

Homework and Performance in Mathematics: The Role of the Teacher, the Family and the Student's Background

Rubén Fernández-Alonso* ^a, Javier Suárez-Álvarez*, and José Muñiz* ^b

*University of Oviedo, ^aConsejería de Educación y Cultura del Principado de Asturias,

^bBiomedical Research Network in Mental Health (CIBERSAM)

Abstract

The role of teacher, family and the background of students in conducting homework and math performance were investigated. Participants were 7,725 Spanish adolescents with the mean age of 13.78 ($\pm .82$) and 2,246 teachers who taught the above mentioned students. A two-level hierarchical linear analysis, students ($N = 7,541$) and classrooms ($N = 353$), was performed, adjusted for background and prior achievement variables. The results indicate that the autonomous work of the students is more important than the time they spent on homework. The weight that homework has in school grades (Level 1) and frequency allocation (level 2) are the two most important variables related to the policy of the teacher assignments. Finally, family involvement in learning and the importance of homework for the family also appear positively and significantly linked to the performance.

Keywords: homework, mathematics, academic performance, multilevel models.

Resumen

Se investiga el papel que juegan el profesorado, la familia y las características del alumnado en la realización de los deberes y el rendimiento en matemáticas. Participan 7725 adolescentes españoles con una media de edad de 13.78 ($\pm .82$) y 2246 profesores que imparten docencia al alumnado mencionado. Se realiza un análisis jerárquico-lineal de dos niveles, estudiantes ($N = 7541$) y aulas ($N = 353$), ajustado por variables antecedentes y de rendimiento previo. Los resultados indican que el trabajo autónomo del alumnado es más importante que el tiempo dedicado a los deberes. El peso que los deberes tienen en las calificaciones escolares (nivel 1) y la frecuencia de asignación (nivel 2) son las dos variables más importantes vinculadas a la política de deberes del profesorado. Por último, la implicación familiar en el aprendizaje y la importancia de los deberes para la familia también aparecen positiva y significativamente vinculadas a los resultados.

Palabras clave: deberes escolares, tareas escolares en el hogar, matemáticas, rendimiento académico, modelos multinivel.

Correspondence concerning this article should be addressed to Javier Suárez-Álvarez, Departamento de Psicología, Universidad de Oviedo, Plaza Feijoo, s/n. 33003 Oviedo, España. E-mail: suarezjavier@uniovi.es

Introduction

The relationship between school homework and academic achievement combines variables that are associated with a student's personal characteristics, family background, and with teaching practices. Therefore research about homework is supported by comprehensive theoretical frameworks which cover the role played by the teacher in homework assignment, the student doing the homework, and family involvement (Cooper, 1989; Epstein & Pinkow, 1988; Trautwein, Lüdtke, Schnyder, & Niggli, 2006). Although homework affects the vast majority of students in Spain (Ministerio de Educación & Ciencia, 2006), there is no research which combines the variables related to these three protagonists in relation to homework.

Student homework behaviour

Reviews from Cooper (1989) and Cooper, Robinson, and Patall (2006) indicate that during the second half of the twentieth century the relationship between time spent and achievement was the most often studied topic, finding that, while it is not a strictly linear association (Cooper & Valentine, 2001), it is in general terms positive. However, the strength of the association depends on age, with effects more clearly seen in secondary rather than primary education (Cooper, Steenbergen-Hu, &

Dent, 2012). Similarly, there are studies which indicate that homework behavior can vary depending on the topic studied (Trautwein & Lüdtke, 2007, 2009). In this century, multilevel studies have refined this relationship and shown that time spent has little effect on results (De Jong, Westerhof, & Creemers, 2000; Farrow, Tymms, & Henderson, 1999; Murillo & Martínez-Garrido, 2013; Núñez, Vallejo, Rosário, Tuero, & Valle, 2014) and, with statistical significance, the effect is negative (Chang, Wall, Tare, Golonka & Vatz, 2014; Trautwein, 2007; Trautwein, Köller, Schmitz, & Baumert, 2002; Trautwein, Schnyder, Niggli, Neumann, & Lüdtke, 2009). These studies show that students who have more difficulty learning or concentrating need more time to do their homework.

With the limited predictive capability of time spent on homework, research turned towards other aspects of behavior, such as effort or homework management, and towards cognitive, affective and personality factors, which are significant once previous academic achievement, intellectual capability, and sociological background have been discounted (Dettmers et al., 2011; Suárez-Álvarez, Fernández-Alonso, & Muñoz, 2014; Trautwein & Lüdtke, 2007). This turn towards psychological variables has been very productive on both sides of the Atlantic, linking homework with key variables

in academic achievement (Ramdass & Zimmerman, 2011; Trautwein & Köller, 2003; Trautwein et al., 2006, Xu, 2013). These new lines of research have shown the potential of self-regulation, self-efficacy, and causal attribution (Bembenutty & White, 2013; Kitsantas, Cheema, & Ware, 2011; Rosário et al., 2009; Zimmerman & Kitsantas, 2005). For example, Kitsantas & Zimmerman (2009) concluded that homework improves self-efficacy and responsibility towards homework, and helps the development of study techniques. Stoeger & Ziegler (2008) showed that self-regulation can be trained during homework. These authors used a hierarchical-linear model of growth and indicated that the students who got the most out of the program were those who had lowest self-efficacy at the beginning, which is evidence that appropriate homework planning can have beneficial effects. Similarly, research by Xu and his team linked attitude to homework and self-regulation, showing that rates of completion (Xu, 2011), making best use of time (Xu, Yuan, Xu, & Xu, 2014), homework management and organization, and the work environment (Xu & Wu, 2013), are linked to the perceived usefulness of the homework, and to improvements in attitude and students' perception of their own ability. Taken together, the data indicate that, in terms of a student's approach to homework *how* is more important than *how much*.

