The association between homework and primary school children's academic achievement. International evidence from PIRLS and TIMSS

John Jerrim, Luis Alejandro Lopez-Agudo & Oscar Marcenaro

Correspondence

John Jerrim, Institute of Education, University College London, 20 Bedford Way, London WC1H 0AL, UK

Email: J.Jerrim@ioe.ac.uk

Luis Alejandro Lopez-Agudo, Faculty of Economics and Business, University of Malaga, Calle Ejido 6, 290971 Malaga, Spain

Email: lopezagudo@uma.es

Oscar Marcenaro, Faculty of Economics and Business, University of Malaga, Calle Ejido 6, 290971 Malaga, Spain

Email: odmarcenaro@uma.es

1. INTRODUCTION

Teachers and educators have considered homework as one of the main mechanisms to continue pupils' learning when they are not at school. Authors like Corno and Xu (2004) defined homework as the 'job of childhood' insofar as it develops pupils' responsibility and attitude, preparing them for their future profession. However, it has become one of the main sources of disagreement between schools and parents (Cooper, 2001) because of the sometimes excessive amount of homework given at an early age. Some parents even consider their children to be 'losing their childhood'("Spanish parents urged to put children on weekend homework strike," 2016), with 'homework strikes' having taken place in some countries ("Goodbye to homework for some elementary schools and classes," 2016). However, whether the amount of time primary school children spend on homework is a worthwhile investment depends on the rewards that it brings. Does homework lead to the development of significantly better math, reading and science skills? Or is it simply a time-consuming activity that has little obvious impact on academic achievement?

Previous work on this issue has produced mixed results. Authors who suggest that homework has a positive significant influence include Cooper, Robinson, and Patall (2006). Carrying out a meta-analysis of studies conducted between 1987 and 2003 in the US, they found a positive correlation (of approximately 0.60 standard deviations) on children's achievement. This evidence was, however, specific to the US, with the

studies included in the meta-analysis varying in terms of size and quality. Outside the US, Baş, Şentürk, and Ciğerci (2017) also carried out a meta-analysis, finding a smaller but still significant average effect of around 0.20. This is consistent with the few cross-national analyses conducted to date. For instance, based on a cross-national analysis of 16 countries, Falch and Rønning (2012) found a positive association of around 0.20 standard deviations. Likewise, using data from Latin America, Murillo and Martinez-Garrido (2014) concluded that time spent on homework had a positive influence on children's achievement, but only when teachers provided feedback in subsequent classes. OECD (2011) found that students in developed countries who were assigned more homework did better in science. More recently, Scheerens and Hendriks (2014) reviewed the literature, showing that homework had a moderately positive association (effect size of 0.29). Similar results had been found by Hattie (2009) who performed a meta-analysis on the influence of homework on academic achievement. Hattie found an average effect size of 0.29 for a total of five meta-analyses composed of 161 studies. The effect sizes ranged from 0.15 in primary education to 0.64 in high school.

Other studies where positive associations were found were those by Scheerens, Luyten, Steen, & Luyten-de Thouars (2007) who carried out a meta-analysis of 21 studies, obtaining an average effect size of 0.073. Importantly, the strength of the association varied by country, with the greatest found in the Netherlands and the US. Similarly, Hendriks, Luyten, Scheerens, and Sleegers (2014) conducted a meta-analysis of seventeen studies at individual level and ten studies at school or class levels. Overall, the effect size they found was very small (around 0.05). Other important research includes that by Baker and LeTendre (2005) who analysed the correlation between homework and academic achievement in mathematics across many countries using data from the TIMSS 1999 assessment; they found a negative association. On the other hand, Dettmers, Trautwein, and Lüdtke (2009) found mixed results for 40 countries that participated in PISA (Programme for International Student Assessment) 2003, with a positive relationship in some countries, but a negative one in others.

Yet a number of important limitations with the existing evidence base motivates the need for further research. Indeed, having conducted a 20th-century review on homework, Trautwein and Köller (2003) concluded that the empirical evidence with respect to its benefits was rather weak. This is supported by a recent analysis by the Education Endowment Foundation in the UK which, based upon the international literature, noted how '*A number of reviews and meta-analyses have explored this issue. There is stronger evidence that it* [homework] *is helpful at secondary level, but there is much less evidence of benefit at primary leve*l' (Education Endowment Foundation, 2017, p. 1). This is supported by Kohn (2006) who highlighted a range of issues with existing studies on the effects of primary school homework, ranging from much evidence being correlational to a reliance upon the homework measures being based solely upon children's self-reports.

