

Students' homework and TIMSS 2003 mathematics results

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Abstract

An aspect of the complex relationship between students homework and academic achievement (Cooper, Robinson, and Patall, 2006) was examined by correlating TIMSS 2003 mathematics results with the data about homework in 46 countries of the TIMSS study. The TIMSS results had no statistically significant correlation with the teachers' emphasis on mathematics homework or students' time for the homework. Students' achievement was significantly lower in countries, in which homework contributed marks, homework was frequently the basis for class discussion, students corrected homework in class, etc. The mentioned ways of class work may not be the most effective use of class time and students in many countries have the optimal amount of homework. Educational leaders can compare the practice of homework in their country with the international average and consider recommendations relating on the correlation coefficients. The paper includes two tables, one figure, and seven references.

Introduction

It is an overall belief that homework facilitates learning. The belief is supported by numerous research data. An overview of the research is recently given by Harris Cooper, Jorgianne C. Robinson, and Erika A. Patall (2006). "The standardized mean difference on unit tests between students who did and did not do homework varied from $d = .39$ to $d = .97$ " (Cooper, Robinson, and Patall, 2006, 47). The mean correlation between the time on homework and achievement was 0.2 in the 69 investigations included in the review. The correlation is statistically significant, however it reveals that time on homework and achievement have only 4% joint variability.

The correlation between the amount of homework and achievement was found to be dependent of the students' age. In elementary grades, the correlation was zero; in middle grades, it was 0.07; and in high school, the correlation between the amount of homework and achievement was 0.25 (Cooper, Robinson, and Patall, 2006, 4 - 5). The correlation depends also on the time on homework. Homework less than 10 minutes per day had no relation to achievement and the homework longer than 1 – 2 hours per day did not have positive relation to homework, either. A positive relationship between the time on homework and achievement was in-between these time intervals (Cooper, Robinson, and Patall, 2006, 52). Homework is the main reason of stress for many students.

Homework has positive influence not only on students' achievement but also on their development in general. Homework develops habits of independent learning, willpower, motivation to learn etc. (Cooper, Valentine, 2001). The influence of homework on achievement can be mediated by the students' personality characteristics. Barry J. Zimmerman and Anastasia Kitsantas (2005) have found that homework effected students' self-efficacy beliefs and their perception of responsibility and these characteristics in turn are correlated with achievement.

The effect of homework depends on its organisation and parental support. Lynne Murray et al. (2006) have found that stimulation of children's thinking and fostering enthusiasm by parents in conversations with children on homework is crucial. The style of support was as important as family background.

Most of the studies of the relationship between homework and achievement have been carried out on individual students' level. For example, the one, which used TIMSS 1999 data for Japan, has revealed the positive relation of more frequent homework to TIMSS mathematics results (House, 2004).

The aggregated data from many countries usually reveal stronger relationships. The aim of this research is to find the relationship between the homework and TIMSS 2003 mathematics results in international comparison. The hypothesis is that teachers' emphasis on mathematics homework and monitoring students' homework is positively related to TIMSS results.

Method

The data for this research were taken from the TIMSS 2003 mathematics grade 8 study (Mullis et al., 2004). TIMSS study was carried out in 46 countries over the world. In every country, a representative sample of students was tested. The average number of students sampled in a country was 5,135 and of these students 4,777 were tested in a country as average. The students were 14 years old.

The TIMSS 2003 mathematics test included items on number, algebra, measurement, geometry, and data. The items were in four cognitive domains: knowing facts and procedures, using concepts, solving routine problems, and reasoning (Mullis et al., 2004, p. 343). About 40% of the items were free response format. The international average scale score was 467 (SD = 73). The reliability of the test was 0.89 (Mullis et al., 2004, 367).

TIMSS study included questionnaires to students, teachers and school head-teachers. Students answered two questions about their amount of homework and the answers were summarised in the TIMSS report into the index of time for mathematics homework (Mullis et al., 2004, 148). Teachers answered five questions about students' homework and their answers resulted in eight characteristics of the homework (Mullis et al., 2004, 298 - 300).

The characteristics of homework were correlated with the TIMSS results. The results were given for the five content areas and as a summary result. The test results in content areas had very high correlation coefficients with each other (0.93 – 0.98) and very high correlation coefficients with the summary test result (0.96 – 0.99). Therefore, the correlation coefficients between the homework characteristics and the summary test result only are given below. In the case of 46 countries, the correlation coefficients with the absolute value over 0.30 are statistically significant at 0.05 level.

