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The multidimensional nature of students' maturity: the Spanish case

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Abstract

Many research works have claimed the relevance that students' maturity may have in their academic achievement but, in spite of this importance, this maturity concept is not so easy to delimit and measure. Because of that, the current work proposes to measure students' maturity by three different proxies: the ages when children began to read and write, the bimester of birth and grade retention. To perform this analysis, a representative sample of primary (age 11-12) and secondary education (age 15-16) Andalusian students (the most populated region in Spain) was used. Our results have shown the unsuitability of the bimester of birth and the ages when children began to read and write as instruments for grade retention, which supports that the three measure different dimensions of students' maturity. In addition, results show that an early beginning in reading and writing positively associates with students' academic achievement.

Keywords: maturity; writing; reading; bimester of birth; grade retention.

JEL Codes: I20; I21; I28.

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1. Introduction

Many research works have pointed at students' maturity as a relevant characteristic which relates to their academic performance and future outcomes. In this sense, it has been found that the different maturity levels presented by students in OECD countries may have a significant long-term influence on their academic achievement (Bedard & Dhuey, 2006). Furthermore, doting students with enough maturity to choose their future career track supposes an essential objective in terms of socio-economic policies, due to the high costs triggered by students' dropout originated by inappropriate academic track elections, what becomes particularly problematic in a context of budgetary constraints. In this sense, Arce, Crespo, and Míguez-Álvarez (2015) indicated that dropout in the first University cycle in Spain – the country under scrutiny – meant a cost of 7,120 Euros per student (equivalent to 1,500 million Euros per year, in 2005 constant prices). What is more, when students do not possess the maturity and skills needed in the grade they are attending to, this could lead them to repeat a course (Agasisti & Cordero, 2017), which has been highlighted as one the most important predictors of dropping out (Eide & Showalter, 2001). This early leaving of compulsory education also involves a high cost for society, as many studies emphasize the positive correlation between education, productivity and economic growth (Asteriou & Agiomirgianakis, 2001; Cabus & De Witte, 2012). To the extent that early school-leaving translates into incomplete learning process – which is a proxy for populations' skills – it is also correlated with higher risk of long-term unemployment, intergenerational poverty or exclusion from society. Hence, all these relationships with students' maturity highlight its relevance for any society.

The relevance of this topic has also been highlighted by supranational organizations. For example, the European Union established in the Lisbon Agenda and in the "Horizon 2020" the design of policies aimed at reducing the early school leaving rate to 10%. Unfortunately, Spain – the country under analysis – is experiencing a rate which exceeds twice the European target, making the analyses of the contribution of maturity to academic achievement a key issue for the educational policy. Similarly, the United States passed the Title I, part A in 1965, in 2001 the "No Child Left Behind Act" and, recently, the "Every Student Succeeds Act" (2015), which are programs aimed at distributing public funding to schools and school districts with a high percentage of students from low-income families. This means the recognition of a clear link between socioeconomic status and academic achievement. Moreover, if the endowment of maturity among students from low and high socioeconomic backgrounds is uneven, this could contribute to deepening the already existing educational inequalities in the access to higher levels of education and social mobility (Agasisti & Cordero, 2013). In this context, we propose to analyse this maturity issue and its influence on students' academic achievement in the Spanish educational context. According to the obtained results, we will propose the design of educational policies to foster the development of students' maturity.

1.1. The delimitation of the concept of maturity

In spite of the relevance of this topic, maturity is not so easy to delimit and measure. In fact, it has been frequently proxied by students' **quarter of birth** (Alet, 2010), which is said to increase students' academic achievement when they have been born early in the year, while a late birth has a comparatively detrimental influence. Pedraja-Chaparro, Santín, and Simancas (2015) also stressed the higher likelihood of students who were born in the last months of the year in Spain and France of repeating a course – using data from the Programme for International Student Assessment (PISA) 2009. Similarly, Agasisti and Cordero (2013) considered students' age, together with grade retention – among other variables – for Spanish and Italian students, finding that students' age contributed to their higher achievement, but grade retention was harmful. This proxy of students' maturity has also been employed by some researchers to analyse how the attendance to previous courses of compulsory education (as early childhood education – before age 3 – or pre-primary education – age 3 to 5 –) might help to reduce the potential disadvantage that students who were born in the fourth quarter of the year

could present. In this regard, Hidalgo-Hidalgo and García-Pérez (2012) analysed the relationship of the attendance to pre-primary education with the negative influence that supposes being born in the fourth quarter of the year. They found that students who were born by that term and took these courses got better results, due to their help in overcoming – to some extent – the difficulties that they could be facing as a consequence of their maturity differences with older students in the classroom. Alternatively, González-Betancor and López-Puig (2015) studied the relationship of early childhood education and the quarter of birth in the education achievement of students in the fourth course of primary education. They found higher academic achievement of those students who had attended to kindergarten, which also helped students who were born in the fourth quarter of the year to obtain better academic achievement. In contrast, Elder and Lutobsky (2009) found that the positive relationship between the entrance age to kindergarten and students' primary school academic achievement was mainly due to the skills that older students acquired before kindergarten.

Focusing on the association of this quarter of birth (as a proxy for students' maturity) with students' academic performance along their academic progression, Ponzo and Scoppa (2014) analysed students of fourth, eight and tenth grade and emphasised that the lower scores of students born in the third and fourth quarter of the year – compared to older students – were kept during all the academic track of the student. A similar association was found by Gutiérrez-Domènech and Adserà (2012) for Catalan students in second, fourth and sixth grade. Likewise, Cunha, Heckman, Lochner, and Masterov (2006) indicated that differences in starting ages could perpetuate along the years, as older students are able to retain more skills than younger ones due to their maturity. Herbst and Strawiński (2016) analysed a recent reform in Poland which let parents enrol their children in the first grade at ages 6 or 7 (on their discretion), so that children in this course may have differences in ages of more than one-year timespan. They found that, although older students performed better than youngsters, this early start was beneficial for younger students, who caught up the older ones and closed the gap with them.

