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THE TOYS THAT MADE US: THE ROLE OF GAME IN GENDER GAPS

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Title: The toys that made us: The role of game in gender gaps

Abstract: Early gender gaps condition future educational decisions and labor market and social outcomes. There is extensive evidence reporting the existence of significant gender gaps in mathematical and scientific competencies at age 15. It has been suggested these patterns may explain why men tend to make a clean sweep on STEM careers. This has led to a debate on which factors may be driving gender gaps in educational outcomes. While some authors point to the existence of differences in psychological traits by gender, others focus on external factors, such as socioeconomic characteristics, parental values and educational trajectories. Another factor which is sometimes claimed to be a relevant determinant of the gender gap in performance are socially determined gender roles. Evidence on this last point has been however rarely tested. In this paper we shed light on this issue. We do so by exploring the relationship between the use of leisure time in science-related activities at early ages and the emergence of gender gaps in performance and career expectations at age 15. We take advantage of intra and across country variation for a set of countries. Results show that game patterns at early ages are decisive for explaining gender gaps in performance. Boys have a higher likelihood of playing brick games when they are at preschool, as well as several science related activities at age 10. More time spent in science-related leisure activities influences performance in grade 4 and at age 15, and, in turn, STEM expectations. In this sense, childhood play patterns contribute to explaining gender gaps in mathematics and science achievement, as well as in STEM expectations. Gender-differentiated play dynamics from an early age can explain the widening of gender gaps several grades later. These results contribute to identifying how certain play practices and leisure activities in childhood may eventually bias mathematics and science achievement and preferences between girls and boys. The implications for an education policy committed to equal educational opportunities are discussed.

JEL Codes: I24, J16, J24, I21.

Keywords: STEM, gender gap, game, academic performance.

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Introduction

Despite decades of reversal of most gender gaps in educational attainment (Buchmann & DiPrete, 2006), gender gaps to the detriment of girls in maths -and, to a lesser extent, science- performance are a persistent problem in our societies (Breda et al., 2018; Gevrek et al., 2020). Gender gaps in maths and science performance have consequences for societal gender equality, as early performance inequalities are the root of future disparities in STEM choice (Sheldrake et al., 2015; Watt et al., 2017; Holmes et al., 2018) that lead to gender segregation in the labour markets (Weeden et al., 2020).

Gender gaps in maths performance emerge at an early age and tend to widen throughout school years (Fryer & Levitt, 2010; Lindberg et al., 2010). On average, at age 15 girls perform significantly lower than boys in maths in half of the 84 participant countries in PISA, while only have a better performance in maths in 17 countries (OECD, 2023). In the US context, despite boys and girls perform equally when starting primary school, a gender gap of nearly 0.2SD emerges in the first six years of compulsory schooling (Fryer & Levitt, 2010). Globally, the effect size of the boys-girls difference in maths performance is small (Hyde et al., 2008; Else-Quest et al., 2010; Lindberg et al., 2010). However, there is a wide variation across cultural contexts (Guiso et al., 2008; Nollenberger et al., 2016, Breda et al., 2018; Gevrek et al., 2020).

Several explanations have been proposed for the emergence of gender differences in mathematics and science achievement, feeding the so-called ‘nature vs nurture’ debate. Early explanations for the gender gaps in maths performance and STEM choice were based on sex differences in spatial abilities, assumed as an innate condition resulting from prenatal hormonal exposure (Kimura, 2002) or different brain anatomy (Baron-Cohen, 2003). However, the circular relationship between social experience and brain structures makes it difficult to establish causal links between brain differences and educational outcomes such as success in mathematics or STEM choice (Halpern et al., 2007). Other approaches have emphasised the influence of social processes in creating gender differences in performance and educational trajectories (Eccles, 1994; Bussey & Bandura, 1999; Eagly & Wood, 1999). These perspectives focus on the role of ‘nurture’, highlighting the way in which differential socialisation between boys and girls is at the root of gender differences in mathematics achievement. The extent to which gender may bias the socialisation and educational experiences of boys and girls varies across social contexts, depending on socio-cultural factors (Baker and Jones, 1993; Breda et al., 2018), such as widely shared beliefs about gender, which can explain differences in the magnitude of gender gaps in mathematics achievement (Nollenberger et al., 2016; Gevrek et al., 2020).

Cultural factors are shared values, beliefs, practices, and norms that shape the behaviour and attitudes of individuals within a particular society or group (Hofstede, 2001) and may emerge as a source of gender inequalities in the acquisition of skills (Nollemberger et al., 2016; Davila Dos Santos et al., 2022). According to Hofstede (2001), culture has several dimensions, such as uncertainty avoidance, power distance, individualism vs. collectivism, masculinity vs. femininity, long-term vs. short-term orientation, and indulgence vs. restraint. These dimensions determine differences in attitudes and behaviours across societies. Hofstede (2001) argues that adults carry “mental programmes” which are developed at home during early childhood and reinforced through formal schooling. These “mental programmes” would contain a component of thar society’s culture.

In this sense, families can play a role in perpetuating gendered maths stereotypes (Nicoletti et al., 2022) and, in turn, gender gaps in children's maths attitudes and performance (Gunderson et al., 2012). From an early age, family investments of time in learning activities with their children have been found to be gender-biased. Families tend to spend significantly more time on learning activities, particularly reading-related activities, with their daughters (Baker and Milligan, 2016; Chuan et al., 2022), which in turn may favour girls' acquisition of vocabulary and verbal skills. No differential time investments in favour of boys have been found in family teaching activities related to mathematics (Baker and Milligan, 2016). However, as we will suggest, some gender-biased leisure activities might explain the boys' advantage in maths.

Game and the use of leisure time of children are thus affected by the country's culture (Roopnarine et al., 1994). Different weights to the importance of individuality, social power structures or, importantly for this study, gender roles, modify the use of leisure time of children (Gracia et al., 2021). There is plenty of evidence that shows the importance of leisure activities such as reading (Jürges and Khanam, 2021), learning music (Hille and Schupp, 2015) or practicing sports (Gorry, 2016) on the development of a set of competencies. In this paper we are interested in assessing the effects of science-related leisure activities at home on scientific competencies and STEM careers expectations. We thus exclude gamified learning and private tutoring activities. We hypothesise that gender gaps in the use of leisure time at home may partially explain gender gaps in STEM competencies and expectations. In fact, it is even possible that, even if the gender gap in the use of leisure time did not exist, the effects of science-related leisure time activities may exert heterogeneous effects across gender.

A well-studied type of leisure activity where gender gaps have been identified are videogames. The effect of playing videogames is controversial. Some authors, such as

Martinez et al. (2022), find that it can lead to improvements in academic performance, especially in language and science. Others, such as Hartanto et al. (2018) describe that playing videogames has a small detrimental effect on academic performance. Finally, Drummond and Sauer (2020), provide a more nuanced answer, finding that gameplay time after classes has a null effect on performance, while playing before classes has a small negative effect. Given the fact that, as Tak and Katsambis (2023) describe, boys play videogames more often than girls, the effect of gameplay on the gender gap in STEM areas will depend on the sign of the relationship. Hamlen (2010) states that the gender gap in the use of videogames may be related to the endogeneity of the increased feeling of success and achievement of boys -the more they play, the larger the reward-, and the existence of gender stereotypes that make girls remain away from videogames. Bustamante-Barreto et al. (2024) show that having a video game console does not only improve the performance in mathematical and scientific competencies but also helps to reduce the gender gap in STEM areas.

Brick games can be useful for enhancing, among others, social and communicative competencies (Lindsay et al., 2017; Owens et al.,2008), spatial skills (Casey et al., 2008) and mathematics (Schmitt et al., 2018). Block games have also been used as learning tools for STEM related activities such as robotics, due to their easiness in use and capacity of modifying STEM attitudes (Graffin et al., 2022). Shenouda and Danovitch (2014) provide evidence of the existence of a gender stereotypy in the use of brick games as early as age 4 and show its effect, by age 10, in the emergence of gender gaps in spatial tasks. Indeed, Reich et al. (2018) warn that some types of block games may be consolidating gender stereotypes, due to differential designs by children.

Regarding the effects of the use of science kits on academic performance in schools, the evidence is inconclusive (Slavin et al., 2014; Cheung et al., 2016). It is therefore complicated to forecast the effect of its use at home, given the concurrence of two additional factors: on the one hand, the possible enhanced motivation of those kids who use them, on the other hand, the lower support -compared to teachers- at home. It is easier to formulate a hypothesis for the case of reading science-related books at home. If reading at home has been shown to improve several competencies (Gao et al., 2018; Lee, 2014), we expect that reading science-related books at home should increase scientific competencies. It is especially important in both cases -science kits and science-related books- to consider possible reverse causality issues and the influence of parental STEM-oriented careers.

The contribution of this paper is threefold. First, we assess the relationship between science-related leisure time activities during childhood on mathematical and scientific competencies at age 15, as well as its effect on the expectations to follow STEM careers. Second, we analyse whether this use of leisure time may be affecting the gender gap in scientific and mathematical competencies by age 15. Finally, we explore the cross-country heterogeneity. This exercise provides a wider perspective on the importance of cultural differences on time use during childhood and its effect on the development of STEM careers.

Our results show that time spent in science-related leisure activities in childhood has a positive effect on performance and STEM preferences several grades later. Children who played brick games often when they were in preschool and at age 10 show significantly higher performance in mathematics and science in 4th grade and at age 15, respectively. Furthermore, the probability of spending time in science-related activities is unevenly distributed by social characteristics, such as gender (but also by parents' educational level, the language spoken at home or parental STEM occupation). Consequently, the latter emerges as a factor that may perpetuate inequalities. Boys are more likely to have played with blocks in preschool, indirectly enhancing their later performance in mathematics and science. Results by age 15 reinforce this conclusion, as having spent time in science-related activities at age 10 –boys being more prone to perform these activities- affects mathematics and scientific competencies and STEM expectations and, additionally, the effect of these leisure activities is especially strong for boys. We also find large heterogeneity across countries, this suggesting the strong links between game and cultural background and gender roles in society.

The remainder of the article is structured as follows. In the next section we present the methodology and data used in our analyses. Then, we display the main results and a discussion of their main implications. Finally, the paper closes with a conclusions section.

Methods

We assess the effect of science related activities on leisure time use at age 10 on a set of outcomes at age 15. This age choice is not chosen at random. While the gender gap in mathematical reasoning between the ages of 4 and 10 is not significant (Spelke, 2005), Machin and Pekkarinen (2008) and Borgonovi et al. (2021) have shown that this gap in numerical competencies widens importantly between ages 10 and 15. We gather this information from the OECD's PISA (Programme for International Students Assessment). Since 2000, PISA assesses every three years, the mathematics, science and reading competencies of 15-years-old students across a varying number of countries. These competencies are measured through a set of plausible variables with a mean initially set at 500 points and a standard deviation of 100.

We account for the clustering of children within schools by adjusting the standard errors using the STATA 'repest' command (Avvisati and Keslair, 2014). Replicate weights are applied throughout for scaling the sample to the total population and considering non-response. OECD (2016) provides an extended analysis of the structure of PISA. More specifically, we work with the 2015 wave as it is the only one to compile information on science-related leisure activities at age 10. We thus restricted our sample to the following 18 jurisdictions that provided this information: Belgium, Chile, Germany, Dominican Republic, Spain, France, Great Britain, Georgia, Hong Kong, Bosnia-Herzegovina, Ireland, Italy, Korea, Luxembourg, Macao, Mexico, Malta and Portugal.

We calculate a set of regressions where the dependent variable is the scientific competencies, numerical competencies and STEM career expectations of the teenager, respectively. The STEM career expectations are codified into a dummy variable using the ISCO codes provided by PISA. School fixed effects are applied throughout.

We first estimate a set of models (M1) where we only include as a control the type of leisure activity of the kid at age 10. These activities are: Playing science-related videogames; playing brick games; reading science-related books; and playing with science kits. These variables are coded into four categories, ranging from “very frequently” to “never”. We then incorporate (M2) individual and family level variables (Table 1) to M1. Importantly, we include whether the parents have a STEM occupation, which may affect the promotion of science-related leisure time activities, and participation in early childhood education, where children might have been exposed to these same activities. Anyway, while having lagged information on the use of leisure time at age 10 reduces the risk of reverse causality, it is true that endogeneity issues may have not been fully addressed by the introduction of the parental occupation variable.

Therefore, aiming to account for the potential endogeneity of leisure activities in determining mathematics and science performance, or in modifying STEM career expectations, we implemented an instrumental variable (IV) strategy, more specifically, a two-stage residual inclusion (2SRI) approach (Terza et al., 2008). In the first stage, we estimated a linear regression model in which three indicator variables corresponding to increasing levels of science-related leisure activity (sometimes, regularly, frequently) were regressed on a set of instrumental variables—regional-level (stratum-level) averages of science related leisure intensity—along with the covariates in model M2. The intuition behind our instrumental variable is that regional norms or peer environments influence how much an individual student devotes to science-related leisure activities, but do not directly affect that student's performance, except through their own science-related leisure activity. This makes it a plausible instrument: it's relevant (correlated with the individual science-related activity) and excludable (unlikely to influence outcomes directly). From this model, residuals were computed for each category at the individual level. Full results of the first-stage regressions are displayed in table A.1 in the appendix.

In the second stage, we estimated a linear probability model of mathematics performance that included the same science-related activities variables, the residuals from the first stage, and the full set of control variables. This specification allows for a direct test of endogeneity by assessing whether the first-stage residuals are significantly correlated with the outcome, conditional on the included instruments and controls.

The results indicate that none of the residual terms are statistically significant ($p > 0.01$), suggesting no evidence of endogeneity in the science-related leisure activities (appendix tables A.2). These findings support the validity of estimates obtained from models that do not explicitly correct for endogeneity. While the absence of statistical significance does not rule out endogeneity entirely—particularly in the presence of weak instruments or measurement error—the first-stage results confirm that the instruments are relevant, as they are significantly associated with the variables which measure the intensity in science-related activities. Moreover, the estimated coefficients on science-related leisure activities categories were qualitatively similar in models with and without endogeneity correction, further supporting the robustness of the main results.

Anyway, given the fact that an IV strategy does not completely exclude the possibility of endogeneity (Brodeur et al, 2020), we estimated a third specification of the model (M3), which provides lower bound estimates of the effect of science-related leisure time activities. We estimate a third model (M3), following Jerrim and Moss (2019), which adds performance in reading as a way of testing for robustness for unobserved confounding -assuming reading doesn't impact science or mathematics performance-. It is worth stating that in our sample the correlations between scientific and numerical competencies and the reading competency in PISA 2015 were 0.88 and 0.83, respectively. Table 1 provides the descriptive statistics for the pooled data. We finally recalculate M3, adding an interaction term between the sex and a frequent leisure activity variable for identifying heterogeneous effects by gender. We refer to this model as M4, which is calculated for the pooled sample and also at the country level.

