PAPER

Title: Are TV and videogames actually affecting children's academic achievement?

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Abstract: *(minimum 300 words)*

There is a common belief that the time that students spend watching TV and playing videogames is harmful for their academic achievement. Nevertheless, besides from this intuition, there is scarce empirical research in this issue; furthermore, most evidence seems correlational. In this context, the current research intends to get as close as possible to a causal effect of the time that students spend watching TV and playing videogames on their academic progression (from primary to secondary education). To do this, we employ rich census and longitudinal data for the region of Andalusia. Our results have shown that the time students spend with TV and videogames does not seem to affect their academic progression, what drives to many policy interventions.

Keywords: *(maximum 6 words) TV, videogames, academic achievement, students' progression*
JEL codes: I21, I25

1. Introduction

We are living in an age in which screens are occupying most of our free time through some sedentary activities we can do at home as, e.g., watching TV, using the mobile phones, playing videogames. This sedentary lifestyle not only affects population's health and ways of life, but also their performance when working or studying. Furthermore, these activities, compared to other hobbies, are likely to become some kind of addiction (Kubey, Csikszentmihalyi, 2002, for the case of TV; or Griffiths, & Meredith, 2009, for videogames). In this sense, the current research focuses on their impact on education and intends to disentangle to what extent the time that students spend, concretely, watching TV or playing videogames, affects their academic progression, understanding this progression in terms of academic achievement. Following Nakamuro, Inui, Senoh, and Hiromatsu (2014), "while much is known about the cross-sectional relationship between TV or video games and children's development, little is known about how children who actually spend more time in front of TV or video games would have developed if they had spent less time doing so." (p. 30); this is where this research puts its attention on, trying to get as close as possible to a causal effect of these activities on students' progression, as we will see.

Particularly, the focus of this research has been placed in the Spanish region of Andalusia, which possesses many characteristics which make its analysis of special interest. First of all, it is the largest populated region in Spain and one of the worst performers in international large-scale assessment tests. Concretely, Andalusia obtained scores which were 11 points below the Spanish average and 19 below the OECD average (OECD, 2014a). In addition, Andalusia has very high dropout rates, i.e., students who dropped their studies before completing compulsory education: around 29% in 2012 (IECA, 2018). Andalusia also presents one of the highest repetition rates of Spanish regions and higher than the average of Spain and the OECD in PISA 2012 (11% of students repeated two courses, while 27% repeated only one course, for a total repetition rate of 38%; OECD, 2014b).

This research is novel for the Spanish case as it uses longitudinal and census data, which is very difficult to obtain for Spain; to the best of our knowledge, this is the first time that the effect of TV and videogames on students' academic achievement has

been studied for the Spanish case using data of these characteristics. This data let us employ time fixed effects, which lets to avoid a potential bias of our results due to endogeneity and/or variable omission and get as close as possible to a causal effect.

This research is structured as follows: first, a literature review on the effect that TV and videogames have on students' academic achievement has been performed; then, the data under analysis and the methodology employed for the current analysis are explained. After that, the results of the current research are presented, finishing with some conclusions and policy implications derived from our results.

2. Literature review

2.1. TV and students' academic achievement

The effect of TV on students' academic achievement has been analysed by many researchers, and it seems to be almost a general consensus in the negative effect that this activity has on students' performance. In this sense, Dumais (2008) studied longitudinal data for American students and indicated that students from low socio-economic backgrounds are more likely to engage in activities as watching TV and, hence, getting lower academic achievement. Other authors as Shin (2004) analysed longitudinal data on Michigan primary school students, finding that students who watch TV tend to spend less time doing homework, studying or reading for leisure, becoming more impulsive and obtaining lower scores at school. Sharif, Wills, and Sargent (2010) also performed a longitudinal study for primary and secondary education United States students and found that TV watching had negative effects on students' performance through school behaviour problems. Ennemoser and Schneider (2007) also supported this result; they analysed 2 cohort-longitudinal data on kindergarten and primary education students, finding that those students who were classified as "heavy" TV viewers progressed less in reading than "medium" and "light" TV viewers. Going further than this negative effect on students' performance Landhuis, Poulton, Welch, and Hancox (2018) performed a longitudinal research on New Zealand primary education students, finding that TV viewing is positively associated with attention problems in adolescence, being these negative effects, then, long-lasting.