Another alternative in the literature to proxy students' maturity has been the use of **students' grade retention**. Nevertheless, its use entangles an important issue when employed to analyse its association with students' academic performance: the potential endogeneity problems which rise with the inclusion of repeater and non-repeater students in the same specification, due to the propensity of school failure and academic achievement to be simultaneously determined. In this sense, García-Pérez, Hidalgo-Hidalgo, and Robles-Zurita (2014) showed that students who repeat a course present the worst learning characteristics so, as these characteristics are unobservable, the obtained differences between repeaters and non-repeaters in academic achievement would be biased. Hence, these authors suggest using the quarter of birth as instrumental variable of grade retention. However, this has been highlighted by many international researches to be an imprecise instrument and a source of inconsistent estimates, because it does not satisfy the monotonicity property (Barua & Lang, 2016) – which is defined as "while the instrument may have no effect on some individuals, all of those who are affected should be affected unidirectionally". (Barua & Lang, 2016, p. 348). This is due to differences in school entry ages: as the legal entrance to the course is in September, children born in the first and second quarters of the year may be entering to the course with a higher age than those born in the last quarter and, then, with some "advantage". In addition, some parents may delay the entrance of the latter group of children for the next year in order to avoid this disadvantage. Thus, the quarter of birth may not be influencing in the same direction all individuals. In the same vein, Buckles and Hungerman (2013) also remarked that the quarter of birth is not a proper instrument, because it is conditioned by the fertility patterns that different family socio-economic backgrounds present.

An additional link between maturity and **learning to read and write** (R&W from now on) has been indicated by authors such as e.g., Neuman, Copple, and Bredekamp (2000) or Cohen and Cowen (2008). They claimed that childhood experiences, which can enhance maturity, may be influencing the development of children literacy skills – reading and writing –

since the very moment of their birth. This could be due to children learning literacy skills from different sources of their environment such as television, technological media, etc., what highlights the relevance of following children's maturity development from an early stage of their lives. In this sense, Cunha, Heckman, Lochner, and Masterov (2006) stated that education is a cumulative process which starts very early, even before when students attend to school for the first time. Hence, the ages of beginning to R&W may be gathering the kind of "mental age" maturity which is not gathered by the previously described other two proxies of maturity.

1.2. The approach on maturity of the present study

Building on the revision of the previous literature on the relationship between students' maturity and academic performance, the ***first contribution*** of the current research consists of disentangling the potential association with student's academic achievement of three different proxies for students' maturity, i.e., the bimester of birth[3], the ages at which the student learnt to read and write and students' grade retention. As the use of students' date of birth has been severely criticised as grade retention instrument, we propose to use it as a regressor together with the ages at which students began to R&W to check the robustness of our results. This will let us to control whether the association of the ages of beginning to R&W with students' academic achievement would be due to it properly proxying students' maturity or a consequence of the omission of the bimester of birth as other form of students' maturity. We find that both proxies of students' maturity are not significantly correlated, which highlights that they are measuring different dimensions of maturity: one related to students' intelligence and innate ability to learn (in the case of the ages of beginning to R&W) and the other to students' experience and age (the bimester of birth). These two concepts may be related to the two components of the traditional definition of the Intelligence Quotient (IQ), which are "mental age" – in case of the ages of beginning to R&W – and "chronological age" – for the bimester of birth"[4]. The third dimension of maturity under scrutiny is that related to academic content-based knowledge, which would be proxied by grade retention.

The ***second contribution*** of this research intends to deal with the previously indicated endogeneity problems that controlling by grade retention may add to our estimations when trying to disentangle the potentially different influences of the three proxies of maturity on students' academic performance. We propose to use the bimester of birth as instrument of grade retention, but it turned out to be a bad instrument (like some international studies highlighted; e.g. Buckles & Hungerman, 2013; Barua & Lang, 2016). This has discouraged its use for the purpose of analysing students' maturity. Furthermore, the use of the ages of beginning to R&W as an instrument has presented the same problems as the bimester of birth. These results support the argument of our first contribution, which states that the ages of beginning to R&W, the bimester of birth and grade retention may be measuring different dimensions of students' maturity. Therefore, due to the impossibility of solving endogeneity problems with the available data, we focus our attention on non-repeater students and the influences of the other two proxies of maturity (i.e. the bimester of birth and the ages of beginning to R&W) on their academic performance.

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[3] Bimester means a two-month period which gathers January with February, March with April, May with June, July with August, September with October, November with December. In this research, the bimester of birth has been employed instead of the quarter of birth, as it provides richer information while not compromising the degrees of freedom. However, every analysis in this research has also been performed with the quarter of birth and the results do not vary – these results will be provided upon request to the authors.

[4] Stern (1912) proposed the IQ concept as the quotient between "mental age" and "chronological age" (multiplied by 100). The concept of "chronological age" of a student corresponds to his/her actual age, while a subject's "mental age" is "(…) based on his or her performance compared with the average performance of individuals in a specific chronological age group. In simple terms, if a 6-year-old can perform the tasks that can be done by two-thirds to three-fourths of the representative group of 8-year-old children, then this child has a mental age of 8." (Kaplan & Saccuzzo, 2013, p. 241).

To estimate our empirical models, we have employed a representative sample of the most populated Spanish region (Andalusia) for students attending primary compulsory education (aged 11-12) and secondary compulsory education (aged 15-16). The relevance of studying this region can be found in that Andalusia was among the three worst performing Spanish regions in the three competences evaluated by PISA 2009 (in reading literacy, mathematics and science; MECD, 2010) – we are employing 2009 figures to the extent that our data is referred to this year, as we will see. Furthermore, this situation is more alarming when looking at Andalusian students' dropping out figures (students not finishing compulsory education), which are really high: 37.2%, which was 6.3% above the Spanish average in 2009 (IECA, 2019). Hence, our ***third contribution*** is to analyse the association of the proposed maturity proxies with students' academic performance for this Spanish region (a subject which, to the best of our knowledge, has not been explored for Spain yet) and also for students in different points of their academic track (primary and secondary education).

The rest of the research is structured as follows: first, we describe the data and methodology employed; then our main results are presented, followed by a discussion and conclusions.

2. Data

The dataset employed in this research is that from the survey Social Survey 2010: Education and Housing (ESOC10) conducted by the Andalusian Institute of Statistics (*Instituto de Estadística de Andalucía*, IECA). This survey is publicly available and comprises information on a wide set of personal, family and school environment characteristics for Andalusia, gathered by student, household and parental questionnaires. It was conducted in 2009/2010 among students born in 1998 (aged 11-12 at the moment of the survey, when they were attending sixth grade) and in 1994 (aged 15-16 at the moment of the survey, when they were attending tenth grade), and their families. In addition, this survey was linked to the results from the administrative records (SENECA) of teacher-based scores – provided by the Education Ministry of Andalusia (*Consejería de Educación de la Junta de Andalucía*) – and to the Andalusian diagnostic assessment tests (competence-based tests which are similar to those conducted by PISA) exclusively for the authors of this research study (for research purposes) and for the academic year 2009-10; this combined database has been renamed as ESOC10-SEN from now on. The employed sampling procedure was a stratified multistage sampling. Firstly, households were stratified in two subsamples, according to whether their children were born in 1994 or 1998. In each subsample a three-stage conglomerate sampling, with stratification in the first stage, was employed. The units of the first stage were composed by census sections, those of the second stage were households and, in the third stage, the child of the corresponding age group was selected. Finally, those students who presented some kind of disability or attended to private schools were not included. This left the database with a subsample of 1,597 observations for students born in 1994 and 1,868 for those born in 1998.