The role of the teacher: homework characteristics and follow up

Research into homework assignment by teachers has shown that it demonstrates multilevel traits (Detters, Trautwein, Lüdtke, Kunter, & Baumert, 2010; Xu, 2012; Xu & Wu, 2013). The two homework characteristics related to the teacher which have been most often studied are frequency and volume of work assigned. When studied together in secondary education samples, frequency appears more closely connected to mathematics achievement than amount (Fernández-Alonso, Suárez-Álvarez, & Muñiz, 2015; Trautwein, 2007; Trautwein et al., 2002). Nonetheless, when amount of homework assigned is analyzed separately it also is found to have a positive association with academic achievement (OCDE, 2013).

The relationship between achievement and control of homework or feedback from homework does not seem so clear. Elawar & Corno (1985) experimentally linked teaching feedback with improved results and attitudes towards homework; however ex-post facto research did not unequivocally confirm these results. Trautwein, Niggli, Schnyder, & Lüdtke (2009) established two types of feedback: controlling (which checks that homework has been done), and motivating (encouraging the student to be responsible for the homework), but did not find any difference in achievement in terms of

teaching style. Nor did Trautwein et al. (2002) find any significant relationship between feedback and achievement, although they did see a positive interaction between the amount of homework and the frequency of correction, which was interpreted as a possible consequence of an inefficient teaching style, i.e. one which combines a large quantity of homework with little follow-up. Multilevel studies which link teacher feedback to other secondary education variables have been more successful. Xu (2012) and Xu & Wu (2013) found positive associations at an individual level between feedback, management, and perception of usefulness of homework, although that research did not indicate significant class-level effects. In terms of teacher control, positive correlations have been found with emotions, time, and effort (Trautwein & Lüdtke, 2007; Trautwein, Niggli et al., 2009) although other, similar multilevel studies note that the effect of feedback and control is more distinct at the individual, rather than the class level. In any case, its influence on academic results seems to be indirect, as teacher control and feedback seem to be associated more with students' homework behavior than school achievement (Núñez et al., 2015).

Family involvement

The relationship between family involvement and academic results has been confirmed in research in

the English (Sammons, Hillman, & Mortimore, 1995) and Spanish (Murillo, 2003) speaking worlds, as well as central Europe (Scheerens, Witzers, & Steen, 2013). However, research into school effectiveness uses measures of involvement based on the school, such as participation in school activities, while help with homework is a variable of involvement based on the home, and in this type of measure "more" is not always "better". Reviews of the relationship between family involvement in homework and academic achievement produce complex results (Cooper et al., 2012; Hoover-Dempsey et al., 2001; Patall, Cooper, & Robinson, 2008; Pomerantz, Moorman, & Litwack, 2007) when they are not negative (Hill & Tyson, 2009). These results reflect the fact that families tend to offer more direct help to children who have more difficulties in learning and less motivation (Wingard & Forsberg, 2009). From a methodological point of view Trautwein and Lüdtke (2009) indicated that the effect of family intervention is clearer with distal variables, such as family communication about school issues, than with more proximal measures such as homework quantity.

The weak connection between amount of help and achievement widened the explanatory search to variables such as quality of interaction and style of family involvement (Fuentes, García, Gracia, & Alarcón, 2014; García-Linares, de

la Torre, Villa Carpio, Cerezo, & Casanova, 2014). Cooper, Lindsay, and Nye (2000) found that children of families which encourage autonomy with homework demonstrate better rates of completion and results than children of more interventionist families. Pomerantz et al. (2007) identify styles of parental involvement which especially harm a student's academic achievement, which indicates a possible interaction between the kind of involvement and educational achievement. Dumont, Trautwein, Nagy and Nagengast (2014) demonstrated the reciprocity of those two variables, so students who, in their fifth year, had shown less effort and had lower achievement were those whose parents were more controlling with homework two years later, while those who procrastinated less with their homework in the seventh year came from families who, two years earlier, had encouraged student responsibility towards homework.

In short, the relationship between parental involvement in homework and achievement does not depend on the amount of help, rather it is a reciprocal, reactive relationship: previous achievement predicts the style of family involvement and certain modes of involvement encourage appropriate homework behavior. In addition, methodologically speaking, distal variables seem to capture the effect of the interaction more clearly than proximal measures.

Objective and hypotheses

Within this context, the objective of this study is to analyze the effects of students' homework behavior, homework characteristics, teacher follow-up, and the role of family involvement on achievement in mathematics. It is the first study of secondary school students in Spain which accommodates a complete homework model combining information from a large sample of Spanish students and teachers. From a methodological point of view, the work combines models derived from Item Response Theory and hierarchical-linear models, which offer robust, reliable data (De Ayala, 2009; Raudenbush & Bryk, 2002). In line with the literature reviewed, the starting hypotheses are:

- Hypothesis 1. Students' self-regulation and autonomous working is more relevant when it comes to results in mathematics than time spent on homework, which is expected to have no effect or a negative effect.
- Hypothesis 2. The frequency of homework assignment is more relevant for results in mathematics than the amount of homework, which is expected to have no effect or a negative effect.
- Hypothesis 3. Teachers' control and follow-up of homework will demonstrate differential results depending on the level of analysis: it will have a positive effect at

the individual level, and no effect or a negative effect at the class level.

