International Journal of Communication 10(2016), 3851–3876 1932–8036/20160005

Internet Usage and Educational Outcomes Among 15-Year-Old Australian Students

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Children in rich countries are using the Internet for social networking and gaming at very high rates, particularly in Australia. This study addresses whether these activities affect educational achievement in mathematics, reading, and science using the Organization for Economic Cooperation and Development's 2012 Program for International Student Assessment data set. The results suggest that using online social networks reduces academic achievement. Conversely, playing online games increases scores. It is argued that although both activities are associated with a high opportunity cost of study, video games potentially allow students to apply and sharpen skills learned in school. Skipping school, failing an academic year in the past, and being indigenous are also important predictors of underachievement. It is suggested that monitoring, counseling, and tutoring students who are at risk of failure may useful.

Keywords: educational attainment, Internet use, online gaming, social networks, Australia

Parents and teachers are probably not surprised to see an increase in studies on Internet usage in the developed world. Psychologists, in particular, have been worried about the growing number of Internet users and the possible effect of this on well-being factors such as depression and social isolation.[2] What most studies, almost invariably, note is that Internet usage among teenagers is massive, particularly in Australia. For example, whereas 83% of adult Australians used the Internet in 2012 to 2013, 97% of children between 15 and 17 years of age reported frequently going online (Australian Bureau of Statistics, 2013). To put this into perspective, Internet usage among adult Australians is similar to that in the United States and average among Organization for Economic Cooperation and Development (OECD) countries. However, evidence suggests that Internet usage among adolescents is significantly higher in Australia

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Date submitted: 2016–03–15

[1] I am thankful to Jo En Yap, Simon Feeny, Larry Gross, and the two anonymous referees for their very helpful comments and suggestions on drafts of this article. All remaining errors are mine.
[2] See, for instance, Brenner (1997), Gross (2004), Cao and Su (2007), and van den Eijnden, Meerkerk, Vermulst, Spijkerman, and Engels (2008).

than in the United States (93%) and Europe (86%).[3] Thus, with so many Australian children currently using the Internet, it is important to consider how this practice affects their educational outcomes. This is crucial for a number of reasons, none more important than that educational outcomes can impact labor market outcomes in the future.

Unsurprisingly, some scholars have begun to look at the nexus between Internet usage and educational outcomes. Landers and Lounsbury (2006), for instance, conducted a survey of 117 American undergraduate students and highlighted that higher Internet usage was negatively correlated with work drive, which in turn resulted in lower grades. Similarly, using a sample of 219 American university students, Kirschner and Karpinski (2010) found that Facebook usage, in particular, was associated with lower grade point averages (GPAs). Likewise, using a sample of 572 American university students, Kubey, Lavin, and Barrows (2001) found that Internet usage was correlated with lower academic achievement. Conversely, using a sample of 2,100 American university students, Stollak, Vandenberg, Burklund, and Weiss (2011) found that a student's GPA did not reflect the use of social sites, such as Facebook, Twitter, or YouTube. Focusing on university students, however, can be problematic in that the true relationship between Internet usage and academic achievement is likely to be difficult to capture from a group of individuals who have decided to take on tertiary-level studies. That is, focusing on university students generates an important source of bias because these types of students are most probably more inclined to study and are better able to manage their time, regardless of their Internet usage.

A better approach, therefore, is to focus on younger students, who are yet to make decisions about further study. Interestingly, mixed evidence on the relationship between Internet usage and academic achievement also has been found from studies on adolescents. For example, using survey data on 237 students from one middle school located in an upper-middle-class neighborhood of the United States, Lei and Zhao (2007) found a positive relationship between technology use (including Internet usage) and GPA. On the other hand, using a sample of 101 students in three schools in Ohio, Hunley, Krise, Rich, and Schell (2005) found no statistically significant relationship between academic achievement and Internet usage.

The problem with these studies, however, is that they covered only small samples of students, which generates issues of underrepresentation. Moreover, the studies reviewed for the current research reveal that the extant literature failed to properly account for many other student-level characteristics that have been found to be important determinants of learning outcomes. For example, the studies reviewed ignored parental levels of education and household wealth, which have been widely recognized as important determinants of children's academic achievement (Black, Devereux, & Salvanes, 2005; Gamboa & Waltenberg, 2012). Such an approach introduces omitted variable bias. This statistical issue arises when a model incorrectly leaves out one or more important determinants of performance and, therefore, compensates for the missing factor by over- or underestimating the effect of one of the specified factors.

[3] For comparative figures with the United States, see Lenhart, Purcell, Smith, and Zickuhr (2010). For comparative figures with Europe, see Livingstone, Haddon, Görzig, and Ólafsson (2011) and Green, Ólafsson, Brady, and Smahel (2012).

In this study, I adopted an empirical strategy that directly took these issues into consideration through a multinomial regression model. This article uncovers the relationship between online use and academic performance after controlling for other important determinants of the latter.

