International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:10, No:5, 2016

Effects of Video Games and Online Chat on Mathematics Performance in High School: An Approach of Multivariate Data Analysis

Lina Wu, Wenyi Lu, Ye Li

***Abstract*—**Regarding heavy video game players for boys and super online chat lovers for girls as a symbolic phrase in the current adolescent culture, this project of data analysis verifies the displacement effect on deteriorating mathematics performance. To evaluate correlation or regression coefficients between a factor of playing video games or chatting online and mathematics performance compared with other factors, we use multivariate analysis technique and take gender difference into account. We find the most important reason for the negative sign of the displacement effect on mathematics performance due to students' poor academic background. Statistical analysis methods in this project could be applied to study internet users' academic performance from the high school education to the college education.

***Keywords*—**Correlation coefficients, displacement effect, gender difference, multivariate analysis technique, regression coefficients

I. Introduction

WITH the development of computer technology, playing video games and chatting online have become the core part of teens' life for the past two decades. For instance, the average time spent on playing games increased from about 30 minutes a day in 2004, to 1 hour 13 minutes a day in 2009 [1]. As middle and high school students associate with mostly same-gender friends, girls tend to spend more time on chatting online than playing video games while boys prefer to play video games. "Video games for boys and online chatting for girls" is a symbolic phrase among parents that represents current adolescent culture. By observing teens' behavior of spending more and more time on video games/online chat compared with less and less time on homework, parents have expressed their serious concern. The growing concern from parents has drawn extensive attention in public, especially to educational researchers.

Researchers who are interested in the effect of playing video games/chatting online on students' academic performance have adopted the displacement effect (or displacement hypothesis) as a theoretical base. A theory of the displacement effect explains that one activity can displace other developmental activities within a time-limited environment. This perspective has mainly been adopted by media studies and started from the early days of television [2], [3]. The basic argument of the displacement effect is that media used by children, such as TV viewing, displaces more developmentally appropriate activities for children, such as reading [4] and interaction with parents [5]. If we only adopt the basic argument of displacement effect, we can expect playing video games and chatting online to displace other valuable activities, such as doing homework. Therefore, students' academic performance will decrease due to lack of time spent on schoolwork.

Researchers who focus on the role of educational video games in learning have identified positive results of students' academic success from video game learning compared with traditional classroom learning [7]. Researchers also pointed out educational video game players have stronger ability of problem-solving than non-players [8]. For an effect of playing non-educational video games on academic outcomes, researchers have not reached an agreement. However, the contemporary research on relationship between video games and academic performance does not take the gender difference into account.

Researchers who place emphasis on parental rule to discipline teens' study behaviors have drawn their conclusions in parent's perspective related to gender difference. In a sample of students aged 11 to 16, Phillips et al. [9] found that male students spent more time on video games and were more likely to neglect homework than female students under parents' influence. In a sample of college students, Burgess et al. [10] reported a negative relationship between playing video games and academic achievements, which was consistently more evident for male students compared with female students under parental rules.

The project in our paper will explore the relationship between playing video games/chatting online and math academic performance with respect to gender difference. Based on the fact that chatting online is prevalent among girls and playing video games is widespread among boys in high school, we are interested in the following research questions:

1. Does the displacement effect of playing video games and chatting online play a significant role in deteriorating math academic performance in high school?
2. How much does the gender difference in terms of time spent on playing video games for boys and chatting online for girls influence their math academic performance?

Lina Wu is with the Department of Mathematics, Borough of Manhattan Community College, The City University of New York, New York, NY 10007, USA (corresponding author phone: 419-509-6381; e-mail: lwu@bmcc.cuny.edu).

Wenyi Lu is with the Division of Finance and Economics, Marshall University Lewis College of Business, Huntington, WV 25755, USA (e-mail: luw@marshall.edu).

Ye Li is with the Department of Mathematics, Central Michigan University, Mount Pleasant, MI 48859, USA (e-mail: ye.li@cmich.edu).

II. Method

A. Participants

The project has used data from the High School Longitudinal Study of 2009 [6] sponsored by National Center for Education Statistics, U.S. Department of Education. 20,000 students from 944 schools were surveyed in fall 2009 as 9th-graders, and then again in spring 2012 as 11th-graders.