- Hypothesis 4. Given that this study deals with distal family involvement variables, a positive effect is expected on achievement in mathematics.

Method

Participants

This is a census study with participation from 7725 students in the second year of compulsory secondary education (ESO) in the Principality of Asturias in the 2010-2011 school year, and from the 2246 teachers who teach in 353 class-groups in 148 centers. The mean student age is 13.78 ($SD = .82$). Girls make up 47.2%; 90.6% have Spanish nationality; and 72.9% are in the school year corresponding to their age, the remaining 27.1% are at least one year behind. In terms of teachers, 63.8% are women; the mean age is 46.14 ($SD = 9.02$); with an average teaching experience of 18.68 years ($SD = 9.80$).

Instruments

Student questionnaire

All of the data related to completion of homework was collected using the *Student Questionnaire*. The daily time spent on homework

was calculated from two multiple choice items, the first asked about frequency of doing homework with options being: (a) never; (b) two or three days a week; (c) most days; (d) every day. The second question asked how many minutes were spent doing homework with options: (a) less than 30; (b) between 30-60; (c) between 60-120; (d) more than 120. The means from both items per class were taken as estimations of Frequency and Amount of homework. Autonomy in homework was evaluated using the item “How do you do your homework?”, the options for which were: (a) without help; (b) I need help occasionally; (c) I often need help; (d) I always need help. A variable was created where 1 = without help; 0 = with occasional help; and -1 = with frequent or constant help. The weight given to homework in grades was measured with a Likert-type item with four alternatives (“Grades take homework performance into account”), where 1 means “never or almost never” and 4 “always or almost always”. In addition, the average of this item by class was used as a level 2 variable. Family prioritization of homework was estimated as the average of two Likert-type items each with four alternatives: “At home we talk about homework and schoolwork” and “My family prioritizes homework over leisure activities”, where 1 means “completely disagree” and 4 “completely agree”.

Teacher questionnaire

Two classroom variables were taken from the teachers' answers. The first estimates the level of homework follow-up through a 4-point Likert-type item, "*I correct students' homework*", where 1 means "*never*" and 4 means "*always*". The second variable estimates family involvement in the education process through 3 Likert-type items ("*Families monitor homework*", "*they collaborate with the teachers*" and "*they are involved with the teaching and learning process*"). The items conform to an essentially unidimensional scale (the first factor explains 73.4% of the variance), Cronbach's alpha coefficient was .81 and McDonald's Omega coefficient was .73.

Test of mathematical ability

The test used to evaluate mathematical ability consisted of 192 items arranged in 8 test papers following the matrix design established in Fernández-Alonso and Muñiz (2011). Each student answered one paper containing 48 items over two 50 minute sessions separated by a break. The bank of items was arranged using the ConQuest 2.0 program (Wu, Adams, Wilson, & Haldane, 2007). The scores were expressed on a scale with a mean of 500 points and standard deviation 100. The mean of Cronbach's Alpha for the 8 papers was .85, with a minimum of .82 and a maximum

of .88. The mean of McDonald's Omega for the 8 papers was .84, with a minimum of .81 and a maximum of .88. A detailed description of the test may be found in Gobierno del Principado de Asturias (2012).

Adjustment variables

Five adjustment variables were included, three sociological: Gender (1 = female), Nationality (1 = at), and Socioeconomic and cultural status (SES). The first two came from registers at the Department of Education and the SES was constructed following the process described in Peña-Suárez, Fernández-Alonso, and Muñiz (2009), with information on qualifications and family professions provided by the teachers. Two measures of previous achievement were used: Academic Repetition (1 = *having repeated*) and Score in Mathematics provided by the teachers using the following scale: *poor* (1 point); *passable or good* (2 points); *very good* (3 points); and *outstanding* (4 points).

Procedure

The tests were part of the Educational Diagnostic Evaluation program in Asturias. Test management in each center is the responsibility of school authorities, while the teachers gave the tests and questionnaires according to the *Instructions for the development of diagnostic evaluations* set down by the

Department of Education. Each student completed the test and a context questionnaire which included questions about homework. At the same time, the teacher completed a questionnaire which included questions about homework follow-up and family involvement.

Data analysis

First, descriptive statistics and Pearson correlations were calculated. Then five multilevel random intercept models were produced in two levels (student and class) using the HLM 6.03 program (Raudenbush, Bryk, Cheong, & Congdon, 2004). The Maximum Likelihood method of estimation was used due to the robustness of estimation of violation of assumptions when using large samples (Hox, 2010). Each model increases in complexity and adds new exploratory variables while keeping those from the previous model. The new models keep the non-significant variables from previous models because with a subject such as homework, the lack of significance in a variable by no means indicates that the result is irrelevant. As HLM does not provide standardized coefficients the variables were normalized about the general mean, which allowed the results to be interpreted as the standardized coefficient of a classical regression. The level 2 variables, which were created from the classroom means of level 1 variable (frequency and

amount of homework, and family communication), were not renormalized. The variables were not centered except in three cases: study time, grades in mathematics and SES, which were centered around the classroom mean in order to control the effect of class-groups (Xu & Wu, 2013). To avoid one individual option (“I don’t do homework because I don’t want to”) masking a classroom effect (in this case the frequency and amount of homework assigned) the 2.4% of students who never did homework were eliminated from the analysis. Because of that, the multilevel adjustments included 7541 students as opposed to the 7752 originally evaluated. The range of missing cases in the variables was between 5% and 12%, the procedure for their recovery was that described in Fernández-Alonso, Suárez-Álvarez, and Muñoz (2012).

