# Teaching practices and cognitive skills ☆

CrossMark

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## HIGHLIGHTS

- Different teaching practices promote different cognitive skills in students.
- Traditional practices promote factual knowledge and routine problem-solving skills.
- Modern, student-centered practices promote reasoning skills.
- Implications for recent proposals to reduce traditional practices are discussed.

## ARTICLE INFO

## ABSTRACT

National Teaching Standards by various educational organizations in the United States call for a decrease in the use of traditional teaching practices (such as learning by rote) and an increase in the use of modern teaching practices (such as working in small groups) in schools. Yet a small literature in economics has consistently found that traditional teaching raises test scores, while the effect of modern teaching appears to be small and sometimes even negative. This paper uses data from the Trends in International Mathematics and Science Study (TIMSS) to show that traditional and modern teaching practices promote different cognitive skills in students. In particular, traditional teaching practices increase students' factual knowledge and their competency in solving routine problems, but have no significant effect on their reasoning skills. The effects of modern teaching practices are exactly the opposite, with modern teaching fostering reasoning skills. I provide evidence that standardized tests do not measure reasoning skills well, which explains the finding of only small or negative effects of modern teaching on test scores in the literature. I discuss the implications of these results for the recommendations made by National Teaching Standards.

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## 1. Introduction

Researchers, teachers, and parents have long debated which teaching practices are best for student learning in schools. Traditionally, teachers have relied on lecturing and repetitive practice in order to teach students basic facts and procedures. Several reform movements during the twentieth century attempted to introduce a more student-centered approach to teaching into schools, in which small group work and discussion among students were supposed to take center stage. Despite these efforts, traditional teaching practices still dominated in American classrooms by the year 1990 (Cuban, 1993). Since then, however, student-centered teaching has gained considerable support with the release and implementation of National Teaching Standards by various educational organizations (e.g., NCTM, 1989, 1991; NRC, 1996). These call for a shift from traditional towards modern, student-centered teaching in schools as a way to promote students' reasoning skills over mere factual knowledge and routine problem-solving skills.[1] This emphasis on reasoning skills is motivated by the perception that such skills are becoming increasingly important in the labor market.

A small literature in economics has examined the effects of teaching practices on student outcomes. These studies find sizable positive impacts of traditional teaching practices, such as lecturing and rote memorization, on test scores (Lavy, 2011; Schwerdt and Wuppermann, 2011). In contrast, estimates of the effects of modern teaching practices,

[1] National Teaching Standards categorize teaching practices as "to be decreased" or "to be increased." In line with the previous literature (e.g., Lavy, 2011; Schwerdt and Wuppermann, 2011), I adopt the terminology "traditional" and "modern" teaching practices here.

such as working in small groups and emphasizing real-life applications, are comparatively small (Lavy, 2011) and sometimes even negative (Murnane and Phillips, 1981; Goldhaber and Brewer, 1997). The existing empirical evidence therefore seems to suggest that a decreased emphasis on traditional teaching and an increased emphasis on modern teaching in schools will lower student test scores. Does this mean that National Teaching Standards are wrong in recommending such a change?

In this paper, I explore a more nuanced interpretation of these results. My starting hypothesis is that traditional and modern teaching practices promote different cognitive skills in students. In particular, I claim that just as National Teaching Standards posit, modern teaching raises students' reasoning skills. However, these skills are not measured well in standardized tests. In contrast, traditional teaching fosters the knowledge of basic facts and procedures that has historically been emphasized in schools and that is primarily assessed in standardized tests. Such heterogeneity of the effects of traditional and modern teaching practices across cognitive skills, if it exists, could explain the sizable positive impact of traditional teaching and the smaller or negative effect of modern teaching on test scores found in the literature, and it would change the way in which these results have to be interpreted with regards to National Teaching Standards.

I test the hypothesis that traditional and modern teaching practices promote different cognitive skills using data from the 2007 wave of the Trends in International Mathematics and Science Study (TIMSS) for the United States. The data contains test scores for eighth-grade students' overall achievement in math and science as well as sub-scores measuring performance on three segments of the test which assessed distinct cognitive skills. One of these skills is reasoning, and the other two are factual knowledge and competency in solving routine problems. The data also includes information on teaching practices from a student questionnaire, which asked students to rate how often they engaged in a range of different classroom activities in a particular subject. Referring to National Teaching Standards, I classify activities as reflecting either a traditional or a modern teaching practice, and I use information on the frequency of these activities to define two class-level indices for use of modern and use of traditional teaching practices.