A set of variables which has been found in the Economics of Education literature as good predictors of students' academic achievement has been chosen for this research. Concretely, these variables are: students' sex, immigrant status, school funding (semi-private or public), education level of the father and the mother, the household level of income, the ages at which the student began to R&W and the bimester of birth, all of them from ESOC10. Specifically, the R&W question was asked in the parental questionnaire as: "In which age does the child began to: 1) read 2) write". Parents could answer with the number of years, the number of months, or any of the four following options: "He/she has not begun yet", "Do not know", "No answer" and "Not applicable". The information about grade retention was obtained from administrative records (SENECA)[5]. Although the variables on the ages when the student began

[5] Regarding the decision of grade retention, it is based on an objective criterion described in the education laws in Spain (BOE, 2006): students who fail a minimum of three subjects will have to repeat or, alternatively, those who fail two subjects, if these are reading and mathematics.

to R&W originally presented a continuous structure, they have been split into categories according to their distribution, in order to pick up their potential non-linearities. The results related to them should be taken with caution, as parents may not remember with a high precision the ages when their child began to R&W; however, the use of categories for these variables may solve in a certain way this parental memory issue. Furthermore, the concepts of reading and writing handled by parents may not be the same in all cases. However, in spite of these drawbacks, the lack of empirical applications which make use of these variables to analyse students' maturity (due to the difficulty to find a database which contains information about them) highlights the relevance and novelty of the current research.

As dependent variable, students' scores in diagnostic assessment tests were chosen, to the extent that they measure students' competences, which are more related to maturity than academic content-based knowledge in a certain subject (which is measured by administrative records of teacher-based scores). These scores in diagnostic assessment tests will be those referred to the linguistic communication and mathematical competences, which are measured in a scale with an average of 500 points and standard deviation of 100 points. In order to avoid losing observations due to individuals who did not provide information about their household income level, ages when their child began to R&W or the child's bimester of birth, we made use of a missing flag methodology. This missing flag methodology consists of recoding all missing information from the explanatory variables that present them to a value of "0", also including a missing flag variable in the estimation for each variable that has been recoded; these missing flag variables display the value "1" for those observations in which there was a missing value in the original variable, and a value of "0" otherwise. This methodology avoids losing observations due to missing values.

3. Methodology

The estimation procedure used in this research has been Ordinary Least Squares (OLS). First, it is necessary to highlight that we cannot control by all the variables which may explain students' academic achievement; hence, we are cautious and interpret our results as conditional associations rather than causal effects. Particularly, we analyse the association of students' maturity with students' academic achievement by estimating the following model:

$$Y_{ij} = \alpha + \beta R\&W_{ij} + \gamma X_{ij} + \delta SCH_j + \varepsilon_{ij} \quad (1)$$

where i represents students and j the school. Y_{ij} are, alternatively (in different specifications), students' standardised test scores in linguistic communication and mathematical competences. These scores have been standardised to have mean 0 and standard deviation 1, so they can be interpreted as effect sizes; $R\&W_{ij}$ are the categorical variables which represent the ages at which students learnt to R&W; these variables were included in alternative specifications in order to avoid the potential bias of the estimates when including them simultaneously; X_{ij} represents student and family characteristics (sex of the student, immigrant status, level of education of the father and the mother, monthly income level of the household); SCH_j are school characteristics (school funding: public or semi-private); α is a constant term and ε_{ij} is the idiosyncratic error term.

Then, as a final model to analyse the association of our proxies of maturity with students' academic achievement, we plug in both alternative specifications of R&W from equation (1) the bimester of birth (BB_{ij}), to determine whether its association with students' academic achievement would be taking part of that from the ages when the student began to R&W or not. Therefore, we estimate the following final model:

$$Y_{ij} = \alpha + \beta R\&W_{ij} + BB_{ij} + \gamma X_{ij} + \delta SCH_j + \varepsilon_{ij} \quad (2)$$

We focus on students born in 1994, as information about both non-repeaters and repeaters is only available for diagnostic assessment test scores in this cohort, so we can check whether grade retention could be considered as a third proxy for students' maturity or not.

Nevertheless, before including grade retention as control variable in our final model in equation (2), we need to start checking whether we can solve its endogeneity problems to the extent that, if we are not able to do this, we will get biased estimates for our complete model. As we will see in the Results' section (subsection 4.1), this is not possible, at least with the information in our database, so we will keep our model of equation (2) for non-repeater students as our final model and analyse it in subsection 4.2. We only have information of diagnostic assessment tests for non-repeater students in the cohort of students born in 1998[6], so it will be employed only to estimate our final model in equation (2), in order to see whether the influence of the ages of beginning to R&W and the bimester of birth on students' academic achievement appears at early ages or not.

4. Results

4.1. The use of grade retention as a third proxy of students' maturity

Table 1 presents the results for the main specification in the case of non-repeater and repeater students born in 1994, based on the model in equation (1), but not including $R\&W_{ij}$. This is because, firstly, we want to check if we can include non-repeaters and repeaters together in the same estimations, so that we can control by grade retention and check the three proxies of maturity at the same time. These results show that female students score 0.41 standard deviations (SD) higher than males in the linguistic communication competence and 0.10 SD lower than males in the mathematical competence (as indicated by OCDE, 2010). Furthermore, immigrant students present approximately between 0.35 and 0.39 SD lower results than natives in linguistic communication and mathematical competences, respectively (Calero, Choi, & Waisgrais, 2010), and attending to semi-private schools positively associates with academic results in both competences, compared to attending public schools. A high level of fathers' education positively associates with academic achievement in the linguistic communication competence (between 0.35 and 0.28 SD for university studies), while a high income level of the household has a positive association with the mathematical competence (until 0.25 SD for the highest level of household income). Mothers' high level of studies has a positive correlation with both competences (between 0.45 and 0.41 SD), as highlighted by authors as González and De la Rica (2016). In fact, PISA reports have highlighted this same result, claiming that, in Spain, those children whose parents have obtained only an elementary education level perform – in standardised tests – about one standard deviation below children from families with higher education studies (OECD, 2010).