Results

Table 1 shows the basic statistics and correlations between the variables. The results of the multilevel fit are in Table 2, although it does not include the data from the null model, where the variance between classes was .180 points and the variance within classes was .820 points. So 18% of the variance of the results is due to systematic differences between classes, which justifies the use of hierarchical linear models in this study. These val-

Table 1
Descriptive Statistics and Correlations Between Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Female	—														
2. Nonnative	.00	—													
3. Socioeconomic and cultural status	-.02	-.11	—												
4. Repeater	-.07	.23	-.34	—											
5. Grade in mathematics	.03	-.16	.32	-.46	—										
6. Time Spent on Homework	.15	-.07	.15	-.28	.21	—									
7. Does homework autonomously	-.02	.03	.01	-.06	.17	-.15	—								
8. Weight given to homework in school grades	.06	-.01	-.05	-.03	.07	.12	.00	—							
9. Family prioritises homework	.07	-.11	.14	-.22	.20	.29	-.04	.12	—						
10. Amount of homework (class)	.05	-.10	.18	-.18	.11	.35	-.06	.05	.13	—					
11. Frequency of homework assignment (class)	.04	-.14	.17	-.19	.15	.25	-.01	.04	.12	.76	—				
12. Weight given to homework in grades (class)	.01	.00	-.11	.01	-.02	.06	-.02	.30	.04	.16	.14	—			
13. Frequency of homework correction (class)	.00	-.03	.02	-.01	.02	.03	.00	.01	.01	.09	.05	.03	—		
14. Family involvement	.00	-.10	.33	-.19	.14	.09	.01	-.04	.07	.26	.29	-.14	.17	—	
15. Achievement in mathematics	-.03	-.19	.35	-.39	.57	.14	.20	.05	.21	.17	.19	-.04	.03	.23	—
Mean	.48	.09	12.41	.26	1.36	73.32	.19	2.53	2.27	72.00	2.40	2.53	2.43	1.52	501.53
Standard deviation	.50	.29	3.51	.44	.88	38.46	.63	.70	.85	14.14	.24	.21	.24	.25	99.94

Correlations above |.02| are significant at the .05 level, and above |.03| significant at the .01 level.

Table 2

Multilevel Models to Predict Achievement in Mathematics

	Model 1: Adjustment Variables β (s.e.)	Model 2: Student Variables β (s.e.)	Model 3: Teacher Variables β (s.e.)	Model 4: Family Variables B (s.e.)
Level 1				
Female	-.06 (.01)***	-.06 (.01)***	-.06 (.01)***	-.06 (.01)***
Nonnative	-.07 (.01)***	-.08 (.01)***	-.08 (.01)***	-.07 (.01)***
Socioeconomic and cultural status	.07 (.01)***	.08 (.01)***	.08 (.01)***	.08 (.01)***
Repeater	-.11 (.01)***	-.11 (.01)***	-.10 (.01)***	-.10 (.01)***
Grade in mathematics	.47 (.01)***	.44 (.01)***	.44 (.01)***	.44 (.01)***
Time spent on homework	—	-.01 (.01)	-.02 (.01)	-.03 (.01)*
Does homework autonomously	—	.12 (.01)***	.12 (.01)***	.12 (.01)***
Weight given to homework in grades	—	—	.04 (.01)***	.03 (.01)**
Family prioritises homework	—	—	—	.06 (.01)***
Level 2				
Amount of homework	—	—	-.12 (.09)	-.08 (.09)
Frequency of homework assignment	—	—	.28 (.09)**	.20 (.09)*
Weight given to homework in grades	—	—	-.06 (.02)**	-.03 (.02)
Frequency of homework correction	—	—	.01 (.02)	-.02 (.02)
Family involvement	—	—	—	.17 (.02)***
Variance				
Between classes	.164	.161	.135	.108
Within Classes	.542	.528	.527	.524
Percentage of variance explained				
Between classes	8.9%	10.6%	25.0%	40.0%
Within Classes	33.9%	35.6%	35.7%	36.1%
Total	29.4%	31.1%	33.8%	36.8%
Deviance	17543.6	17366.1	17319.7	17226.1

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

ues of variance distribution are the reference for interpreting the percentage of variance explained in the second table.

Model 1, with only adjustment variables, explains almost 30% of

the total variance and more than a third of the differences between classes, it indicates the relevance of previous achievement, highlighting the effect of mathematics grade, and the negative effect of repetition. The

variables being female or nonnative demonstrate negative effects, while socioeconomic and cultural level shows positive effects.

Model 2 shows that autonomous working is the student behavior with greatest effect, while time spent is not significant. This model adds only 2% to the explanation of the total variance to the previous model.

In Model 3, which includes the teaching variables, the frequency of homework assignment stands out, while the weight given to homework in school grades is positive at the individual level and negative at the class level. Finally, the amount of homework and the frequency of correction are not statistically significant. Model 3 provides an additional 15% of explanation for the variance between classes.

The final model shows that family involvement is the level 2 variable with greatest effect after frequency of homework assignment. Furthermore, its inclusion means that the level 2 teaching variables lose their explanatory power. At the individual level, once the adjustment factors are discounted, the variable with greatest effect is doing homework autonomously, followed by the importance given to homework by the family, and the weight given to homework in school grades, whereas time spent gives a significant negative coefficient. The final model adds an additional 15% to the explanation of differences be-

tween classes and, in total accounts for a little less than 40% of the variance.