I begin my analysis of the effects of teaching practices on cognitive skills by relating the traditional and modern teaching indices to students' overall test scores in math and science. The empirical model exploits the fact that each student is observed twice in the data – once in math, and once in science – in order to include student fixed effects. This means that the impacts of teaching practices on test scores are identified from the variation of teaching practices between the two subjects for each student. The student fixed effects net out most potential confounding factors, such as the sorting of students to teachers and teachers' adjustment of teaching practices to their students' academic abilities. Moreover, the inclusion of a rich set of teacher-level control variables in the regression model mitigates the concern that overall teacher quality, rather than the teaching practices themselves, is driving the results. In line with the previous literature, my results show that traditional teaching has a positive and significant effect on students' overall math and science test scores, while the impact of modern teaching is close to zero and not statistically significant.

I then estimate separately the effects of traditional and modern teaching practices on each of the three cognitive skills for which sub-scores are available in the data. There is a positive impact of the traditional teaching index on students' factual knowledge and on their competency in solving routine problems, but no significant effect on students' reasoning skills. Conversely, the impact of the modern teaching index on students' factual knowledge and on their routine problem-solving skills is close to zero, while its estimated impact on reasoning is positive and significant. This positive effect of modern teaching on reasoning skills is masked in the overall test score

regression because standardized tests, both in TIMSS and elsewhere, contain relatively few questions measuring these skills. Taken together, the results are in line with my initial hypothesis, and they suggest that an increased emphasis on modern teaching practices and a decreased emphasis on traditional teaching practices will lower students' overall test scores but promote their reasoning skills, the latter of which is the stated aim of National Teaching Standards.

This paper makes three important contributions relative to the small previous literature on the effects of teaching practices on student outcomes. First, it provides the first comprehensive analysis of the impacts of traditional and modern teaching practices on student test scores for the United States.[2] The only prior study that defines teaching practices in a similar way as this paper does is the analysis by Lavy (2011) for Israel. Like in this current paper, the author uses information from a student survey on the frequency of the use of a range of classroom activities in order to define two class-level indices of traditional and modern teaching. Lavy (2011) finds that both traditional and modern teaching practices are positively related to student achievement, but that the impact of traditional teaching is larger. Second, to the best of my knowledge, this is the first study to analyze whether traditional and modern teaching practices affect different cognitive skills in different ways. Third, in an extension of my analysis, I exploit the international dimension of the TIMSS database in order to estimate the effects of traditional and modern teaching practices across a large set of European and Asian countries. The similarity between the estimates from these regressions and those obtained for the United States lends credibility to my headline results and is evidence of their external validity.

The remainder of the paper is organized as follows. Section 2 describes the nature and content of National Teaching Standards in more detail. Section 3 presents the data and discusses the measurement of teaching practices and cognitive skills. Section 4 explains the empirical strategy. Section 5 presents the headline estimates as well as results from several robustness checks. Section 6 extends the analysis to other countries. Section 7 concludes.

## 2. National teaching standards

In its influential 1983 report *A Nation At Risk*, President Ronald Reagan's National Commission on Excellence in Education painted a grim picture of the state of the education system in the United States. Citing falling SAT scores and disappointing results of American students in international tests, it warned of a "rising tide of mediocrity that threatens our very future as a Nation and a people" (NCEE, 1983, pp.5). The perception of the Commission was that the United States were falling behind other nations in terms of economic competitiveness, and that flaws in the education system were one of the principal reasons for this development. Consequently, the report called for large-scale educational reform that would lead to the excellence in education needed for the country to keep its competitive edge in global markets. One of the key elements of such reform was supposed to be an improvement in the quality of teaching in schools.

As a response to *A Nation At Risk*, the National Council of Teachers of Mathematics published the *Curriculum and Evaluation Standards for*

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[2] Most previous studies based on United States data have focused either on teaching practices that would be classified as modern by National Teaching Standards (Murnane and Phillips, 1981; Goldhaber and Brewer, 1997) or on practices that do not fit into the framework of traditional versus modern teaching (Kane et al., 2011; some practices in Murnane and Phillips, 1981). Schwerdt and Wuppermann (2011) compare the impact of lecturing – an unambiguously traditional practice – with that of in-class problem solving. While they regard the latter as a modern teaching practice, this is not necessarily how National Teaching Standards would classify it (see the discussion in footnote 10). In a cross-national context, Algan et al. (2013) examine the impacts of traditional and modern teaching practices on students' social capital.