Table 1. Descriptives

Variable	Mean	SD	Min.	Max.
Mathematics	467.29	100.52	25.35	863.90
Science	469.94	99.74	58.96	856.16
Reading	474.66	101.92	54.22	842.61

Dichotomous Variables	*% [0]*	*% [1]*
Gender: *Girl*	0.49	0.50
STEM career expectations: *1=yes*	0.20	0.40
At least one parent has a STEM background	0.09	0.28
Books at home: *0 to 10*	0.21	0.41
Books at home: *11 to 25*	0.18	0.39
Books at home: *26 to 100*	0.25	0.43
Books at home: *101 to 200*	0.14	0.35
Books at home: *more than 200*	0.18	0.38
Parental education:	0.01	0.12
Parental education:	0.05	0.22
Parental education:	0.16	0.37
Parental education: isced 3	0.05	0.22
Parental education: isced 4	0.22	0.41
Parental education: isced 5b	0.18	0.38
Parental education: isced 5a, 6	0.28	0.45
Played brick games at age 10: *very often*	0.17	0.38
Played brick games at age 10: *regularly*	0.29	0.46
Played brick games at age 10: *sometimes*	0.18	0.39
Played brick games at age 10: *never*	0.17	0.38
Used a science, electronics, or chemistry set: *very often*	0.42	0.49
Used a science, electronics, or chemistry set: *regularly*	0.30	0.46
Used a science, electronics, or chemistry set: *sometimes*	0.07	0.26
Used a science, electronics, or chemistry set: *never*	0.03	0.17
Played computer games with science content: *very often*	0.40	0.49
Played computer games with science content: *sometimes*	0.31	0.46
Played computer games with science content: *never*	0.08	0.27
Played computer games with science content: *very often*	0.04	0.19
Read science books at age 10: *very often*	0.32	0.47
Read science books at age 10*: regularly*	0.38	0.49
Read science books at age 10: *sometimes*	0.09	0.29
Read science books at age 10: *never*	0.03	0.18
Native	0.89	0.32
Immigrant background*: first generation*	0.03	0.17
Immigrant background: *second generation*	0.04	0.20
Early childhood education: l*ess than one year*	0.02	0.14
Early childhood education: *one to two years*	0.10	0.31
Early childhood education: *two to three years*	0.22	0.41

Early childhood education: *three to four years*	0.37	0.48
Early childhood education: *four to five years*	0.10	0.30
Early childhood education: *five to six years*	0.02	0.15
Early childhood education: *six to seven years*	0.00	0.06
Early childhood education: *seven to eight years*	0.00	0.03
Early childhood education: *more than eight years*	0.00	0.02
N Countries 18		
N Schools 3,452		
N Students 107,618		

Source: Self-elaboration from PISA-2015.

Given the importance of understanding the determinants of the use of leisure time and its effect at age 10, we turn to the information provided by the Trends in International Mathematics and Science Study (TIMSS) 2011, produced by the International Association for the Evaluation of Educational Achievement (IEA). TIMSS assesses the performance of 4th grade students in mathematics and science through standardised tests. The performance data are supplemented by information from background questionnaires sent to students, their families, teachers and school administrations. We selected nine countries that also participated in PISA-2015 and that have information on the variables of interest for our analysis. In total, we have a sample of 48,695 students, which is reduced to 41,654 (85.5%) after excluding missing cases. The 2011 wave was selected as it assessed the cohort which is the closest to the cohort that participated in PISA-2015.

In this exploratory analysis, previous to the calculation of the abovementioned models, we estimate a set of models which a) study the determinants of leisure time use and b) assess the relationship between the use of leisure time and the acquisition of numerical and scientific competencies. No information on occupational expectations is available for 4th grade students in TIMSS-2011. This analysis, combined with the latter, will allow us to follow the evolution of the gender gap across time. Consequently, we define as dependent variables, whether the child did a certain activity and the results of the standardised tests in mathematics and science, respectively. In the case of leisure time use, TIMSS provided information on the frequency with which the student played with blocks before entering school, the options being ‘Never’, ‘Sometimes’ and ‘Often’. The performance variables are measured through a set of plausible values originally standardised with mean 500 and standard deviation 100. These means rise in the subsample of selected countries to 510-520, and the standard deviation comprises to 75-88 (Table 2). Again, sampling weights and school fixed effects are applied throughout. Models in this exploratory analysis with TIMSS-2011 are displayed in a similar way (M1, M2 and M3) to those calculated with PISA-2015. Table 2 displays the descriptive statistics of the variables.

Table 2. Descriptive Statistics (TIMSS-2011)

Variable	Mean	SD	Min	Max
Maths	512.789	72.592	100.474	800.370
Science	519.643	73.719	62.317	783.527
Dichotomous Variable			*% [0]*	*% [1]*
Gender: *Boy*			0.50	0.50
Books at home: *0 to 10*			0.90	0.10
Books at home: *11 to 25*			0.75	0.25
Books at home: *26 to 100*			0.68	0.32
Books at home: *101 to 200*			0.86	0.14
Books at home: *More than 200*			0.87	0.13
Parental Education: *ISCED ≤ 1*			0.97	0.03
Parental Education: *ISCED 2*			0.79	0.21
Parental Education: *ISCED 3*			0.79	0.21
Parental Education: *ISCED 4*			0.85	0.15
Parental Education: *ISCED ≥ 5*			0.78	0.22
Language: *Never speaks the language of test at home*			0.97	0.03
Language: *Sometimes speaks the language of test at home*			0.82	0.18
Language: *Always speaks the language of test at home*			0.26	0.74
Played brick games at preschool: *Never*			0.94	0.06
Played brick games at preschool: *Sometimes*			0.74	0.26
Played brick games at preschool: *Often*			0.44	0.56
Attended preschool: *Did not attend*			0.97	0.03
Attended preschool: *One year of less*			0.97	0.03
Attended preschool: *More than 1 year, less than 3*			0.77	0.23
Attended preschool: *3 years or more*			0.42	0.58

Source: Self-elaboration from TIMSS-2011.

Results

This section is divided into two main blocks: first, we present the results at age 10 –i.e. using TIMSS data- and, second, we display the results at age 15.

Results at age 10: Determinants and effects of playing with bricks at preschool

We found a significant association between gender and the likelihood of students playing with bricks at home when they were in pre-school (Table 3). According to family responses, boys are more likely than girls to play with building blocks when they were in preschool (β = 0.103). The results in Table 3 are reflected in probit coefficients, which indicate the change in the latent z-score associated with the probability of block play occurring for each one-unit change in the predictor. This effect remains significant after including the rest of the controls; in fact the coefficient associated with being a boy rises slightly (β = 0.122). We observe that a higher educational level of the household is associated with a higher probability of playing with building blocks, reaching the maximum effect among households where at least one of the parents has higher education (ISCED ≥ 5; β = 0.199) compared to households with primary education or no education. We find a similarly significant effect in the case of books in the household, another indicator of the household's cultural level. In the case of language spoken at home, students who never speak the test language at home (β = -0.049) and those who speak it only sometimes (β = -0.055) are less likely to have played with building blocks. Finally, less than three years of preschool attendance reduces the probability of playing with blocks, with the largest effect among those who did not attend preschool (β = -0.115), compared to students who received 3 or more years of preschool.

Table 3. Probability of playing often with brick games at preschool, by gender, parents' education, books at home, language spoken at home and preschool attendance (N = 37,927)

	Model 1			Model 2		
	Coef.	*Std. Err.*	*P>z*	*Coef.*	*Std. Err.*	*P>z*
Gender: Boy	0.103	0.010	0.000	0.122	0.009	0.000
Parental Education. Reference: *Some primary, lower secondary or no school (ISCED <= 1)*						
ISCED 2				0.120	0.021	0.000
ISCED 3				0.145	0.023	0.000
ISCED 4				0.168	0.026	0.000
ISCED >= 5				0.199	0.025	0.000
Books at home. Reference: *(0-10)*						
(11-20)				0.056	0.016	0.000
(26-100)				0.074	0.014	0.000
(101-200)				0.084	0.019	0.000
200+				0.106	0.019	0.000
Language. Reference: *Always speaks the language of test at home*						

Never				-0.049	0.023	0.032
Sometimes				-0.055	0.011	0.000
Preschool attendance. Reference: 3 years or more						
Did not attend				-0.115	0.020	0.000
1 year or less				-0.075	0.025	0.002
Less than 3, more than 1				-0.037	0.011	0.001
Intercept	0.519	0.007	0.000	0.389	0.022	0.000

Source: Self-elaboration from TIMSS-2011.

Results at age 10: Effects of leisure-time activities at preschool by 4th grade

We hypothesised that the dynamics of play and leisure activities in childhood have an effect on students' performance in later grades. We test this using a series of regression models. Before including any controls (Model 1), we observe that playing with bricks when the student was in preschool has significant effects on performance in 4th grade. In mathematics, playing often with bricks is associated with an increase of 26 points in mathematics and 27.7 points in science (Table 4, Model 1). In this initial model, this effect may be confounded with the effects of gender, parental education level, books in the home, language spoken, or preschool attendance, which, as seen above, are groups associated with an increased likelihood of playing often with bricks, so in the following model we test this effect after including the appropriate controls.

After including controls, the effect of playing with bricks remains significant ($p < 0.001$), predicting an improvement of 12.8 points in mathematics and 13.8 points in science for students who often played with bricks versus those who never played with bricks (Table 5, Model 2). We can therefore affirm that student brick-playing in pre-school is strongly associated with mathematics and science achievement several grades later, regardless of gender, socio-cultural characteristics of the household and students' previous schooling.

Table 4. Model 1. Maths and Science performance in 4th grade by brick games (N = 37,927)

	MATHS	SCIENCE

	Coef.	SE	P>z	Coef.	SE	P>z
How often played with brick games at preschool. Reference: *Never*						
Sometimes	16.457	2.375	0.000	19.138	2.616	0.000
Often	25.994	2.360	0.000	29.742	2.723	0.000
Intercept	494.004	2.425	0.000	498.134	3.223	0.000

Source: Self-elaborated from TIMSS-2011 data.

Table 5. Model 2. Maths and Science performance in 4th grade by brick games, gender, parents' education, books at home, language spoken at home and preschool attendance (N = 37,927)

	MATHS			SCIENCE		
	Coef.	*SE*	*P>z*	*Coef.*	*SE*	*P>z*
How often played with brick games at preschool. Reference: *Never*						
Sometimes	8.325	2.191	0.000	9.174	2.495	0.000
Often	12.791	2.234	0.000	13.781	2.763	0.000
Gender: Boy	10.165	1.356	0.000	10.813	1.139	0.000
Home Education. Ref.: *Primary, lower secondary or no school (ISCED <= 1)*						
ISCED 2	8.643	2.968	0.004	10.726	3.552	0.003
ISCED 3	21.961	3.287	0.000	23.030	3.670	0.000
ISCED 4	22.138	3.042	0.000	24.746	3.656	0.000
ISCED >= 5	39.200	3.225	0.000	41.237	4.024	0.000
Books at home. Reference: *(0-10)*						
(11-20)	15.689	2.196	0.000	20.942	1.898	0.000
(26-100)	30.158	2.265	0.000	35.205	2.410	0.000
(101-200)	36.670	2.431	0.000	43.726	2.747	0.000
200+	37.835	2.822	0.000	47.341	2.807	0.000
Language. Reference: *Always speaks the language of test at home*						
Never	-14.357	3.519	0.000	-30.131	4.101	0.000
Sometimes	-9.952	1.595	0.000	-17.678	1.654	0.000
Preschool attendance. Reference: 3 years or more						
Did not attend	-8.332	3.081	0.007	-8.697	2.768	0.002
1 year or less	-4.433	2.927	0.130	-3.335	3.409	0.328
Less than 3, more than 1	-2.658	1.435	0.064	-1.965	1.440	0.172
Intercept	456.409	3.569	0.000	457.487	5.025	0.000

Source: Self-elaborated from TIMSS-2011 data.

Results at age 15: Effects of leisure-time activities at age 10 by age 15

The associations between leisure-time activities at age 10 by age 15 are resumed in Table 6, which is divided into three blocks, one for each model specification. Model 1 shows a positive relationship between being engaged in science related activities during childhood and performance in mathematics, science and the expectations of following a STEM career. For all the activities, these associations grow stronger the more time the student spent. Reading science books shows the higher coefficients, followed by playing brick games, using science kits and, finally, playing videogames with a scientific content.

Table 6. Effect of science related leisure time activities at age 10 on maths and science performance and STEM expectations at age 15

Model1		**Brick games**		**Videogames**		**Science kits**		**Science books**	
		Beta	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**
	Sometimes	5,90***	1,72	6,64***	1,34	10,59***	1,25	9,86***	1,30
Maths	**Regularly**	12,84***	2,01	9,66***	1,93	18,11***	1,83	20,45***	1,55
	Very often	21,60***	1,72	11,06***	2,24	19,87***	2,55	34,79***	2,52
	Sometimes	6,36***	1,44	8,58***	0,99	13,32***	0,99	12,24***	0,94
Science	**Regularly**	13,46***	1,43	14,00***	1,49	21,81***	1,52	27,63***	1,44
	Very often	23,88***	1,51	15,64***	1,79	23,57***	2,30	43,16***	2,46
	Sometimes	0,02***	0,01	0,03***	0,00	0,02***	0,00	0,02***	0,01
STEM	**Regularly**	0,05***	0,01	0,03***	0,01	0,06***	0,01	0,05***	0,01
	Very often	0,09***	0,01	0,07***	0,01	0,08***	0,01	0,10***	0,01
Model2		**Brick games**		**Videogames**		**Science kits**		**Science books**	
		Beta	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**
	Sometimes	3,16*	1,69	4,21***	1,32	9,12***	1,07	6,37***	1,31
Maths	**Regularly**	7,64***	2,02	5,76***	1,86	14,34***	1,68	13,94***	1,54
	Very often	13,23***	1,71	6,55***	2,11	15,12***	2,37	26,42***	2,47
	Sometimes	3,72***	1,37	6,23***	0,95	11,94***	0,97	8,69***	0,94
Science	**Regularly**	8,47***	1,37	10,22***	1,41	18,22***	1,45	21,18***	1,39
	Very often	15,83***	1,38	11,39***	1,64	19,16***	2,17	34,78***	2,34
	Sometimes	0,01	0,01	0,01***	0,00	0,01***	0,00	0,01**	0,01
STEM	**Regularly**	0,02***	0,01	0,02***	0,01	0,04***	0,01	0,02***	0,01
	Very often	0,05***	0,01	0,04***	0,01	0,06***	0,01	0,07***	0,01
Model3		**Brick games**		**Videogames**		**Science kits**		**Science books**	
		Beta	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**
	Sometimes	0,99	1,39	1,26	1,37	3,01***	0,73	2,23*	1,35
Maths	**Regularly**	3,41**	1,63	0,19	1,79	5,39***	1,62	3,46**	1,34
	Very often	6,46***	1,47	2,86	2,02	8,59***	1,82	8,60***	1,86
	Sometimes	1,20	1,26	2,82***	1,03	4,89***	0,88	3,90***	0,87
Science	**Regularly**	3,58***	0,90	3,79***	0,98	7,87***	1,44	9,06***	1,02
	Very often	8,01***	1,30	7,12***	1,30	11,60***	1,46	14,20***	1,49
	Sometimes	0,01	0,01	0.01***	0.00	0,01**	0,00	0,01*	0.01
STEM	**Regularly**	0,02***	0,01	0.01*	0.01	0,04***	0,01	0,02*	0.01

	Very often	0,04***	0,01	0.04***	0.01	0,05***	0,01	0,06***	0,01

Source: Self-elaborated from PISA-2015 data.