Using the 2011 round of the Progress in International Reading Literacy Study (PIRLS) and Trends in International Mathematics and Science Study (TIMSS), we investigated the association between homework time and children's academic achievement across 24 countries. By using data in three subjects (reading, science and mathematics), we were able to use a student fixed-effects approach. This allowed us to rule out a wide range of potential confounding characteristics that did not vary within-students (e.g., gender, socio-economic status). We used the variation in the amount of homework that was assigned in different subjects, to go further than much of the existing literature on correlation has done. We found almost no association between the amount of homework set by teachers and children's achievement in any of our 24

countries. This is consistent across various sub-groups and survives a series of robustness tests. We thus conclude that the homework teachers assign in primary school does not produce a meaningful positive influence on achievement. Homework needs to be improved if this time-consuming activity is to become a worthwhile investment.

2. DATA AND METHODS

The data are drawn from the 2011 PIRLS and TIMSS assessments, focusing on students in the fourth grade (aged nine or ten years). PIRLS tests children's literacy skills, whilst TIMSS captures their performance in mathematics and science. Both studies are conducted by the International Association for the Evaluation of Educational Achievement (IEA). An unusual feature of the 2011 round is that, in many countries, the same fourth grade students who participated in TIMSS also took part in PIRLS. Hence, information was available regarding children's achievement in three subjects (reading, science and mathematics) in the 24 countries we included in our analysis[1].

A two-stage cluster sample design was used in PIRLS and TIMSS (Martin & Mullis, 2012). In the first stage, schools were sampled with probabilities that were proportional to size; in the second, all students in one or more fourth grade classes were chosen to participate. The technical documentation of PIRLS and TIMSS provides details regarding response rates across countries (Martin & Mullis, 2012, Appendix C.3 and C.4). Response rates were high at both the school and the pupil level, typically above 96% of those initially selected (after replacement schools were considered)[2].

As part of the PIRLS and TIMSS studies, children sit a one-hour test. To minimise the burden on children, a 'rotated booklet design' was used (Martin & Mullis, 2012), with children randomly assigned to take only a sub-sample of all test questions. Using their responses, an item response theory (IRT) model was used to estimate their latent ability in a given subject. In the PIRLS and TIMSS datasets, five 'plausible values' for each child summarising their achievement in each subject were obtained. These are the outcome variables we focus on in our analysis.

Sampled children, their teachers and their parents (PIRLS only) completed background questionnaires. The key variable was the amount of homework assigned by class teachers, as recorded by answers to the following question:

> When you assign (subject) homework to the students in this class, about how many minutes do you usually assign? (Consider the time it would take an average student in your class)
>
> - I do not assign (subject) homework[3]
> -15 minutes or less.
> -16-30 minutes.
> -31-60 minutes.
> -More than 60 minutes.

This variable has the advantage of being reported directly by teachers and is, hence, likely to be more accurately reported than by primary school children (as is often the case, see e.g. Kohn, 2006 or international large-scale assessments such as PISA). We used these data to estimate the influence of homework time on primary school children's academic achievement. Our starting model was:

$$Y_{its} = \alpha + \beta HT_{ts} + \gamma X_{its} + \delta T_{ts} + \varepsilon_{its} \quad (1)$$

where the sub-index i represented the student, t the teacher and s the school. Y_{its} was students' standardised academic achievement[4]; HT_{ts} the homework time reported by the teacher; X_{its} student characteristics, which are the same within-students between-subjects (e.g., socioeconomic status, gender, etc.); T_{ts} teacher characteristics, which are the same within-teacher and between-subjects (e.g., gender, level of education, etc.).

We estimated model (1) having included student fixed-effects. This exploited the variation in the amount of homework time set across the three subjects (reading, science and maths) to investigate how the *differences* were related to *differences* in achievement, given that we fixed the rest of the students' and teachers' characteristics. This means that it would not be necessary to control for any variable which may influence the association between homework time and academic achievement whenever this variable was the same between-subjects for the same student and teacher. In other words, we estimated:

$$\Delta Y = \beta \Delta HT + \gamma \Delta X + \delta \Delta T + \Delta \varepsilon \quad (2)$$

These Xs are the same within-students, so $\Delta X = 0$. For example, students' socio-economic background (SES) is the same for each student between different subjects, so we do not have to control by it, as it does not vary between subjects (variation equals zero; $\Delta X = 0$). As we used students taught by the same teacher in the three subjects, it was also the case that $\Delta T = 0$,i.e., characteristics such as the gender or the level of education of the teacher do not change because the teacher was the same for the three subjects. Hence, we were able to estimate β, the degree of association between homework time and students' academic achievement. However, although we fixed the observables, one had to acknowledge that controlling for all un-observables was almost impossible. Hence, we considered the results of our estimates to be conditional associations rather than causal effects.

The aforementioned 'identification strategy', i.e., the capacity to get closer to a precise measure of the degree of association between time spent upon homework and academic achievement, relied upon two key assumptions. First, that the amount of homework time set by teachers varied across subjects. We checked this for each pair of subjects by country, finding that, for reading and mathematics, almost half the teachers reported different homework time across countries. The same was true for science and mathematics; around half the teachers who were questioned reported setting a different amount of homework (on average, across countries). The proportion was slightly higher, at around 60%, in reading and science (on average across countries). Further country-specific details are presented in Table 1. Hence, there does seem to be sufficient variation in the amount of homework time teachers set across different subjects to make our identification strategy credible.