Results

The characteristics of homework, their average values for 46 countries, standard deviations (SD) of the characteristics, values for three Baltic States and linear correlation coefficients (r) with the TIMSS mathematics 2003 results are given in Table 1.

Table 1

The correlation coefficients of the homework characteristics with the TIMSS 2003 mathematics results

The characteristics of countries	Ave- rage	SD	Value for			r
			Esto nia	Latvi a	Lithua nia	
TIMSS 2003 mathematics scale score in Grade 8.	467	76	531	508	502	1.00
Teachers' emphasis on math homework high (EMH)	30	21	12	17	13	-0,15
High index of time for math homework (TMH)	26	13	28	33	32	-0,02
Teachers monitor whether the homework was completed	78	14	72	80	67	-0,20
Teachers correct assignments and give feedback	57	23	20	57	26	-0,47
Students correct homework in class	36	22	19	11	8	-0,38
Homework is the basis for discussion	27	15	21	9	6	-0,56
Homework contributes marks	25	20	13	26	6	-0,37

Teachers' emphasis on mathematics homework was considered high if the teachers assigned homework for more than 30 minutes on half of the mathematics lessons or more (Mullis et al., 2004, 298). Low emphasis on mathematics homework means that teachers assign homework for less than 30 minutes in every second lesson or even less frequently. The values of the characteristic in Table 1 express the percentage of students whose teachers had high emphasis on mathematics homework. The data are taken from the teachers' questionnaire.

The correlation between the teachers' emphasis on mathematics homework and TIMSS results was negative but not significant. The situation is depicted in Figure 1.

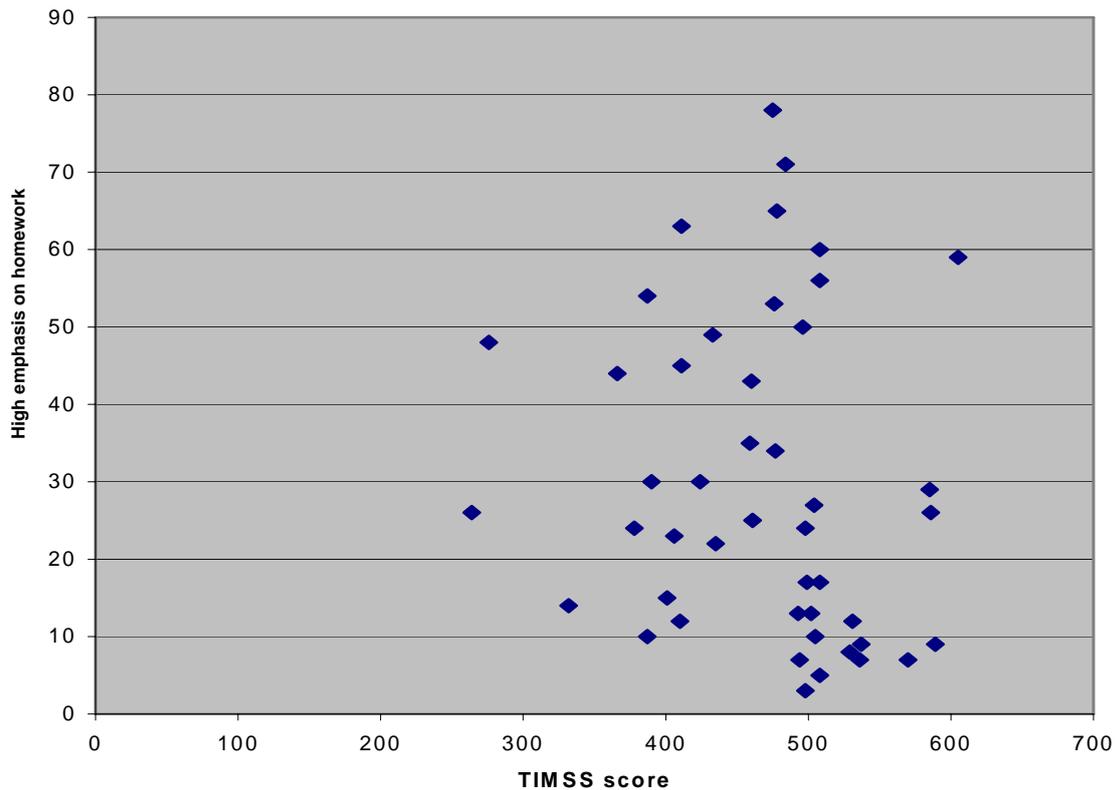


Figure 1. The teachers' emphasis on mathematics homework and TIMSS results (every dot is a country)

The index of time for mathematics homework was composed of students' answers to their questionnaire. The index was considered high if students reported mathematics homework assigned at least three times a week for 30 minutes or more (Mullis et al., 2004, 148). A low index of time for mathematics homework indicates that students did homework no more than 30 minutes twice a week or less. The values of the characteristic in Table 1 express the percentage of students whose answers fitted the high index of mathematics homework. The correlation between the teachers' high emphasis on mathematics homework and the students' high index of time for mathematics homework was 0.74.