-Insert Table 1-

Table 2 presents the same specification as in Table 1 but when the repeater condition – the dimension of maturity related to academic content-based knowledge – is controlled. These repeater students present a different education production function compared to non-repeaters, as repeater students have different characteristics that influence their own education attainment and, to the extent that these characteristics are unobservable, estimated differences in educational outcomes between repeaters and non-repeaters may be biased under OLS, so the grade retention control variable would be a stochastic regressor (García-Pérez, Hidalgo-Hidalgo, & Robles-Zurita, 2014). This problem is easily visible when taking into account that the inclusion of the grade retention control variable in Table 2 increases the R-squared of the estimations in more than 10%, together with the high and significant association with students' competences of the coefficient of this grade retention control variable (approximately between 0.80 and 0.90 SD) and the loss of significance in the rest of conditional variables. This means that, in order to control by grade retention in our model, we need to find a proper instrument for

[6] Although we have contextual information for this cohort of students, due to a change in the grades of application of diagnostic assessment tests we do not have information for repeater students born in 1998 for the linguistic communication and mathematical competence. Repeater students represent 8.07% of the total sample of students born in 1998.

it, which accomplishes the relevance requirement (to account for a significant variation in the endogenous variable) and the validity requirement (not being correlated to the error term).

As students could repeat one or more courses due to a delay in the acquisition of the necessary academic content-based knowledge (because of their late birth, i.e., bimester of birth) or due to their low mental maturity (proxied by the ages of beginning to R&W) it was checked whether or not these variables would be proper instruments for the repeater condition of students born in 1994. It was found that the bimester of birth satisfies the relevance requirement (to account for a significant variation in the endogenous variable, as it can be seen in Figure A1, Appendix) but not the validity requirement (not being correlated to the error term). Hence, when used as an instrument of grade retention in Two-Stage Least Squares (2SLS) estimations it does not work for the sample under analysis (also postestimation tests support this conclusion[7]), as highlighted in some international studies (Buckles & Hungerman, 2013; Barua & Lang, 2016) – these 2SLS estimations have not been included for reasons of space, but they will be provided upon request to the authors. In the case of alternatively using the ages of beginning to R&W as instruments for grade retention, both variables presented the same problems as the bimester of birth. This is because they accomplish the relevance requirement (as it can be seen for the age of beginning to read in Figure A2, Appendix; the age of beginning to write has not been presented to conserve space, but it will be provided upon request to the authors) but not the validity requirement. In addition, estimation results and postestimation tests do not recommend their use as instruments. Furthermore, there are not any other variables which could work as a proper instrument for grade retention in this database. Therefore, these results reinforce the argument which states that the ages of beginning to R&W, the bimester of birth and grade retention may be measuring different dimensions of students' maturity.

-Insert Table 2-

4.2. Main results for two proxies of students' maturity: the ages of beginning to R&W and the bimester of birth

As controlling by repeaters introduces endogeneity problems in our estimations, in the following the analysis will be focused on non-repeater students born in 1994. To perform this analysis, maturity will be proxied by the ages of beginning to R&W (i.e., "mental age") and the bimester of birth (i.e., "chronological age"), which will be sequentially included in the estimations. The results of a preliminary bivariate descriptive analysis are displayed in Table A1 (Appendix) and show that, for non-repeater students born in 1994, scores in the linguistic communication and mathematical competences present a decreasing trend with the ages of beginning to R&W, so a late start in these practices relates to lower scores in the two competences; same applies to those born in the last bimesters of the year.

These associations with academic achievement of the ages of beginning to R&W are corroborated when estimating Table 3, which presents the results of our model in equation (1), so the ages of beginning to R&W are alternatively included[8]. When students start soon with these practices this correlates with higher achievement in both competences – with the exception of writing for the mathematical competence. In addition, the association of a very early start (24 to 35 months) in reading and writing is even higher for both linguistic communication and mathematical competences (around 0.60 SD for the linguistic

[7] The association with students' academic achievement of grade retention control variable is almost tripled when it was instrumentalised with the bimester of birth. In addition, Durbin and Wu-Hausman endogeneity tests have been significant at 1%.

[8] Our sample is composed by 1,376 non-repeater students born in 1994. However, this figure is reduced to 1,218 students due to missing observations in the linguistic communication and mathematical competence variables. A test of mean differences between those non-repeater students who are dropped and those who are kept has been performed for the main variables in our analysis, and we do not find significant differences between them. These estimations will be provided by authors upon request.

communication competence and around 0.47 SD for the mathematical competence, except for early writing with the mathematical competence).

-Insert Table 3-

Table 4 includes as an additional control variable the bimester of birth of the student, as presented in our final model in equation (2). Being born in the five first bimesters has a positive association with students' academic achievement in the linguistic communication competence (between 0.32 and 0.22 SD), while only the first and fourth bimesters have a positive association with the mathematical competence (between 0.32 and 0.23 SD). From the view of these results – and comparing with Table 3 – it can be concluded that the bimester of birth does not take part of the association of the ages at which the student began to R&W with students' competences, what highlights the robustness of these estimates. Moreover, this result may be denoting that they are measuring different dimensions of students' maturity: on the one hand, that related to students' chronological age – the bimester of birth – and, on the other hand, that related to students' mental age – in the case of the ages of beginning to R&W. In addition, the bimester of birth has been included without the ages of beginning to R&W – keeping the rest of socio-economic variables of Table 1 – and its association with students' competences is similar to that shown in Table 4. These tables have not been included for reasons of space, but they will be provided upon request to the authors.

-Insert Table 4-

In the case of non-repeater students born in 1998, a preliminary bivariate descriptive analysis in Table A2 (Appendix) shows that scores in the linguistic communication and mathematical competences have a decreasing trend with the ages of beginning to R&W, so a late start in these practices relates to lower scores in the two competences; a similar trend is found for those born in the last bimesters of the year. Table 5 replicates the same specifications of Table 4 but for students born in 1998[9]. These results also support the positive association with students' competences of an early start in reading and writing (from around 0.38 to 0.19 SD for both ages). Focusing on the bimester of birth, the five first have a positive influence on students' linguistic communication and mathematical competences scores – from around 0.34 to 0.19 SD, with the exception of the fifth bimester for the linguistic communication competence. Hence, the association of the bimester of birth and the ages of beginning to R&W with students' competences are present for non-repeaters in primary education (those born in 1998) and for those in secondary education (those born in 1994), with similar effect sizes for both cohorts.