<< Table 1 >>

The second assumption was that the association between homework time and academic achievement was the same across the three subjects, i.e., β does not change between-subjects, so students' un-observables – mainly ability – do not make the productivity of homework (i.e., its influence on academic achievement) differ across subjects. We tried to investigate this in our robustness checks by restricting our sample to: (a) only those students who reported equally enjoying the three subjects and (b) students who reported equal confidence across the three subjects[5]. The premise was that the time spent on homework by these children was likely to be equally as efficient across the three subject areas. We report the results from this robustness test in the following section[6].

Another set of robustness checks was performed using the previously described weekly homework frequency variable in addition to three homework control variables from the teacher questionnaire[7]. These variables were interacted with the homework time variable in order to analyse whether considering other aspects of homework time and teachers' practices with this homework time may influence its association with academic achievement. According to Trautwein and Köller (2003) and Trautwein (2007), homework time can be studied in depth by using homework-related variables (e.g., weekly frequency), as taking only a daily homework time variable may show an aggregated influence of all of them. In this sense, Fernández-Alonso, Suárez-Álvarez, and Muñiz (2015, 2016) indicated that the frequency of homework was a relevant explanatory variable of the influence of homework on students' academic achievement; they also tested for the association of teaching style by teachers' practices in monitoring students' homework, but did not find any significant association. Murillo and Martinez-Garrido (2014) indicated that only homework which was effectively implemented by teaching practices improved students' academic achievement. Following Trautwein, Köller, Schmitz, and Baumert (2002), an incorrect combination of homework time and frequency in monitoring students' homework may influence its effectiveness on students' learning, underlining the relevance of teachers' teaching style with respect to homework. In this context, we found it necessary to check if our results could be the consequence of using only daily homework time by considering other aspects of homework time and teaching practices with this homework time.

We also investigated potential heterogeneous associations across different sub-groups. First, as emphasised by Harris, Nixon, and Rudduck (1993) and Kackar, Shumow, Schmidt, and Grzetich (2011), there may be gender differences in the way that students tackle their homework which may alter its association with their academic achievement. For example, Trautwein, Köller, Schmitz, and Baumert (2002) indicated that girls obtained more achievement gains with homework than boys and that the length of homework had less influence on them. Second, as suggested by Rønning (2011), there may be heterogeneity in the association of homework by socioeconomic background. For instance, advantaged parents may be more likely to help their child with their homework, thus making the time children invest in this activity more productive. We therefore investigated whether there was any evidence of a heterogeneous association by analysing the interaction between homework time and (a)

a

gender and (b) tertiles of the PIRLS and TIMSS 'Home Resources for Learning' scale[8] as a proxy for socioeconomic background.

3. RESULTS

3.1. Main results

The main results are presented in Table 2. The homework time variable was expressed in a quasi-continuous form and its unit of measurement was a ten-minute change in homework time[9]. The results illustrate how the amount of homework-time teachers set is not related to children's achievement in most of the countries considered. For instance, the average association across the 24 countries is just 0.01 standard deviations for every extra ten-minute increase, with the results only statistically significant in Georgia and Lithuania. However, even in these countries, the effects are small (0.022 and 0.024 standard deviations for every extra 10-minute increase in homework time respectively). Moreover, given the large sample sizes, one can see that these small effects are estimated quite precisely, providing further evidence of a genuine null association (i.e., it is not a lack of power as a result of poor sample sizes that drives this result). Very similar results emerge when the homework variable is entered into the model in its original categorical form (these estimations are available upon request to the authors). Hence, the evidence in Table 2 provides no support for the hypothesis that homework time is positively associated with students' academic achievement. Indeed, we believe this evidence provides quite strong support for a zero association.

<< Table 2 >>

3.2. Robustness checks

The first robustness test checked whether using student fixed-effects was appropriate, as explained in the methodology section. To do this, we restricted the sample to those students who reported they liked learning the three subjects equally and were equally confident in the three subjects. The results for the sample of students who reported the same level of enjoyment across the three subjects are presented in Table 3 and for those who expressed the same level of confidence across the three subjects in Table 4. Consistent with the results presented in Table 2, the homework time coefficient is rarely significant and is typically small. It thus provides support for the conclusions reached from the homework time β coefficient obtained in the baseline model.