For better understanding of the relationship between time for homework and TIMSS results, we will use the summarised data for within-country comparison from Mullis et al. (2004, 148). The data are given in Table 2.

Table 2.

Index of time for mathematics homework and TIMSS results in within-country comparison (Mullis et al., 2004, 148)

	High index of TMH	Medium index of TMH	Low index of TMH
Percent of students in 46 countries	26	54	19
Average TIMSS score	468	471	456
Standard error of the score	0.8	0.6	1.0

The next five characteristics in Table 1 are based on teachers' answers to the question what do they do with the students' homework assignments (Mullis et al., 2004, 300). This question had five options to answer as given in Table 1. The values of the characteristic express the percentage of teachers who used the option "always" or "almost always". We see in the table that many teachers use two or more of the options. For example, 78% of teachers monitor "always" or "almost always" whether the homework was completed, 57% of teachers correct assignments and give feedback, etc.

In Japan and Korea, students have extra tutoring which is not considered in the homework assigned by teachers but the tutoring effects TIMSS scores. When the two countries were excluded from the database, the correlation coefficients in the Table 1 diminished by 0.02 to 0.15 and yet all the statistically significant correlation coefficients in Table 1 were significant after the exclusion of the countries and no statistically significant correlation was added.

Discussion and conclusion

The aim of this research was to find the relationship between the characteristics of homework and TIMSS 2003 mathematics results in international comparison. The relationship was detected by correlation coefficients. In the interpretation of these coefficients, we have to keep in mind that the coefficient of correlation indicates relationship and not the influence of one variable to another. We cannot be sure that the discussed characteristics of homework cause the differences in TIMSS results between countries. The characteristics may cause the differences but the differences in TIMSS results may be caused by some other variables, as well.

The three Baltic States were successful in TIMSS 2003 mathematics test – they belong to the top third of countries in the sample. Lithuania achieved the sixteenth place, Latvia the twelfth place and Estonia the eighth place in the international comparison.

Teachers' high emphasis on mathematics homework had no significant correlation with the TIMSS results ($r = -0.15$) in the inter-country comparison. There are more than ten countries that have few teachers with high emphasis on homework and nevertheless the countries had high TIMSS score (Figure 1). These countries are for example, Belgium, Hungary, Netherlands, etc. The three Baltic States belong also to the group in which teachers give relatively little homework and the test results are good (Table 1).

One explanation for the missing relationship between the teachers' high emphasis on homework and TIMSS results is that in some countries all teachers tend to give a lot of homework and students are overloaded. High emphasis on mathematics homework denoted that teachers assigned homework at least for 30 minutes on at least every second lesson. If the other teachers assign as much homework, then the optimal amount of homework 1 – 2 hours per night is exceeded (Cooper, Robinson, and Patall, 2006, 52).

The TIMSS report contains data for the within-country comparison of the TIMSS results of students according to teachers with different emphasis on homework. The students of teachers with the high emphasis on homework achieved an average score of 473 on TIMSS test; in the case of medium emphasis the score was 469; and the students of teachers with the low emphasis on homework achieved an average score of 453 (Mullis et al., 2004, 298). The difference between the high and low emphasis is statistically significant and the effect size $d = 0.26$. However, the difference between the high and medium emphasis is small ($d = 0.05$) and in the third of the sample countries the students of teachers with medium emphasis on homework achieved better results than the students of teachers with the high emphasis on homework. Teachers' low emphasis on homework reduces the students' TIMSS results.

It is difficult to explain the difference in the conclusions based on inter-country and within-country comparison. The revealed effect in within-country comparison can be explained by other important characteristics of teachers with high or low emphasis on homework. On the other hand, cultural and other differences between countries may shadow the positive effect of the teachers' emphasis on students' homework in inter-country comparison.