In addressing the role of online use, most previous studies have focused heavily on social networks, such as Facebook and chatting, but have ignored simultaneous consideration of other online activities, such as online gaming, an increasingly popular activity among teenagers who use the Internet (Lenhart et al., 2010). This is important because some researchers have found that heavy or excessive use of online gaming tends to lower academic achievement (Chen & Peng, 2008; Kuss & Griffiths, 2012). However, not everyone who regularly plays online video games is a heavy or excessive user, and some studies suggest that playing video games may be associated with positive cognitive outcomes, depending on the type of game (Greitemeyer & Mügge, 2014).[4] Indeed, in reviews of the literature, Subrahmanyam, Greenfield, Kraut, and Gross (2001) and Subrahmanyam, Kraut, Greenfield, and Gross (2000) found that playing computer games can allow children to build computer literacy, enhancing their ability to read and visualize images in three-dimensional space, while learning how to deal with multiple images simultaneously, which is assumed to lead to better academic performance. Kirriemuir and McFarlane (2004) expanded on this point by arguing that commentators often suggest that computer games, particularly strategy or adventure games, can support the development of logical thinking and problem-solving skills, which may encourage cognitive abilities linked to higher educational outcomes.

However, Kirriemuir and McFarlane (2004) also argued that much of this research relies on inference from the structure of computer games coupled with psychological theory rather than on empirical evidence. In fact, there is no evidence to suggest that children translate problem-solving skills learned for game playing into identifying problems and generating solutions in other contexts. Overall, analyses of whether video games lead to better educational outcomes, particularly mathematics and reading, are limited to studies on discrete educational software used to teach children these skills and provide schools with useful recommendations on curriculum change (Cole, 1998; Fisch, 2005; Murphy et al., 2002; Papastergiou, 2009; Paraskeva, Mysirlaki, & Papagianni, 2010). A review of the educational implications of general (nonexcessive) video game playing, implicitly including popular violent and nonviolent games, has (until now) been missing from the literature (Anderson & Warburton, 2012).

Notable exceptions include studies by Sharif and Sargent (2006) and Anand (2007). Sharif and Sargent found that video game (console) time was not significantly associated with self-assessed school performance in the northeastern United States. The present study differs by concentrating on an objective assessment, rather than self-assessment, of school performance. Anand used data from a survey of 245 New York University students and found that the amount of time students spent playing video games had a negative correlation with students' GPA and SAT scores. However, as in most previous studies, Anand did not control for other determinants of educational performance that have been found to be important.

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[4] Furthermore, what constitutes "heavy" or "excessive" use of the Internet is controversial (Smahel et al., 2012).

The current study used data from the OECD's Program for International Student Assessment (PISA) to consider the effect of these prominent online leisure activities— Internet socializing and gaming—on the educational outcomes of adolescents. PISA is an international survey that evaluates education systems by testing skills and knowledge in mathematics, reading, and science of 15-year-old students in a random selection of schools. The latest available Australian survey (2012) covered 772 schools and 12,004 students. Aside from testing students, PISA also collects an impressive amount of information on students' online activities, including usage and usage frequency of social networks and games. Importantly, the data also allow the analysis to consider these factors after controlling for the amount of time that students use the Internet for study, a factor that has been largely neglected in this literature. PISA surveys also collect household-level information as well as data on parents' occupation and educational attainment, which serve as important controls when assessing educational attainment.

To preview the results, this study found mixed evidence of the effect of Internet usage on educational outcomes among Australian adolescents. For example, the more that students used online social networks, the lower their skill and knowledge scores in mathematics, reading, and science. However, online gaming was found to have a positive effect on these scores. A host of other determinants of achievement were also considered. The remainder of this article is structured as follows: The next section presents the data, the following section addresses the empirical results, and the final section discusses and concludes.

Data

In this study, I used PISA data collected by the OECD in 2012. This is the most recent and complete student achievement data set available for Australia (Herrero et al., 2014). Moreover, PISA 2012 has the latest and most comprehensive data on information and communications technology used by students. PISA includes comprehensive data for the evaluation of adolescent (15-year-old) academic achievement, as well as key indicators of their schooling and family environments. In Australia, 775 schools and a total of 14,481 students participated in PISA 2012. This study employed data from 772 schools and 12,018 student observations given that not all students answered the questions about their personal interests. Australia is represented by a larger sample than other OECD countries to oversample indigenous students to ensure that reliable estimates could be inferred from the data (Thomson, De Bortoli, & Buckley, 2013).

The aim of PISA is to assess the extent to which students who are nearing the end of compulsory education have acquired practical skills and knowledge in three broad categories, namely, mathematics, reading, and science.[5] The questionnaire has been carefully devised to assess not only whether students can reproduce what they have learned, but also to examine how well they can extrapolate from what they have learned in class by applying their knowledge to a series of complex real-life problems (OECD, 2009).

[5] PISA sample questions are available from http://www.oecd.org/pisa/test/.

This type of assessment, therefore, provides a comprehensive reflection of academic achievement and understanding.

PISA measures academic achievement and understanding with a two-hour paper-based test that covers the three areas of interest. The tests mix open-ended and multiple-choice questions and generally aim to reflect the use of math, reading, and science in real-life situations. In the three subjects tested, a score is calculated for each student after rescaling all scores such that the average score among OECD countries is 500 points and the standard deviation is 100 points. As a result, researchers can easily make comparisons within and between countries (OECD, 2015). The overall scores in math, reading, and science are summarized in Figure 1 in terms of each Australian state and territory. The figure shows that Australian students performed at levels similar to the OECD average in math, and achieved above-average results in reading and science. Within Australia, Western Australia, Victoria, New South Wales, and the Australian Capital Territory perform exceptionally well. The Northern Territory and Tasmania, on the other hand, drag down the national average.