Discussion

The results confirm the idea already put forward by Cooper (1989) about the need for research into the relationship between homework and achievement to consider variables about the student, teachers and families together, as they all impact on the results. Furthermore, the data confirms that the study of homework should be based on a multilevel approximation, since the variables have effects and significance which varies according to the level analyzed (Trautwein & Köller, 2003).

Model 2 allows us to verify this study's first hypothesis, indicating that doing homework autonomously is more important than time spent, which confirms the importance of self-regulation and self-management in homework (Kitsantas & Zimmerman, 2009; Xu, 2013; Zimmerman & Kitsantas, 2005). In keeping with other multilevel studies (Farrow et al., 1999; Trautwein, 2007), once adjustment variables are controlled, time studying has hardly any predictive capacity.

The results of Model 3 are consistent with hypotheses 2 and 3, and confirm the importance of teachers in assigning and controlling homework. In the first place, systematic homework assignment was seen to

be the class-level variable with the greatest effect, while the amount assigned had a negative, albeit non-significant effect. These results are in line with evidence accumulated by other multilevel studies which indicate that the frequent assignment of homework has more explanatory power than the amount (De Jong et al., 2000; Fernández-Alonso, Suárez-Álvarez, & Muñoz, 2014; Trautwein, 2007; Trautwein et al., 2002; Trautwein, Schnyder et al., 2009), something which has clear educational implications for teaching policy on homework assignment. This confirms that, at least for Spanish year eight students, the optimum amount of homework is between seven and eight hours per week (Fernández-Alonso et al., 2015). Homework correction, on the other hand, does not demonstrate statistical significance, something which was predictable considering the data which indicate that teachers' control of homework has more impact on student behavior than class averages (Xu, 2012). The last variable in model 3, the weight given to homework in school grades, demonstrates differential behavior depending on the level: individually a positive effect, that is, when a student thinks that doing homework will be reflected in their grades, they demonstrate higher achievement in mathematics. However, the classrooms in which homework has most impact on grades tend to have worse results. This data may reflect the fact that faced with demo-

tivated class groups, teachers incentivize homework and weight it in their grading, which is unnecessary with highly motivated class groups. In any case, the differential behavior of a homework related variable depending on the level of analysis is relatively common; time, frequency, and difficulty of homework are variables which are significant and have differing effects depending on the level analyzed (Dettmers et al., 2010; Trautwein, 2007).

Finally, Model 4 verifies the fourth hypothesis by showing that family involvement in the teaching and learning process, and the importance families place on homework are positively related to results in the mathematics test. This finding is consistent with data from Hill and Tyson (2009) and, Trautwein and Lüdtke (2009), as both variables are distal measures of family involvement, which seem to be more closely linked to academic results than proximal measures of family involvement in the home such as direct help with homework or control over its completion. It is also worth mentioning that, in line with the expectations of hypothesis 1, once teaching and family variables are considered, the coefficient of time spent on homework is not only negative but also significant. This result coincides with findings from other multilevel studies that have analyzed results in mathematics and used samples of similar ages (Trautwein, 2007; Trautwein & Lüdtke, 2007). This indicates that, for sim-

ilar amounts and types of homework (once background factors are accounted for), those students with more difficulties need more time to do their homework. Recent studies have established student profiles, bringing together time spent on homework and effort made doing homework which have opened up new perspectives for work on time spent on homework (Flunger et al., 2015). In addition, once the family variables in model 4 are included, the weight given to homework in school grades at level 2 is no longer seen to be statistically significant, which leaves frequency of homework assignment as the only teaching variable at a class level which is statistically significant. This corroborates hypothesis 3 and seems to confirm that teacher control (at least as measured in this kind of survey) has greater impact on achievement at an individual level than at class level (Xu, 2012).

It is worth highlighting that the homework models explain a discrete percentage of the variance. Model 1, with only the adjustment variables, explains almost 34% of the variance, while model 4 provides 2% of the explanation of intra-group variation, which is in line with De Jong et al. (2000) who warn that individual attitude to homework has a moderate impact on school results. Nonetheless, as has already been shown (Prentice & Miller, 1992) these small effects can have significant consequences over a long period of time, which

would confirm the role of regular homework assignment throughout schooling. Furthermore it confirms the need for research into the homework-performance relationship to include adjustment factors to avoid overestimating the effects of homework-related variables (Dettmers, Trautwein, & Lüdtke, 2009). Some limitations of this work must be borne in mind when interpreting the results. While it is possible to derive significant educational implications, it must be remembered that the data are correlational and, as such, do not permit causal interpretations to be made. Some of the variables in this research (such as: receiving help to do homework, teachers' correction of homework, and the weight given to homework in school grades) have been evaluated through a single item, which might compromise the robustness of these measures. In addition, although the sample is large, it comes from a single region, and the data is only from students in the second year of compulsory secondary education (ESO). There is evidence that motivation and commitment to homework (Regueiro, Suárez, Valle, Núñez, & Rosário, 2015), and the relationship between homework and results (Cooper & Valentine, 2001) depend on the student's age. This research focuses on achievement in mathematics, while Trautwein & Lüdtke (2007, 2009) indicate that the homework-result relationship varies with subject. This suggests the need to widen the study to other subjects, especially

those linked to language communication. Finally it must be noted that in relation to teacher behavior, apart from frequency and amount of homework assigned, the study only looked at control and review of homework. There is evidence, however, that quality and other characteristics of homework assignment affect academic achievement (Dettmers et al., 2010; Trautwein et al., 2002; Trautwein, Niggli et al.,

2009). Along these lines work by Murillo & Martínez-Garrido (2013, 2014) analyzing types and tailoring of homework is finding differential effects with different types of assignment and achievement, which suggests a very productive line of study. Because of that, new research is needed to provide empirical evidence that reinforces the validity of the results (Lane, 2014; Sireci & Padilla, 2014).

