



Policy Brief

Are teacher characteristics and teaching practices associated with student performance?

Contents

Summary	1
.....
Introduction	1
.....
Data	2
.....
Index of teaching strategies	3
.....
What is the relationship of the different strategies with the academic performance of students?	5
.....
Results	6
.....
Conclusions and policy implications	7
.....
References	8
.....

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Summary

The different strategies and methodologies used by teachers in their day-to-day activity may have an impact on the academic performance of their students. Indexes constructed to summarize how teachers address different teaching tasks can be used to quantify the teaching activities' associations with academic results. In the IEA's Trends in Mathematics and Science Study (TIMSS) for eighth grade, the same students take both the mathematics and science tests. As mathematics and science are usually taught by two different teachers at the eighth grade, the results may reveal whether the different strategies used by teachers have an effect on the results of their students. The analyses revealed that collegial activities (collaboration among teachers) exhibited more positive associations than negative associations with student performance among countries. Conversely, two other strategies, passive teaching and active assessment, were more often negatively associated than positively associated with student achievement.



Introduction

The importance of teachers in the academic performance of their students is firmly established in the academic literature (Rivkin, Hanushek, & Kain, 2005). Teachers interact with students mainly through their teaching, and teachers may adopt differing teaching strategies. More active teaching approaches, which differ from traditional formal classes, may have a positive effect (Bietenbeck, 2014). This same active philosophy of teaching may also be identified in the methods used by teachers to assess student work.

Furthermore, although there may be no direct impact on the student, the way the teacher addresses a subject may also be related to the academic performance of the student. Of primary importance is the effort teachers invest in making their teaching disciplines more attractive to students. In addition, relying on other teachers and sharing resources with them is also thought to improve students' results.

Data

We analyzed eighth-grade mathematics and science data from the 2011 cycle of the IEA's Trends in International Mathematics and Science Study (TIMSS). Administered every four years since 1995, TIMSS is a large-scale, cross-national assessment of fourth- and eighth-grade students' mathematics and science achievement. It also collects extensive background information on the participating students, and about their schools and teachers (see Martin & Mullis, 2012, for more information). In this study, we were particularly interested in the items that measured teachers' strategies when teaching.

Index of teaching strategies

We summarized the responses of teachers collected in the TIMSS questionnaire, creating indexes designed to model the strategies. We selected only the questions that related to the aim of this study; these could be grouped into four categories:

- (1) Collegial activities,
- (2) Student engagement,
- (3) Passive and active teaching strategies, and
- (4) Active student assessment methods.

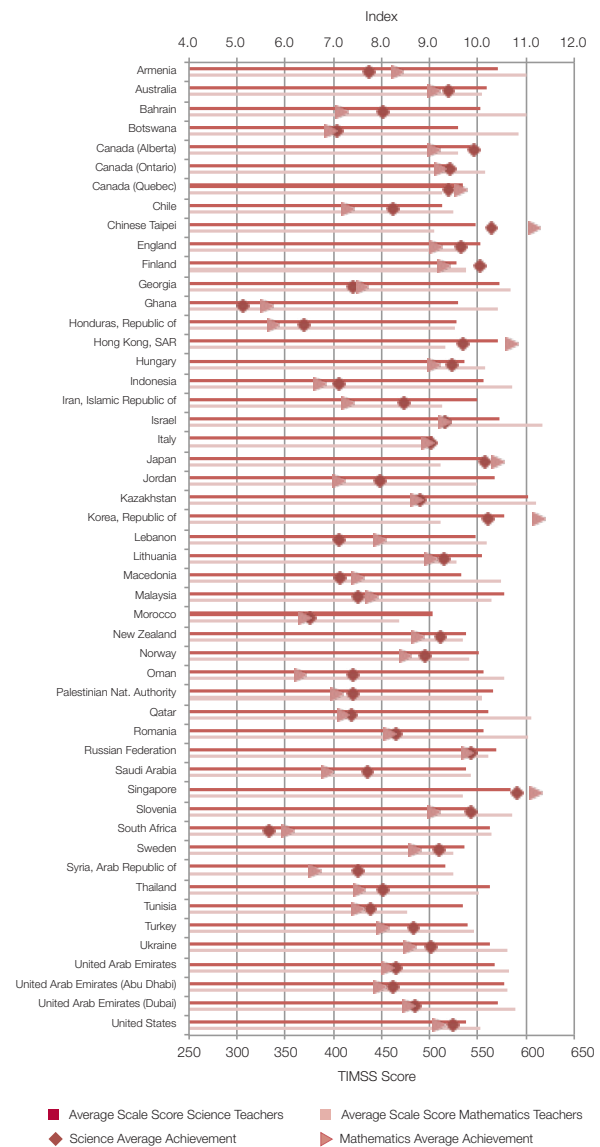
We constructed our indexes using IRT (item response theory) methodology, employing some or all of the sub-sections of the selected questions; we recoded the questions if necessary. The resulting indexes had an average value of ten and a standard deviation of two.