-Insert Table 5-

5. Discussion and conclusions

Maturity has been found in the literature as a relevant element to explain students' academic achievement. The ***first contribution*** of the current research work is to evaluate its association with three dimensions of students' maturity: the age at which the student learnt to R&W (proxying mental age), the bimester of birth (representing chronological age) and grade retention (maturity related to academic content-based knowledge). This distinction of maturity's dimensions has been reinforced by checking that both the bimester of birth and the ages of beginning to R&W are not proper "substitutes" or instruments of the repeater condition, which is the ***second contribution*** of the current research. Our main results have also corroborated that they represent different dimensions of students' maturity, as the bimester of birth and the ages of beginning to R&W do not seem to be correlated when included in the same specification. Finally, our ***third contribution*** is to analyse the association of the proposed maturity proxies

[9] Table 5 has also been estimated by only including the bimester of birth and, in other specifications, including alternatively the ages of beginning to R&W, as a robustness check – keeping the rest of socio-economic variables of Table 1 in these specifications. The results have not changed – what supports the existence of the proposed different dimensions of maturity. These tables have not been included for reasons of space, but they will be provided upon request to the authors.

with students' academic performance for the Spanish region of Andalusia (a subject which, to the best of our knowledge, has not been explored for Spain) and also for students in different points of their academic track (primary and secondary education).

Dealing with our empirical results, a soon start in reading and writing and being born in the first bimesters of the year have been found to be positively associated with students' academic achievement, with a decreasing trend of this positive association when increasing the age or the bimester. In addition, these positive associations have been found both for primary education students – those born in 1998 – and for those in secondary education – those born in 1994 – with very similar effect sizes. Furthermore, to the extent that our results are based on associations with students' competences (i.e., real-life skills) and not in academic content-based knowledge, fostering students' maturity becomes a more relevant objective. Hence, an important policy implication of this research might be the increase of public support for the early education of students, in order to assure them a proper command on the reading and writing skills as soon as possible. This might be achieved by increasing the number of public early education centres and subsidies to help students who are late learners in these skills (as indicated by authors such as Cortázar, 2015, Felfe, Nollenberger, & Rodríguez-Planas, 2015, or Haeck, Lefebvre, & Merrigan, 2015, among others). Moreover, libraries might be also relevant to support the potential lack of educational resources and books in the household, so public investment in these institutions should be fostered (as found by Lance, Rodney, Rodney, & Hamilton-Pennell, 2000), or even in programs to make accessible these book resources in other places (such as e.g. in a laundromat, as it was analysed by Neuman, & Knapczyk, 2022).

But funding is not the only intervention needed. For instance, libraries might also play a relevant role by, e.g., organising events to attract young students and their parents to reading (as explored by authors such as Celano & Neuman, 2015, or Lopez, Caspe, & Simpson, 2017). It is also relevant that schools inform parents about the benefits of reading to their children, as it may be favourable for students' reading achievement (Sénéchal & LeFevre, 2002; Kleeck, Stahl, & Bauer, 2003; Kraaykamp, 2003; Demir-Lira, Ece, Applebaum, Goldin-Meadow, & Levine, 2019). In this sense, Patall, Cooper and Robinson (2008) studied the association of parental involvement with students' academic achievement, finding that it helps students to develop skills which they have not learned yet in early stages of their education. Furthermore, it might be advisable to put special emphasis on parents with lower socio-economic background, as they are less likely to perform these practices with their children (Parsons & Bynner, 2007; Bracken & Fischel, 2008). What is more, to the extent that students from this group may present higher likelihood of grade retention and, consequently, higher early school leaving rates, this disadvantage might be compensated by parents' actions providing their children with early literacy skills (Bracken & Fischel, 2008). This improvement of their academic situation might help to avoid the economic costs of students dropping out their studies and might also foster social mobility and equity (Pascual, 2009; Author, 2015). In other words, helping students to develop enough maturity to choose their future career track supposes an essential objective in terms of social policies, due to the high costs triggered by students' dropout potentially originated by inappropriate academic track elections. This dropout supposes an incomplete learning process and, hence, a lack of basic skills by the population, which may have further negative influence on economic growth (Lamb, Markussen, Teese, Sandberg, & Polesel, 2011).

Regarding to the bimester of birth, students who were born in the last bimester of the year may also need an additional help in order to compensate the lower experience that they could present in relation to their older classmates (Cáceres-Delpiano & Giolito, 2019). One of the interventions which might help to solve this problem – together with the lack of an adequate level of reading and writing skills – might be to provide students with preparatory classes in which they can reinforce the concepts learned before compulsory education (as indicated by authors such as e.g. Havrylenko & Kuziomko, 2018, Hendrychová, 2018, or Vítová, Wolf, & Maněnová, 2021). In addition, the concept of "family-schools", denoted by González (2012), is also interesting; this author also highlighted the need to improve the relationship of parents with

the school and increase their participation, creating an "alliance" between families and school. The positive influence on students' academic achievement of this parental involvement in schools has been remarked by the literature along the years (see, e.g., Benner, Boyle, & Sadler, 2016; Carvalho, 2000). In the Spanish case, the school entry cut-off is set in the year that students reach 6 years old, so that students with that age start first grade of compulsory education in September of that year, and parents cannot choose to advance or delay this school entry. Thus, a useful policy – as indicated by McEwan and Shapiro (2008) – might be giving parents the option to delay one year their children's incorporation to compulsory education when they are born very close to the school entry cut-off – e.g., in the last bimester, so they will be among the youngest in the classroom and, hence, they may not be mature enough. To the extent that this is a very important decision, it could be useful to base it in objective criteria such as making students pass cognitive tests before their school enrolment (this has been performed in many countries as, e.g., the United Kingdom; Author, 2007). Therefore, it could be possible to check whether students are cognitively prepared to start compulsory education and objectively fundament such an important decision as delaying students' school enrolment one year.

This research presents the previously highlighted limitation that the accuracy of the results related to the ages when students began to R&W is subject to the capacity of parents to accurately remember the exact age when their children started with these practices – a figure which may not be registered by some families. Nevertheless, this issue is, to some extent, reduced when using categorical measures for these variables, as stated in our estimates. In addition, the concepts of reading and writing handled by the parents may not be the same in all cases. For instance, parents may associate reading and writing with decoding and encoding processes, respectively, but they may not consider that reading is also accessing meaning and that writing is also producing meaning. Furthermore, we do not have longitudinal data, so we cannot measure students' academic progression, but we can check for differences between two cohorts of students; in addition, we cannot obtain causal effect estimates, but conditional associations. However, these drawbacks are further compensated by the novelty of this research, as the analysis of students' maturity based on these three dimensions is – to the best of our knowledge – a less studied field in the Economics of Education literature – due to the difficulty to find datasets which contain information on these variables simultaneously, especially the ages of beginning to R&W. This novelty may also set up a precedent for future research, e.g. the analysis of the influence of boys' and girls' differences in maturity endowments on the potential gap between their academic achievement – or their high school track choices.