Note: Full results available in appendix tables A.3.

Results remain stable when taking into account individual and family level characteristics (model 2). Coefficients are lower than in model 1 but still statistically significant in almost all cases. Non-surprisingly, the effects of spending leisure time in science related activities are higher on scientific competencies than on mathematics. Again, the highest effects are linked to reading science related books and, the lowest, for playing videogames.

Table 7 displays the results of the IV estimations. These are consistent in the direction and significance of the coefficients with those presented in model M2 (Table 6), the absolute value of the coefficients of the IV estimates being in general lower. Again, the size of the coefficients grows monotonically with the increase in science-related leisure activities. The highest effects are linked to reading science books, while the lowest are those for playing science-related videogames.

Table 7. IV estimates of the effect of science related leisure time activities at age 10 on maths and science performance and STEM expectations at age 15

		Brick games		**Videogames**		**Science kits**		**Science books**	
		Beta	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**
Mathematics	**Sometimes**	4.66*	2.59	5.35**	2.20	4.55**	2.15	5.66***	2.07
	Regularly	6.79***	3.10	8.01***	2.75	8.18**	2.69	12.46***	2.74
	Frequently	13.10***	2.51	10.29**	4.48	16.57***	4.25	20.87***	4.31
Science	**Sometimes**	4.17*	2.45	7.10***	1.87	6.93	1.99	8.32***	1.75
	Regularly	9.26***	2.50	11.71***	2.29	14.57	2.67	19.09***	2.54
	Frequently	15.54***	2.49	14.78***	3.63	20.50	4.39	26.6***	4.48
STEM	**Sometimes**	0.01	0.01	0.01	0.01	0.00	0.01	0.03***	0.01
	Regularly	0.03**	0.01	0.02	0.01	0.03**	0.01	0.01	0.01
	Frequently	0.05***	0.01	0.05***	0.02	0.05**	0.02	0.04**	0.02

Source: Self-elaborated from PISA-2015 data. Regressions include all controls in model M2. Reference category: never played that activity at age 10.

Note: Full results available in appendix tables A.2.

Finally, we added performance in reading competencies to the equation, in an attempt to take into account additional unobserved confounding factors (Table 6, model 3). While the size of the coefficients shrinks, the patterns observed for models 1 and 2 remain consistent and, statistically significant for all the science related activities, at least for those who reported being engaged in them on a “regular” or “very often” basis. One should anyway interpret results in model 3 as a lower bound as it is plausible that reading competencies may affect, at least to a certain extent, performance on other competencies.

Given the aim of this research, we added to model 3 an interaction term of gender with being engaged frequently in science related leisure time activities at age 10. The main results are displayed in Table 8 (model 4). Interestingly, playing brick games is the only activity the effect of which is higher for boys in the three assessed outcomes. Indeed, it is the only leisure activity to positively affect performance in mathematics.

Table 8. Effect by gender of science related leisure time activities at age 10 on maths and science performance and STEM expectations at age 15 (model 4)

		Brick games		Videogames		Science kits		Science books	
		Beta	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**	**Beta**	**S.E.**
Maths	**Frequent play**	2,25*	1,26	0,03	1,60	3,42*	1,89	2,69*	1,35
	Play x sex	3,65***	1,21	0,72	2,05	2,56	2,01	1,25	1,70
Science	**Frequent play**	3,62***	0.73	2,96**	1,18	5,01***	1,38	6,33***	1,21
	Play x sex	2,29**	0,91	0,96	1,42	2,91	1,86	2,92**	1,45
STEM	**Frequent play**	0,01**	0,01	-0,02***	0,01	0,00	0,01	0,00	0,01
	Play x sex	0,02**	0,01	0,07***	0,01	0,06***	0,01	0,03**	0,01

Source: Self-elaborated from PISA-2015 data.

Note: Full results available in Table A.5.

Playing brick games and reading science books has a higher positive effect on scientific competencies and STEM expectations for boys. While playing videogames and using science kits do not show a differential effect on mathematic and scientific competencies by gender, they do have a stronger effect on the STEM expectations of boys.

Finally, results of model 4 at the country level (table A.6 in the appendix) show large variation in the effect of science-related activities by countries and across competencies. The effect by gender of these activities is also heterogeneous.

Discussion

Gender-differentiated socialisation shapes students' educational experiences, outcomes and expectations in different ways. Family plays an important role in the emergence of gender gaps in achievement through the dynamics of differentiated interaction between boys and girls (Baker and Milligan, 2016; Chuan et al., 2022; Gurgand et al., 2025) and the transmission of gender stereotypes in mathematics and science (Gunderson et al., 2012; Nicoletti et al., 2022). Here we have focused on a largely unexplored factor in the transmission of educational inequalities, that of leisure activities. We hypothesised that differential play and leisure activities between boys and girls may explain part of the gender differences in mathematics and science achievement and, in turn, in STEM expectations.

Our results show that boys and girls are differently likely to play with bricks in pre-school; specifically, boys are about 10% more likely to play with bricks. Block and building games are traditionally a male-dominated play. As our variable focuses on play at home, it is likely that this effect is reflecting a family effect in terms of what type of games families provide for children. Previous research suggests that parents tend to communicate their stereotypical attitudes and beliefs about play to children at an early age (Freeman, 2007), which influences their gender socialisation (Rogers et al., 2024), and probably other areas of students' lives, such as educational experiences and outcomes.

Playing often with bricks in early childhood has significant positive effects on mathematics and science performance in 4th grade and at age 15. As gender influences the probability of playing with bricks, and brick games have an impact on maths and science performance in 4th grade, it is likely that there are indirect effects of gender on performance through differential play dynamics. Recent studies have suggested that gender-typed play can be at the root of gender disparities in spatial skills (Wong et al., 2025), an important predictor of success in mathematics and science (Ganley et al., 2014; Geer et al., 2019). Next steps involve developing mediation analyses to determine whether unequal game dynamics are indeed a significant channel contributing to the widening of gender gaps in mathematics and STEM. Anyway, we cannot discard that the differential effect by gender of playing bricks may be associated to the existence of gender targeted types of brick games.

It is also remarkable that playing science-related videogames and using science kits do not show a differential effect on mathematic and scientific competencies by gender but do have a stronger effect on the STEM expectations of boys. This shows that games, a manifestation of culture, can modify expectations even without the need to improve the competencies which are more closely related to STEM careers. The fact that game patterns are gender biased and associated to the socioeconomic status of families raises concerns in terms of educational opportunities. However, breaking these stereotypes and their transmission from homes (Gunderson et al., 2012) and friendships (Sims et al., 2022) is clearly no easy task.

Finally, there is also considerable variability in gender differences in play patterns across countries, suggesting that other country-level factors may have an impact. For example, additional analyses show a strong correlation, at age 15, between the presence of households in which at least one parent has a STEM-related occupation and frequent play with building blocks ($r = 0.84$, $r^2 = 0.71$). We observe that Central European and Anglo-Saxon countries tend to rank above average in both the percentage of STEM households and frequent play with building blocks (Figure A1). In turn, we found a moderate correlation between the gender gap in parental STEM occupations[1] and the gender gap in the frequency of playing with building blocks ($r = 0.51$, $r^2 = 0.26$), such that when the gender gap in STEM occupations is smaller, patterns of playing with building blocks tend to be more similar between girls and boys. Central European and Anglo-Saxon countries tend to have a large gender gap in STEM professions, as well as in the frequency of playing with building blocks. On the other hand, both gaps tend to narrow in Mediterranean and Latin American contexts (Figure A2). This suggests a possible impact of gender equality in labour markets, which in turn is likely to influence cultural patterns and gender roles in society, on gender-unequal play dynamics in childhood. Play is therefore positioned as a potential driver of gender gaps in STEM, insofar as gender gaps in play patterns subsequently influence performance in mathematics and science and expectations towards STEM.

Conclusions

This study has analyzed the importance of early childhood play in the acquisition of competencies and the formation of career expectations during adolescence. Our findings highlight how science-related leisure activities in childhood influence mathematical and scientific competencies, as well as future expectations of working in STEM occupations. We also show that there are differences favoring boys in both performance in these competencies and in expectations; that girls participate less in science-related leisure activities during childhood; and that the effect associated with engaging in such activities is greater for boys. These findings have significant implications not only for the

[1] The difference between the proportion of mothers employed in STEM relative to the total number of employed mothers, and the proportion of fathers employed in STEM relative to the total number of employed fathers.

accumulation of human capital but also for educational and labor market equality of opportunity. Our results raise concerns that unequal access to science-related leisure activities may lead to inequalities—both socioeconomic and gender-based—in access to STEM jobs, which are in high demand and offer better working conditions in the digital economy. We also found a moderate correlation between the gender gap in parents' STEM professions and the gender gap in the frequency of playing with building blocks in childhood, suggesting a trend towards the reproduction of gender gaps in STEM, as gender gaps in play patterns, in turn, have an effect on math and science performance and STEM expectations.

Our results support the need for public intervention. Such intervention could focus on correcting play patterns within households, compensating for inequalities in these patterns through initiatives in educational institutions, or implementing measures aimed at mitigating the effects of unequal participation in science-related leisure activities during childhood. Within the first line of intervention, given the disparities in play patterns by gender and socioeconomic status, possible actions include informational campaigns, regulations on toys and games to avoid sexist connotations, and subsidies for certain types of toys. In terms of educational policy, the role of schools and educational centers can counteract stereotyped play dynamics as a measure to promote equal educational opportunities. In this regard, there have been a number of promising actions aimed at increasing awareness about gender stereotypes in preschool and schools in order to compensate for inequalities. Projects such as Skolae in Spain and Mind the Gap in several European countries, and organisations such as Lifting Limits and You Be You in the UK, have implemented comprehensive school-based approaches to reduce gender stereotypes by integrating gender equality into the school curriculum and culture and providing the education community with resources, including specific teacher training, to understand and address gender stereotypes (Brussino and McBrien, 2022). Focusing specifically on gender bias in play is the Let Toys Be Toys campaign, which targets challenging stereotypes of certain toys as “for boys” or “for girls” (Day, 2019), including recommendations for families and teachers to promote gender-equitable play[2]. Classroom interventions aimed at helping students identify stereotypes have been shown to be successful in promoting awareness of gender equality (Keating and Baker, 2025), as well as flexibility in relation to playing with toys and a sense that they could perform a wider range of occupations in the future (Spinner et al., 2021).

Finally, public interventions may focus on moderating educational and labor market inequalities once they have emerged. In this regard, measures such as the implementation of gender quotas in higher education programs in STEM fields (Strifezzi and Choi, 2023), show this may be a promising line of intervention, or affirmative action policies in the labor market, could help mitigate the consequences of this source of inequality, at least while its underlying causes remain unaddressed.

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[2] See https://www.lettoysbetoys.org.uk/resources/

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Table A.1. IV estimations: First stage regressions

A. Brick games

	Instrument 1		Instrument 2		Instrument 3	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Instrument	-106.75	6.13	-98.67	8.19	-115.10	6.22
Sex (1=boy)	-0.05	0.00	0.02	0.00	0.10	0.00
Early child edu: <1 year	0.00	0.01	0.02	0.01	-0.01	0.01
Early child edu: 1-2 years	0.01	0.01	0.00	0.01	-0.01	0.01
Early child edu: 2-3 years	0.00	0.01	0.01	0.01	-0.01	0.01
Early child edu: 3-4 years	0.00	0.01	0.01	0.01	0.00	0.01
Early child edu: 4-5 years	-0.01	0.01	0.02	0.01	0.00	0.01
Early child edu: 5-6 years	-0.01	0.01	0.01	0.01	0.00	0.01
Early child edu: 6-7 years	0.03	0.03	0.05	0.03	-0.03	0.03
Early child edu: 7-8 years	-0.06	0.06	0.06	0.06	0.02	0.04
Early child edu: >8 years	-0.06	0.09	0.03	0.07	-0.10	0.04
Books at home: 11-25	-0.01	0.01	0.01	0.01	0.01	0.00
Books home: 26-100	-0.02	0.01	0.02	0.01	0.02	0.00
Books home: 101-200	-0.01	0.01	0.01	0.01	0.04	0.01
Books home: >200	-0.04	0.01	0.01	0.01	0.06	0.01
Parental edu: ISCED 1	0.07	0.02	0.00	0.02	0.01	0.01
Parental edu: ISCED 2	0.07	0.02	0.02	0.01	0.01	0.01
Parental edu: ISCED 3B-C	0.07	0.02	0.03	0.02	0.02	0.01
Parental edu: ISCED 3A-4	0.08	0.02	0.03	0.01	0.01	0.01
Parental edu: ISCED 5B	0.08	0.02	0.03	0.01	0.02	0.01
Parental edu: ISCED 5A6	0.08	0.02	0.04	0.01	0.02	0.01
Immigrant: first gen	0.00	0.01	0.01	0.01	-0.01	0.01
Immigrant: second gen	0.01	0.01	-0.02	0.01	-0.02	0.01
Parental STEM occup.	-0.01	0.01	-0.01	0.01	0.02	0.01
Intercept	31.44	1.79	18.29	1.50	20.18	1.08