Collegiality

We used answers to the TIMSS question "How often do you have the following types of interactions with other teachers?" to prepare an index that reflected the different types of collegial relationships existing among teachers in a school. Collegial activities were identified as: (a) discuss how to teach a particular topic; (b) collaborate in planning and preparing instructional materials; (c) share what I have learned about my teaching experiences; (d) visit another classroom to learn more about teaching; or (e) work together to try out new ideas.

Responses were initially codified as: never/ 2 or 3 times per month/ 1–3 times per week/ daily or almost daily; a later transformation was unnecessary, since higher response values indicated greater collaboration between teachers.

Graph 1: Performance in TIMSS 2011, and index of interaction between teachers.

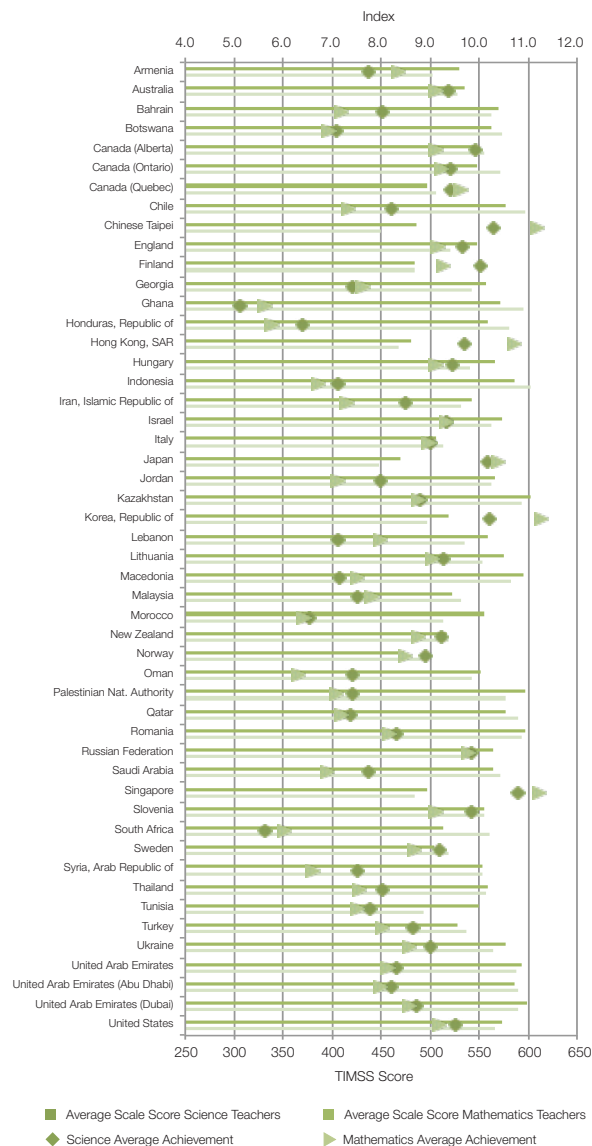


Sources: TIMSS 2011 International Results in Mathematics (Mullis et al., 2012) and TIMSS 2011 International Results in Science (Martin et al. 2012).