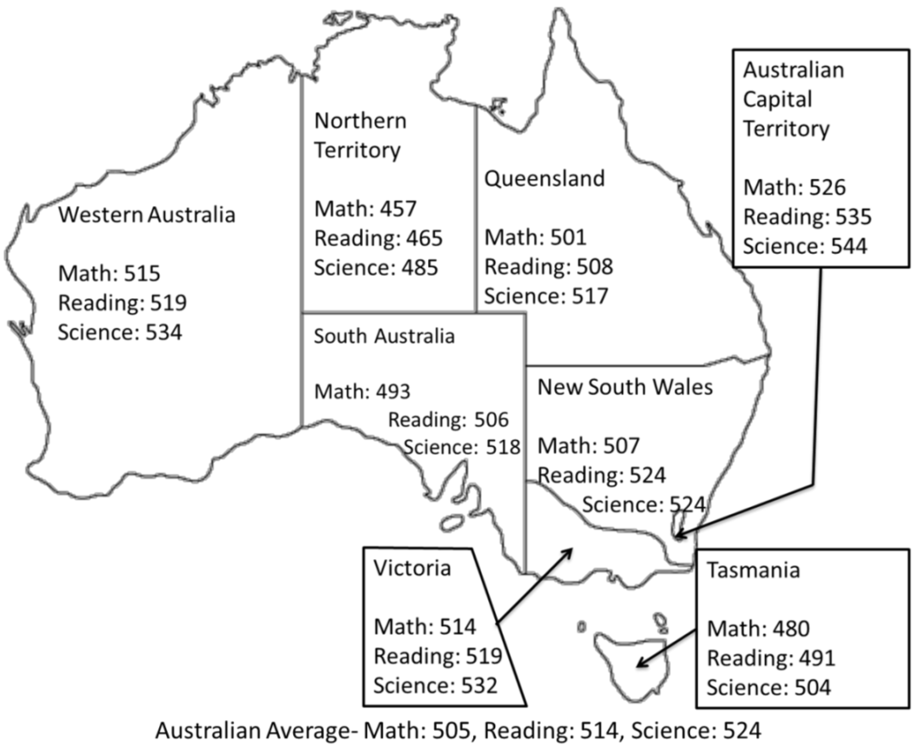

Figure 1. Program for International Student Assessment scores in math, reading, and science for Australia, by state (2012). The calculation is based on test scores in math, reading, and science from 12,018 15-year-old students from 772 schools across Australia.

The purpose of this study was to understand how Internet usage affects these scores. Accordingly, I used a set of dummy variables to determine the level of out-of-school or leisure usage of (a) online social networks and (b) online video games. The social network variables included activities such as using Facebook and Twitter, as well general online chatting. The online video games variables included both multiplayer and solo games. These variables determined usage from *never*, to *once or twice a month*, to *once or twice a week*, to *almost every day*, to *every day*.[6] Therefore, I was able to capture not only Internet usage, but also the intensity of usage. This is an important feature given that, for example, excessive gaming has been found to be problematic, but playing games once a week may not necessarily be so.

A proxy for proficiency with the Internet was included using a dummy variable equal to 1 if the respondent used the Internet before the age of 10. It was also recognized that the Internet is often used for study. Therefore, dummy variables were employed to capture how often students used the Internet at home for school purposes, such as for homework or contacting a teacher. These variables determined usage in the same manner as the two leisure variables described above.

The control variables employed in this study reflect findings from previous studies on educational attainment and achievement as well as data availability. Overall, most studies suggest that educational achievement is a function of both students' personal characteristics and commitment to study, as well as their household and school environments (Byrnes & Miller, 2007; Tomul & Savasci, 2012; Wilson, 2001).

Students' personal characteristics included age (measured in days); gender; and whether the student was indigenous, broader community, or a new Australian immigrant. Although most students were around 15 years of age, the variable age was included to test for possible cohort effects, where older students in a class are generally expected to perform better (Crawford, Dearden, & Greaves, 2014). To capture the possible effect that being a recent immigrant may have on educational achievement, I used a dummy variable equal to 1 if the student arrived in Australia within the five years prior to the survey. However, many migrants to Australia are from English-speaking nations (Canada, Ireland, New Zealand, the United Kingdom, and the United States); as a result, the transition to Australian education for such a child may be comparatively unproblematic. To better reflect the potential problems faced by the children of migrants from non–English-speaking countries, I also included a dummy variable equal to 1 if the child did not speak English at home. Interestingly, Australia's reputation as a multicultural society is highlighted by the 9% of respondents who used a language other than English at home.

Commitment to study was captured by two ordinal variables that asked students how often they skipped school or class in the past two weeks. These variables ranged from 0 (*none*) to 1 (*one or two times*) to 2 (*three or four times*) to 3 (*five or more times*). In addition, students who repeated a year in either primary or secondary schooling were controlled for with a dummy variable. Following Wilson (2001), I also controlled for students' commitment to out-of-school study (homework) with a variable that

[6] The omitted category in the regression analysis was "*never.*"

measured the number of hours dedicated to either solo or guided study (or both), in which the latter included support from parents or a tutor.

Other relevant control variables included household-level wealth and parents' educational and occupational characteristics. Following OECD (2009), household wealth is an index generated using principal components analysis and includes factors such as whether the student has his/her own room and whether the household has a dishwasher and Internet access, as well as the number of mobile phones, TVs, computers, bathrooms, and cars. As is common with wealth indices using principal components analysis, scores ranged from negative to positive values with a mean of zero.