<< Table 3 >>

<< Table 4 >>

Furthermore, robustness checks employing the remaining homework-related variables in the teacher questionnaire were carried out[10]. These variables were respectively interacted with the homework time variable and are, particularly, the frequency of homework, correcting assignments and giving feedback, discussing the homework in class and monitoring whether or not the homework was completed (the tables for these results have not been included for reasons of space but they will be provided upon

request to the authors). Once again, our main results do not change. Hence, they continue to show a zero correlation between time spent on doing homework and outcomes in TIMMS or PIRLS, even when we considered the effectiveness of the teaching style with time spent on homework (as found by authors such as Fernández-Alonso, Suárez-Álvarez, & Muñiz, 2015, 2016).

Additional robustness checks dividing the sample by gender and by socio-economic status were performed (the tables for these results have not been included for reasons of space but they will be provided upon request to the authors). Once again, we found a null association of homework time. These results contradict the commonly reported gender differences in the correlation of homework time with students' academic achievement (Harris, Nixon, & Rudduck, 1993; Trautwein, Köller, Schmitz, & Baumert, 2002; Kackar, Shumow, Schmidt, & Grzetich, 2011) and by socio-economic background (Rønning, 2011).

Hence, all these checks supported the robustness of our main result: homework time presents zero correlation with students' academic achievement.

4. DISCUSSION

The obtained 'null' result is relevant for education policy. Homework does not seem to be positively associated with students' academic performance (as most of the literature highlights), at least not for the skills measured by the PIRLS and TIMSS assessments. These skills are not content-based knowledge of reading, mathematics and science (Kohn, 2006), but rather the capability to apply knowledge and skills in real life situations. Critically, homework in its current form in primary schools does not seem to influence these real-life skills. This could be because the homework currently set by teachers is 'content-based', i.e., designed to develop knowledge of national curricula, rather than based on more real-world competencies. One potential policy implication is that more competence-oriented curricula need to be developed by national governments, with homework time then devoted to the development of such skills.

Education policies on homework touch also on concerns related to the equity of student outcomes. As we have found, students from different socioeconomic backgrounds are not differentially influenced by homework assignments. In other words, we obtained a null association for the different socioeconomic backgrounds. Hence, it seems that homework may not prejudice poor students nor benefit rich ones (unlike the results of Rønning, 2011). The same holds true for gender. This may suggest that content-based homework may be a problem for the education system as a whole and not specific to one particular group.

The content of homework was also found to have an influence on students' motivation. For instance, Trautwein, Lüdtke, Schnyder, and Niggli (2006) and Trautwein and Lüdtke (2009, p. 243) illustrated how 'students' homework motivation and homework effort varied primarily as a function of their shared perceptions of homework quality and control (classroom level) and of their conscientiousness, individual perception of homework quality, and expectancy and value beliefs (student level)'. Hence, as these authors suggest, in order to motivate students, homework needs to be of high quality. Trautwein and colleagues indicated that '*high-quality homework requires careful selection and preparation of appropriate and interesting tasks. It means using homework assignments to reinforce classroom learning and to diagnose individual students' learning progress and difficulties'* (p. 244). In the same vein, Dettmers, Trautwein, Lüdtke, Kunter, and Baumert (2010) found that students in classes

with high quality homework assignments learned more than those in other classes. Hence, although we do not have information on students' homework motivation, previous evidence shows that it is influenced by homework quality.

These results stress the need for more thoughtful approaches when designing homework assignments and providing feedback to students. Critically, assignments should build students' abilities to use reading, science and mathematics skills in real-world situations. This may, in turn, depend upon the quality of the teacher. Barber and Mourshed indicated that '*the quality of an education system cannot exceed the quality of its teachers*' (Barber & Mourshed 2007, p. 7), highlighting the relationship between teacher quality and pupil performance. Of course, as indicated by Dolton and Marcenaro (2011), teacher quality is extremely difficult to measure. Nevertheless, training teachers so that they design competence-oriented homework and provide higher quality feedback to students may, in some countries, be an important direction for education policy.

In terms of future research, one potential direction could be for teachers' competences to be measured. This would allow to directly test whether the relationship between homework and children's achievement depends upon teachers' knowledge and quality. Moreover, information on students' prior achievement across several subjects (e.g., reading, science and mathematics) would enable one to investigate how homework was associated with pupil progress via the estimation of 'value-added' models. It is critical that studies such as PISA, PIRLS and TIMSS start to collect such information in order to provide further evidence on how homework is associated with students' outcomes across countries. Finally, further research is also needed about students' homework motivation, how this differs between subjects and how this relates to homework time and pupil performance. This would provide a more complete picture with respect to the homework of primary school children and whether this time-consuming activity is really a worthwhile endeavour.

5. CONCLUSIONS

The main results of the current analysis show that homework time did not seem to influence students' academic achievement. This conclusion has survived a series of robustness checks. As mentioned above, previous research has been far from conclusive: while some studies have found a positive association, others have produced null results. More generally, there is a consensus in the literature that more research into the impact of primary school homework in particular is needed. This article therefore used a student fixed-effects approach to fill this gap in the literature, going further from the correlation of homework with students' academic achievement found in most existing studies. We find that, despite the quantity and quality of primary school homework potentially varying across countries, there is little clear evidence that children's achievement actually benefits from it.