B. Science-related videogames

	Instrument 1		Instrument 2		Instrument 3	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
Instrument	-102.81	5.47	-105.24	10.70	-80.38	10.53
Sex (1=boy)	0.03	0.00	0.02	0.00	0.02	0.00
Early child edu: <1 year	0.02	0.01	-0.01	0.01	0.00	0.00
Early child edu: 1-2 years	-0.02	0.01	-0.01	0.01	0.01	0.00
Early child edu: 2-3 years	0.00	0.01	0.00	0.00	0.00	0.00
Early child edu: 3-4 years	0.00	0.01	0.00	0.00	0.00	0.00
Early child edu: 4-5 years	0.00	0.01	0.01	0.00	0.00	0.00
Early child edu: 5-6 years	-0.03	0.01	0.00	0.01	0.01	0.01
Early child edu: 6-7 years	0.01	0.03	0.02	0.02	-0.01	0.01
Early child edu: 7-8 years	-0.03	0.06	0.04	0.04	-0.01	0.02
Early child edu: >8 years	-0.09	0.11	-0.03	0.04	-0.06	0.01
Books at home: 11-25	0.02	0.01	0.01	0.00	0.00	0.00
Books home: 26-100	0.02	0.01	0.01	0.00	0.00	0.00
Books home: 101-200	0.01	0.01	0.02	0.00	0.00	0.00
Books home: >200	0.02	0.01	0.02	0.00	0.01	0.00
Parental edu: ISCED 1	0.03	0.02	0.02	0.01	-0.01	0.01
Parental edu: ISCED 2	0.03	0.02	0.02	0.01	0.00	0.01
Parental edu: ISCED 3B-C	0.05	0.02	0.04	0.01	0.00	0.01
Parental edu: ISCED 3A-4	0.05	0.02	0.03	0.01	0.01	0.01
Parental edu: ISCED 5B	0.06	0.02	0.04	0.01	0.01	0.01
Parental edu: ISCED 5A6	0.07	0.02	0.05	0.01	0.02	0.01
Immigrant: first gen	0.00	0.01	0.02	0.01	0.02	0.00
Immigrant: second gen	-0.01	0.01	0.01	0.01	0.01	0.00
Parental STEM occup.	0.00	0.01	0.01	0.00	0.01	0.00
Intercept	31.49	1.66	8.52	0.86	3.09	0.40

C. Science kits

	Instrument 1		Instrument 2		Instrument 3	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
Instrument	-93.14	5.89	-139.34	10.45	-122.54	8.35
Sex (1=boy)	0.01	0.00	0.02	0.00	0.01	0.00
Early child edu: <1 year	-0.01	0.01	-0.01	0.01	0.00	0.00
Early child edu: 1-2 years	0.01	0.01	0.00	0.00	0.00	0.00
Early child edu: 2-3 years	0.01	0.01	0.00	0.00	0.00	0.00
Early child edu: 3-4 years	0.00	0.01	0.00	0.00	0.00	0.00
Early child edu: 4-5 years	0.01	0.01	-0.01	0.00	0.00	0.00
Early child edu: 5-6 years	0.00	0.01	-0.01	0.01	0.01	0.01
Early child edu: 6-7 years	-0.01	0.03	0.02	0.02	0.01	0.02
Early child edu: 7-8 years	0.05	0.06	0.01	0.04	-0.02	0.01
Early child edu: >8 years	-0.22	0.18	-0.07	0.02	-0.03	0.01
Books at home: 11-25	0.02	0.01	0.00	0.00	0.00	0.00
Books home: 26-100	0.03	0.01	0.01	0.00	0.00	0.00
Books home: 101-200	0.06	0.01	0.02	0.00	0.01	0.00
Books home: >200	0.06	0.01	0.03	0.00	0.01	0.00
Parental edu: ISCED 1	-0.01	0.02	0.01	0.01	0.00	0.01
Parental edu: ISCED 2	-0.02	0.02	0.00	0.01	0.01	0.00
Parental edu: ISCED 3B-C	-0.02	0.02	0.01	0.01	0.01	0.01
Parental edu: ISCED 3A-4	0.00	0.02	0.01	0.01	0.01	0.00
Parental edu: ISCED 5B	0.01	0.02	0.02	0.01	0.01	0.00
Parental edu: ISCED 5A6	0.02	0.02	0.02	0.01	0.01	0.00
Immigrant: first gen	-0.02	0.01	0.00	0.01	0.01	0.00
Immigrant: second gen	-0.06	0.01	-0.01	0.00	0.00	0.00
Parental STEM occup.	0.00	0.01	0.01	0.00	0.00	0.00
Intercept	28.33	1.77	10.17	0.76	3.65	0.25

D. Science books

	Instrument 1		Instrument 2		Instrument 3	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
Instrument	-100.77	6.33	-143.68	13.13	-100.32	16.90
Sex (1=boy)	0.02	0.00	0.02	0.00	0.01	0.00
Early child edu: <1 year	0.00	0.01	0.00	0.01	0.00	0.00
Early child edu: 1-2 years	-0.01	0.01	0.01	0.01	0.00	0.00
Early child edu: 2-3 years	0.00	0.01	0.01	0.00	0.00	0.00
Early child edu: 3-4 years	0.00	0.01	0.00	0.00	0.00	0.00
Early child edu: 4-5 years	0.00	0.01	0.00	0.01	0.01	0.00
Early child edu: 5-6 years	-0.01	0.01	0.00	0.01	0.00	0.01
Early child edu: 6-7 years	-0.01	0.03	-0.01	0.02	0.00	0.01
Early child edu: 7-8 years	0.13	0.06	-0.02	0.04	-0.02	0.01
Early child edu: >8 years	-0.15	0.15	-0.09	0.03	-0.03	0.01
Books at home: 11-25	0.03	0.01	0.01	0.00	0.00	0.00
Books home: 26-100	0.04	0.01	0.02	0.00	0.01	0.00
Books home: 101-200	0.04	0.01	0.04	0.00	0.02	0.00
Books home: >200	0.04	0.01	0.05	0.01	0.04	0.00
Parental edu: ISCED 1	-0.01	0.02	0.00	0.01	-0.01	0.01
Parental edu: ISCED 2	0.00	0.02	-0.01	0.01	0.00	0.01
Parental edu: ISCED 3B-C	0.01	0.02	-0.01	0.01	0.00	0.01
Parental edu: ISCED 3A-4	0.02	0.02	-0.01	0.01	0.00	0.01
Parental edu: ISCED 5B	0.03	0.02	0.00	0.01	0.00	0.01
Parental edu: ISCED 5A6	0.03	0.02	0.00	0.01	0.00	0.01
Immigrant: first gen	0.02	0.01	0.01	0.01	0.01	0.00
Immigrant: second gen	-0.02	0.01	0.01	0.01	0.01	0.00
Parental STEM occup.	0.01	0.01	0.01	0.01	0.00	0.00
Intercept	38.76	2.41	13.39	1.22	3.28	0.55

Source: Self-elaborated from PISA-2015 data.

Table A.2. IV estimations: Second stage regressions

A. Brick games

	Mathematics		Science		STEM expectations	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
Bricks: Sometimes	4.66	2.59	4.18	2.45	0.01	0.01
Bricks: Regularly	6.79	3.11	9.26	2.50	0.03	0.01
Bricks:Very often	13.10	2.51	15.54	2.49	0.05	0.01
First stage residual 1	-1.83	2.48	-0.60	2.35	0.00	0.01
First stage residual 2	0.72	2.94	-1.10	2.51	0.00	0.01
First stage residual 3	-0.21	2.47	0.13	2.34	-0.01	0.01
Sex (1=boy)	14.70	0.89	11.30	0.92	0.13	0.00
Sex (1=boy)	-20.15	2.83	-24.44	2.83	-0.01	0.01
Early child edu: <1 year	0.99	1.74	-1.88	1.63	0.01	0.01
Early child edu: 1-2 years	7.11	1.43	2.48	1.23	0.02	0.01
Early child edu: 2-3 years	8.79	1.30	4.33	1.25	0.02	0.01
Early child edu: 3-4 years	2.74	1.59	-1.02	1.55	0.02	0.01
Early child edu: 4-5 years	-4.53	3.12	-7.68	2.60	0.01	0.01
Early child edu: 5-6 years	-23.39	5.69	-27.62	5.26	0.01	0.03
Early child edu: 6-7 years	-22.52	15.29	-24.93	11.53	0.01	0.05
Early child edu: 7-8 years	-43.72	24.74	-62.81	21.37	-0.15	0.09
Books at home: 11-25	5.66	1.81	9.69	1.23	0.02	0.01
Books home: 26-100	23.35	1.25	26.28	1.28	0.03	0.01
Books home: 101-200	31.23	1.56	36.76	1.40	0.04	0.01
Books home: >200	46.54	1.57	52.36	1.48	0.05	0.01
Parental edu: ISCED 1	-0.62	4.30	-3.18	4.20	0.03	0.02
Parental edu: ISCED 2	7.34	4.20	4.80	3.65	0.01	0.02
Parental edu: ISCED 3B-C	8.99	3.94	10.30	3.68	-0.01	0.02
Parental edu: ISCED 3A-4	11.48	3.77	11.16	3.45	0.01	0.02
Parental edu: ISCED 5B	9.56	3.97	9.29	3.58	0.01	0.02
Parental edu: ISCED 5A6	11.81	3.82	9.21	3.45	0.01	0.02
Immigrant: first gen	-16.46	2.64	-19.56	2.21	0.05	0.01
Immigrant: second gen	-12.52	2.02	-18.22	1.79	0.02	0.01
Parental STEM occup.	10.50	1.14	11.89	1.16	0.07	0.01
Intercept	426.53	4.49	434.19	4.18	0.05	0.02

B. Science-related videogames

	Mathematics		Science		STEM expectations	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
Sci videogames: Sometimes	5.35	2.20	7.10	1.88	0.01	0.01
Sci videogames: Regularly	8.01	2.75	11.71	2.30	0.02	0.01
Sci videogames: Very often	10.29	4.48	14.78	3.63	0.05	0.02
First stage residual 1	-1.31	2.07	-1.00	1.96	0.00	0.01
First stage residual 2	-2.62	2.32	-1.74	2.29	0.00	0.01
First stage residual 3	-4.24	4.52	-3.85	4.14	0.00	0.02
Sex (1=boy)	15.71	0.87	13.22	0.98	0.13	0.00
Sex (1=boy)	-19.65	3.07	-24.52	2.77	-0.01	0.01
Early child edu: <1 year	2.88	1.84	-0.25	1.63	0.02	0.01
Early child edu: 1-2 years	7.51	1.62	2.67	1.29	0.02	0.01
Early child edu: 2-3 years	8.79	1.50	4.26	1.29	0.02	0.01
Early child edu: 3-4 years	2.08	1.78	-1.54	1.59	0.02	0.01
Early child edu: 4-5 years	-4.51	3.28	-8.22	2.69	0.01	0.01
Early child edu: 5-6 years	-22.55	5.99	-26.93	5.47	0.02	0.03
Early child edu: 6-7 years	-20.72	15.85	-23.63	11.80	0.00	0.05
Early child edu: 7-8 years	-43.18	28.46	-70.59	21.96	-0.14	0.10
Books at home: 11-25	4.81	1.87	8.39	1.29	0.02	0.01
Books home: 26-100	20.53	1.31	22.31	1.36	0.03	0.01
Books home: 101-200	28.51	1.51	32.43	1.51	0.04	0.01
Books home: >200	42.23	1.51	46.96	1.64	0.05	0.01
Parental edu: ISCED 1	-0.25	4.38	-3.34	4.27	0.03	0.02
Parental edu: ISCED 2	7.80	4.33	4.87	3.71	0.01	0.02
Parental edu: ISCED 3B-C	8.29	4.10	9.45	3.80	-0.01	0.02
Parental edu: ISCED 3A-4	11.60	3.80	10.69	3.49	0.01	0.02
Parental edu: ISCED 5B	9.99	4.11	9.34	3.66	0.01	0.02
Parental edu: ISCED 5A6	11.79	3.99	8.92	3.53	0.01	0.02
Immigrant: first gen	-20.84	2.70	-21.80	2.36	0.04	0.01
Immigrant: second gen	-16.49	2.14	-21.96	1.97	0.02	0.01
Parental STEM occup.	10.18	1.14	11.58	1.17	0.07	0.01
Intercept	426.98	4.51	433.42	3.96	0.07	0.02

C. Science kits

	Mathematics		Science		STEM expectations	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
Science kits: Sometimes	4.56	2.15	6.94	1.99	0.00	0.01
Science kits: Regularly	8.18	2.69	14.57	2.67	0.03	0.01
Science kits:Very often	16.57	4.25	20.50	4.39	0.05	0.02
First stage residual 1	2.45	2.34	2.55	2.00	0.01	0.01
First stage residual 2	4.46	2.59	1.08	2.57	0.01	0.01
First stage residual 3	-4.64	4.15	-4.81	4.42	0.01	0.03
Sex (1=boy)	15.52	0.85	12.24	0.90	0.13	0.00
Sex (1=boy)	-20.12	2.81	-24.38	2.82	-0.01	0.01
Early child edu: <1 year	0.83	1.73	-2.10	1.64	0.01	0.01
Early child edu: 1-2 years	7.12	1.43	2.48	1.24	0.02	0.01
Early child edu: 2-3 years	8.78	1.31	4.33	1.27	0.02	0.01
Early child edu: 3-4 years	2.78	1.60	-0.92	1.55	0.02	0.01
Early child edu: 4-5 years	-4.57	3.13	-7.68	2.62	0.01	0.01
Early child edu: 5-6 years	-23.63	5.67	-28.08	5.23	0.01	0.03
Early child edu: 6-7 years	-22.74	15.29	-25.13	11.44	0.02	0.05
Early child edu: 7-8 years	-43.07	25.16	-61.35	21.23	-0.15	0.09
Books at home: 11-25	5.69	1.81	9.72	1.22	0.02	0.01
Books home: 26-100	23.42	1.23	26.32	1.28	0.03	0.01
Books home: 101-200	31.21	1.55	36.62	1.40	0.04	0.01
Books home: >200	46.47	1.55	52.09	1.47	0.06	0.01
Parental edu: ISCED 1	-0.43	4.28	-3.09	4.18	0.03	0.02
Parental edu: ISCED 2	7.77	4.15	5.25	3.59	0.01	0.02
Parental edu: ISCED 3B-C	9.41	3.91	10.67	3.65	-0.01	0.02
Parental edu: ISCED 3A-4	11.79	3.74	11.34	3.45	0.01	0.02
Parental edu: ISCED 5B	9.86	3.93	9.44	3.57	0.01	0.02
Parental edu: ISCED 5A6	12.06	3.79	9.27	3.44	0.01	0.02
Immigrant: first gen	-16.43	2.63	-19.53	2.19	0.05	0.01
Immigrant: second gen	-12.46	2.01	-18.13	1.80	0.02	0.01
Parental STEM occup.	10.49	1.15	11.83	1.17	0.07	0.01
Intercept	429.14	4.27	436.19	3.83	0.06	0.02