Parents' educational attainment was classified using UNESCO's International Standard Classification of Education codes. The codes state whether parents finished primary, secondary, or tertiary schooling, and the latter differentiates between undergraduate and postgraduate qualifications. Postgraduate education, in turn, also discerns between master's and doctoral attainment. In addition, using the International Labour Organisation's International Standard Classification of Occupations, I classified parents' occupation as highly skilled, semiskilled, and unskilled. Furthermore, parents' work status was controlled for with four dummy variables equal to 1 for each other the following categories: the parent was unemployed; the parent is a stay-at-home mother or father, the parent works part time, or the parent works full time.

Tomul and Savasci (2012) also demonstrated that the size of a household is an important determinant of educational achievement. As a result, this study included dummy variables to indicate whether the mother, father, or (potential) siblings lived at home with the student. Finally, school-level and grade-level fixed effects were included to control for unobserved characteristics of the school and grade environment that can influence educational outcomes.[7] Table 1 presents the summary statistics.

Results

The dependent variables in this study were normally distributed and considered exogenous because a test result held during a survey at time t is unlikely to influence household-level determinants as well as whether students decided to skip school or do more homework at time $t - 1$. Therefore, the regression analysis presented in this section estimated three separate sets of equations for each of the skills and knowledge test results in math (see Table 2), reading (see Table 3), and science (see Table 4) using ordinary least squares.[8] In addition, all equations included school and grade fixed effects to control for unobserved characteristics that could have influenced educational outcomes. Importantly, given that

[7] Even though most students were around 15 years old, they were enrolled in grades ranging from 7 to 12. The majority, however, were enrolled in grades 9, 10, and 11.

[8] Ordinary least squares is a statistical method used to estimate the relationship between a dependent variable and a predictor variable by essentially drawing a line between the observations that best explain the correlation between those variables, while simultaneously considering the relationship between the dependent variable and other predictors.

schools did not change location, these fixed effects also controlled for state-level educational policies that could have influenced individual-level outcomes.[9] Also note that in all regressions, heteroscedasticity robust standard errors were clustered at the school level.[10] Clustering standard errors assumes that observations pertaining to a given school are correlated with each other in an undetermined way. Across all tables, certain variables were used interchangeably to reduce the possibilities of collinearity.

Table 1. Summary Statistics (N = 12,018 Observations).

	Variable	Mean	Std. Dev.	Min	Max
	Math score	505.29	92.05	170.91	819.53
	Reading score	514.10	91.47	135.67	783.75
	Science score	524.25	94.98	165.27	822.21
Uses online social networks:[a]					
	Never	0.07	0.26	0	1
	Once or twice a month	0.04	0.19	0	1
	Once or twice a week	0.10	0.30	0	1
	Almost every day	0.24	0.43	0	1
	Every day	0.54	0.50	0	1
Plays online games:[a]					
	Never	0.34	0.47	0	1
	Once or twice a month	0.18	0.39	0	1
	Once or twice a week	0.23	0.42	0	1
	Almost every day	0.15	0.36	0	1
	Every day	0.10	0.30	0	1

[9] State-level fixed effects were included as a robustness exercise. The results, available on request, were similar to those presented here.

[10] Heteroscedasticity occurs when the variability of a variable is unequal across the range of values of a second variable that predicts it. This could potentially affect the statistical significance of the relationship, creating a statistical bias. Robust standard errors correct for this bias.

Use of Internet for school:[a]					
	Never	0.04	0.21	0	1
	Once or twice a Month	0.09	0.28	0	1
	Once or twice a week	0.32	0.47	0	1
	Almost every day	0.33	0.47	0	1
	Every day	0.21	0.41	0	1
	Used Internet before 10 y/o	0.67	0.47	0	1
	Age	15.79	0.29	15.25	16.33
	Girl	0.50	0.50	0	1
	Indigenous	0.12	0.32	0	1
	Recent migrant	0.05	0.22	0	1
	English not spoken at home	0.09	0.29	0	1
	Late to school	0.50	0.78	0	3
	Skipped school	0.41	0.68	0	3
	Skipped class	0.18	0.50	0	3
	Repeated a year	0.07	0.26	0	1
	Homework	3.81	5.39	0	30
	Wealth	0.10	1.63	-7.49	2.08
	Mother is unemployed	0.04	0.19	0	1
	Mother works full time	0.51	0.50	0	1
	Mother works part time	0.24	0.43	0	1
	Father is unemployed	0.03	0.17	0	1
	Father works full time	0.83	0.38	0	1
	Father works part time	0.06	0.24	0	1
	Mother is high-skilled	0.11	0.32	0	1
	Mother is semi-skilled	0.39	0.49	0	1
	Father is high-skilled	0.19	0.39	0	1
	Father is semi-skilled	0.24	0.43	0	1
	Mother ISCED classification	4.29	1.53	0	6
	Father ISCED classification	4.12	1.60	0	6
	Mother lives at home	0.95	0.21	0	1
	Father lives at home	0.85	0.36	0	1
	Siblings live at home	0.85	0.35	0	1

Notes: [a]Usage outside of school. Virtually all students reported using the Internet or computers at school. ISCED = International Standard Classification of Education.

Internet Use and Educational Outcomes

Tables 2–4 show that using online social networks, such as Facebook or chatting, was significantly associated with lower performance in math, reading, and science. For example, the results suggest that a student who uses online social networks on a daily basis will also obtain a grade in math that is 20 points lower than a student who never uses this type of social media. Alternatively, this can be interpreted as students who use online social media score 4% lower than the sample average, all other things being equal. Furthermore, the results show that the more often a student uses the Internet for these activities, the worse the effect on grades. For example, a student who uses online social networks once or twice a month scores 8 points lower than the average. Similarly, a student who uses online social networks can expect to score lower in reading and science by similar magnitudes, with more frequent usage again having a larger effect. These results, therefore, can be interpreted as suggesting that there is a seemingly high opportunity cost of engaging in social networking.