On the other hand, another strand of the literature bets for a neutral or positive to negative effect (when students abuse of TV watching). In this field, Nakamuro, Inui, Senoh, and Hiromatsu (2014) employed longitudinal data to analyse the effect that TV time has on Japanese children's problem behaviour, orientation to school and obesity. They found that, although positive, the effect of TV watching on these variables is so low that it could be considered negligible. Haapala, Poikkeus, Kukkonen-Harjula, Tompuri, Lintu, Väistö, Leppänen, Laaksonen, Lindi, and Lakka (2014) analysed the effect of sedentary activities, as TV watching, on primary education students' academic achievement in Finland through grades 1 to 3, finding that this particular activity did not affect students' performance. Razel (2001) performed a meta-analysis on six studies for around 1 million students with an international focus and formulated a complex model on the effect of TV on academic achievement; they found that small amount of TV watching increased students' academic achievement but, when this TV time increased until a certain point, it was harmful for students' performance.

Hence, as it could be appreciated, there is plenty of international and longitudinal research on this issue which provides quite mixed results. Nevertheless, to the best of our knowledge, this is the first time that longitudinal census data has been employed to analyse the effect of TV watching on Spanish students' academic progression, overcoming correlational studies for this country and filling the gap in the literature.

2.2. Videogames and students' academic achievement

As it happens with TV viewing, most of the videogame research – general videogame research, not that focused on educative videogames – highlights that the time spent by students on this activities can have a negative impact on their academic results. In this subject, Weis and Cerankosky (2010) performed a randomised controlled trial on boys and found that their reading and writing skills were harmed by this activity. Jackson, von Eye, Witt, Zhao, and Fitzgerald (2011) performed a longitudinal study and found for 12-year-old American students that videogame playing was associated with a higher visual-spatial skill, but also with lower academic achievement; they amplified their research for the same age children to study the impact of videogames on Body Mass Index and body weight (Jackson, von Eye, Fitzgerald, Witt,

& Zhao, 2011), finding that videogames only decreased academic achievement for older children and those from low income households. Dumais (2008) also analysed longitudinal data for American students and found that students from low socio-economic background are more likely to play videogames and, then, get lower academic achievement. In the case of Asian countries, Yeh, and Cheng (2016) found for 11-14 Taiwanese students that playing videogames was negatively correlated with academic achievement and that parental interventions trying to avoid these practices did not improve students' performance. Other authors as McCoy, Byrne, and Banks (2012) studied longitudinal data on primary school students in Ireland, finding that videogames were negative for students' engagement, and particularly for boys.

Another strand of the literature states that academic achievement is not harmed by this videogame time, but positively or neutrally affected. In the case of a positive effect, Adachi and Willoughby (2013) found that Canadian students were benefited by certain types of videogames (role playing and strategy games), which increased students' problem solving skills and academic achievement. Sedeño (2010) also highlighted that videogames and their different types can develop certain student skills, so they are relevant for the teaching-learning process. Other authors as Haapala, Poikkeus, Kukkonen-Harjula, Tompuri, Lintu, Väistö, Leppänen, Laaksonen, Lindi, and Lakka (2014) analysed the effect of videogames on primary education students' academic achievement in Finland through grades 1 to 3, finding that it increased boys' arithmetic skills. Kovess-Masfety, Keyes, Hamilton, Hanson, Bitfoi, Golitz, Koç, Kuijpers, Lesinskiene, Mihova, Otten, Fermanian, and Pez (2016) studied five European countries and found that primary education students were benefited by playing videogames in the sense of mental health, intellectual functioning and academic achievement. Young, Slota, Cutter, Jalette, Mullin, Lai, Simeoni, Tran, and Yukhymenko (2012) performed a meta-analysis of more than 300 research papers finding that videogames had a positive effect on language learning, history and physical education, but little academic value in mathematics and science. Some interesting research which found a neutral effect of videogames on students' academic achievement, in an international context, is that of Drummond and Sauer (2014), who found for 22 countries participating in PISA 2009 that videogame had little impact on

their academic achievement in reading, mathematics and science. For Asian countries, Nakamuro, Inui, Senoh, and Hiromatsu (2014) used Japanese longitudinal data and found that videogames affected in a very low amount children's problem behaviour, orientation to school and obesity.

In the context of the previous research, the current study presents the novelty that, to the best of our knowledge, this is the first time that census and longitudinal data has been used to study this videogame issue for Spain; this lets to reach conclusions which go further from correlational ones and, hence, fill this gap in the literature.