In most countries, teachers of science and mathematics appear to behave in a very similar manner (Graph 1), although there are notable exceptions (see for example, Botswana and Japan). Kazakhstan and Israel exhibit particularly high levels of cooperation in the sciences, while Italy and Morocco exhibit very low levels of cooperation.



Graph 2: Performance in TIMSS 2011, and index of strategies designed to make the subject more attractive to the student.



Sources: TIMSS 2011 International Results in Mathematics (Mullis et al., 2012) and TIMSS 2011 International Results in Science (Martin et al. 2012).

Student engagement

The TIMSS questionnaire assesses teacher strategies designed to make school subjects more interesting to the student. Teachers were asked: “How often do you do the following in teaching this class?” We constructed an index to summarize this information from the teacher responses to the options: (a) relate the lesson to students’ daily lives; (b) encourage all students to improve their performance; (c) praise students for good effort; and (d) bring interesting materials to class.

The possible responses were: every or almost every lesson/ about half the lessons/ some lessons/ never. After recoding the items, high values in this index indicate increased use of strategies that encourage positive student engagement (Graph 2).

The index revealed the strategies followed by teachers of mathematics and sciences in each country were generally similar. Romania, Kazakhstan and United Arab Emirates (Dubai), among others, stand out positively, and Chinese Taipei, Finland, Hong Kong, Japan, Norway and Singapore stand out negatively.

Active and passive teaching strategies

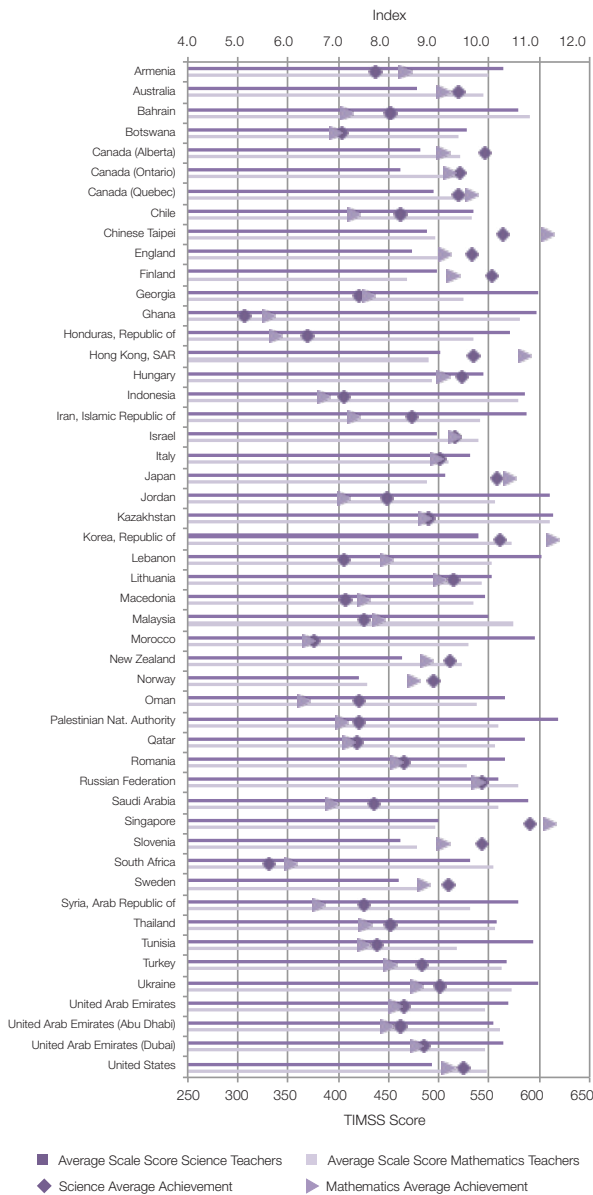
We distinguished active and passive teaching strategies, measured by assessing the degree of involvement of the students in their learning. The information came from the different tasks that were included under the general heading: “In teaching mathematics/science to this class, how frequently do you usually ask students to do the following?” Obviously, these tasks differed between the sciences and mathematics.