Yet, the reality today is that worldwide education and training systems are, to a greater or lesser extent, marked by inequalities in terms of access to quality education as well as in outcomes (as indicated by, e.g., PISA results); a crude fact that is known to increase the socio-economic inequality of countries themselves (Agasisti & Cordero, 2013; Checchi & Peragine, 2010). Thus, to the extent that students from diverse socio-economic backgrounds are able to access the same high quality education and start their education from a similar maturity starting point, we will be moving towards a more equal society.

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Appendix

-Insert Table A1-

-Insert Table A2-

-Insert Figure A1-

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Table 1. Estimation of the conditional association with academic achievement of socio-economic variables (non-repeaters and repeaters, 1994 cohort)

Variables	**Linguistic Communication Competence**	**Mathematical Competence**
Female (*Reference group: Male*)	0.408***	-0.102**
	(0.045)	(0.048)
Immigrant (*Reference group: Native*)	-0.347**	-0.386***
	(0.135)	(0.142)
Semi-private school (*Reference group: Public school*)	0.431***	0.217***
	(0.057)	(0.060)
Father's education level (*Reference group: Lower than primary education*)		
Primary education	-0.023	0.010
	(0.099)	(0.104)
Secondary education	0.120	0.090
	(0.084)	(0.088)
High school education	0.267***	0.192*
	(0.095)	(0.100)
University education	0.352***	0.284***
	(0.101)	(0.106)
Mother's education level (*Reference group: Lower than primary education*)		
Primary education	-0.053	-0.084
	(0.110)	(0.115)
Secondary education	0.151	0.084
	(0.097)	(0.102)
High school education	0.360***	0.329***
	(0.105)	(0.110)
University education	0.445***	0.410***
	(0.111)	(0.116)
Monthly income level of the household (*Reference group: 1100 Euros or less*)		
From 1101 to 1800 Euros	0.066	0.115*
	(0.062)	(0.065)
From 1801 to 2700 Euros	0.130*	0.147*
	(0.077)	(0.080)
More than 2700 Euros	0.198**	0.245**
	(0.100)	(0.104)
Missing flag	0.135	0.321***
	(0.095)	(0.100)
Constant	-0.759***	-0.420***
	(0.108)	(0.113)
Observations	1,597	1,597
R-squared	0.189	0.111

Notes: Standard errors in parentheses.
Dependent variable: Students' linguistic communication competence and mathematical competence, respectively.
Estimation method: Ordinary Least Squares (OLS).
Significance: *** denotes variable significant to level 1%; ** to 5%; * to 10%.
Source: Authors' own calculations from ESOC10-SEN.

Table 2. Estimation of the conditional association with academic achievement of socio-economic variables, controlling by grade retention (non-repeaters and repeaters, 1994 cohort)

Variables	**Linguistic Communication Competence**	**Mathematical Competence**
Repeaters (*Reference group: Non-repeaters*)	-0.796***	-0.906***
	(0.053)	(0.055)
Female (*Reference group: Male*)	0.317***	-0.206***
	(0.043)	(0.044)
Immigrant (*Reference group: Native*)	-0.216*	-0.236*
	(0.127)	(0.131)
Semi-private school (*Reference group: Public school*)	0.362***	0.139**
	(0.054)	(0.055)
Father's education level (*Reference group: Lower than primary education*)		
Primary education	-0.064	-0.037
	(0.093)	(0.096)
Secondary education	0.061	0.022
	(0.079)	(0.081)
High school education	0.140	0.047
	(0.090)	(0.093)
University education	0.204**	0.115
	(0.095)	(0.098)
Mother's education level (*Reference group: Lower than primary education*)		
Primary education	-0.056	-0.088
	(0.103)	(0.107)
Secondary education	0.047	-0.034
	(0.091)	(0.094)
High school education	0.196**	0.142
	(0.099)	(0.102)
University education	0.270***	0.211*
	(0.105)	(0.108)
Monthly income level of the household (*Reference group: 1100 Euros or less*)		
From 1101 to 1800 Euros	0.043	0.088
	(0.058)	(0.060)
From 1801 to 2700 Euros	0.083	0.093
	(0.072)	(0.074)
More than 2700 Euros	0.141	0.180*
	(0.093)	(0.097)
Missing flag	0.100	0.281***
	(0.089)	(0.092)
Constant	-0.292***	0.111
	(0.106)	(0.109)
Observations	1,597	1,597
R-squared	0.289	0.240

Notes: Standard errors in parentheses.
Dependent variable: Students' linguistic communication competence and mathematical competence, respectively.
Estimation method: Ordinary Least Squares (OLS).
Significance: *** denotes variable significant to level 1%; ** to 5%; * to 10%.
Source: Authors' own calculations from ESOC10-SEN.

Table 3. Estimation of the conditional association with academic achievement of the ages of beginning to read/write (non-repeaters, 1994 cohort)

Variables	**Linguistic Communication Competence**		**Mathematical Competence**	
Additional control variables	✓	✓	✓	✓
Age of beginning to read (*Reference group: 72 months or more*)				
From 24 to 35 months	0.642***		0.477**	
	(0.187)		(0.194)	
From 36 to 47 months	0.285***		0.190*	
	(0.097)		(0.100)	
From 48 to 59 months	0.234***		0.128	
	(0.085)		(0.088)	
From 60 to 71 months	0.234***		0.159*	
	(0.086)		(0.089)	
Missing flag	0.393**		0.315*	
	(0.157)		(0.163)	
Age of beginning to write (*Reference group: 72 months or more*)				
From 24 to 35 months		0.599**		0.381
		(0.274)		(0.283)
From 36 to 47 months		0.191**		0.074
		(0.094)		(0.097)
From 48 to 59 months		0.210***		0.067
		(0.077)		(0.080)
From 60 to 71 months		0.185**		0.080
		(0.076)		(0.079)
Missing flag		0.215		0.253
		(0.151)		(0.156)
Constant	-0.411***	-0.346**	0.014	0.076
	(0.150)	(0.145)	(0.155)	(0.150)
Observations	1,218	1,218	1,218	1,218
R-squared	0.121	0.116	0.076	0.072

Notes: Standard errors in parentheses. The tick (✓) means that additional control variables have been included in the estimates. These are: sex of the student, immigrant status, school funding, education level of the father and the mother and monthly income level of the household.
Dependent variable: Students' linguistic communication competence and mathematical competence, respectively.
Estimation method: Ordinary Least Squares (OLS).
Significance: *** denotes variable significant to level 1%; ** to 5%; * to 10%.
Source: Authors' own calculations from ESOC10-SEN.