In order to interpret this 'null' result it is also relevant to consider that PIRLS and TIMSS measure students' skills or competencies in the three subjects and not their content-based knowledge (Kohn, 2006). This means that these competences are the skills that children are likely to use in later life. Thus, although our analysis does not let us firmly conclude on the determinants of these null results, it suggests that the quality of primary school homework is not enough to develop students' academic competencies. This could motivate the implementation of two policies: the first, to increase the quality of homework so that fourth grade students can improve their learning at a competence level; the second, to provide students with the necessary formation in the classroom for them to devote less time to studying at home. Hence,

these two policies would provide students with less but higher quality homework time which may improve their academic achievement. Furthermore, this would allow students more time for extra-curricular activities and leisure-time for developing other skills such as social skills.

NOTES

1 37 countries participated in the TIMSS and PIRLS fourth grade assessments. We dropped thirteen of these countries because of different pupils completing the TIMSS and PIRLS assessments (Denmark, England, Netherlands, New Zealand and the US) or to a large number of cases in which different teachers were teaching children across the three subjects (Chinese Taipei, Hong Kong, Italy, Morocco, Oman, Qatar, Saudi Arabia and the United Arab Emirates). Within the remaining 24 countries, we also excluded any teacher missing information on the key homework time variables. There are some cases in our final sample in which students were taught by two teachers in the three subjects: in these cases, each teacher was considered as a separate observation. Information about the percentage of the initial PIRLS and TIMSS common sample in the final sample and the sample used in our analysis – in which the duplicated teachers were considered as previously indicated –, together with descriptive statistics for the sample employed in our analysis, are available upon request to the authors.

2 Throughout our analysis, the final student weights and jackknife replication weights are applied to take this complex sampling design into account (this helps to solve problems such as, e.g., heteroscedasticity).

3 This response category is based on the preceding question in the questionnaire: '*How often do you usually assign (subject) homework to the students in this class?*' and corresponds to teachers who selected the option '*I do not assign (subject) homework*'. Other answers to this question are '*Less than once a week*', '*1 or 2 times a week*', '*3 or 4 times a week*' and '*Every day*'.

4 Standardisation was performed using each country's mean and standard deviation for each subject (Mullis, Martin, Foy, & Drucker, 2012; Mullis, Martin, Foy, & Arora, 2012; Martin, Mullis, Foy, & Stanco, 2012).

5This was measured by the 'students like learning the subject' and 'students confident in the subject' scales, respectively. Specifically, the categories of the 'subject enjoyment scale' are: 'Like learning the subject', 'Somewhat like learning the subject' or 'Do not like learning the subject'. For the confidence scale: 'Confident', 'Somewhat confident' or 'Not confident'. Details on the creation of these scales can be found in PIRLS/TIMSS technical documentation (Martin & Mullis, 2012).

6 Furthermore, a similar test to that proposed in Metzler and Woessmann (2012) (replicated by authors such as Cattaneo, Oggenfuss, & Wolter, 2017) was also applied and its results suggest that the β obtained in this research are the same for the three subjects. This test can be provided upon request to the authors.

7 These variables are part of the question: '*How often do you do the following with the (subject) homework assignments for this class?*', being the three variables '*Correct assignments and give feedback to students*', '*Discuss the homework in class*' and '*Monitor whether or not the homework was completed*'. The answers to these variables are '*Always or almost always*', '*Sometimes*' and '*Never or almost never*'.

8 Details on the creation of this scale can be found in PIRLS/TIMSS technical documentation (Martin & Mullis, 2012).

9 The homework time variable was translated into a ten-minute quasi-continuous variable in the following way: 'I do not assign (subject) homework' 0 ten-minutes, '15 minutes or less' 0.75, '16-30 minutes' 2.3, '31-60 minutes' 4.55 and 'More than 60 minutes' 6. Alternatively, all the estimations and robustness checks in the current research were replicated using for the 'More than 60 minutes' category the values of 7.5 and 9 and results do not change. These estimations are available from authors upon request.

10 Whenever teachers presented a missing observation in any of the three subjects' robustness check homework variables they were not included for the specific robustness check using that variable.

REFERENCES

Baker, D. P. & LeTendre, G. K. (2005). *National differences, global similarities: World culture and the future of schooling*. Stanford: Stanford University Press.

Barber, M. & Mourshed, M. (2007). *How the world's best-performing school systems come out on top*. London: McKinsey & Company.

Baş, G., Şentürk, C., & Ciğerci, F. M. (2017). Homework and academic achievement: A meta-analytic review of research. *Issues in Educational Research, 27,* 31-50.