In mathematics teaching, passive strategies were: (a) memorize rules, procedures, and facts; (b) work problems (individually or with peers) while I am occupied by other tasks; (c) apply facts, concepts, and procedures to solve routine problems; and (d) explain their answers. Active strategies were: (e) work problems (individually or with peers) with my guidance; (f) relate what they are learning in mathematics to their daily lives; (g) decide on their own procedures for solving complex problems; and (h) work on problems for which there is no immediately obvious method of solution.

For sciences, passive strategies were: (a) watch me demonstrate an experiment or investigation; (b) read their textbooks or other resource materials; (c) have students memorize facts and principles; (d) use scientific formulas and laws to solve routine problems; and (e) give explanations about something they are studying. Active strategies for sciences are: (f) observe natural phenomena and describe what they see; (g) design or plan experiments or investigations; (h) conduct experiments or investigations; (i) relate what they are learning in science to their daily lives; and (j) do field work outside of class.

The teachers’ responses indicated how often they implemented these methods: every or almost every lesson/ about half the lessons/ some lessons/ never. Responses were recoded so that high values for passive strategies reflected frequent use of passive strategies by teachers.

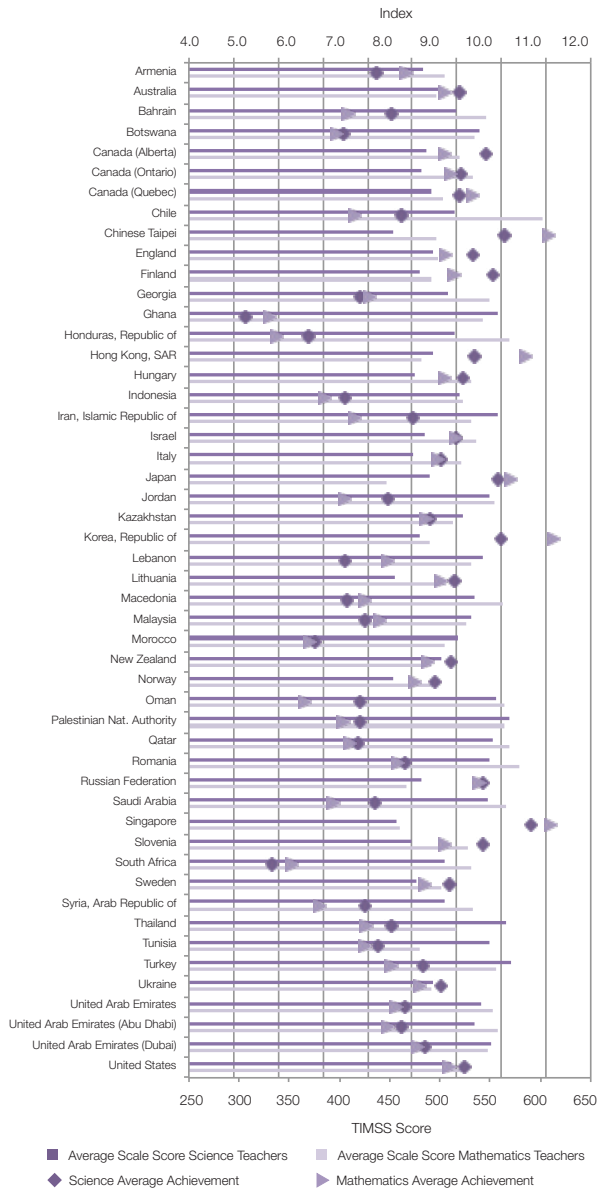
Graph 3: Performance in TIMSS 2011, and index of the implementation of passive teaching strategies.



Sources: TIMSS 2011 International Results in Mathematics (Mullis et al., 2012) and TIMSS 2011 International Results in Science (Martin et al. 2012).