Table 4. Estimation of the conditional association with academic achievement of the ages of beginning to read/write and the bimester of birth (non-repeaters 1994, cohort)

Variables	**Linguistic Communication Competence**		**Mathematical Competence**	
Additional control variables	✓	✓	✓	✓
Age of beginning to read (*Reference group: 72 months or more*)				
From 24 to 35 months	0.619***		0.444**	
	(0.188)		(0.195)	
From 36 to 47 months	0.284***		0.186*	
	(0.096)		(0.100)	
From 48 to 59 months	0.230***		0.122	
	(0.085)		(0.088)	
From 60 to 71 months	0.229***		0.147	
	(0.086)		(0.090)	
Missing flag	0.380**		0.302*	
	(0.157)		(0.163)	
Age of beginning to write (*Reference group: 72 months or more*)				
From 24 to 35 months		0.551**		0.350
		(0.274)		(0.283)
From 36 to 47 months		0.192**		0.075
		(0.094)		(0.097)
From 48 to 59 months		0.203***		0.063
		(0.077)		(0.080)
From 60 to 71 months		0.175**		0.072
		(0.076)		(0.079)
Missing flag		0.194		0.231
		(0.151)		(0.157)
Bimester of birth (*Reference group: Sixth –November, December–*)				
First (January, February)	0.322***	0.322***	0.325***	0.325***
	(0.110)	(0.110)	(0.114)	(0.114)
Second (March, April)	0.244**	0.255**	0.179	0.191*
	(0.108)	(0.108)	(0.112)	(0.112)
Third (May, June)	0.222**	0.215**	0.126	0.124
	(0.107)	(0.108)	(0.111)	(0.112)
Fourth (July, August)	0.252**	0.268**	0.231**	0.239**
	(0.110)	(0.111)	(0.114)	(0.115)
Fifth (September, October)	0.314***	0.305***	0.129	0.123
	(0.110)	(0.111)	(0.114)	(0.115)
Missing flag	0.173*	0.174*	0.128	0.130
	(0.091)	(0.091)	(0.094)	(0.094)
Constant	-0.638***	-0.571***	-0.157	-0.098
	(0.171)	(0.167)	(0.177)	(0.173)
Observations	1,218	1,218	1,218	1,218
R-squared	0.126	0.121	0.079	0.075

Notes: Standard errors in parentheses. The tick (✓) means that additional control variables have been included in the estimates. These are: sex of the student, immigrant status, school funding, education level of the father and the mother and monthly income level of the household.
Dependent variable: Students' linguistic communication competence and mathematical competence, respectively.
Estimation method: Ordinary Least Squares (OLS).
Significance: *** denotes variable significant to level 1%; ** to 5%; * to 10%.
Source: Authors' own calculations from ESOC10-SEN.

Table 5. Estimation of the conditional association with academic achievement of the ages of beginning to read/write and the bimester of birth (non-repeaters, 1998 cohort)

Variables	**Linguistic Communication Competence**		**Mathematical Competence**	
Additional control variables	✓	✓	✓	✓
Age of beginning to read (*Reference group: 72 months or more*)				
From 24 to 35 months	0.174		0.121	
	(0.188)		(0.188)	
From 36 to 47 months	0.381***		0.375***	
	(0.088)		(0.088)	
From 48 to 59 months	0.189**		0.213***	
	(0.078)		(0.079)	
From 60 to 71 months	0.256***		0.202***	
	(0.077)		(0.077)	
Missing flag	-0.022		-0.038	
	(0.154)		(0.154)	
Age of beginning to write (*Reference group: 72 months or more*)				
From 24 to 35 months		0.123		0.107
		(0.231)		(0.230)
From 36 to 47 months		0.296***		0.381***
		(0.084)		(0.084)
From 48 to 59 months		0.190***		0.237***
		(0.070)		(0.070)
From 60 to 71 months		0.204***		0.226***
		(0.068)		(0.068)
Missing flag		-0.052		-0.091
		(0.153)		(0.152)
Bimester of birth (*Reference group: Sixth –November, December–*)				
First (January, February)	0.196**	0.208**	0.330***	0.343***
	(0.099)	(0.099)	(0.099)	(0.099)
Second (March, April)	0.264***	0.273***	0.237**	0.244***
	(0.094)	(0.095)	(0.094)	(0.094)
Third (May, June)	0.205**	0.215**	0.204**	0.210**
	(0.097)	(0.097)	(0.097)	(0.097)
Fourth (July, August)	0.194**	0.201**	0.199**	0.202**
	(0.098)	(0.099)	(0.099)	(0.098)
Fifth (September, October)	0.155	0.149	0.256***	0.253***
	(0.097)	(0.097)	(0.097)	(0.097)
Missing flag	0.176**	0.185**	0.248***	0.253***
	(0.080)	(0.080)	(0.080)	(0.080)
Constant	-0.964***	-0.940***	-0.866***	-0.880***
	(0.140)	(0.134)	(0.140)	(0.134)
Observations	1,868	1,868	1,868	1,868
R-squared	0.114	0.111	0.112	0.114

Notes: Standard errors in parentheses. The tick (✓) means that additional control variables have been included in the estimates. These are: sex of the student, immigrant status, school funding, education level of the father and the mother and monthly income level of the household.
Dependent variable: Students' linguistic communication competence and mathematical competence, respectively.
Estimation method: Ordinary Least Squares (OLS).
Significance: *** denotes variable significant to level 1%; ** to 5%; * to 10%.
Source: Authors' own calculations from ESOC10-SEN.