References

- Bembenutty, H., & White, M. C. (2013). Academic performance and satisfaction with homework completion among college students. *Learning and Individual Differences, 24*, 83-88. doi: 10.1016/j.lindif.2012.10.013
- Chang, C. B., Wall, D., Tare, M., Golonka, E., & Vatz, K. (2014). Relations of attitudes toward homework and time spent on homework to course outcomes: The case of foreign language learning. *Journal of Educational Psychology, 106*(4), 1049-1065. doi: 10.1037/a0036497
- Cooper, H. (1989). *Homework*. White Plains, NY: Longman. doi: 10.1037/11578-000
- Cooper, H., Lindsay, J. J., & Nye, B. (2000). Homework in the home: How student, family, and parenting-style differences relate to the homework process. *Contemporary Educational Psychology, 25*(4), 464-487. doi: 10.1006/ceps.1999.1036
- Cooper, H., Robinson, J. C., & Patall, E. A. (2006). Does homework improve academic achievement? A synthesis of research, 1987-2003. *Review of Educational Research, 76*, 1-62. doi: 10.3102/00346543076001001
- Cooper, H., Steenbergen-Hu, S., & Dent, A. L. (2012). Homework. In K. R. Harris, S. Graham, & T. Urdan (Eds.), *APA educational psychology handbook, Vol. 3: Application to learning and teaching* (pp. 475-495). Washington, DC, US: American Psychological Association.
- Cooper, H., & Valentine, J. C. (2001). Using research to answer practical questions about homework. *Educational Psychologist, 36*, 143-153. doi: 10.1207/S15326985EP3603_1
- De Ayala, R. J. (2009). *The theory and practice of item response theory*. New York: Guilford Press.
- De Jong, R., Westerhof, K. J., & Creemers, B. P. M. (2000). Homework and student math achievement in junior high schools. *Educational Research and Evaluation, 6*, 130-157. doi: 10.1076/1380-3611(200006)6:2;1-E;F130

- Dettmers, S., Trautwein, U., & Lüdtke, O. (2009). The relationship between homework time and achievement is not universal: Evidence from multilevel analyses in 40 countries. *School Effectiveness and School Improvement, 20*, 375-405.
- Dettmers, S., Trautwein, U., Lüdtke, O., Goetz, T., Pekrun, R., & Frenzel, A. (2011). Students' emotions during homework in mathematics: Testing a theoretical model of antecedents and achievement outcomes. *Contemporary Educational Psychology, 36*, 25-35. doi: 10.1016/j.cedpsych.2010.10.001
- Dettmers, S., Trautwein, U., Lüdtke, M., Kunter, M., & Baumert, J. (2010). Homework works if homework quality is high: Using multilevel modeling to predict the development of achievement in mathematics. *Journal of Educational Psychology, 102*, 467-482. doi: 10.1037/a0018453
- Dumont, H., Trautwein, U., Nagy, G., & Nagengast, B. (2014). Quality of parental homework involvement: Predictors and reciprocal relations with academic functioning in the reading domain. *Journal of Educational Psychology, 106*(1), 144-161. doi: 10.1037/a0034100
- Elawar, M. C., & Corno, L. (1985). A factorial experiment in teachers' written feedback on student homework: Changing teacher behavior a little rather than a lot. *Journal of Educational Psychology, 77*(2), 162-173.
- Epstein, J. L., & Pinkow, L. (1988). *A model for research on homework based on U.S. and international studies*. Baltimore, MD: Johns Hopkins University. (ERIC Document Reproduction Service N: ED301323)
- Farrow, S., Tymms, P., & Henderson, B. (1999). Homework and attainment in primary schools. *British Educational Research Journal, 25*(3), 323-341.
- Fernández-Alonso, R., & Muñiz, J. (2011). Diseños de cuadernillos para la evaluación de competencias básicas. *Aula Abierta, 39*(2), 3-34.
- Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2012). Imputación de datos perdidos en las evaluaciones diagnósticas educativas. *Psicothema, 24*(1), 167-175.
- Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2014). Tareas Escolares en el hogar y rendimiento en Matemáticas: una aproximación multinivel con estudiantes de enseñanza primaria. *Revista de Psicología y Educación, 9*(2), 15-30.
- Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2015, March 16). Adolescents' homework performance in mathematics and science: Personal factors and teaching practices. *Journal of Educational Psychology*. Advance online publication. doi: 10.1037/edu0000032
- Flunger, B., Trautwein, U., Nagengast, B., Lüdtke, O., Niggli, A., & Schnyder, I. (2015). The Janus-faced nature of time spent on homework: Using latent profile analyses to predict academic achievement over a school year. *Learning and Instruction, 39*, 97-106. doi: 10.1016/j.learninstruc.2015.05.008
- Fuentes, M. C., García, F., Gracia, E., & Alarcón, A. (2014). Parental socialization styles and psychological adjustment: A study in Spanish adolescents. *Revista de Psicodidáctica, 20*(1), 117-138. doi: 10.1387/RevPsicodidact.10876
- García-Linares, M. C., de la Torre, M. J., Villa Carpio, M. V., Cerezo, M. T., & Casanova, P. F. (2014). Consistency/Inconsistency in paternal and maternal parenting styles and daily stress in adolescence. *Revista de Psicodidáctica, 19*(2), 307-325. doi: 10.1387/RevPsicodidact.721.