For passive strategies (Graph 3), few countries exhibited notable differences between the values obtained for science and mathematics teachers, the most extreme case being Georgia. Norway, Slovenia, Sweden and New Zealand were least likely to implement passive teaching strategies in sciences. Middle Eastern countries, Ghana, Jordan and Kazakhstan were most likely to implement passive learning strategies.

Graph 4: Performance in TIMSS 2011, and index of the implementation of active teaching strategies.

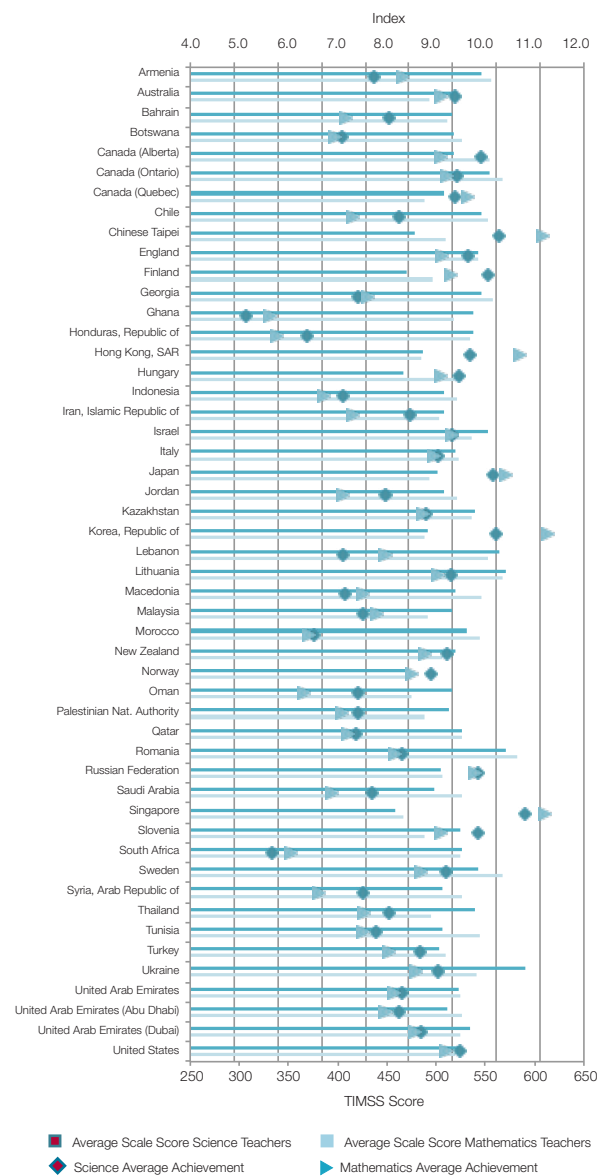


Sources: TIMSS 2011 International Results in Mathematics (Mullis et al., 2012) and TIMSS 2011 International Results in Science (Martin et al. 2012).

For active strategies (Graph 4), Chile stands out positively in mathematics, and once again, Middle Eastern countries, along with the Russian Federation and New Norway, were least likely to implement active learning strategies in their classrooms, both in mathematics and in sciences.



Graph 5: Performance in TIMSS 2011, and index of student assessment methods.



Sources: TIMSS 2011 International Results in Mathematics (Mullis et al., 2012) and TIMSS 2011 International Results in Science (Martin et al. 2012).

Active student assessment

Finally, we also considered how teachers implemented different methodologies to assess their students. Specifically, we analyzed the information contained in the section: “How much emphasis do you place on the following resources to monitor student’s progress?”

In order to calculate this index, we used the following questions: (a) evaluation of students’ ongoing work; (b) classroom tests (for example, teacher-made or textbook tests); (c) questions based on recall of facts and procedures; (d) questions based on the application of knowledge and understanding; (e) questions involving searching for patterns and relationships; and finally (f) questions requiring explanations or justifications.