On the other hand, the data indicate that students who play online games gain higher scores in math, reading, and science. That is to say, although there may be an opportunity cost of gaming in terms of educational outcomes, it is possible that a number of skills associated with online gaming correlate positively with generalized knowledge and skills tests in math, reading, and science. This may be because many online games require players to solve puzzles that, in turn, require some understanding of these three subjects. Gee (2014) and Schrader and McCreery (2008) argued that video games, particularly massive multiplayer online games, foster a range of skills that promote higher order thinking, which could potentially lead to improvements in math and literacy. The findings here give some support to this notion, although it could be argued that people who are good at math and reading also enjoy games that allow them to employ (or even sharpen) these skills. This point is discussed in more detail below.

The results show that students who play online games almost every day score 15 points above the average in math and reading and 17 points above the average in science. Furthermore, Tables 2–4 also show some evidence of a quadratic relationship in online gaming, such that playing almost every day has a larger positive effect on test scores than playing once a week or every day. These findings can be interpreted as suggesting that whereas frequent online gaming possibly sharpens a number of skills needed to perform well in school, excessive gaming may begin to have a marginally negative effect on educational outcomes.

Overall, the results indicate that students who engage in online social networking have below-average PISA performance, whereas students who spend time online gaming perform at above-average levels. It is important to note that although it is possible to hypothesize a causal relationship between online activities and academic achievement, the results here cannot in fact be considered as causal without controlling for student ability. That is, it is possible that children who are already gifted in the areas of math, science, and reading are also more likely to play online games and children with lower academic abilities spend more time socializing.[11] In the absence of a direct measure of ability, the regression analysis focuses on controlling for other factors that may determine academic achievement. However, such strategies are not definitive and the results must still be interpreted with caution.

Turning to other online activities, Tables 2–4 show that students who reported using the Internet for school purposes also scored higher in the three PISA subjects. Students who reported using the Internet daily for activities such as homework and contacting teachers scored, on average, 21 points more in math than those who did not do so. This finding is consistent with international evidence detailed in Subrahmanyam et al. (2000). As with online gaming, however, the findings reported here indicate that students who use the Internet for school every day score below those who use it almost every day. This may reflect that some students need to ask more questions or do more online searches because they find the academic material difficult, all other things being equal. Similar results were obtained for science and reading. Proficiency in Internet usage, assessed by the proxy of whether a student started using the Internet before turning 10, was found to increase scores in math, reading, and science by approximately 9, 5, and 8 points, respectively.

Individual Student Characteristics and Educational Outcomes

Turning to individual student-level characteristics, their effects on performance varied significantly across subjects. For example, older students performed significantly worse in math, while showing no significant change in performance in reading and science, other things being equal. This is an interesting finding as it is generally perceived that older students outperform younger ones within particular cohorts. This may reflect a variety of factors, including maturity differences that begin in primary school and persist (at a declining rate) toward secondary school (Crawford et al., 2014; Smith, 2009). The evidence presented here suggesting that the cohort effects discussed in the literature can vary by subject, and can be negative, is new and worthy of further research.

Turning to gender, girls were found to underperform relative to boys in math and science, but did significantly better in reading. This finding is in line with literature that highlights girls as underperformers in the so-called hard sciences, such as math and science. Some scholars argue that gender-based disparity in achievement reflects sociocultural issues within the classroom, where teachers (and sometimes parents) persuade girls to avoid science, technology, engineering, and math subjects, and reading is constructed as an appropriately feminine activity (Francis, 2000; Marsh & Yeung, 1998).

Compared with other students, indigenous Australians were found to underperform in all subjects by approximately 30 points. That is, indigenous Australians scored 6% lower than the OECD and Australian averages. It is impossible for this article to do justice to the large policy debate explaining the gap in educational outcomes between indigenous and broader community Australians (Gray & Beresford 2008; Leigh & Gong, 2009). A pillar of this debate recognizes that the “traditional” school curricula in

[11] I am thankful to an anonymous referee for making this point.

indigenous communities can be perceived as an instrument of cultural assimilation of indigenous peoples into wider society (Hickling-Hudson & Ahlquist, 2003). As a result, for example, different communities have adopted "culturally negotiated" schools, where institutions aim to develop a bilingual and bicultural program for students, thereby allowing indigenous self-determination to become a reality. Consequently, Aboriginal and other children attending culturally negotiated schools may systematically underperform on Eurocentric tests, such as PISA. This may not necessarily reflect deficiencies in the educational system or learning outcomes, but rather reflect a cultural difference in such schools. Nevertheless, disparity in test scores remains useful for recognizing a gap in generalized educational outcomes, which the international evidence suggests is correlated with adulthood earning capacity in the formal labor market (Dale & Krueger, 2002, 2014). Indeed, some experts suggest that indigenous communities require labor market opportunities that offer quality employment with transferable skills not limited to career paths tied to indigenous-related work to realize socioeconomic improvements (Walter, 2015). To achieve this, Taylor, Gray, Hunter, Yap, and Lahn (2012) argued that indigenous qualifications need to be broadened beyond their current focus around health, education, culture, and society. Evidence in this study suggests that further work is needed to address the gaps in so-called "mainstream" educational outcomes between indigenous and broader community students.