3. Data

In this research census and longitudinal data provided by the *Agencia Andaluza de Evaluación Educativa* (AGAEVE) of the *Consejería de Educación* – Junta de Andalucía – has been employed. Particularly, this dataset was obtained from the Diagnostic Assessment (*Evaluación de Diagnóstico*, DA, from now on[1]) for the whole population of Andalusian students in a particular course, and it was conducted with an annual basis. The objective of this assessment was to improve the knowledge of students and their learning in the Andalusian education system; in order to achieve this, students' basic curricular competences were evaluated.

This research is focused on the 2008-09, 2011-12 and 2012-13 DA waves. Concretely, we analysed those students who were in 5th course of primary education (5th grade) in the course 2008-09 and followed them in the course 2011-12, when they were in the 2nd course of secondary education (8th grade). The 8th grade 2012-13 data was used to follow those students who repeated between the course 2008-09 and 2011-12, so

[1] This DA was regulated in the education law which was applicable for the courses under analysis (*Ley Orgánica 2/2006, de 3 de mayo, de Educación* – LOE; BOE, 2006, art. 21, for the conduction of these DA in primary education; art. 29, for secondary education and art. 144 for the competences that Administrations have in this DA).

they will appear in 2012-13[2]. From the 78,413 5th grade Andalusian students in 2008-09, a total of 70,131 of them can be followed in 8th grade. The current research focuses on the competences of linguistic communication[3] in Spanish language ("reading", from now on) and mathematics reasoning[4] (mathematics, from now on). Students' scores in these competences have been standardised[5] to have mean 0 and standard deviation 1 to make their interpretation easier.

The information contained in this dataset also included contextual questionnaires about students, families, schools and teachers. Particularly, the 5th and 8th student questionnaires contained these questions, which are the focus of our analysis: "Approximately, how much time do you spend, out of school, doing these activities": "Watching TV (videos, DVD)" and "Playing videogames or computer games". Students can answer to each one of these two activities one of the following answers: "no time", "until 1 hour", "1 to 3 hours", "3 to 5 hours" or "5 hours or more".

4. Methodology

[2] Repeater students were identified, firstly, by following the applicable Spanish education law for the previous courses to 2008/09 – *Ley Orgánica 10/2002, de 23 de diciembre, de Calidad de la Educación*, i.e., LOCE (BOE, 2002), from 2002 to 2006. According to this law, students can only repeat once in primary education (BOE, 2002, art. 17.3). The following education law, *Ley Orgánica 2/2006, de 3 de mayo, de Educación*, i.e., LOE (BOE, 2006) also highlighted this (BOE, 2006, art. 20.2) and lasted from 2006 to 2013.

[3] This competence is defined as "the use of language as an instrument of oral and written communication, of presentation, interpretation and comprehension of reality; to construct and communicate the knowledge, to organize and to auto-regulate thinking, emotions and behaviour" (AGAEVE, 2009, p. 7).

[4] This competence is defined as "the ability to use and relate numbers, their basic operations, symbols and expression forms and mathematic reasoning, to produce and interpret different types of information and to increase knowledge on quantitative and spatial aspects of reality and to solve problems related to daily life and to the labour world" (AGAEVE, 2009, p. 7).

[5] With the objective of interpreting the results' section, we provide here the mean and standard deviation of the population in each subject and course used to standardize students' scores: in 2008-09 the mean score in reading (mathematics in brackets) was 68.14 (48.92) with a standard deviation of 17.21 (12.74); in 2011-12, the mean score in reading was 78.92 (39.75) with a standard deviation of 18.38 (11.50); in 2012-13, the mean score in reading was 70.24 (40.78) with a standard deviation of 18.44 (11.92).

This research relies on an identification strategy based on the use of time fixed effects to get the effect of TV and videogames on students' progression between primary and secondary education. This method lets to account for those characteristics which are the same within-students between-years – for example, socio-economic characteristics, sex, etc. – and obtain the effect of TV and videogames on students' progression from primary to secondary education.

We depart from the definition of an education production function to explain the effect of watching TV and playing videogames on students' academic achievement for panel data:

$$Y_{ijt} = \alpha + \beta TV_{ijt} + \gamma X_{ijt} + \delta SC_{jt} + \varepsilon_{ijt} \quad (1)$$

$$Y_{ijt} = \alpha + \delta Vid_{ijt} + \gamma X_{ijt} + \delta SC_{jt} + \varepsilon_{ijt} \quad (2)$$

where i is the student, j the school and t the grade ($t = 0$ in 5th grade and $t = 1$ in 8th grade).