We termed this index “active student assessment,” and here aimed to show whether students were assessed

in a more participatory way through their own reasoning or assessed by traditional examination (Graph 5).

Excluding Ukraine and Oman, in the other countries assessment methods were the same for teachers of both mathematics and sciences. No country exhibited highly positive values in the assessment, although we found that Singapore, Norway, Korea and Hong Kong used more passive and less participatory traditional methods of student assessment.

What is the relationship of the different strategies with the academic performance of students?

Clearly, there are a diversity of ways in which science and mathematics teachers undertake their daily work, but are any of these behaviors related to the learning process? We developed an identification strategy to tackle this question.

Identification strategy

Identification of the effect of teacher characteristics and teaching practices on student performance requires an exogenous variation in both, namely changes in both teacher characteristics and teaching practices that are independent of student performance and its determinants. This is clearly unlikely to be the case in schools currently. Indeed, it is likely that teachers adapt their practices to their students’ performance and that students select themselves or are streamed into different classrooms with different teachers and teaching practices according to their performance. Thus, observational data on student performance and teachers’ teaching practices is unlikely to provide much information concerning the causal effect of teaching practices on student outcomes.

To address this limitation, we used the within-student variation in performance across the two subjects evaluated in TIMSS 2011 8th grade to identify the effect of teaching practices, comparing the uneven performance of students in mathematics and sciences to the unequal relative importance that mathematics and science teachers in that school gave to the different teaching practices considered in the estimation. This approach enabled us to identify associations of interest independently of the innate intellectual ability of the students and any other common determinant of performance across subjects, such as the students’ attributes and personal characteristics, and those of their family and the school. Similar identification strategies have been widely used (see for example, Lavy, 2011; Algan, Cahuc, & Shleifer, 2013; Bietenbeck, 2014).

We controlled for teachers’ sex, age and educational attainment in our indexes regarding teaching practices.

Results

We analyzed data from all the countries that participated in TIMSS 2011 8th grade, except Finland and Italy; Finland was excluded from the estimation sample because of sample size considerations, and Italy because there was a lack of information on teachers' educational attainment (regression results for all countries are provided as an Appendix (see http://www.iea.nl/fileadmin/user_upload/Policy_Briefs/IEA_PB_Sep2016_Appendix.pdf).

Table 1: Number of countries exhibiting relationship of teaching activities to student achievement (summary of regression coefficients).

Index of teaching activities	Positive	Neutral	Negative
Active assessment	13	4	18
Collegiality	16	9	10
Passive teaching	11	6	18
Active teaching	13	9	13
Student engagement	11	11	13

Note: Positive and negative results represent regression coefficients with $p < 0.10$. Neutral results indicate coefficients that did not meet test criteria ($p < 0.10$) for statistical significance.

None of the teaching practices are positively associated in all the 35 countries considered (Table 1). Conversely, we found significant heterogeneity among countries in the efficacy of the teaching practices analyzed. Collegiality, student assessment and active practices were the teaching practices that enhanced student performance in a largest number of countries. In particular, we found that the higher the frequency with which teachers used student assessment practices, the higher students' average achievement in 13 out of the 35 countries analyzed. The same result is obtained for active teaching practices. A higher frequency of collegiality practices in class is associated with higher average test achievement in 16 out of the 35 countries. Student engagement and passive teaching practices effectively increase student performance in 11 out of the 35 countries considered.

All the teaching strategies were found to enhance student performance in some countries while lowering it in others, but only collegiality strategies had more positive than negative impact on student performance improving average student performance in 16 countries. Active teaching practices were both positively and negatively correlated with student performance in exactly the same number of countries. Conversely, student engagement, student assessment and, particularly, passive strategies showed more negative than positive associations with student performance internationally.

Collegiality practices were generally identified as the largest positive coefficient among those estimated for the teaching strategies positively associated with performance. These practices had the largest positive coefficient in 13 out of the 35 countries where at least

one positive coefficient was estimated for the teaching practices considered.