Cattaneo, M. A., Oggenfuss, C., & Wolter, S. C. (2017). The more, the better? The impact of instructional time on student performance. *Education Economics, 25*, 433-445. doi: 10.1080/09645292.2017.1315055

Cooper, H. (2001). *The battle over homework: Common ground for administrators, teachers, and parents*. Thousand Oaks: Corwin Press.

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

Corno, L. & Xu, J. (2004). Homework as the job of childhood. *Theory into practice, 43*, 227-233. doi: 10.1207/s15430421tip4303_9

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. doi: 10.1080/09243450902904601

Dettmers, S., Trautwein, U., Lüdtke, O., 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

Dolton, P. & Marcenaro, O. D. (2011). If you pay peanuts do you get monkeys? A cross-country analysis of teacher pay and pupil performance. *Economic Policy, 26*, 5-55. doi: 10.1111/j.1468-0327.2010.00257.x

Education Endowment Foundation (2017). *Homework (Primary). Low impact for very low or no cost, based on limited evidence*. Teaching and Learning Toolkit, 10th November 2017, p. 1. Retrieved from https://educationendowmentfoundation.org.uk/evidence-summaries/teaching-learning-toolkit/homework-primary

Falch, T. & Rønning, M. (2012). *Homework assignment and student achievement in OECD countries*. Discussion Papers No. 711. Oslo: Statistics Norway, Research Department. Retrieved from https://www.ssb.no/a/publikasjoner/pdf/DP/dp711.pdf

Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2015). Adolescents' homework performance in mathematics and science: Personal factors and teaching practices. *Journal of Educational Psychology*, *107*, 1075-1085. doi: 10.1037/edu0000032

Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2016). Homework and performance in mathematics: The role of the teacher, the family and the student's background. *Revista de Psicodidáctica*, *21*, 5-23. doi: 10.1387/RevPsicodidact.13939

Goodbye to homework for some elementary schools and classes (2016, September 26), *Daily Mail Online*. Retrieved from https://www.dailymail.co.uk/wires/ap/article-3807263/Goodbye-homework-elementary-schools-classes.html

Harris, S., Nixon, J., & Rudduck, J. (1993). School work, homework and gender. *Gender and Education*, *5*, 3-15. doi: 10.1080/0954025930050101

Hattie, J. (2009). *Visible learning. A synthesis of over 800 meta-analyses relation to achievement*. Abingdon: Routledge.

Hendriks, M., Luyten, H., Scheerens, J., & Sleegers, P. (2014). Meta-analyses. In Scheerens (Ed.), *Effectiveness of time investments in education. Insights from a review and meta-analysis*. New York, Dordrecht, London: Springer Cham Heidelberg.

Kackar, H. Z., Shumow, L., Schmidt, J. A., & Grzetich, J. (2011). Age and gender differences in adolescents' homework experiences. *Journal of Applied Developmental Psychology*, *32*, 70-77. doi: 10.1016/j.appdev.2010.12.005

Kohn, A. (2006). Does homework improve learning? A fresh look at the evidence, in Da Capo Press (Ed.), *The homework myth: Why our kids get too much of a bad thing*. Cambridge, MA: Da Capo Life Long.

Martin, M. O. & Mullis, I. V. S. (2012). *Methods and procedures in TIMSS and WPIRLS 2011*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Martin, M. O., Mullis, I. V. S., Foy, P., & Stanco, G. M. (2012). *TIMSS 2011 International Results in Science*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Metzler, J. & Woessmann, L. (2012). The impact of teacher subject knowledge on student achievement: Evidence from within-teacher within-student variation. *Journal of Development Economics*, *99*, 486-496. doi: 10.1016/j.jdeveco.2012.06.002

Mullis, I. V. S., Martin, M. O., Foy, P., & Arora, A. (2012). *TIMSS 2011 International Results in Mathematics*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Mullis, I. V. S., Martin, M. O., Foy, P., & Drucker, K. T. (2012). *PIRLS 2011 International Results in Reading*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Murillo, F. J. & Martinez-Garrido, C. (2014). Homework and primary-school students' academic achievement in Latin America. *International Review of Education*, *60*, 661-681. doi: 10.1007/s11159-014-9440-2

OECD (2011). *Quality time for students: Learning in and out of school*. Paris: OECD Publishing. doi: 10.1787/9789264087057-en

Rønning, M. (2011). Who benefits from homework assignments? Economics of *Education Review, 30*, 55-64. doi: 10.1016/j.econedurev.2010.07.001

Scheerens, J. & Hendriks, M. (2014). State of the art of time effectiveness. In Scheerens (Eds.), *Effectiveness of time investments in education. Insights from a review and meta-analysis*. New York, Dordrecht, London: Springer Cham Heidelberg.

Scheerens, J., Luyten, H., Steen, R., & Luyten-de Thouars, Y. (2007). *Review and meta-analyses of school and teaching effectiveness*. Enschede: Department of Educational Organisation and Management, University of Twente.