D. Science books

	Mathematics		Science		STEM expectations	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Sci books: Sometimes	5.66	2.07	8.32	1.75	0.03	0.01
Sci books: Regularly	12.46	2.74	19.09	2.54	0.01	0.01
Sci books:Very often	20.87	4.31	26.61	4.48	0.04	0.02
First stage residual 1	0.49	1.98	0.11	1.89	-0.02	0.01
First stage residual 2	1.18	2.82	1.90	2.48	0.02	0.01
First stage residual 3	5.55	4.27	8.55	4.35	0.03	0.02
Sex (1=boy)	15.28	0.85	11.90	0.90	0.13	0.00
Sex (1=boy)	-20.23	2.81	-24.55	2.80	-0.01	0.01
Early child edu: <1 year	0.87	1.72	-2.06	1.63	0.01	0.01
Early child edu: 1-2 years	7.07	1.43	2.42	1.24	0.02	0.01
Early child edu: 2-3 years	8.84	1.30	4.41	1.24	0.02	0.01
Early child edu: 3-4 years	2.76	1.58	-0.94	1.52	0.02	0.01
Early child edu: 4-5 years	-4.32	3.12	-7.38	2.56	0.01	0.01
Early child edu: 5-6 years	-23.25	5.68	-27.43	5.27	0.01	0.03
Early child edu: 6-7 years	-22.83	15.37	-25.25	11.60	0.01	0.05
Early child edu: 7-8 years	-42.60	24.78	-60.80	21.39	-0.15	0.09
Books at home: 11-25	5.50	1.81	9.45	1.24	0.02	0.01
Books home: 26-100	23.09	1.24	25.85	1.27	0.03	0.01
Books home: 101-200	30.75	1.57	36.00	1.42	0.04	0.01
Books home: >200	45.63	1.58	51.01	1.50	0.06	0.01
Parental edu: ISCED 1	0.14	4.30	-2.31	4.17	0.03	0.02
Parental edu: ISCED 2	8.17	4.14	5.76	3.58	0.01	0.02
Parental edu: ISCED 3B-C	9.88	3.88	11.30	3.62	-0.01	0.02
Parental edu: ISCED 3A-4	12.35	3.72	12.13	3.42	0.01	0.02
Parental edu: ISCED 5B	10.25	3.90	10.00	3.53	0.01	0.02
Parental edu: ISCED 5A6	12.57	3.77	9.99	3.41	0.01	0.02
Immigrant: first gen	-17.00	2.62	-20.36	2.18	0.05	0.01
Immigrant: second gen	-12.92	2.00	-18.84	1.78	0.02	0.01
Parental STEM occup.	10.54	1.15	11.92	1.16	0.07	0.01
Intercept	427.38	4.50	433.79	3.83	0.05	0.02

Source: Self-elaborated from PISA-2015 data.

Table A.3. Models 1 to 3. Full results

A. Playing brick games

	Playing brick games: Mathematics								
	Model 1			Model 2			Model 3		
	Beta	SE		Beta	SE		Beta	SE	
Intercept	460.58	1.62	***	425.11	4.35	***	122.82	4.98	***
Bricks: sometimes	5.90	1.72	***	3.16	1.69	*	1.26	1.37	
Bricks: regularly	12.84	2.01	***	7.64	2.02	***	0.19	1.79	
Bricks: very often	21.60	1.72	***	13.23	1.71	***	2.86	2.02	
Sex (1=boy)				14.68	0.87	***	24.63	0.76	***
Early child edu: <1 year				-19.65	3.07	***	-3.56	2.28	
Early child edu: 1-2 years				2.98	1.84		-0.26	2.04	
Early child edu: 2-3 years				7.51	1.62	***	2.92	1.77	*
Early child edu: 3-4 years				8.74	1.49	***	3.11	1.46	**
Early child edu: 4-5 years				2.03	1.79		0.99	1.50	
Early child edu: 5-6 years				-4.65	3.27		-0.79	2.82	
Early child edu: 6-7 years				-22.57	6.00	***	-6.03	6.21	
Early child edu: 7-8 years				-20.68	15.89		5.46	11.84	
Early child edu: >8 years				-43.30	28.46		9.01	25.71	
Books at home: 11-25				4,78	1,88	**	-1.08	1.72	
Books home: 26-100				20,33	1,31	***	5.08	1.06	***
Books home: 101-200				28,16	1,50	***	6.91	1.28	***
Books home: >200				41.63	1.49	***	11.83	1.30	***
Parental edu: ISCED 1				-0.28	4.38		1.78	3.97	
Parental edu: ISCED 2				7.62	4.38	*	3.75	4.37	
Parental edu: ISCED 3B-C				8.19	4.17	**	2.42	4.07	
Parental edu: ISCED 3A-4				11.60	3.89	***	3.27	3.66	

	Playing brick games: Science								
	Model 1			Model 2			Model 3		
	Beta	SE		Beta	SE		Beta	SE	
Intercept	463.14	1.31	***	431.74	3.96	***	81.62	3.27	***
Bricks: sometimes	6.36	1.44	***	3.72	1.37	***	2.82	1.03	***
Bricks: regularly	13.46	1.43	***	8.47	1.37	***	3.79	0.98	***
Bricks: very often	23.88	1.51	***	15.83	1.38	***	7.12	1.31	***
Sex (1=boy)				12.13	0.97	***	23.47	0.91	***
Early child edu: <1 year				-24.52	2.78	***	-5.91	2.37	**
Early child edu: 1-2 years				-0.14	1.63		-3.88	1.79	**
Early child edu: 2-3 years				2.68	1.26	**	-2.64	1.37	*
Early child edu: 3-4 years				4.20	1.27	***	-2.31	1.08	**
Early child edu: 4-5 years				-1.57	1.60		-2.80	1.21	**
Early child edu: 5-6 years				-8.39	2.67	***	-3.92	1.95	**
Early child edu: 6-7 years				-26.90	5.47	***	-7.85	4.65	*
Early child edu: 7-8 years				-23.53	11.87	**	6.62	6.95	
Early child edu: >8 years				-70.96	21.71	***	- 10.15	18.10	
Books at home: 11-25				8.38	1.28	***	1.56	0.89	*
Books home: 26-100				22.12	1.35	***	4.42	0.96	***
Books home: 101-200				32.06	1.50	***	7.43	1.09	***
Books home: >200				46.30	1.63	***	11.77	1.24	***
Parental edu: ISCED 1				-3.32	4.28		-1.02	3.40	
Parental edu: ISCED 2				4.73	3.75		0.15	2.74	
Parental edu: ISCED 3B-C				9.47	3.85	**	2.59	2.70	
Parental edu: ISCED 3A-4				10.86	3.52	***	0.99	3.00	

	Playing brick games: expectations								
	Model 1			Model 2			Model 3		
	Beta	SE		Beta	SE		Beta	SE	
Intercept	0.16	0.01	***	0.06	0.02	**	- 0.14	0.03	***
Bricks: sometimes	0.02	0.01	***	0.01	0.01		0.01	0.00	***
Bricks: regularly	0.05	0.01	***	0.02	0.01	***	0.01	0.01	*
Bricks: very often	0.09	0.01	***	0.05	0.01	***	0.04	0.01	***
Sex (1=boy)				0.13	0.00	***	0.14	0.00	***
Early child edu: <1 year				- 0.01	0.01		0.00	0.01	
Early child edu: 1-2 years				0.02	0.01	*	0.01	0.01	
Early child edu: 2-3 years				0.02	0.01	**	0.02	0.01	**
Early child edu: 3-4 years				0.02	0.01	**	0.01	0.01	*
Early child edu: 4-5 years				0.02	0.01	***	0.02	0.01	***
Early child edu: 5-6 years				0.01	0.01		0.01	0.01	
Early child edu: 6-7 years				0.02	0.03		0.03	0.03	
Early child edu: 7-8 years				0.00	0.05		0.02	0.05	
Early child edu: >8 years				- 0.14	0.10		- 0.10	0.11	
Books at home: 11-25				0.02	0.01	***	0.02	0.01	**
Books home: 26-100				0.03	0.01	***	0.02	0.01	***
Books home: 101-200				0.04	0.01	***	0.02	0.01	***
Books home: >200				0.05	0.01	***	0.03	0.01	***
Parental edu: ISCED 1				0.03	0.02		0.03	0.02	
Parental edu: ISCED 2				0.01	0.02		0.01	0.02	
Parental edu: ISCED 3B-C				- 0.01	0.02		- 0.01	0.02	
Parental edu: ISCED 3A-4				0.01	0.02		0.00	0.02	

Parental edu: ISCED 5B	9.95	4.15	**	4.30	3.92		9.48	3.71	**	2.68	2.76		0.01	0.02		0.00	0.02	
Parental edu: ISCED 5A6	11.90	4.08	***	6.26	3.89		9.29	3.58	**	2.42	2.83		0.01	0.02		0.00	0.02	
Immigrant: first gen	-20,40	2,69	***	-4.06	2.16	*	-21.15	2.35	***	-2.46	1.69		0.04	0.01	***	0.05	0.01	***
Immigrant: second gen	-16,09	2.16	***	-7.23	1.98	***	-21.39	1.98	***	-11.27	1.74	***	0.02	0.01	**	0.03	0.01	***
Parental STEM occup.	10,22	1.13	***	3.14	0.94	***	11.66	1.15	***	3.42	0.82	***	0.07	0.01	***	0.07	0.01	***
Reading scores				0.68	0.01	***				0.78	0.00	***				0.00	0.00	***

B. Playing science-related videogames

	Science related videogames: Mathematics									Science related videogames: Science									Science related videogames: STEM expectations								
	Model 1			Model 2			Model 3			Model 1			Model 2			Model 3			Model 1			Model 2			Model 3		
	Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE	
Intercept	466.44	1.34	***	427.46	4.41	***	122.82	4.98	***	468.38	1.05	***	433.79	3.91	***	81.62	3.27	***	0.18	0.00	***	0.07	0.02	***	-0.14	0.03	***
Videog: sometimes	6.64	1.34	***	4.21	1.33	***	1.26	1.37		8.58	0.99	***	6.23	0.95	***	2.82	1.03	***	0.03	0.00	***	0.01	0.00	***	0.01	0.00	***
Videog: regularly	9.66	1.93	***	5.76	1.86	***	0.19	1.79		14.00	1.48	***	10.22	1.41	***	3.79	0.98	***	0.03	0.01	***	0.02	0.01	**	0.01	0.01	*
Videog: very often	11.06	2.24	***	6.55	2.11	***	2.86	2.02		15.64	1.79	***	11.39	1.64	***	7.12	1.31	***	0.07	0.01	***	0.04	0.01	***	0.04	0.01	***
Sex (1=boy)				15.86	0.85	***	24.63	0.76	***				13.34	0.98	***	23.47	0.91	***				0.13	0.00	***	0.14	0,00	***
Early child edu: <1 year				-19,67	3,07	***	-3.56	2.28					-24.54	2.78	***	-5.91	2.37	**				-0.01	0.01		0.00	0.01	
Early child edu: 1-2 years				2,88	1,84		-0.26	2.04					-0.25	1.63		-3.88	1.79	**				0.02	0.01	*	0.01	0.01	
Early child edu: 2-3 years				7,51	1,62	***	2.92	1.77	*				2.67	1.29	**	-2.64	1.37	*				0.02	0.01	**	0.02	0.01	
Early child edu: 3-4 years				8,79	1,50	***	3.11	1.46	**				4.26	1.29	***	-2.31	1.08	**				0.02	0.01	**	0.01	0.01	
Early child edu: 4-5 years				2,10	1.78		0.99	1.50					-1.52	1.59		-2.80	1.21	**				0.02	0.01	***	0.02	0.01	
Early child edu: 5-6 years				-4,51	3,28		-0.79	2.82					-8.21	2.69	***	-3.92	1.95	**				0.01	0.01		0.01	0.01	
Early child edu: 6-7 years				-22,57	6,00	***	-6.03	6.21					-26.95	5.46	***	-7.85	4.65	*				0.02	0.03		0.03	0.03	
Early child edu: 7-8 years				-20,75	15,88		5.46	11.84					-23.67	11.81	**	6.62	6.95					0.00	0.05		0.02	0.05	
Early child edu: >8 years				-43,58	28.52		9.01	25.71					-70.93	22.04	***	-10.15	18.10					-0.14	0.10		-0.10	0.11	
Books at home: 11-25				4,86	1.87	**	-1.08	1.72					8.43	1.28	***	1.56	0.89	*				0.02	0.01	***	0.02	0.01	**
Books home: 26-100				20,61	1,31	***	5.08	1.06	***				22.37	1.35	***	4.42	0.96	***				0.03	0.01	***	0.02	0.01	***
Books home: 101-200				28,60	1,50	***	6.91	1.28	***				32.49	1.51	***	7.43	1.09	***				0.04	0.01	***	0.02	0.01	***
Books home: >200				42,32	1,51	***	11.83	1.30	***				47.03	1.64	***	11.77	1.24	***				0.05	0.01	***	0.03	0.01	***
Parental edu: ISCED 1				-0,20	4,39		1.78	3.97					-3.31	4.28		-1.02	3.40					0.03	0.02		0.03	0.02	
Parental edu: ISCED 2				7,89	4.34	*	3.75	4.37					4.92	3.71		0.15	2.74					0.01	0.02		0.01	0.02	
Parental edu: ISCED 3B-C				8,46	4,12	**	2.42	4.07					9.57	3.82	**	2.59	2.70					-0.01	0.02		-0.01	0.02	
Parental edu: ISCED 3A-4				11,78	3,82	***	3.27	3.66					10.82	3.50	***	0.99	3.00					0.01	0.02		0.00	0.02	
Parental edu: ISCED 5B				10,20	4,12	**	4.30	3.92					9.50	3.68	**	2.68	2.76					0.01	0.02		0.00	0.02	

Parental edu: ISCED 5A6	12,07	4,02	***	6.26	3.89		9.13	3.54	**		2.42	2.83	0.01	0.02		0.00	0.02	
Immigrant: first gen	-20,71	2,69	***	-4.06	2.16	*	-21.70	2.35	***	-2.46	1.69		0.04	0.01	***	0.05	0.01	***
Immigrant: second gen	-16,43	2,14	***	-7.23	1.98	***	-21.91	1.97	***	-11.27	1.74	***	0.02	0.01	**	0.03	0.01	***
Parental STEM occup.	10,24	1,14	***	3.14	0.94	***	11.62	1.17	***	3.42	0.82	***	0.07	0.01	***	0.07	0.01	***
Reading scores				0.68	0.01	***				0.78	0.00	***				0.00	0.00	***