The percent of students who assessed their time for mathematics homework high had no significant correlation with the TIMSS score ($r = - 0.02$). The hypothesis about positive relationship between time for homework and TIMSS results was not proved in inter-country comparison. The correlation coefficient is even lower than the mean correlation coefficient between the time on homework and achievement in Cooper, Robinson, and Patall (2006, 47) meta-analysis.

The missing relationship between the time on mathematics homework and TIMSS results can be explained by individual differences of students. Some students are rapid learners and others are slow learners. Slow learners need more time for learning but their results are usually not higher than the average result. The not significant correlation does not mean that every individual student can not achieve higher results when she/he studies more. The other reason for the missing relationship can be in the character of mathematics homework assigned to students in different countries.

The data for within-country comparison reveal that the relationship between time for mathematics homework and TIMSS results can be curvilinear (Table 2). The highest average score in TIMSS test 471 was achieved by students who spent the medium amount of time doing mathematics homework. The students did mathematics homework 1 - 1.5 hours per week. The students who spent more than 1,5 hours or less than 1 hour for mathematics homework in a week did not achieve such positive results on the TIMSS test. In all three Baltic States, the percent of students whose index of time for mathematics homework is medium is rather high: in Latvia 61, Lithuania 63, and Estonia 66 (Mullis et al., 2004, 148).

Most teachers (78%) in the TIMSS sample monitor whether the homework was completed. However, monitoring had no statistically significant correlation with TIMSS results ($r = - 0.20$) (Table 1). Monitoring is not the most effective use of study time; some other methods can be as effective or even more effective. The teachers in Lithuania monitor homework less than the international average.

Good teachers usually correct assignments and then give feedback to students. The percentage of students whose teachers do it "always" or "almost always" had a

negative correlation with TIMSS results ($r = -0.47$). This statistically significant correlation contradicts the usual recommendations to correct assignments and give feedback to students.

One explanation of the finding is that some other methods of teaching are as effective as correcting students' assignments. The correcting can overload teachers and lead to the lower efficiency of teachers. The other explanation is that some students need correcting assignments; however, even in this case, they do not reach average or high results. For example, students with low learning abilities may learn from correcting their assignments but their test results are nevertheless below the average.

In Estonia and in Lithuania, teachers "always" or "almost always" correct assignments and give feedback twice less than the international average. This practice correlates with high TIMSS scores in these countries.

The next two characteristics in Table 1 specify the use of homework in class. Both of them have statistically significant negative correlation with TIMSS results. The more there are teachers who "always" or "almost always" have students correct homework in class, the lower the TIMSS score of the country ($r = -0.38$). Correcting homework in class is a rapid way of giving feedback to students, but it may reduce the TIMSS score by 14%. Fortunately, the teachers of Lithuania and Latvia are using the method 3 – 4 times less frequently and this may be one basis for the success of these countries.

The more teachers use homework as a basis for class discussion, the lower the TIMSS results of the country ($r = -0.56$). We can hypothesise that working with students' homework is not the most effective use of the lesson time. As the international average, 27% of teachers used the method "always" or "almost always". In Baltic States, mathematics teachers used the method less frequently, especially in Lithuania and in Latvia.

The more there are teachers who use homework to contribute students' marks, the lower the TIMSS results ($r = -0.37$). The finding raises some hypothesis. 1. Teachers who give marks for homework are using some other teaching methods that are not the most effective. For example, giving marks for homework had a correlation 0.56 with the use of homework as the basis for class discussion. 2. Marks are not the best motivator for students' and overuse of them hinders learning results. 3. It is easier to pass a course if part of grade comes from homework (Mikk, 2006)

The teachers of Baltic States have a different practice in giving marks for homework. The Latvian teachers are on the international average level, Estonian teachers use homework to contribute marks twice less, and the Lithuanian teachers four time less than teachers in the tested sample of countries. The last practise is the most favourable for knowledge acquisition in Table 1.

The correlation coefficients in Table 1 reveal that homework has no relationship to academic achievement or it has even negative effect on TIMSS results. To explain the finding, three ideas are raised for further research:

- 1) students have already optimal amount of homework and longer times for it will not improve the results of learning,

- 2) the ways of using homework and its content may be related to other methods of teaching and learning, which considerably influence the learning results and shadow the possibly positive effect of homework on test results,
- 3) students in different countries differ in their learning abilities and the high ability students achieve good results in shorter time and smaller amount of support for homework than the low ability students.

The results of the research have been reached in inter-country comparison, which may not give the full picture of the effect of homework on TIMSS score. The real effect of homework may be found in experiments, where equal groups of students who do homework in different ways or who do not do homework are compared.

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