On a similar note, the evidence in Tables 2, 3, and 4 indicates that children who do not speak English at home are also more likely to obtain lower scores in PISA subjects, particularly in reading and science. These results imply that some Australian students would benefit from English-as-a-second-language courses when they do not speak this language at home. Recent migrants were also found to perform significantly worse in science, with some indication of lower performance in reading. The evidence in Table 4 may also highlight differences in the curriculum that migrant children are exposed to before arriving in Australia.

The final set of personal student characteristics in the tables pertain to general commitment to schooling. Children who were late to school or skipped school or class in the past week performed significantly worse in math, reading, and science than those who were not late to school or did not skip school or class. For example, students who skipped school or class three or four times in the past week scored 24 and 14 points lower in math, respectively, than the average student, other things being equal. Similarly, students who repeated a year in either primary or secondary school also tended to do worse; students who repeated a year scored 26, 23, and 24 points lower than the average in math, reading, and science, respectively. Not surprisingly, however, students who spent more time on their homework performed better. For example, an additional three hours of homework per week (the sample average) was associated with 6 additional test points in the three subjects. This relatively small effect possibly implies that efficiency with time when doing homework is important.

Students' Household Characteristics Use and Educational Outcomes

Turning to household-level characteristics, students from wealthier households were found to score lower in math, reading, and science, controlling for other factors. This is a surprising result given that children from wealthier households generally have access to more cultural capital and are thus expected to do better in school (Orr, 2003). The results do not necessarily contradict this hypothesis; instead, they highlight that cultural capital may be transferred to children via the parent's level of education and employment type. The tables indicate that children from households with employed, educated, or more skilled parents performed better in all three subjects. The impact of parents' educational and occupational status on children's academic achievement is widely accepted in the literature.[12] Finally, children who live with their families were also found to perform better.

Table 2. Internet Usage and Mathematics Outcomes.

		(1)	(2)	(3)	(4)
		Coef	t-stat	Coef	t-stat
Uses online social networks:±					
	Once or twice a Month	-8.17*	[-1.83]	-8.20*	[-1.85]
	Once or twice a week	-14.8***	[-4.26]	-15.2***	[-4.42]
	Almost every day	-14.0***	[-4.67]	-14.2***	[-4.73]
	Every day	-19.4***	[-6.75]	-20.1***	[-7.05]
Plays online games:±					
	Once or twice a Month	2.48	[1.24]	3.21	[1.62]
	Once or twice a week	9.02***	[4.70]	9.09***	[4.73]
	Almost every day	15.2***	[6.48]	15.1***	[6.40]
	Every day	8.86***	[3.19]	9.21***	[3.33]
Use of Internet for school:±					
	Once or twice a Month	13.9***	[3.21]	14.8***	[3.43]
	Once or twice a week	24.2***	[6.40]	25.6***	[6.67]
	Almost every day	24.8***	[6.47]	26.1***	[6.75]
	Every day	20.6***	[4.93]	22.4***	[5.33]
	Used Internet before 10 years old	8.73***	[5.87]	9.05***	[6.02]
	Age	-8.48***	[-2.77]	-9.30***	[-3.01]
	Girl	-12.1***	[-6.91]	-12.2***	[-7.00]
	Indigenous	-28.7***	[-11.6]	-29.8***	[-12.2]
	Recent migrant	-4.37	[-1.24]	-3.36	[-0.96]
	English not spoken at home	-5.10*	[-1.76]	-4.33	[-1.51]

[12] See, for instance, Patterson, Kupersmidt, and Vaden (1990) and Davis-Keane (2005).

Late to school	-9.86***	[-9.94]	-9.78***	[-9.84]
Skipped school	-12.3***	[-10.8]	-12.6***	[-11.2]
Skipped class	-7.37***	[-5.21]	-7.37***	[-5.22]
Repeated a year	-23.9***	[-7.97]	-23.7***	[-7.89]
Homework	1.86***	[13.0]	1.87***	[13.1]
Wealth	-2.54***	[-5.21]	-2.35***	[-4.94]
Mother is unemployed	-10.9***	[-2.82]		
Mother works full time	2.04	[1.01]		
Mother works part time	9.16***	[4.12]		
Father is unemployed	5.69	[1.28]		
Father works full time	7.50***	[2.85]		
Father works part time	11.6***	[3.12]		
Mother is high-skilled			8.05***	[3.67]
Mother is semi-skilled			15.2***	[10.1]
Father is high-skilled			15.2***	[8.03]
Father is semi-skilled			22.9***	[12.4]
Mother ISCED classification	3.52***	[6.70]		
Father ISCED classification	5.31***	[10.3]		
Mother lives at home	15.7***	[4.27]	16.9***	[4.70]
Father lives at home	12.2***	[5.87]	12.1***	[5.85]
Siblings live at home	8.35***	[3.82]	9.35***	[4.29]
Constant	398***	[8.10]	425***	[8.67]
School and grade FE?	Yes		Yes	
Observations	12,018		12,018	
R-squared	0.46		0.46	
Number of school-level clusters	772		772	

Notes: Robust t-statistics clustered at the school level in brackets. *, **, *** indicates 10%, 5% and 1% levels of statistical significance, respectively. ± The omitted category is 'never' uses the Internet for this activity. Degrees of freedom are not included with t statistics because regression diagnostics are based on a Wald test, rather than the sums of squares. ISCED = International Standard Classification of Education.

Table 3. Internet Usage and Reading Outcomes.