C. Playing with scientific kits

	Science kits: Mathematics								
	Model 1			Model 2			Model 3		
	Beta	SE		Beta	SE		Beta	SE	
Intercept	464.16	1.21	***	423.74	4.31	***	122.27	4.77	***
Sci kits: sometimes	10.59	1.25	***	9.12	1.07	***	3.01	0.73	***
Sci kits: regularly	18.11	1.83	***	14.34	1.68	***	5.39	1.62	***
Sci kits: very often	19.87	2.55	***	15.12	2.37	***	8.59	1.82	***
Sex (1=boy)				15.27	0.85	***	24.41	0.77	***
Early child edu: <1 year				-19,73	3,03	***	-3.54	2.28	
Early child edu: 1-2 years				2,72	1,85		-0.29	2.03	
Early child edu: 2-3 years				7,52	1,62	***	2.92	1.77	*
Early child edu: 3-4 years				8,89	1,50	***	3.10	1.45	**
Early child edu: 4-5 years				2,17	1,80		0.98	1.50	
Early child edu: 5-6 years				-4,58	3,27		-0.84	2.82	
Early child edu: 6-7 years				-23,35	5,99	***	-6.31	6.19	
Early child edu: 7-8 years				-20,88	15,89		5.36	11.80	
Early child edu: >8 years				-41,12	29,07		9.97	25.96	
Books at home: 11-25				4,92	1.89	***	-1.13	1.74	
Books home: 26-100				20,48	1.32	***	4.94	1.07	***
Books home: 101-200				28,15	1.51	***	6.60	1.29	***
Books home: >200				41,48	1.49	***	11.36	1.31	***
Parental edu: ISCED 1				-0,10	4.35		1.75	3.95	
Parental edu: ISCED 2				8,18	4.32	*	3.77	4.36	
Parental edu: ISCED 3B-C				8,81	4,11	**	2.39	4.08	
Parental edu: ISCED 3A-4				11,86	3,81	***	3.17	3.67	

	Science kits: Science								
	Model 1			Model 2			Model 3		
	Beta	SE		Beta	SE		Beta	SE	
Intercept	465.98	1.00	***	429.58	3.81	***	81.06	3.12	***
Sci kits: sometimes	13.32	0.99	***	11.94	0.97	***	4.89	0.88	***
Sci kits: regularly	21.81	1.52	***	18.22	1.45	***	7.87	1.44	***
Sci kits: very often	23.57	2.30	***	19.16	2.17	***	11.60	1.46	***
Sex (1=boy)				12.77	0.97	***	23.33	0.93	***
Early child edu: <1 year				-24.61	2.75	***	-5.90	2.36	**
Early child edu: 1-2 years				-0.46	1.65		-3.95	1.79	**
Early child edu: 2-3 years				2.67	1.29	**	-2.65	1.37	*
Early child edu: 3-4 years				4.37	1.29	***	-2.34	1.08	**
Early child edu: 4-5 years				-1.42	1.61		-2.80	1.21	**
Early child edu: 5-6 years				-8.30	2.69	***	-3.98	1.95	**
Early child edu: 6-7 years				-27.91	5.46	***	-8.21	4.62	*
Early child edu: 7-8 years				-23.86	11.89	**	6.46	6.90	
Early child edu: >8 years				-68.01	21.84	***	-8.96	17.79	
Books at home: 11-25				8.52	1.28	***	1.53	0.89	*
Books home: 26-100				22.24	1.36	***	4.27	0.98	***
Books home: 101-200				31.94	1.51	***	7.03	1.10	***
Books home: >200				45.98	1.61	***	11.15	1.25	***
Parental edu: ISCED 1				-3.11	4.26		-0.98	3.39	
Parental edu: ISCED 2				5.38	3.68		0.29	2.74	
Parental edu: ISCED 3B-C				10.18	3.83	***	2.76	2.70	
Parental edu: ISCED 3A-4				11.09	3.51	***	1.04	3.00	

	Science kits: STEM expectations								
	Model 1			Model 2			Model 3		
	Beta	SE		Beta	SE		Beta	SE	
Intercept	0.18	0.00	***	0.06	0.02	***	-0.14	0.03	***
Sci kits: sometimes	0.02	0.00	***	0.01	0.00	***	0.01	0.00	**
Sci kits: regularly	0.06	0.01	***	0.04	0.01	***	0.04	0.01	***
Sci kits: very often	0.08	0.01	***	0.06	0.01	***	0.05	0.01	***
Sex (1=boy)				0.13	0.00	***	0.14	0.00	***
Early child edu: <1 year				-0.01	0.01		0.00	0.01	
Early child edu: 1-2 years				0.02	0.01	*	0.01	0.01	
Early child edu: 2-3 years				0.02	0.01	**	0.02	0.01	
Early child edu: 3-4 years				0.02	0.01	**	0.01	0.01	
Early child edu: 4-5 years				0.02	0.01	***	0.02	0.01	
Early child edu: 5-6 years				0.01	0.01		0.01	0.01	
Early child edu: 6-7 years				0.02	0.03		0.03	0.03	
Early child edu: 7-8 years				0.00	0.05		0.02	0.05	
Early child edu: >8 years				-0.13	0.10		-0.10	0.10	
Books at home: 11-25				0.02	0.01	***	0.02	0.01	**
Books home: 26-100				0.03	0.01	***	0.02	0.01	***
Books home: 101-200				0.04	0.01	***	0.02	0.01	***
Books home: >200				0.05	0.01	***	0.03	0.01	***
Parental edu: ISCED 1				0.03	0.02		0.03	0.02	
Parental edu: ISCED 2				0.01	0.02		0.01	0.02	**
Parental edu: ISCED 3B-C				-0.01	0.02		-0.01	0.02	*
Parental edu: ISCED 3A-4				0.01	0.02		0.00	0.02	***

Parental edu: ISCED 5B	10,17	4,08	**	4.13	3.89		9.66	3.68	***	2.68	2.77		0.01	0.02		0.00	0.02	
Parental edu: ISCED 5A6	11,99	3,99	***	6.04	3.89		9.28	3.55	***	2.41	2.84		0.01	0.02		0.00	0.02	
Immigrant: first gen	-20,78	2.68	***	-4.00	2.19	*	-21.57	2.34	***	-2.18	1.67		0.04	0.01	***	0.06	0.01	***
Immigrant: second gen	-16,51	2.14	***	-7.07	1.95	***	-21.82	2.00	***	-10.91	1.74	***	0.02	0.01	**	0.03	0.01	***
Parental STEM occup.	10,30	1.14	***	3.10	0.94	***	11.74	1.17	***	3.41	0.82	***	0.07	0.01	***	0.07	0.01	***
Reading scores				0.68	0.01	***				0.78	0.00	***				0.00	0.00	***

D. Reading science books

	Science books: Mathematics									Science books: Science									Science books: STEM expectations								
	Model 1			Model 2			Model 3			Model 1			Model 2			Model 3			Model 1			Model 2			Model 3		
	Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE	
Intercept	462.23	1.23	***	424.99	4.42	***	122.68	5.13	***	463.28	0.99	***	430.55	3.73	***	81.46	3.13	***	0.18	0.00	***	0.06	0.02	***	-0.14	0.03	***
Sci kits: sometimes	9.86	1.30	***	6.37	1.31	***	2.23	1.35	*	12.24	0.95	***	8.69	0.94	***	3.91	0.87	***	0.02	0.01	***	0.01	0.01	**	0.01	0.01	*
Sci kits: regularly	20.45	1.55	***	13.94	1.54	***	3.46	1.34	**	27.63	1.44	***	21.18	1.39	***	9.06	1.02	***	0.05	0.01	***	0.02	0.01	***	0.02	0.01	*
Sci kits: very often	34.79	2.52	***	26.42	2.47	***	8.60	1.86	***	43.16	2.46	***	34.78	2.34	***	14.20	1.49	***	0.10	0.01	***	0.07	0.01	***	0.06	0.01	***
Sex (1=boy)				15.32	0.86	***	24.44	0.78	***				12.65	0.97	***	23.18	0.91	***				0.13	0.00	***	0.14	0.00	***
Early child edu: <1 year				-19,74	3,05	***	-3.60	2.28					-24.65	2.73	***	-6.03	2.35	**				-0.01	0.01		0.00	0.01	
Early child edu: 1-2 years				2,82	1.84		-0.25	2.03					-0.37	1.63		-3.90	1.78	**				0.02	0.01	*	0.01	0.01	
Early child edu: 2-3 years				7,46	1.62	***	2.91	1.77	*				2.57	1.27	***	-2.68	1.37	**				0.02	0.01	**	0.02	0.01	***
Early child edu: 3-4 years				8,79	1.49	***	3.12	1.46	**				4.26	1.26	***	-2.30	1.07	**				0.02	0.01	**	0.01	0.01	*
Early child edu: 4-5 years				2,04	1.77		0.96	1.50					-1.56	1.56		-2.81	1.20	**				0.02	0.01	***	0.02	0.01	***
Early child edu: 5-6 years				-4,37	3.26		-0.74	2.83					-8.02	2.64	***	-3.84	1.94	**				0.01	0.01		0.01	0.01	
Early child edu: 6-7 years				-22,47	5.99	***	-6.11	6.20					-26.78	5.48	***	-7.90	4.67	*				0.02	0.03		0.03	0.03	
Early child edu: 7-8 years				-20,79	16.03		5.28	11.88					-23.67	12.00	**	6.43	6.91					0.00	0.05		0.02	0.05	
Early child edu: >8 years				-41,42	28.53		9.53	25.80					-68.13	21.90	***	-9.30	17.97					-0.13	0.10		-0.10	0.11	
Books at home: 11-25				4.56	1.89	**	-1.18	1.73					8.04	1.29	***	1.42	0.90					0.02	0.01	***	0.02	0.01	**
Books home: 26-100				19.96	1.31	***	4.91	1.05	***				21.49	1.35	***	4.10	0.96	***				0.03	0.01	***	0.02	0.01	***
Books home: 101-200				27,44	1.52	***	6.59	1.29	***				30.91	1.51	***	6.83	1.09	***				0.04	0.01	***	0.02	0.01	**
Books home: >200				40.32	1.52	***	11.27	1.30	***				44.28	1.62	***	10.74	1.24	***				0.05	0.01	***	0.03	0.01	***
Parental edu: ISCED 1				0,48	4.36		1.95	3.95								-0.64	3.40					0.03	0.02		0.03	0.02	
Parental edu: ISCED 2				8,41	4.30	*	3.88	4.36					-2.34	4.24		0.49	2.74					0.01	0.02		0.01	0.02	
Parental edu: ISCED 3B-C				9,09	4.08	***	2.56	4.07					5.72	3.66		3.04	2.70					-0.01	0.02		-0.01	0.02	
Parental edu: ISCED 3A-4				12,41	3.79	***	3.42	3.66					10.58	3.78	***	1.45	3.00					0.01	0.02		0.00	0.02	
Parental edu: ISCED 5B				10,53	4.06	**	4.35	3.88					11.84	3.46	***	2.98	2.76					0.01	0.02		0.01	0.02	

Parental edu: ISCED 5A6	12,55	3.98	***	6.35	3.89	*		10.11	3.64	***	2.83	2.84		0.01	0.02		0.01	0.02	
Immigrant: first gen	-21.22	2.69	***	-4.27	2.17	**	9.99	3.51	***	***	-2.77	1.66	*	0.04	0.01	***	0.05	0.01	***
Immigrant: second gen	-16,67	2.14	***	-7.32	1.98	***		-22.23	1.97	***	- 11.42	1.74	***	0.02	0.01	**	0.03	0.01	***
Parental STEM occup.	10,28	1.15	***	3.16	0.94	***		11.72	1.17	***	3.50	0.82	***	0.07	0.01	***	0.07	0.01	***
Reading scores	424,99	4.42	***	0.68	0.01	***					0.78	0.00	***				0.00	0.00	***

Source: Self-elaborated from PISA-2015 data.

Table A.4. Model 4. Full results, pooled sample.

A. Playing brick games

	Mathematics			Science			STEM Expectations		
	Beta	SE		Beta	SE		Beta	SE	
Sex (1=boy)	22.87	0.82	***	22.31	0.90	***	0.13	0.01	***
Many brick games	2.25	1.26	*	3.62	0.73	***	0.01	0.01	**
Sex * many brick games	3.65	1.21	***	2.29	0.91	**	0.02	0.01	**
Early child edu: <1 year	-3.59	2.29		-5.95	2.37	**	0.00	0.01	
Early child edu: 1-2 years	-0.16	2.03		-3.80	1.78	**	0.02	0.01	
Early child edu: 2-3 years	2.94	1.77	*	-2.64	1.37	*	0.02	0.01	**
Early child edu: 3-4 years	3.14	1.46	**	-2.32	1.07	**	0.01	0.01	*
Early child edu: 4-5 years	0.97	1.51		-2.83	1.21	**	0.02	0.01	***
Early child edu: 5-6 years	-0.80	2.82		-3.96	1.94	**	0.01	0.01	
Early child edu: 6-7 years	-6.14	6.24		-7.93	4.66	*	0.03	0.03	
Early child edu: 7-8 years	5.37	11.82		6.45	6.95		0.02	0.05	
Early child edu: >8 years	9.30	25.91		-10.43	18.04		-0.10	0.10	
Books at home: 11-25	-1.15	1.73		1.54	0.89	*	0.02	0.01	**
Books at home: 26-100	4.92	1.07	***	4.32	0.97	***	0.02	0.01	***
Books at home: 101-200	6.71	1.29	***	7.28	1.09	***	0.02	0.01	***
Books at home: >200	11.50	1.29	***	11.50	1.24	***	0.03	0.01	***
Parental edu: ISCED 1	1.87	3.95		-0.87	3.41		0.03	0.02	
Parental edu: ISCED 2	3.78	4.37		0.24	2.75		0.01	0.02	
Parental edu: ISCED 3B-C	2.37	4.08		2.71	2.70		-0.01	0.02	
Parental edu: ISCED 3A-4	3.28	3.68		1.19	3.00		0.00	0.02	
Parental edu: ISCED 5B	4.26	3.90		2.87	2.76		0.01	0.02	
Parental edu: ISCED 5A6	6.23	3.90		2.70	2.84		0.01	0.02	
Immigrant: first gen	-3.97	2.17	*	-2.18	1.68		0.06	0.01	***
Immigrant: second gen	-7.05	1.99	***	-10.97	1.75	***	0.03	0.01	***