Spanish parents urged to put children on weekend homework strike (2016, November 2), *The Guardian*. Retrieved from https://www.theguardian.com/world/2016/nov/02/spanish-parents-urged-to-put-children-on-weekend-homework-strike

Trautwein, U. (2007). The homework-achievement relation reconsidered: Differentiating homework time, homework frequency, and homework effort. *Learning and Instruction, 17*, 372-388. doi: 10.1016/j.learninstruc.2007.02.009

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. & 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

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in PILRS 2011 webpage at https://timssandpirls.bc.edu/pirls2011/international-database.html and TIMSS 2011 webpage at https://timssandpirls.bc.edu/timss2011/international-database.html.

TABLE I Variability in minutes of homework by pair of subjects

	Variability (proportion of students with different minutes of homework) by pair of subjects		
Countries	Mathematics – Science	Reading - Science	Reading - Mathematics
Australia	0.65	0.78	0.46
Austria	0.76	0.61	0.63
Azerbaijan	0.39	0.61	0.70
Croatia	0.38	0.53	0.42
Czech Republic	0.40	0.51	0.39
Finland	0.35	0.51	0.52
Georgia	0.42	0.57	0.50
Germany	0.63	0.50	0.49
Hungary	0.42	0.62	0.49
Iran, Islamic Rep. Of	0.49	0.58	0.57
Ireland	0.57	0.62	0.37
Lithuania	0.45	0.66	0.50
Malta	0.76	0.77	0.49
Northern Ireland	0.74	0.80	0.42
Norway	0.61	0.66	0.37
Poland	0.45	0.63	0.46
Portugal	0.38	0.44	0.29
Romania	0.71	0.83	0.61
Russian Federation	0.33	0.62	0.58
Singapore	0.32	0.59	0.67
Slovak Republic	0.37	0.48	0.49
Slovenia	0.45	0.55	0.42
Spain	0.37	0.46	0.33
Sweden	0.51	0.60	0.28
Average	0.50	0.61	0.48

Source: Authors' own calculations.

TABLE 2 Association of assigned homework time with students' academic achievement

	Assigned homework time		Constant		Observations
Countries	Coeff.	S.E.	Coeff.	S.E.	
Australia	-0.004	0.010	0.013	0.052	10,407
Austria	0.019	0.013	-0.033	0.048	11,781
Azerbaijan	0.016	0.018	0.080	0.086	7,956
Croatia	-0.009	0.010	0.023	0.038	13,254
Czech Republic	-0.005	0.013	0.039	0.047	9,813
Finland	0.017	0.019	-0.031	0.055	11,850
Georgia	0.024**	0.009	-0.045	0.058	8,727
Germany	0.007	0.017	-0.048	0.058	5,688
Hungary	-0.007	0.011	-0.014	0.075	7,521
Iran, Islamic Rep. Of	0.002	0.007	-0.017	0.039	16,305
Ireland	0.002	0.017	0.015	0.038	12,939
Lithuania	0.022**	0.010	-0.025	0.044	13,206
Malta	0.010	0.009	-0.058**	0.028	7,668
Northern Ireland	0.008	0.009	0.012	0.043	8,037
Norway	-0.019	0.015	0.005	0.059	4,233
Poland	0.001	0.011	0.001	0.039	14,442
Portugal	-0.003	0.016	0.007	0.073	11,409
Romania	-0.014	0.010	0.042	0.055	13,476
Russian Federation	0.011	0.014	-0.037	0.065	12,822
Singapore	-0.004	0.008	0.065	0.065	6,939
Slovak Republic	-0.017	0.018	0.000	0.071	9,675
Slovenia	-0.006	0.012	0.016	0.038	12,738
Spain	0.003	0.016	0.004	0.052	10,608
Sweden	-0.020	0.015	0.005	0.061	4,680

Notes: PIRLS/TIMSS recommended practices were applied, using both PIRLS and TIMSS Jackknife and student weights. The 'Assigned homework time' variable is measured in ten-minutes. 'Coeff.' stands for Coefficient and 'S.E.' for Standard error. It has also been controlled by subject (coefficients can be provided upon request to the authors).

Estimation method: Student fixed-effects.

Dependent variable: PIRLS/TIMSS standardised five plausible values.

Coefficient: ***Significant at 1%, ** significant at 5%, * significant at 10%.

Source: Authors' own calculations.