		(1)	(2)	(3)	(4)
		Coef	t-stat	Coef	t-stat
Uses online social networks:±	Once or twice a month	-12.3***	[-2.64]	-12.4***	[-2.68]
	Once or twice a week	-14.8***	[-4.22]	-15.4***	[-4.44]
	Almost every day	-13.8***	[-4.65]	-14.3***	[-4.76]
	Every day	-16.1***	[-5.60]	-17.1***	[-5.97]
Plays online games:±	Once or twice a month	0.95	[0.50]	1.71	[0.90]
	Once or twice a week	8.45***	[4.59]	8.46***	[4.54]
	Almost every day	14.9***	[6.68]	14.8***	[6.58]
	Every day	9.83***	[3.60]	10.2***	[3.73]
Use of Internet for school:±	Once or twice a month	23.7***	[5.45]	24.7***	[5.67]
	Once or twice a week	32.3***	[8.52]	33.8***	[8.78]
	Almost every day	31.3***	[8.21]	32.9***	[8.51]
	Every day	25.3***	[6.07]	27.6***	[6.54]
	Used Internet before 10 years old	4.30***	[3.00]	4.76***	[3.29]
	Age	-1.66	[-0.55]	-2.42	[-0.79]
	Girl	33.1***	[18.9]	33.0***	[19.0]
	Indigenous	-27.6***	[-10.9]	-28.9***	[-11.5]
	Recent migrant	-5.86*	[-1.65]	-4.63	[-1.30]
	English not spoken at home	-16.6***	[-5.63]	-15.8***	[-5.33]
	Late to school	-9.55***	[-9.77]	-9.44***	[-9.63]
	Skipped school	-10.6***	[-9.33]	-10.9***	[-9.71]

Skipped class	-5.58***	[-3.80]	-5.60***	[-3.83]
Repeated a year	-23.2***	[-7.67]	-23.0***	[-7.59]
Homework	1.74***	[12.3]	1.76***	[12.6]
Wealth	-4.49***	[-9.23]	-4.28***	[-9.00]
Mother is unemployed	-16.7***	[-4.25]		
Mother works full time	-0.086	[-0.04]		
Mother works part time	9.16***	[4.26]		
Father is unemployed	2.19	[0.48]		
Father works full time	6.05**	[2.29]		
Father works part time	10.6***	[2.90]		
Mother is high-skilled			7.72***	[3.63]
Mother is semi-skilled			15.9***	[10.7]
Father is high-skilled			16.1***	[8.75]
Father is semi-skilled			24.2***	[13.3]
Mother ISCED classification	4.18***	[8.18]		
Father ISCED classification	5.88***	[11.5]		
Mother lives at home	16.6***	[4.38]	17.9***	[4.78]
Father lives at home	13.0***	[6.21]	12.9***	[6.18]
Siblings live at home	8.23***	[3.82]	9.46***	[4.40]
Constant	260***	[5.37]	288***	[5.90]
School and grade FE?	Yes		Yes	
Observations	12,018		12,018	
R-squared	0.48		0.47	
Number of school-level clusters	772		772	

Notes: Robust t-statistics clustered at the school level in brackets. *, **, *** indicates 10%, 5% and 1% levels of statistical significance, respectively. ± The omitted category is 'never' uses the internet for this activity. Degrees of freedom are not included with t statistics because regression diagnostics are based on a Wald test, rather than the sums of squares. ISCED = International Standard Classification of Education.

Table 4. Internet Usage and Science Outcomes.

		(1)	(2)	(3)	(4)
		Coef	t-stat	Coef	t-stat
Uses online social networks:±					
	Once or twice a month	-11.5**	[-2.31]	-11.6**	[-2.36]
	Once or twice a week	-14.5***	[-3.82]	-15.2***	[-4.04]
	Almost every day	-14.5***	[-4.51]	-15.1***	[-4.64]
	Every day	-19.3***	[-6.15]	-20.4***	[-6.54]
Plays online games:±					
	Once or twice a month	2.30	[1.10]	3.08	[1.47]
	Once or twice a week	10.6***	[5.30]	10.6***	[5.28]
	Almost every day	17.5***	[7.14]	17.5***	[7.09]
	Every day	12.4***	[4.21]	12.8***	[4.33]
Use of Internet for school:±					
	Once or twice a month	21.0***	[4.52]	21.9***	[4.73]
	Once or twice a week	30.9***	[7.58]	32.4***	[7.88]
	Almost every day	30.5***	[7.41]	32.1***	[7.76]
	Every day	25.5***	[5.72]	27.8***	[6.21]
	Used internet before 10 years old	7.93***	[5.12]	8.37***	[5.35]
	Age	-0.43	[-0.13]	-1.23	[-0.38]
	Girl	-4.75***	[-2.59]	-5.00***	[-2.75]
	Indigenous	-30.0***	[-11.2]	-31.3***	[-11.8]
	Recent migrant	-12.8***	[-3.34]	-11.4***	[-3.00]
	English not spoken at home	-19.5***	[-6.23]	-18.7***	[-5.96]
	Late to school	-10.3***	[-9.84]	-10.2***	[-9.74]

