134	-.077	-.153	-.058
Overall	-.135	.0137	-9.804	.000	-.162	-.108	-.223	-.046

a. Based on t-distribution.