TABLE 3 Association of assigned homework time and students' academic achievement for students who equally like learning the three subjects

	Assigned homework time		Constant		Observations	R-squared
Countries	Coeff.	S.E.	Coeff.	S.E.		
Australia	0.000	0.018	0.078	0.068	2,328	0.866
Austria	0.018	0.018	-0.028	0.057	2,775	0.821
Azerbaijan	0.027	0.028	0.100	0.101	2,868	0.727
Croatia	-0.024	0.016	0.014	0.070	2,748	0.814
Czech Republic	0.003	0.028	0.058	0.071	2,334	0.809
Finland	0.036	0.039	-0.117	0.076	2,553	0.797
Georgia	0.021	0.015	0.126*	0.071	3,339	0.835
Germany	0.002	0.026	0.036	0.093	1,125	0.816
Hungary	-0.004	0.022	0.028	0.084	1,917	0.875
Iran, Islamic Rep. Of	-0.004	0.008	0.040	0.049	6,165	0.853
Ireland	0.017	0.025	0.013	0.065	2,973	0.850
Lithuania	0.026*	0.015	-0.009	0.056	3,321	0.847
Malta	0.011	0.017	-0.055	0.054	1,878	0.848
Northern Ireland	0.002	0.019	0.066	0.073	1,707	0.855
Norway	-0.040	0.034	0.134	0.096	894	0.817
Poland	-0.003	0.014	0.023	0.057	3,447	0.855
Portugal	-0.022	0.021	0.115	0.091	4,209	0.822
Romania	-0.018	0.017	0.116*	0.065	4,812	0.857
Russian Federation	0.008	0.022	0.000	0.085	3,429	0.812
Singapore	-0.005	0.017	0.083	0.101	1,332	0.894
Slovak Republic	-0.002	0.025	0.026	0.072	2,313	0.857
Slovenia	-0.016	0.020	0.022	0.048	3,279	0.858
Spain	0.025	0.023	0.004	0.075	2,868	0.839
Sweden	0.006	0.033	0.062	0.095	939	0.761

Notes: PIRLS/TIMSS recommended practices were applied, using both PIRLS and TIMSS Jackknife and student weights. The 'Assigned homework time' variable is measured in ten-minutes. 'Coeff.' stands for Coefficient and 'S.E.' for Standard error. The sample is that of students who equally like learning the three subjects – 'like learning the subject', 'somewhat like learning the subject' or 'do not like learning the subject'. It was also controlled by subject (coefficients can be provided upon request to the authors).
Estimation method: Student fixed-effects.
Dependent variable: PIRLS/TIMSS standardised five plausible values.
Coefficient: ***Significant at 1%, ** significant at 5%, * significant at 10%.
Source: Authors' own calculations.

TABLE 4 Association of assigned homework time with students' academic achievement for students who are equally confident in the three subjects

	Assigned homework time		Constant		Observations	R-squared
Countries	Coeff.	S.E.	Coeff.	S.E.		
Australia	0.011	0.014	0.129**	0.059	2,799	0.863
Austria	0.016	0.014	0.192***	0.050	3,804	0.816
Azerbaijan	0.027	0.023	0.323***	0.107	2,619	0.739
Croatia	-0.001	0.013	0.266***	0.059	3,840	0.818
Czech Republic	-0.002	0.020	0.175***	0.059	2,388	0.828
Finland	0.067**	0.027	0.056	0.084	3,198	0.808
Georgia	0.003	0.018	0.155**	0.063	2,562	0.827
Germany	-0.008	0.023	0.243***	0.088	1,587	0.828
Hungary	0.004	0.015	0.194**	0.081	2,412	0.881
Iran, Islamic Rep. Of	-0.001	0.010	0.067	0.052	6,183	0.857
Ireland	-0.002	0.020	0.176***	0.052	4,089	0.840
Lithuania	0.030**	0.015	0.084	0.063	3,639	0.847
Malta	0.026*	0.014	0.166***	0.046	1,977	0.839
Northern Ireland	0.015	0.019	0.212***	0.060	2,127	0.838
Norway	-0.017	0.020	0.173*	0.099	1,398	0.815
Poland	-0.019	0.018	0.231***	0.048	4,548	0.850
Portugal	-0.003	0.023	0.181*	0.093	3,642	0.806
Romania	-0.007	0.011	0.150**	0.066	5,085	0.862
Russian Federation	0.003	0.022	0.102	0.082	3,378	0.809
Singapore	-0.007	0.015	0.136	0.090	1,341	0.884
Slovak Republic	-0.027	0.021	0.219***	0.067	2,820	0.842
Slovenia	0.011	0.018	0.193***	0.042	4,227	0.852
Spain	0.026	0.023	0.119	0.075	2,805	0.847
Sweden	-0.024	0.025	0.038	0.081	1,665	0.779

Notes: PIRLS/TIMSS recommended practices were applied, using both PIRLS and TIMSS Jackknife and student weights. The 'Assigned homework time' variable was measured in ten-minutes. 'Coeff.' stands for Coefficient and 'S.E.' for Standard error. The sample is that of students who are equally confident in the three subjects – 'confident', 'somewhat confident' or 'not confident'. It was also controlled by subject (coefficients canbe provided upon request to the authors).
Estimation method: Student fixed-effects.
Dependent variable: PIRLS/TIMSS standardised five plausible values.
Coefficient: ***Significant at 1%, ** significant at 5%, * significant at 10%.
Source: Authors' own calculations.