- Gobierno del Principado de Asturias (2012). *Evaluación de diagnóstico. Asturias 2011*. Oviedo: Consejería de Educación, Cultura y Deporte.
- Hill, N. E., & Tyson, D. F. (2009). Parental involvement in middle school: A meta-analytic assessment of the strategies that promote achievement. *Developmental Psychology, 45*(3), 740-763.
- Hoover-Dempsey, K. V., Battiato, A. C., Walker, J. M. T., Reed, R. P., DeJong, J. M., & Jones, K. P. (2001). Parental involvement in homework. *Educational Psychologist, 36*, 195-209.
- Hox, J. J. (2010). *Multilevel analysis: Techniques and applications (Second Edition)*. New York, NY: Routledge.
- Kitsantas, A., Cheema, J., & Ware, H. (2011). The role of homework support resources, time spent on homework, and self-efficacy beliefs in mathematics achievement. *Journal of Advanced Academics, 22*(2), 312-341.
- Kitsantas, A., & Zimmerman, B. J. (2009). College students homework and academic achievement: The mediating role of self-regulatory beliefs. *Metacognition and Learning, 4*(2), 1556-1623.
- Lane, S. (2014). Validity evidence based on testing consequences. *Psicothema, 26*, 127-135.
- Ministerio de Educación & Ciencia (2006). *Sistema estatal de indicadores de educación 2006*. Madrid: Instituto de Evaluación.
- Murillo, F. J. (2003). *La investigación sobre eficacia escolar en Iberoamérica. Revisión internacional sobre el estado del arte*. Bogotá: Convenio Andrés Bello.
- Murillo, F. J., & Martínez-Garrido, C. (2013). Homework influence on academic performance. A study of Iberoamerican students of Primary Education. *Revista de Psicodidáctica, 18*(1), 157-171. doi: 10.1387/RevPsicodidact.6156
- Murillo, F. J., & Martínez-Garrido, C. (2014). Las tareas para casa como recurso para una enseñanza de calidad. *Revista de Psicología y Educación, 9*(2), 31-48.
- Núñez, J. C., Suárez, N., Rosário, P., Vallejo, G., Cerezo, R., & Valle, A. (2015). Teachers' feedback on homework, homework-related behaviors, and academic achievement. *The Journal of Educational Research, 108*(3), 204-216. doi: 10.1080/00220671.2013.878298
- Núñez, J. C., Vallejo, G., Rosário, P., Tuero, E., & Valle, A. (2014). Student, teacher, and school context variables predicting academic achievement in biology: Analysis from a multilevel perspective. *Revista de Psicodidáctica, 19*(1), 145-171. doi: 10.1387/RevPsicodidact.7127
- OCDE (2013). *PISA 2012 results, Vol. IV: What makes schools successful? Resources, policies and practices*, Paris: OECD Publishing. doi: 10.1787/9789264201156-en
- Patall, E. A., Cooper, H., & Robinson, J. C. (2008). Parent involvement in homework: A research synthesis. *Review of Educational Research, 78*(4), 1039-1101.
- Peña-Suárez, E., Fernández-Alonso, R., & Muñoz, J. (2009). Estimación del valor añadido de los centros escolares. *Aula Abierta, 37*(1), 3-18.
- Pomerantz, E. M., Moorman, E. A., & Litwack, S. D. (2007). The how, whom, and why of parents' involvement in children's academic lives: More is not always better. *Review of Educational Research, 77*(3), 373-410.
- Prentice, D. A., & Miller, D. T. (1992). When small effects are impressive. *Psychological Bulletin, 112*(1), 160-164. doi: 10.1037/0033-2909.112.1.160
- Ramdass, D., & Zimmerman, B. J. (2011). Developing self-regulation skills: The