Around 1770 students were randomly chosen from the sample pool. Survey data from those students, their parents, math teachers, school administrators, and school counselor was analyzed. Participants were 52.0% white and non-Hispanic, 22.3% Hispanic, 13.2% Black and non-Hispanic, 3.4% Asian and 9.1% others.

B. Settings

In this project, in order to take various factors into account, we define many different variables to reflect different aspects. We also classify variables into different categories such as dependent variables, independent variables and control variables. The main technique of variable analysis used in this project is multivariate analysis. We use multivariate analysis to study interactions among different variables and to exam degrees of effects between playing video games/online chatting and academic achievements. To conduct multivariate analysis among various variables, we will use statistical knowledge to calculate correlations and regressions among variables.

III. Results

Table II displays correlations and Chi-squares between selected independent variables (one of activities including playing video games and online chatting) and two dependent variables (hours spent on math homework and academic achievements). Hours spent on playing video games and chatting online are significantly related to hours spent on doing math homework (Chi-2=16.551 and 10.606, respectively) and academic achievement in math (r= -.123 and -.092, respectively). Heavy video game players and super online chat lovers tend to forget their books, pens, and homework for class more often than normal students.

TABLE I
Comparison of Each Activity between Male and Female Students

	Chatting or surfing online				Playing video games			
	~ 1 hr	1 ~ 4 hrs	4 hrs+	Mean	~ 1 hr	1 ~ 4 hrs	4 hrs+	Mean
Male	44.2%	43.9%	11.9%	2.26	45.5%	41.0%	13.5%	2.30
Female	30.9%	54.0%	15.1%	2.61	84.0%	12.7%	3.3%	1.33
Chi-2		31.817***				268.546***		

*** $p < .001$

TABLE II
Correlation Coefficients or Chi-squares between Selected Independent Variables and Dependent Variables

Independent variables	Dependent variables	
	Hrs spent doing math HW (N) (~1hr, 1~2hrs, 3hrs+)	11th grade math achievement (N)
Hours spent on math HW (6 categories)	1	.065** (1559)
Hours spent chatting or surfing online (~ 1hr, 1 ~ 4hrs, 4hrs+)	16.551** (Chi2) (1532)	-.123*** (1696)
Hours spent playing video games (~ 1hr, 1 ~ 4hrs, 4hrs+)	10.606* (Chi2) (1497)	-.092*** (1663)
Hours spent on extracurricular activities	.179*** (1541)	.036 (1707)
Hours spent on working for pay	.082** (1491)	-.213*** (1651)
Scale of students' engagement	-.124*** (1539)	-.204*** (1727)
Friends' attitude toward education	.105*** (1534)	.190*** (1707)
Parents' educational aspiration for their child	.005 (1456)	.090*** (1666)
Parents' school governance	.085*** (1446)	-.006 (1642)
Parent-school communication about students' progress	.064* (1435)	-.076** (1630)
Learning environment at home	.139*** (1389)	.278*** (1546)
Parents' access to community resources	.065* (1447)	.112*** (1641)
Parent participation in school events	.061* (1453)	.229*** (1637)
Years of math teachers' teaching high school math	.037 (1106)	.146*** (1242)
Math teachers' college classes related to math	-.039 (1107)	.058* (1244)

*** $p < .001$, ** $p < .01$, * $p < .05$

TABLE III
OLS REGRESSION COEFFICIENTS ON ELEVENTH GRADE MATH ACHIEVEMENT BY PLAYING VIDEO GAMES AND OTHER VARIABLES (STANDARD ERRORS PRESENTED AS NUMBERS IN PARENTHESES)