Table A1. Bivariate descriptive analysis of linguistic communication and mathematical competences achievement with the ages when the student began to R&W and the bimester of birth (1994 cohort). Non-repeater students

		Linguistic Communication Competence			Mathematical Competence		
		Obs.	Mean	S.d.	Obs.	Mean	S.d.
Age of beginning to read	**From 24 to 35 months**	24	580.22	85.51	24	563.13	86.97
	From 36 to 47 months	194	549.51	83.82	194	547.33	88.30
	From 48 to 59 months	441	544.53	88.37	441	541.30	87.68
	From 60 to 71 months	396	543.00	87.04	396	543.75	90.07
	72 months or more	126	519.62	92.72	126	525.08	99.36
	Missing flag	37	549.99	86.79	37	558.16	85.56
Age of beginning to write	**From 24 to 35 months**	10	591.70	88.92	10	565.82	102.12
	From 36 to 47 months	155	544.16	84.76	155	543.07	86.34
	From 48 to 59 months	406	547.20	88.75	406	541.46	87.63
	From 60 to 71 months	438	544.90	85.86	438	543.54	88.49
	72 months or more	171	525.66	92.83	171	535.38	102.01
	Missing flag	38	540.49	85.87	38	559.51	83.57
Bimester of birth	**First (January, February)**	131	553.15	86.73	131	558.36	89.99
	Second (March, April)	142	545.91	88.70	142	546.42	94.56
	Third (May, June)	144	541.66	83.69	144	537.19	80.81
	Fourth (July, August)	128	548.59	85.42	128	551.19	87.87
	Fifth (September, October)	129	556.07	91.22	129	542.01	87.50
	Sixth (November, December)	105	519.01	90.37	105	528.02	90.28
	Missing flag	439	540.07	87.80	439	538.82	91.84

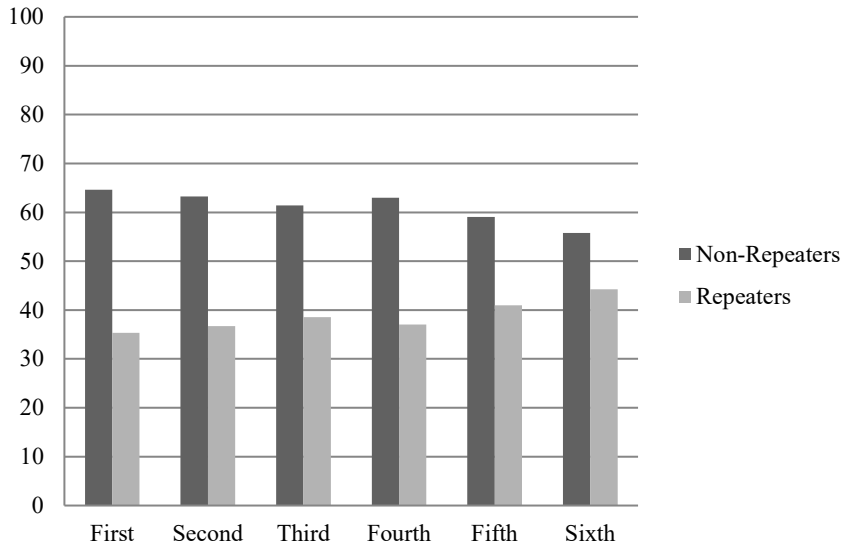
Notes: “Obs.” stands for “Observations” and “S.d.” for “Standard deviation”.
Source: Authors’ own calculations from ESOC10-SEN.

Table A2. Bivariate descriptive analysis of linguistic communication and mathematical competences achievement with the ages when the student began to R&W and the bimester of birth (1998 cohort). Non-repeater students

		Linguistic Communication Competence			Mathematical Competence		
		Obs.	Mean	S.d.	Obs.	Mean	S.d.
Age of beginning to read	**From 24 to 35 months**	29	521.02	89.27	29	513.12	106.60
	From 36 to 47 months	292	534.49	95.98	292	531.94	90.80
	From 48 to 59 months	624	516.26	94.29	624	517.85	93.51
	From 60 to 71 months	682	524.42	88.50	682	518.56	93.56
	72 months or more	193	498.53	93.67	193	498.54	91.88
	Missing flag	48	483.81	110.80	48	484.16	116.75
Age of beginning to write	**From 24 to 35 months**	18	524.16	80.83	18	512.61	106.10
	From 36 to 47 months	251	528.38	93.98	251	529.52	90.33
	From 48 to 59 months	588	521.41	95.59	588	520.81	95.25
	From 60 to 71 months	697	522.84	89.75	697	519.30	92.66
	72 months or more	268	503.58	92.42	268	500.64	91.84
	Missing flag	46	486.95	111.20	46	477.47	114.83
Bimester of birth	**First (January, February)**	191	519.78	94.64	191	524.79	87.69
	Second (March, April)	228	526.66	92.80	228	517.49	99.39
	Third (May, June)	209	522.61	92.83	209	518.10	93.68
	Fourth (July, August)	190	519.31	92.01	190	513.08	94.72
	Fifth (September, October)	203	519.24	92.30	203	523.43	94.21
	Sixth (November, December)	179	506.07	93.84	179	497.92	93.15
	Missing flag	668	519.73	93.97	668	519.59	94.20

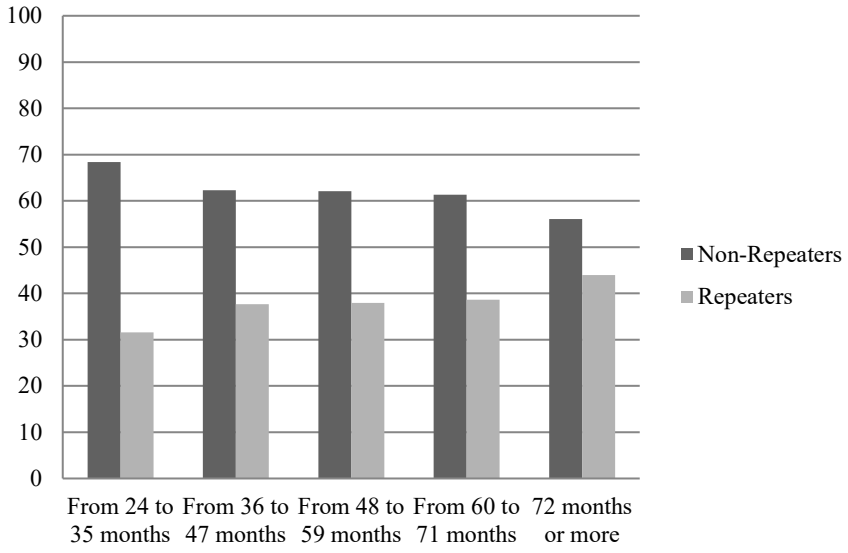
Notes: “Obs.” stands for “Observations” and “S.d.” for “Standard deviation”.
Source: Authors’ own calculations from ESOC10-SEN.

Figure A1. Proportion of non-repeater and repeater students in relation with the bimester of birth (1994 cohort)



Source: Authors' own calculations from ESOC10-SEN.

Figure A2. Proportion of non-repeater and repeater students in relation with the age of beginning to read (1994 cohort)



Source: Authors' own calculations from ESOC10-SEN.