Skipped school	-11.4***	[-9.45]	-11.7***	[-9.76]
Skipped class	-8.13***	[-5.10]	-8.17***	[-5.15]
Repeated a year	-26.4***	[-8.26]	-26.2***	[-8.16]
Homework	1.64***	[11.0]	1.67***	[11.2]
Wealth	-4.74***	[-9.08]	-4.58***	[-8.94]
Mother is unemployed	-13.6***	[-3.26]		
Mother works full time	-0.61	[-0.29]		
Mother works part time	8.92***	[3.79]		
Father is unemployed	0.39	[0.080]		
Father works full time	4.19	[1.52]		
Father works part time	5.85	[1.52]		
Mother is high-skilled			9.00***	[3.84]
Mother is semi-skilled			18.0***	[11.1]
Father is high-skilled			16.9***	[8.53]
Father is semi-skilled			25.2***	[12.8]
Mother ISCED classification	5.33***	[9.54]		
Father ISCED classification	5.52***	[9.93]		
Mother lives at home	18.6***	[4.70]	19.8***	[5.06]
Father lives at home	12.0***	[5.35]	11.6***	[5.19]
Siblings live at home	4.72**	[2.03]	6.01***	[2.58]
Constant	301***	[5.81]	325***	[6.23]
School and grade FE?	Yes		Yes	
Observations	12,018		12,018	
R-squared	0.43		0.43	
Number of school-level clusters	772		772	

Notes: Robust t-statistics clustered at the school level in brackets. *, **, *** indicates 10%, 5% and 1% levels of statistical significance, respectively.± The omitted category is 'never' uses the internet for this activity. Degrees of freedom are not included with t statistics because regression diagnostics are based on a Wald test, rather than the sums of squares. ISCED = International Standard Classification of Education.

Discussion

PISA tests are developed to examine a student's capacity to apply things learned via the formal educational curriculum to real-world problems; however, the real world for many young people has become increasingly virtual. This study concerned how educational attainment may be affected by children's leisure activities online. Namely, I asked whether teenagers' use of social networks and video gaming lowers their capacity to retain and apply information learned in school.

Previous studies addressing this issue have focused solely on either online social networking or gaming, but not both issues simultaneously. Moreover, previous work has not considered other key determinants of academic success when addressing the aforementioned nexus. That is, previous work suffers from omitted variable bias, which leads to over- or underestimation of the effect of one of the specified factors. In this study, I adopted a multinomial regression strategy that addressed these considerations. Therefore, this article reveals the relationship between Australian teenagers' online use and academic performance after controlling for important determinants of the latter.

Overall, using tests results for 15-year-old children in Australia, the analysis reveals that children who regularly use online social networks, such as Facebook, tend to obtain lower scores in math, reading, and science than students who never or hardly ever use these sites. Conversely, the analysis shows that those students who play online video games obtain higher scores on PISA tests, all other things being equal. It is argued that social networks have a high opportunity cost of study. Although this may also be true of video games, gameplay appears to equip students to apply and sharpen knowledge learned in school by requiring them to solve a series of puzzles before moving to the next game level.

Should we advocate that parents stop their children accessing Facebook and online chatting and force them to play video games? On the margin, playing video games and limiting online social network activities should have some positive effect on performance, at least on generalized tests such as PISA. Nevertheless, parents and teachers should be aware that there is some evidence that online gaming, particularly violent video games, may be detrimental. For instance, Greitemeyer and Mügge (2014) found that children who play violent video games are more likely to become violent later in life. Even so, based on the results discussed in this study, the potential for online games to positively impact adolescents' math, reading, and science skills seems worthy of further research. Therefore, it is important for schools, parents, and, perhaps, government to invest in research to uncover the different ways by which children learn from online games to inform teaching practices and curricula.

Given that 78% of children in the sample used online social networks almost every day or every day, schools could be more proactive in the use of these networks for teaching-related activities. Many subjects, for example, already have Facebook pages; perhaps, this approach could be useful for encouraging those students who are actively using social media to use it for educational purposes. Schools could also continue using video games for teaching activities; possibly using popular online games (some of which can be found or promoted through Facebook) in more innovative ways may prove useful.

Furthermore, the evidence suggests that schools should encourage children to use the Internet for homework, as this has been found to have a positive effect on academic achievement.

Nevertheless, the most important step that schools (and government) can take is to address the main drivers of educational underperformance. According to the results in this study, repeating an academic year can have a significantly larger effect on educational attainment than, say, using social networks. Furthermore, the results also reveal that skipping school every day is approximately twice as bad for performance as using Facebook or chatting on a daily basis. Accordingly, schools should prioritize helping children who have repeated an academic year. Tutoring and counseling programs, at the school or district level, could support such students. In addition, monitoring, counseling, and tutoring at-risk students, for example, those who frequently skip class or school, may prevent the need for a child to repeat a year.

Finally, the results indicate that belonging to a minority ethnicity and/or linguistic group was a major determinant of underperformance among this sample of 15-year-old Australian students. Tutoring programs for children with a non–English-speaking background, including English-as-a-second-language support, may prove useful. Importantly, the results also show that being an indigenous Australian is associated with a statistically larger impact on academic achievement in science, reading, and math than failing an academic year. The Australian government has taken a number of steps toward addressing the educational gap faced by indigenous Australians. For example, under the government's National Indigenous Reform Agreement, it allocates funds to assist schools in the provision of additional support for indigenous students, supports boarding students from remote and very remote areas, and provides targeted literacy programs aimed at children in remote primary schools (Department of Education and Training, 2015). However, the results of this study suggest that more needs to be done to ensure that schools in locations such as the Northern Territory, which has a very large proportion of indigenous Australians, can support their students in achieving better results. It is of crucial importance that future research evaluates existing policy initiatives to propose new evidence-based policy directions that can support more indigenous children, achieving better results in terms of their broader community contemporaries and at least an average performance in relation to the international PISA study.

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