	11th Grade Math Achievement					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Playing video game 2-4 hrs (Ref. less than 1 hr)	-.064 (.065)	-.033 (.062)	-.063 (.066)	-.066 (.118)	-.013 (.096)	.019 (.117)
Playing video game 4 hrs+ (Ref. less than 1 hr)	-.448*** (.103)	-.284** (.096)	-.204* (.104)	-.453* (.210)	-.119 (.189)	.243 (.225)
Male		.062 (.055)	.139* (.059)	.114 (.070)	.061 (.052)	.044 (.067)
SES		.525*** (.034)	.456*** (.037)	.455*** (.037)	.193*** (.033)	.205*** (.038)
Hrs spent doing math hw/study			.064 (.033)	.065* (.033)	.039 (.024)	.062 (.032)
Hrs spent working for pay			-.157*** (.025)	-.156*** (.025)	-.064** (.019)	-.067** (.026)
School engagement			-.256*** (.046)	-.254*** (.046)	-.057 (.035)	-.049 (.047)
Friends' academic attitude			.467*** (.127)	.465*** (.127)	.166 (.111)	.155 (.132)
Interaction Male x video gaming 1-4 hrs				.018 (.143)	.101 (.117)	.090 (.140)
Interaction Male x gaming 4 hrs +				.327 (.240)	-.109 (.212)	-.229 (.250)
9th grade math score					.804*** (.024)	.778*** (.031)
Parental aspiration					.015 (.015)	.019 (.017)
Parent-school communication about students' progress					-.059 (.059)	-.094 (.069)
Learning environment at home					.049 (.061)	.058 (.072)
Parental school engagement					.043 (.081)	-.013 (.095)
Math teachers' college classes related to math						-.074 (.115)
years of math teachers' teaching high school math						.007* (.003)
N	1662	1662	1415	1415	1114	811
R^2	.011	.217	.262	.263	.600	.604

* $p < .05$, ** $p < .01$, *** $p < .001$

We can reveal the relationship between playing video games and academic achievement by analyzing a sequence of models in Table III. As seen in Model 1 and Model 2, students who play video games more than 4 hours per day tend to have a significantly lower academic performance than those who play less than 1 hour. The negative sign of the displace effect of playing video games on math academic performance is obvious. However, the strength of negative sign becomes weaker substantially from Model 3 to Model 6 when other variables are taken into account. Those additional introduced variables represent school environment, home environment, parents' involvements, and influence by friends' academic attitudes, and students' math background. In particular, the effect of students' 9th grade score (provided from the variable of student's math background) on students' 11th grade (provided from the variable of student's math academic performance) is substantially the highest (r= .804 in Model 5 and r=0.778 in Model 6) among the effects of all variables on the students' math academic performance in 11th grade. Moreover, in Model 5 and Model 6, the 9th grade math scores explained the effect of other variables to a substantial degree. Consequently, we draw a conclusion that the negative sign for the displacement effect of playing video game on math academic achievements is caused primarily by students' poor academic background.

We analyze the relation between the amount of time on online chatting and math academic performance in Table IV. By observing the effect of students' 9th grade on students' 11th grade from Model 3 to Model 6 with high values (r=0.820 in Model 3, r=0.819 in Model 4, r=0.809 in Model 5, and r=0.780 in Model 6), we can infer that the major reason for the negative sign of the displacement effect on math academic performance for super online chat lovers is students' poor academic background.

Overall, we prove the existence of gender difference in terms of time on video games and online chat by Table I. We verify the negative sign of the displacement effect of internet use on math academic performance by Table II. By studying Tables III and IV, we realize that gender difference of internet use does not affect too much and the amount of time on internet use plays a role in affecting internet users' academic performance. However, we explore the main reasons of negative signs on academic performance for video game players and online chat lovers are due to internet users' poor math academic background.

IV. DISCUSSION

In the 21st century, internet use has become the core part of teens' life. The big change of teens' lifestyle involved with internet use will lead to a big change of teens' academic performance. We have investigated gender difference in terms of activities in which adolescents are engaged, time spent on their favorite activities, and concomitant effects on their school academic performance. The information of this project can be the guidance for further studies of internet users' academic performance in college-education.

This project also raises a question: How can math educators improve students' math background to make students well-

prepared for their future study? The project reveals the serious consequence for under-prepared students in the math study. As a chain of action, under-prepared students with poor math background compared with well-prepared students will have the bigger probability of failure in the future study.