- important role of homework. *Journal of Advanced Academics*, 22, 194-218. doi: 10.1177/1932202X1102200202
- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods. 2nd edition*. Newbury Park, CA: Sage.
- Raudenbush, S. W., Bryk, A. S., Cheong, Y. F., & Congdon, R. T. (2004). *HLM6: Hierarchical linear and non-linear modeling*. Chicago: Scientific Software International.
- Regueiro, B., Suárez, N., Valle, A., Núñez, J. C., & Rosário, P. (2015). La motivación e implicación en los deberes escolares a lo largo de la escolaridad obligatoria. *Revista de Psicodidáctica*, 20(1), 47-63. doi: 10.1387/RevPsicodidact.12641
- Rosário, P., Mourão, R., Baldaque, M., Nunes, T., Núñez, J. C., González-Pianda, J. A., ...Valle A. (2009). Homework, self-regulated learning and math achievement. *Revista de Psicodidáctica*, 14(2), 179-192. doi: 10.1387/RevPsicodidact.721
- Sammons, P., Hillman, J., & Mortimore, P. (1995). *Key characteristics of effective schools: A review of school effectiveness research*. London: Office for Standards in Education. (ERIC Document Reproduction Service N: ED389826)
- Scheerens, J., Witziers, B., & Steen, R. (2013). A meta-analysis of school effectiveness studies. *Revista de Educación*, 361, 619-645.
- Sireci, S., & Padilla, J. L. (2014). Validating assessments: Introduction to the special section. *Psicothema*, 26, 97-99.
- Stoeger, H., & Ziegler, A. (2008). Evaluation of a classroom based training to improve self-regulation in time management tasks during homework activities with fourth graders. *Metacognition and Learning*, 3, 207-230.
- Suárez-Álvarez, J., Fernández-Alonso, R., & Muñiz, J. (2014). Self-concept, motivation, expectations and socioeconomic level as predictors of academic performance in mathematics. *Learning and Individual Differences*, 30, 118-123.
- Trautwein, U. (2007). The homework-achievement relation reconsidered: Differentiating homework time, homework frequency, and homework effort. *Learning and Instruction*, 17, 372-388.
- Trautwein, U., & Köller, O. (2003). The relationship between homework and achievement: Still much of a mystery. *Educational Psychology Review*, 15, 115-145. doi: 10.1023/A:1023460414243
- Trautwein, U., Köller, O., Schmitz, B., & Baumert, J. (2002). Do homework assignments enhance achievement? A multilevel analysis in 7th grade mathematics. *Contemporary Educational Psychology*, 27, 26-50. doi: 10.1006/ceps.2001.1084
- Trautwein, U., & Lüdtke, O. (2007). Students' self-reported effort and time on homework in six school subjects: Between-student differences and within-student variation. *Journal of Educational Psychology*, 99, 432-444. doi: 10.1037/0022-0663.99.2.432
- Trautwein, U., & Lüdtke, O. (2009). Predicting homework motivation and homework effort in six school subjects: The role of person and family characteristics, classroom factors, and school track. *Learning and Instruction*, 19, 243-258. doi: 10.1016/j.learninstruc.2008.05.001
- Trautwein, U., Lüdtke, O., Schnyder, I., & Niggli, A. (2006). Predicting homework effort: Support for a domain-specific, multilevel homework model. *Journal of Educational Psychology*, 98, 438-456. doi: 10.1037/0022-0663.98.2.438

- Trautwein, U., Niggli, A., Schnyder, I., & Lüdtke, O. (2009). Between-teacher differences in homework assignments and the development of students' homework effort, homework emotions, and achievement. *Journal of Educational Psychology, 101*, 176-189. doi: 10.1037/0022-0663.101.1.176
- Trautwein, U., Schnyder, I., Niggli, A., Neumann, M., & Lüdtke, O. (2009). Chameleon effects in homework research: The homework-achievement association depends on the measures used and the level of analysis chosen. *Contemporary Educational Psychology, 34*, 77-88. doi: 10.1016/j.cedpsych.2008.09.001
- Wingard, L., & Forsberg, L. (2009). Parent involvement in children's homework in American and Swedish dual-earner families. *Journal of Pragmatics, 41*, 1576-1595.
- Wu, M. L., Adams, R. J., Wilson, M. R., & Haldane, S. A. (2007). *ACER ConQuest 2.0: Generalised item response modelling software*. Camberwell, Victoria: Australian Council for Educational Research.
- Xu, J. (2011). Homework completion at the secondary school level: A multi-level analysis. *The Journal of Educational Research, 104*(3), 171-182. doi: 10.1080/00220671003636752.
- Xu, J. (2012). Secondary school students' interest in homework: What about race and school location? *School Community Journal, 22*(2), 65-86.
- Xu, J. (2013). Why do students have difficulties completing homework? The need for homework management. *Journal of Education and Training Studies, 1*(1), 98-105.
- Xu, J., & Wu, H. (2013). Self-regulation of homework behavior: Homework management at the secondary school level. *The Journal of Educational Research, 106*(1), 1-13. doi: 10.1080/00220671.2012.658457.
- Xu, J., Yuan, R., Xu, B., & Xu, M. (2014). Modeling students' time management in math homework. *Learning and Individual Differences, 34*, 33-42.
- Zimmerman, B. J., & Kitsantas, A. (2005). Homework practices and academic achievement: The mediating role of self-efficacy and perceived responsibility beliefs. *Contemporary Educational Psychology, 30*, 397-417. doi: 10.1016/j.cedpsych.2005.05.003

Rubén Fernández-Alonso is coordinator at the service of Evaluation Assessment of the Ministry of Education and Culture of the Principality of Asturias. He is a PhD in Psychometrics at the University of Oviedo and expert in educational measurement. He has recently published several papers on homework using multilevel methodology and models based on Item Response Theory.

Javier Suárez-Alvarez is a PhD in Psychometrics at the Department of Psychology of the University of Oviedo. His main research interests focus on educational measurement and personality assessment, and he has published several papers on these issues in national and international journals. The FPI subprogram of the Ministry of Economy and Competitiveness of the Government of Spain recently allowed a stay at the University of Massachusetts during an academic year under the supervision of Professors Ronald K. Hambleton and Steve Sireci.

Jose Muñoz is a professor of Psychometrics at the University of Oviedo, Spain. He has published numerous books and papers in national and international journals. He has been president of the International Test Commission (ITC), and the European Association of Methodology (EAM). A Fulbright grant allowed him to work at the University of Massachusetts (Amherst) with Profs. Ronald K. Hambleton and Steve Sireci.

Received date: 13-02-2014

Review date: 14-08-2015

Accepted date: 13-11-2015