Y_{ijt} are students' scores in reading or mathematics; TV_{ijt} is the time that students spend watching TV; Vid_{ijt} is the time that students spend playing videogames; X_{ijt} are those student observable characteristics which are the same between-years; SC_{jt} are school characteristics which are the same between-years; ε_{ijt} is the idiosyncratic error term.

We obtain our base models when estimating these education production functions by the use of time fixed effects. If we define t_0 for 5th grade data and t_1 for 8th grade data, eliminating the sub-indexes of equation (1) and (2) and applying differences between years, our base models are defined as:

$$Y_{ijt_1} - Y_{ijt_0} = \Delta Y = \beta \Delta TV + \gamma \Delta X + \delta \Delta SC + \Delta \varepsilon \quad (3)$$

$$Y_{ijt_1} - Y_{ijt_0} = \Delta Y = \delta \Delta Vid + \gamma \Delta X + \delta \Delta SC + \Delta \varepsilon \quad (4)$$

The X and SC characteristics are the same between-years, so their differences are zero, letting us obtain the effect of TV (β) and videogames (δ) on students' academic achievement. In addition, school dummy variables have been included in models (3) and (4) in order to account for the variation in students' academic achievement due to students changing school – around 75% of students changed school

between primary and secondary education, because most primary schools in Andalusia do not offer both primary and secondary education. Furthermore, a year dummy control has been added to both models (3) and (4) to capture the variation in students' academic achievement between years which is not caused by TV or videogames (alternatively) as, e.g., the change in subject difficulty between the two grades.

This identification strategy builds upon an important requirement of the variables under analysis: particularly, we need that TV and videogame variables present enough variability between both grades. The fact that we are exploring a period of time which supposes the transition between primary and secondary education could, in some way, assure us a certain variation in these variables, as students may have to change the distribution of their out-of-school time use due, e.g., to higher time on homework tasks when reaching secondary education. In relation to this, our data indicates that around 77% of students changed their time watching TV between 5th and 8th grade and 85% in the case of playing videogames, what assures enough variability to support our results. One additional requirement is that TV and videogame variables have to be measured before they influence students' progression, what lets to avoid temporal asymmetry between the dependent and independent variables (Trusty, Plata, & Salazar, 2003). In the case of our data this happens, as students are tested after they have performed the TV and videogames activities they report.

5. Results

In the following, we analyse the effect of TV and videogames on students' progression using the models proposed in the previous section. Beginning with the effect of these activities on our first measurement of students' progression, i.e., students' academic achievement, the results of this analysis are presented in Table 1.a. for watching TV and Table 1.b. for playing videogames. Two different specifications have been defined for each one of the two variables: specification I, in which the corresponding variable is presented in its original categorical form and specification II,

in which it has been translated into a quasi-continuous variable[6]. Our main results in specification I for time fixed effects (FE) show, for both activities, that until one hour of them may increase students' academic achievement between 0 and 0.050 standard deviations but, while this time increases, the effect becomes zero and even negative for the highest amounts of time (in a range of 0.039 and 0.099 for the highest number of hours in these activities). This shows that the time devoted to these activities presents a decreasing effect on students' academic achievement, departing from a positive effect to a negative one (as found by Razel, 2001, for the case of TV viewing). As it can be appreciated from specification II, this positive effect of a little time in these activities cannot be captured when defining these variables in a quasi-continuous form.

When these models are estimated by the use of ordinary least squares (OLS) we can see a similar trend in the effect of TV and videogame time, but the quantity of the effects is higher, most likely due to the biasing effect of omitted time-invariant variables, which are controlled by when using time fixed effects.

[6] The values in hours which have been assigned to create this quasi-continuous variable have been the class marks for each one of the categories in TV and videogame variables: 0 hours for "no time", 0.5 hours for "until 1 hour", 2 hours for "1 to 3 hours", 4 hours for "3 to 5 hours" and 6 hours for "5 hours or more".