The large heterogeneity in the returns to teaching practices across countries suggests both that the efficacy of teaching strategies depends on some contextual variables not included in traditional datasets and that their effect is heterogeneous in some student and contextual characteristics. For example, Lavy (2011) found strong evidence that two elements of teaching practices effectively improved test achievement of fifth and eighth grade students in Israel. He found that the so-called "traditional" or "passive" teaching practices that emphasize the instilment of knowledge and comprehension had a positive and relevant effect on test results, particularly so for girls and students of low socioeconomic status. Lavy (2011) also found that the use of teaching practices that endow students with analytical and critical skills ("modern" teaching practices) had a very large positive effect. This evidence suggests that traditional and modern teaching practices are not necessarily rivals, but can coexist in the same school if appropriately targeted at students of differing abilities and origin. This, in turn, might partially account for the heterogeneity in the returns to a particular teaching strategy across countries (see Appendix, Tables A1 to A5); the relative importance of the socioeconomic groups analyzed by Lavy (2011) varied across countries. We were unable to identify a general association between countries' level of development, as measured by gross domestic product (GDP) per person, and the efficacy of teaching strategies. The estimated correlation between the estimated coefficient for a particular teaching strategy and GDP per person ranges from -0.29 (student engagement) and 0.02 (collegiality).

This, in turn, means that the higher the country's level of development, the less likely it is that teaching practices aimed at increasing interaction among teachers in the same school will be positively associated with student performance. A detailed analysis of the main driving forces behind the differential efficacy of teaching strategies around the world is still needed.

Some interesting results were obtained when we separated the analysis into countries that are OECD (Organisation for Economic Co-operation and Development) members (here, developed countries) versus non-OECD (developing) countries. First, we found that almost all the teaching strategies analyzed were more likely to effectively enhance students' performance in developing than in developed countries. In particular, we found the developing countries had a higher percentage of countries where there was a positive coefficient than the developed countries.

Moreover, we also found that collegiality, active, and student engagement teaching practices were more likely to enhance than to lower student achievement in developed countries. Student assessment teaching practices also had this effect in developing countries.

We also identified striking differences between developed and developing countries in the correlation between the estimated coefficient for a particular teaching practice and GDP per person. In particular, while the estimated correlation between the coefficient associated with collegiality and student engagement practices and GDP per person is positive and relevant (0.43 and 0.20, respectively) for developed countries, it is negative and also of relevant magnitude (−0.24 and −0.38, respectively) for developing countries. Conversely, while the estimated correlation between a country's level of development and the coefficient associated to passive teaching strategies is positive and close to 0.16 for developing countries, it is close to zero for developed countries.

Conclusions and policy implications

The indexes identified some interesting associations, with potential implications for future policy research.

- (1) **Only one strategy, collegial practices, exhibited more positive associations than negative associations with student performance among countries.**
- (2) **Among the countries, two strategies, passive teaching and active assessment, were more often negatively associated than positively associated with student achievement. Two of the strategies in the analysis—active teaching and student engagement—had approximately equal numbers of countries showing positive and negative associations with achievement.**
- (3) **Countries exhibited heterogeneous effects, depending upon economic development. In higher GDP per person countries, active teaching strategies were associated with enhanced student performance, while passive teaching strategies appeared detrimental.**
- (4) **Policymakers should exercise caution when importing policies that have apparently worked well in other countries. The national (and local) context may dramatically change how policies affect outcomes.**
- (5) **These results support the continued need for a detailed analysis of the main driving forces behind the differential efficacy of teaching strategies around the world. More research is needed on the contextual conditions that either support or hinder the efficacy of particular practices. The findings that seemingly opposing strategies (such as active and passive teaching) may both be positively related to achievement under differing conditions should be recognized by both policymakers and policy researchers.**

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The International Association for the Evaluation of Educational Achievement, known as the IEA, is an independent, international consortium of national research institutions and governmental agencies, with headquarters in Amsterdam. Its primary purpose is to conduct large-scale comparative studies of educational achievement with the aim of gaining more in-depth understanding of the effects of policies and practices within and across systems of education.

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