B. Playing science related videogames

	Mathematics			Science			STEM Expectations		
	Beta	SE		Beta	SE		Beta	SE	
Sex (1=boy)	24.63	0.81	***	23.53	0.94	**	0.13	0.00	***
Many sci videogames	0.03	1.60		2.96	1.18	**	-0.02	0.01	***
Sex * many sci video	0.72	2.05		0.96	1.42		0.07	0.01	***
Early child edu: <1 year	-3.54	2.28		-5.88	2.37	**	0.00	0.01	
Early child edu: 1-2 years	-0.26	2.03		-3.90	1.78	**	0.01	0.01	
Early child edu: 2-3 years	2.92	1.78	*	-2.64	1.37	*	0.02	0.01	**
Early child edu: 3-4 years	3.11	1.46	**	-2.31	1.08	**	0.01	0.01	*
Early child edu: 4-5 years	1.00	1.50		-2.78	1.21	**	0.02	0.01	***
Early child edu: 5-6 years	-0.82	2.81		-3.98	1.94	**	0.01	0.01	
Early child edu: 6-7 years	-6.07	6.21		-7.89	4.64	*	0.03	0.03	
Early child edu: 7-8 years	5.34	11.82		6.41	6.92		0.02	0.05	
Early child edu: >8 years	8.74	25.74		-10.65	18.18		-0.10	0.10	
Books at home: 11-25	-1.06	1.73		1.62	0.89	*	0.02	0.01	**
Books at home: 26-100	5.12	1.07	***	4.51	0.97	***	0.02	0.01	***
Books at home: 101-200	6.94	1.30	***	7.49	1.09	***	0.02	0.01	***
Books at home: >200	11.86	1.31	***	11.84	1.24	***	0.03	0.01	***
Parental edu: ISCED 1	1.79	3.95		-0.95	3.40		0.03	0.02	
Parental edu: ISCED 2	3.78	4.36		0.23	2.74		0.01	0.02	
Parental edu: ISCED 3B-C	2.48	4.08		2.74	2.69		-0.01	0.02	
Parental edu: ISCED 3A-4	3.34	3.67		1.17	2.99		0.00	0.02	
Parental edu: ISCED 5B	4.39	3.89		2.90	2.75		0.01	0.02	
Parental edu: ISCED 5A-6	6.38	3.88	*	2.70	2.83		0.01	0.02	
Immigrant: first gen	-4.02	2.16	*	-2.38	1.69		0.05	0.01	***
Immigrant: second gen	-7.22	1.98	***	-11.26	1.74	***	0.03	0.01	***

Parental STEM occup.	3.16	0.94	***	3.49	0.82	***	0.07	0.01	***
Reading scores	0.68	0.01	***	0.78	0.00	***	0.00	0.00	***
Intercept	122.73	4.87	***	81.81	3.28	***	-0.14	0.03	***

Parental STEM occup.	3.17	0.94	***	3.46	0.83	***	0.07	0.01	***
Reading scores	0.68	0.01	***	0.78	0.00	***	0.00	0.00	***
Intercept	123.2	4.94	***	82.41	3.26	***	-0.13	0.03	***

C. Playing science kits

	Mathematics			Science			STEM Expectations		
	Beta	SE		Beta	SE		Beta	SE	
Sex (1=boy)	24.28	0.78	***	23.23	0.97	***	0.13	0.00	***
Many brick games	3.42	1.89	*	5.01	1.38	***	0.00	0.01	
Sex * many brick games	2.56	2.01		2.91	1.86		0.06	0.01	***
Early child edu: <1 year	-3.52	2.28		-5.88	2.37	**	0.00	0.01	
Early child edu: 1-2 years	-0.26	2.03		-3.89	1.79	**	0.01	0.01	
Early child edu: 2-3 years	2.92	1.77	*	-2.64	1.37	*	0.02	0.01	**
Early child edu: 3-4 years	3.10	1.46	**	-2.34	1.08	**	0.01	0.01	*
Early child edu: 4-5 years	1.02	1.51		-2.74	1.21	**	0.02	0.01	***
Early child edu: 5-6 years	-0.86	2.82		-4.01	1.95	**	0.01	0.01	
Early child edu: 6-7 years	-6.34	6.18		-8.22	4.60	*	0.02	0.03	
Early child edu: 7-8 years	5.43	11.85		6.62	6.91		0.02	0.05	
Early child edu: >8 years	9.10	25.77		-10.38	18.15		-0.10	0.11	
Books at home: 11-25	-1.06	1.74		1.64	0.89	*	0.02	0.01	**
Books at home: 26-100	5.06	1.07	***	4.47	0.97	***	0.02	0.01	***
Books at home: 101-200	6.82	1.30	***	7.39	1.08	***	0.02	0.01	***
Books at home: >200	11.61	1.31	***	11.56	1.24	***	0.03	0.01	***
Parental edu: ISCED 1	1.72	3.95		-1.01	3.40		0.03	0.02	
Parental edu: ISCED 2	3.74	4.37		0.23	2.75		0.01	0.02	
Parental edu: ISCED 3B-C	2.38	4.08		2.74	2.70		-0.01	0.02	
Parental edu: ISCED 3A-4	3.23	3.67		1.15	3.00		0.00	0.02	
Parental edu: ISCED 5B	4.22	3.89		2.82	2.77		0.01	0.02	

D. Reading science related books

	Mathematics			Science			STEM Expectations		
	Beta	SE		Beta	SE		Beta	SE	
Sex (1=boy)	24.43	0.84	***	23.06	0.90	***	0.14	0.00	***
Many sci videogames	2.69	1.35	**	6.33	1.21	***	0.00	0.01	
Sex * many sci video	1.25	1.70		2.92	1.45	**	0.03	0.01	**
Early child edu: <1 year	-3.56	2.28		-5.96	2.36	**	0.00	0.01	
Early child edu: 1-2 years	-0.29	2.03		-3.97	1.78	**	0.01	0.01	
Early child edu: 2-3 years	2.89	1.77		-2.71	1.37	**	0.02	0.01	**
Early child edu: 3-4 years	3.11	1.46	**	-2.31	1.07	**	0.01	0.01	*
Early child edu: 4-5 years	0.99	1.50		-2.78	1.20	**	0.02	0.01	***
Early child edu: 5-6 years	-0.81	2.82		-3.95	1.93	**	0.01	0.01	
Early child edu: 6-7 years	-6.01	6.22		-7.75	4.67	*	0.03	0.03	
Early child edu: 7-8 years	5.52	11.84		6.91	6.95		0.02	0.05	
Early child edu: >8 years	9.03	25.71		-10.13	18.15		-0.10	0.11	
Books at home: 11-25	-1.09	1.74		1.56	0.90	*	0.02	0.01	**
Books at home: 26-100	5.03	1.07	***	4.33	0.96	***	0.02	0.01	***
Books at home: 101-200	6.77	1.29	***	7.16	1.08	***	0.02	0.01	***
Books at home: >200	11.55	1.30	***	11.19	1.23	***	0.03	0.01	***
Parental edu: ISCED 1	1.84	3.95		-0.79	3.41		0.03	0.02	
Parental edu: ISCED 2	3.84	4.36		0.43	2.75		0.01	0.02	
Parental edu: ISCED 3B-C	2.54	4.08		3.00	2.71		-0.01	0.02	
Parental edu: ISCED 3A-4	3.41	3.67		1.45	3.00		0.00	0.02	
Parental edu: ISCED 5B	4.40	3.88		3.06	2.76		0.01	0.02	

Parental edu: ISCED 5A6	6.20	3.89		2.66	2.85		0.01	0.02		Parental edu: ISCED 5A-6	6.39	3.89	*	2.91	2.83		0.01	0.02	
Immigrant: first gen	-4.01	2.16	*	-2.23	1.68		0.06	0.01	***	Immigrant: first gen	-4.12	2.17	*	-2.52	1.69		0.05	0.01	***
Immigrant: second gen	-7.20	1.98	***	-11.15	1.75	***	0.03	0.01	***	Immigrant: second gen	-7.28	1.98	***	-11.38	1.74	***	0.03	0.01	***
Parental STEM occup.	3.12	0.94	***	3.45	0.82	***	0.07	0.01	***	Parental STEM occup.	3.17	0.94	***	3.54	0.82	***	0.07	0.01	***
Reading scores	0.68	0.01	***	0.78	0.00	***	0.00	0.00	***	Reading scores	0.68	0.01	***	0.78	0.00	***	0.00	0.00	***
Intercept	123.31	4.96	***	82.55	3.29	***	-0.13	0.03	***	Intercept	123.46	5.00	***	82.97	3.24	***	-0.13	0.03	***

Source: Self-elaborated from PISA-2015 data.

Table A.5. Effect by gender of science related leisure time activities at age 10 on maths and science performance and STEM expectations at age 15 (model 4), by countries

A. Playing brick games

	Mathematics									Science									STEM career expectations								
	Sex			Many brick games			Sex x many brick			Sex			Many brick games			Sex x many brick			Sex			Many brick games			Sex x many brick		
	Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Coef	SE		Beta	SE		Beta	SE		Beta	SE	
BEL	26.83	2.50	***	2.22	2.82		1.56	3.30		22.35	1.98	***	4.19	2.66		2.59	2.66										
CHL	24.86	2.70	***	1.51	3.30		0.97	3.16		21.55	2.21	***	3.18	1.80	*	2.03	2.51		0.15	0.02	***	0.02	0.02		0.02	0.03	
DEU	29.89	2.60	***	5.36	3.13	*	4.99	4.22		26.31	2.14	***	5.77	2.68	**	5.17	3.62		0.05	0.01	***	0.02	0.01		0.04	0.02	*
DOM	14.25	2.64	***	1.26	3.02		2.44	3.24		22.07	2.40	***	3.94	2.16	*	2.40	2.80		0.22	0.02	***	-0.01	0.02		0.03	0.03	
ESP	31.62	2.71	***	0.86	4.52		0.10	3.56		24.00	2.79	***	4.59	3.21		1.40	2.68		0.09	0.01	***	0.00	0.02		0.07	0.02	***
FRA	25.47	3.00	***	-1.00	2.73		3.70	2.90		23.44	2.44	***	3.28	2.37		2.47	2.51		0.11	0.01	***	0.00	0.01		0.04	0.02	
GBR	22.55	3.39	***	-6.64	5.40		2.07	5.54		18.76	2.50	***	2.73	4.19		3.43	5.04		0.12	0.02	***	-0.02	0.03		0.07	0.03	**
GEO	25.45	3.55	***	9.38	4.11	**	4.13	5.08		16.90	3.46	***	4.39	4.15		6.79	4.91		0.04	0.01	***	0.04	0.02	*	-0.03	0.03	
HKG	26.96	3.61	***	3.83	3.34		-2.79	3.78		22.42	2.37	***	1.16	2.68		0.73	2.86		0.07	0.01	***	0.04	0.01	**	0.00	0.02	
HRV	31.19	3.67	***	-2.52	2.22		2.86	3.19		26.93	2.39	***	0.79	2.03		1.99	2.71		0.08	0.02	***	0.02	0.01	*	0.02	0.02	
IRL	23.37	2.56	***	3.00	2.03		0.30	2.83		19.21	2.42	***	5.83	2.06	***	1.34	2.50		0.09	0.02	***	0.02	0.02		0.05	0.02	**
ITA	23.21	2.45	***	-0.09	4.07		4.42	4.09		21.64	2.82	***	0.81	3.39		5.73	3.33	*	0.06	0.01	***	0.01	0.01		0.01	0.02	
KOR	23.04	3.86	***	4.63	3.26		0.31	3.45		24.85	3.24	***	9.54	2.78	***	-4.36	3.30		0.11	0.02	***	0.01	0.02		0.03	0.02	
LUX	25.14	3.71	***	4.88	2.87	*	3.01	3.32		21.85	2.33	***	4.14	2.58		7.15	2.62	***	0.07	0.01	***	0.00	0.02		0.09	0.02	***
MAC	16.35	2.60	***	1.33	3.21		-6.40	4.39		21.83	1.92	***	1.17	2.65		-2.16	2.94		0.09	0.01	***	0.00	0.01		0.03	0.02	
MEX	17.25	1.95	***	3.11	3.34		4.47	3.15		19.29	1.66	***	2.28	2.04		2.19	2.65		0.21	0.01	***	0.03	0.02		0.02	0.03	
MLT	25.10	8.33	***	1.19	4.62		2.10	5.04		18.77	7.36	**	7.14	4.25	*	0.35	4.37		0.18	0.05	***	0.02	0.02		0.03	0.03	
PRT	24.33	3.77	***	3.09	2.43		-0.01	3.87		26.95	2.53	***	4.27	2.27	*	-3.86	2.78		0.11	0.02	***	-0.02	0.02		0.07	0.03	**

B. Playing science-related videogames

	Mathematics									Science									STEM career expectations									
	Sex			Many video games			Sex x many video			Sex			Many video games			Sex x many video			Sex			Many video games			Sex x many video		
	Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Coef	SE		Beta	SE		Beta	SE		Beta	SE	
BEL	28,00	1,99	***	3.09	5.11		1.93	6.06		23.28	2.04	***	1.69	3.69		8.67	4.77	*									
CHL	25,24	2,10	***	8.04	3.25	**	-0.33	3.70		22.57	2.14	***	5.09	2.74	*	0.78	3.41		0.16	0.01	***	0.02	0.02		0.00	0.03	
DEU	31,95	2,92	***	-6.28	5.69		11.40	7.09		28.53	1.93	***	0.81	5.75		11.05	6.73	*	0.07	0.01	***	0.00	0.03		0.09	0.04	**
DOM	15,35	2,24	***	1.39	2.92		0.12	3.17		23.57	2.20	***	2.74	3.03		-1.00	3.19		0.22	0.02	***	-0.03	0.02		0.06	0.03	*
ESP	30,91	2,63	***	6.35	4.99		3.57	5.04		24.39	2.76	***	6.33	4.30		2.34	4.34		0.10	0.01	***	0.03	0.02		0.06	0.03	*
FRA	26,79	2,68	***	-2.42	5.68		4.74	6.37		24.91	2.42	***	5.46	4.81		3.72	5.60		0.12	0.01	***	0.02	0.03		0.01	0.04	
GBR	22,65	3,05	***	4.03	7.93		-4.86	9.94		20.03	2.26	***	15.90	6.55	**	-6.64	7.46		0.14	0.02	***	-0.01	0.04		0.07	0.05	
GEO	27,60	3,35	***	-3.11	3.25		2.35	4.16		19.92	3.36	***	-3.46	4.28		-0.05	5.05		0.04	0.01	***	0.01	0.02		0.00	0.02	
HKG	25,96	3,37	***	1.78	4.41		1.59	5.19		22.27	2.28	***	6.43	3.24	**	0.07	3.67		0.07	0.01	***	0.00	0.02		0.03	0.03	
HRV	32,53	3,26	***	-0.26	4.25		0.75	5.31		28.07	2.38	***	0.59	3.25		0.81	4.60		0.08	0.01	***	0.00	0.02		0.03	0.03	
IRL	23,69	2,53	***	-0.09	3.29		1.92	4.18		20.29	2.14	***	8.60	3.83	**	1.71	4.56		0.11	0.02	***	0.01	0.03		0.08	0.04	**
ITA	25,07	2,25	***	-3.66	3.75		1.42	4.45		24.12	2.21	***	0.83	3.00		2.06	4.34		0.06	0.01	***	0.00	0.02		0.03	0.02	
KOR	24,93	3,58	***	-3.16	5.45		-3.91	6.66		25.22	2.76	***	4.34	5.41		-5.31	6.05		0.12	0.01	***	-0.02	0.02		0.09	0.03	***
LUX	26,78	3,57	***	0.77	5.89		0.30	7.14		25.29	2.20	***	9.81	4.31	**	-4.02	5.41		0.10	0.01	***	0.00	0.03		0.04	0.05	
MAC	14,49	2,22	***	0.72	4.46		-1.08	4.89		21.60	1.81	***	0.10	2.84		-1.81	3.74		0.10	0.01	***	-0.02	0.02		0.00	0.02	
MEX	18,29	1,78	***	-1.16	3.60		4.49	3.85		19.58	1.67	***	0.68	2.29		3.46	2.69		0.21	0.01	***	-0.04	0.02	**	0.06	0.03	*
MLT	27,40	8,62	***	12.73	5.65	**	-4.85	7.58		21.10	7.38	***	15.27	5.70	***	-4.57	7.54		0.21	0.05	***	0.04	0.03		-0.03	0.04	
PRT	24,40	3,05	***	-3.53	3.51		0.43	4.58		24.97	1.79	***	6.62	2.29	***	-2.54	3.35		0.14	0.01	***	0.01	0.02		0.04	0.02	*