Table 1.a. The effect of time devoted to watch TV (videos, DVD) on students' academic achievement

	Specification I				Specification II			
	Reading		Mathematics		Reading		Mathematics	
Variables	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Time devoted to watch TV (videos, DVD) each day (Ref.: no time)								
5 hours or more	-0.067***	-0.077***	-0.109***	-0.039***				
	(0.017)	(0.015)	(0.017)	(0.015)				
3 to 5 hours	0.142***	-0.008	0.100***	0.028**				
	(0.014)	(0.013)	(0.014)	(0.013)				
1 to 3 hours	0.266***	0.031**	0.267***	0.037***				
	(0.014)	(0.013)	(0.014)	(0.013)				
Until 1 hour	0.205***	0.036***	0.191***	0.050***				
	(0.014)	(0.014)	(0.015)	(0.013)				
Time devoted to watch TV (videos, DVD) each day (quasi-continuous variable in hours)					-0.027***	-0.014***	-0.035***	-0.008***
					(0.002)	(0.002)	(0.002)	(0.002)
8th Grade (Ref.: 5th Grade)	0.120***	0.165***	0.150***	0.217***	0.140***	0.168***	0.173***	0.219***
	(0.010)	(0.008)	(0.010)	(0.008)	(0.010)	(0.008)	(0.010)	(0.008)
School dummies	✓	✓	✓	✓	✓	✓	✓	✓
Constant	-0.630***	-0.980**	-0.959***	-0.727	-0.388***	-0.940**	-0.695***	-0.682
	(0.146)	(0.415)	(0.157)	(0.475)	(0.146)	(0.412)	(0.159)	(0.477)
Observations	94,632	94,632	94,834	94,834	94,632	94,632	94,834	94,834

Notes: Standard errors are in parentheses and robust. The thick (✓) means that a dummy for each school has been included.
Estimation method: Ordinary Least Squares (OLS) and Time Fixed Effects (FE).
Dependent variable: Standardised scores using the mean and standard deviations of the total population for that particular DA cycle.
Coefficient: ***Significant at 1%, ** significant at 5%, * significant at 10%.
Source: Authors' own calculations.

Table 1.b. The effect of time devoted to play videogames or computer games on students' academic achievement

	Specification I				Specification II			
	Reading		Mathematics		Reading		Mathematics	
Variables	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Time devoted to play videogames or computer games each day (Ref.: no time)								
5 hours or more	-0.137***	-0.099***	-0.142***	-0.066***				
	(0.012)	(0.010)	(0.012)	(0.010)				
3 to 5 hours	0.025**	-0.050***	0.071***	-0.014*				
	(0.010)	(0.009)	(0.010)	(0.009)				
1 to 3 hours	0.048***	-0.017*	0.152***	-0.002				
	(0.010)	(0.009)	(0.010)	(0.009)				
Until 1 hour	0.027***	0.009	0.099***	0.024***				
	(0.010)	(0.009)	(0.010)	(0.009)				
Time devoted to play videogames or computer games each day (quasi-continuous variable in hours)					-0.019***	-0.017***	-0.025***	-0.011***
					(0.002)	(0.001)	(0.002)	(0.001)
8th Grade (Ref.: 5th Grade)	0.150***	0.153***	0.183***	0.211***	0.135***	0.152***	0.168***	0.209***
	(0.010)	(0.008)	(0.011)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)
School dummies	✓	✓	✓	✓	✓	✓	✓	✓
Constant	-0.417***	-0.279	-0.723***	-0.005	-0.363**	-0.246	-0.608***	0.045
	(0.152)	(0.236)	(0.178)	(0.500)	(0.153)	(0.237)	(0.182)	(0.502)
Observations	94,872	94,872	95,092	95,092	94,872	94,872	95,092	95,092

Notes: Standard errors are in parentheses and robust. The thick (✓) means that a dummy for each school has been included.
Estimation method: Ordinary Least Squares (OLS) and Time Fixed Effects (FE).
Dependent variable: Standardised scores using the mean and standard deviations of the total population for that particular DA cycle.
Coefficient: ***Significant at 1%, ** significant at 5%, * significant at 10%.
Source: Authors' own calculations.

6. Conclusions

The current research has focused on analysing the effect that watching TV and playing videogames could have on Andalusian students' progression, particularly measured by students' academic achievement. Our main results show that TV and videogames seem to have a positive effect when students devote a moderate amount of time to them, but a negative one when these activities take a lot of their daytime.

These results could be showing that, to the extent that these practices are used by students as a way of "distraction" from school or as a "hobby", i.e., activities in which they devote a few hours of their free time after school, they are not harmful for their academic progression. Nevertheless, when these activities become more like an "obsession" than a hobby, students may see their performance reduced.

Building on these results, it seems that students may be benefited for devoting a moderate amount of time to these activities, so policies related to controlling this time that students spend on them may be advisable. In this sense, informing parents at school on this issue is of vital importance, to the extent that they can regulate the time that their children spend on these activities. Furthermore, students should be advised on this issue also, as they should get enough autonomy to organise their time.

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