TABLE IV
OLS REGRESSION COEFFICIENTS ON ELEVENTH GRADE MATH ACHIEVEMENT BY CHATTING OR SURFING ONLINE AND OTHER VARIABLES (STANDARD ERRORS PRESENTED AS NUMBERS IN PARENTHESES)

	11th Grade Math Achievement					
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Chatting 1-4 hours (ref. less than 1 hr)	-.020 (.060)	-.011 (.054)	-.024 (.043)	-.052 (.062)	-.055 (.067)	-.047 (.078)
Chatting 4 hours or more (ref. less than 1 hr)	-.553*** (.087)	-.388*** (.080)	-.130* (.064)	-.235** (.087)	-.151 (.101)	-.105 (.118)
Male		.011 (.050)	.026 (.039)	-.027 (.064)	-.030 (.066)	.023 (.083)
SES		.517*** (.033)	.201*** (.027)	.202*** (.027)	.200*** (.028)	.209*** (.038)
9th grade math score			.820*** (.023)	.819*** (.023)	.809*** (.027)	.780*** (.031)
Hrs spent doing math hw/study			.056* (.024)	.055* (.024)	.038 (.027)	.057 (.032)
Hrs spent working for pay			-.066*** (.018)	-.065*** (.018)	-.054* (.022)	-.055* (.025)
Interaction: Male x chatting 1-4 hrs				.046 (.085)	.068 (.094)	.057 (.110)
Interaction: Male x chatting 4 hrs or more				.226 (.126)	.142 (.144)	.157 (.167)
Parental aspiration					.017 (.015)	.025 (.017)
Parent-school communication about students' progress					-.065 (.059)	-.105 (.068)
Learning environment at home					.058 (.060)	.082 (.070)
Parent access to community resources					.040 (.058)	.062 (.068)
Parental school engagement					.080 (.080)	.032 (.095)
Math teachers' college classes related to math						-.108 (.114)
years of math teachers' teaching high school math						.008* (.003)
School locations' urbanization						-.009 (.023)
N	1695	1695	1477	1477	1149	834
R^2	.026	.216	.585	.586	.598	.603

* $p < .05$, ** $p < .01$, *** $p < .001$

ACKNOWLEDGMENT

The research from the first author Lina Wu was supported by PSC-CUNY Grant. Support for Lina Wu's project was supported by PSC-CUNY Award, jointly funded by The Professional Staff Congress and The City University of New York.

REFERENCES

[1] Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). *Generation M2: Media in the lives of 8- to 18-year-olds. Henry J. Kaiser Family Foundation.* Retrieved on 01/20/2013 from the Henry J. Kaiser Family Foundation Website: http://www.kff.org/newsroom

[2] Hornik, R. (1981). Out-of-school television and schooling: Hypotheses and methods. *Review of Educational Research, 51*(2), 193-214. doi:10.3102/00346543051002193

[3] Robinson, J. P. (1969). Television and leisure time: yesterday, today, and (maybe) tomorrow. *Public Opinion Quarterly, 33*(2), 210-222. doi:10.1086/267692

[4] Ritchie, D., Price, V., & Roberts, D. F. (1987). Television, Reading, and Reading Achievement: A Reappraisal. *Communication Research, 14*(3), 292-315. doi:10.1177/009365087014003002

[5] Vandewater, E. A., Bickham, D. S., & Lee, J. H. (2006). Time well spent? Relating television use to children's free-time activities. *Pediatrics, 117*(2), 181-191. doi: 10.1542/peds.2005-0812

[6] Ingels, S. J., Pratt, D. J., Herget, D. R., Dever, J. A., Fritch, L. B., Ottem, R., ... Christopher, E. (2013). *High School Longitudinal Study of 2009: Base-year to first follow-up data files documentation* (Report No. NCES 2014-361). Retrieved on 01/30/2014 from National Center for Education Statistics Website: http://nces.ed.gov

[7] Barko, T., & Sadler, T. D. (2013). Practicality in virtuality: Finding student meaning in video game education. *Journal of Science Education and Technology, 22*(2), 124-132. doi:10.1007/s10956-012-9381-0

[8] Squire, K. D. (2008). Video game–based learning: An emerging paradigm for instruction. *Performance Improvement Quarterly, 21*(2), 7-36. doi:10.1002/piq.21139

[9] Phillips, C. A., Rolls, S., Rouse, A., & Griffiths, M. D. (1995). Home video game playing in schoolchildren: A study of incidence and patterns of play. *Journal of Adolescence, 18*(6), 687-691. doi:10.1006/jado.1995.1049

[10] Burgess, S. R., Stermer, S. P., & Burgess, M. C. (2012). Video game playing and academic performance in college students. *College Student Journal, 46*(2), 376-87.