C. Using science kits

	Mathematics									Science									STEM career expectations								
	Sex			Many science kits			Sex x many kits			Sex			Many science kits			Sex x many kits			Sex			Many science kits			Sex x many kits		
	Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Coef	SE		Beta	SE		Beta	SE		Beta	SE	
BEL	27.25	2.02	***	6.57	5.23		2.98	5.59		23.26	1.98	***	5.96	4.83		6.57	4.91										
CHL	24.90	2.24	***	-0.73	4.93		5.10	6.07		22.11	2.06	***	0.74	4.06		6.28	5.30		0.15	0.01	***	0.03	0.03		0.02	0.03	
DEU	32.41	2.90	***	-1.48	5.72		4.34	6.48		28.52	1.91	***	-1.28	5.21		10.68	6.04	*	0.07	0.01	***	0.06	0.04		0.01	0.04	
DOM	15.23	2.31	***	0.79	5.10		0.85	5.72		23.31	2.04	***	8.35	3.75	**	-2.28	5.03		0.24	0.01	***	0.03	0.04		-0.05	0.05	
ESP	31.35	2.54	***	3.44	4.77		2.99	5.25		24.51	2.85	***	8.11	3.90	**	2.89	4.88		0.10	0.01	***	0.00	0.02		0.09	0.04	**
FRA	26.78	2.80	***	2.33	5.00		1.91	4.78		24.40	2.58	***	3.79	3.06		5.72	4.08		0.11	0.01	***	0.00	0.02		0.07	0.03	**
GBR	21.93	3.03	***	-3.87	7.61		4.96	8.93		19.54	2.17	***	1.88	6.94		8.09	7.91		0.14	0.01	***	-0.01	0.05		0.08	0.06	
GEO	27.18	3.38	***	5.93	5.57		5.28	7.29		18.89	3.16	***	4.08	5.68		4.45	7.36		0.04	0.01	***	0.01	0.03		0.00	0.04	
HKG	26.49	3.49	***	4.16	6.09		-1.43	7.18		22.64	2.30	***	3.96	4.68		0.87	5.08		0.07	0.01	***	-0.03	0.02		0.08	0.04	*
HRV	32.22	3.13	***	-5.35	5.15		6.53	6.09		27.70	2.15	***	3.43	4.74		3.70	5.72		0.09	0.01	***	0.03	0.03		0.00	0.04	
IRL	24.06	2.41	***	3.52	4.21		-0.71	4.23		20.43	2.12	***	8.39	3.30	**	2.13	3.79		0.12	0.02	***	0.08	0.02	***	0.01	0.03	
ITA	24.43	2.29	***	2.45	5.86		4.61	6.26		23.56	2.14	***	4.95	3.64		3.88	4.16		0.05	0.01	***	-0.02	0.02		0.08	0.03	***
KOR	23.23	3.86	***	4.82	5.43		2.28	6.29		23.82	2.79	***	12.85	4.42	***	-3.11	5.99		0.12	0.01	***	0.03	0.03		0.04	0.03	
LUX	26.59	3.57	***	3.92	7.72		3.68	7.47		25.20	2.20	***	13.15	5.19	**	-3.43	6.01		0.10	0.01	***	0.05	0.04		0.01	0.05	
MAC	14.90	2.16	***	-3.16	7.69		-3.29	9.43		21.69	1.78	***	1.94	6.13		-7.01	6.42		0.10	0.01	***	-0.01	0.03		-0.01	0.04	
MEX	18.77	1.79	***	4.51	3.90		1.92	4.29		19.98	1.63	***	3.02	2.77		1.88	3.43		0.21	0.01	***	-0.01	0.02		0.07	0.03	**
MLT	26.37	8.76	***	8.83	6.72		-2.36	8.16		20.41	7.42	***	20.50	6.61	***	-7.87	7.39		0.19	0.05	***	0.01	0.04		0.06	0.06	
PRT	23.61	2.80	***	1.72	4.44		5.67	5.77		24.27	1.69	***	8.78	3.92	**	1.08	4.40		0.14	0.01	***	0.01	0.02		0.05	0.04	

D. Reading science books

	Mathematics									Science									STEM career expectations								
	Sex			Many science books			Sex x many books			Sex			Many science books			Sex x many books			Sex			Many science books			Sex x many books		
	Beta	SE		Beta	SE		Beta	SE		Beta	SE		Beta	SE		Coef	SE		Beta	SE		Beta	SE		Beta	SE	
BEL	27.41	1.89	***	1.32	6.77		5.66	6.56		23.35	1.99	***	9.20	5.18	*	5.64	5.72										
CHL	25.04	2.22	***	-2.12	4.72		4.02	4.40		22.33	2.03	***	3.01	3.12		4.40	3.84		0.15	0.01	***	0.01	0.02		0.03	0.04	
DEU	32.44	2.80	***	-5.19	5.46		4.85	5.78		28.25	1.84	***	4.54	5.35		8.13	5.25		0.06	0.01	***	0.02	0.03		0.07	0.04	*
DOM	15.19	2.39	***	-2.89	3.10		0.62	4.02		22.82	2.13	***	-0.69	3.00		3.04	3.40		0.24	0.02	***	0.00	0.02		-0.03	0.04	
ESP	31.36	2.61	***	7.94	5.34		2.62	6.53		24.63	2.82	***	8.22	4.60	*	2.66	5.15		0.11	0.01	***	0.03	0.02		-0.01	0.04	
FRA	27.00	2.66	***	-0.54	5.42		1.39	4.78		24.33	2.48	***	10.22	3.91	***	3.03	3.85		0.12	0.01	***	0.04	0.03		-0.01	0.03	
GBR	22.08	3.00	***	-7.88	6.88		5.83	9.26		19.19	2.22	***	8.55	7.05		10.71	8.59		0.14	0.01	***	-0.03	0.05		0.08	0.06	
GEO	27.47	3.15	***	3.09	3.45		1.94	4.71		19.78	3.22	***	10.92	3.42	***	-1.75	5.84		0.04	0.01	***	0.01	0.02		-0.03	0.03	
HKG	26.49	3.30	***	2.82	4.04		-1.33	5.26		22.30	2.18	***	12.13	3.89	***	-3.12	4.19		0.07	0.01	***	0.00	0.02		0.03	0.03	
HRV	33.06	2.99	***	-2.72	4.57		-2.08	6.40		27.87	2.10	***	6.56	4.35		0.87	5.31		0.09	0.01	***	-0.02	0.03		0.03	0.04	
IRL	23.51	2.36	***	-0.97	4.13		5.14	4.35		19.96	2.09	***	10.09	3.68	***	4.67	4.51		0.12	0.02	***	0.02	0.03		0.04	0.05	
ITA	24.51	2.37	***	3.43	3.82		4.42	5.10		23.33	2.17	***	7.45	3.85	*	4.87	4.07		0.06	0.01	***	0.01	0.03		0.02	0.03	
KOR	23.48	3.89	***	4.02	4.42		1.27	5.01		23.12	2.86	***	11.70	3.14	***	1.17	4.05		0.11	0.01	***	0.02	0.02		0.07	0.02	***
LUX	26.91	3.76	***	5.18	4.98		-0.92	6.33		25.10	2.27	***	12.52	4.54	***	-2.45	5.45		0.10	0.01	***	-0.01	0.03		0.02	0.04	
MAC	14.07	2.32	***	9.94	5.32	*	1.55	7.55		21.41	1.69	***	7.98	4.05	**	-3.43	4.88		0.10	0.01	***	-0.03	0.02		0.04	0.03	
MEX	18.51	1.88	***	1.99	2.89		3.01	3.81		19.75	1.51	***	1.47	2.31		2.88	2.99		0.22	0.01	***	0.00	0.02		-0.01	0.03	
MLT	25.62	8.52	***	17.65	6.86	**	-6.08	8.58		19.24	7.24	***	26.17	5.89	***	-10.24	7.55		0.20	0.05	***	0.00	0.04		0.03	0.05	
PRT	24.96	2.59	***	1.88	5.79		-3.66	7.10		24.76	1.56	***	9.68	3.99	**	-4.19	5.70		0.14	0.01	***	0.01	0.02		0.07	0.03	**

Source: Self-elaborated from PISA-2015 data.

Note: All the regressions include the controls included in model 4 (refer to table A2 for further reference).

Table A.6. Effect by gender of science related leisure time activities at preschool on maths and science performance in 4th Grade (model 4), by countries

	Mathematics									Science								
	Sex			Many brick games			Sex x many brick			Sex			Many brick games			Sex x many brick		
	Beta	SE	*p*	Beta	SE	*p*	Beta	SE	*p*	Beta	SE	*p*	Beta	SE	*p*	Coef	SE	*p*
HRV	11.82	3.13	***	5.53	2.77	*	-1.12	4.47		3.61	3.27		5.04	2.89		3.65	4.10	
GEO	-10.20	3.86	**	6.07	4.49		12.13	5.08	*	-13.81	4.73	**	6.09	5.07		15.28	5.48	**
DEU	9.03	2.68	**	3.05	2.56		-0.08	3.73		10.40	2.91	***	3.13	4.63		3.53	4.51	
HKG	11.73	2.70	***	6.07	3.12		3.42	4.97		9.68	2.85	**	2.99	4.10		8.56	5.92	
IRL	9.63	5.15		7.76	4.20		5.00	6.18		8.39	6.43		9.97	3.63	**	2.62	6.29	
ITA	10.67	4.03	**	6.99	3.74		0.74	4.33		10.62	5.17	*	5.49	4.25		0.54	5.42	
MLT	11.37	4.03	**	7.99	3.81	*	1.85	5.75		14.79	5.32	**	9.46	5.15		4.63	6.62	
PRT	7.17	4.43		-1.63	4.97		6.41	6.32		4.85	4.43		-0.58	4.61		8.78	6.02	
ESP	15.66	4.00	***	9.73	3.56	**	-5.23	4.72		13.80	3.86	***	8.24	4.00	*	-3.87	4.77	

Figure A.1. Scatter plot of the percentage of students who frequently played with building blocks at age 10 and the percentage of households with at least one parent working in a STEM occupation, by country

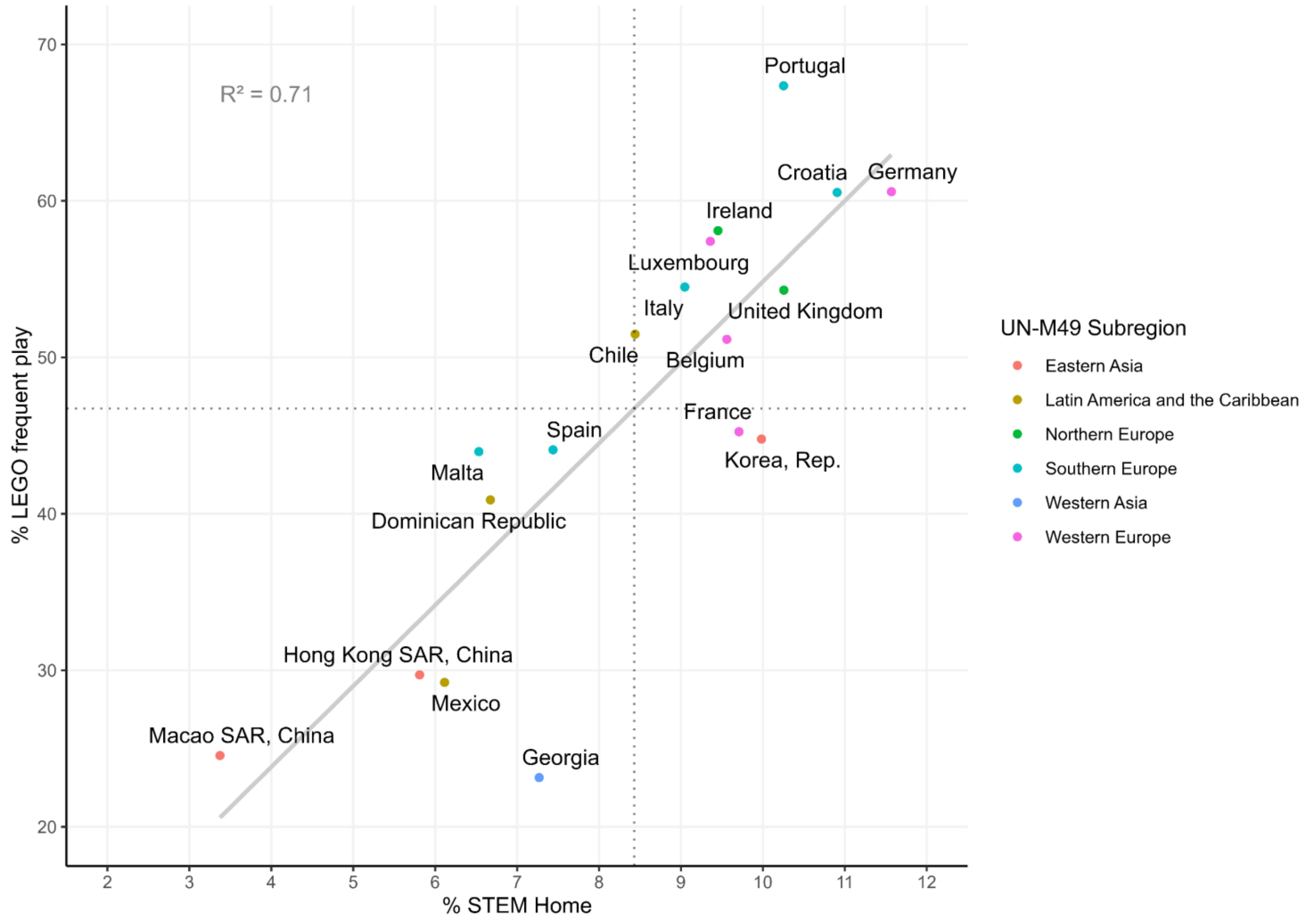

Figure A.2. Scatter plot of the gender gap in the percentage of students who frequently played with building blocks at age 10 and the gender gap in parents' STEM professions, by country