Classroom Instructional Practices and Eighth Grade Math Achievement in the U.S. : A Preliminary Analysis of TIMSS 2015 Data

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Introduction

Student mathematics achievement is influenced by many factors. However, since what happens inside the classroom is the daily work of teachers and students, the role of instructional strategies in the classroom is especially important to consider. Although small-scale studies have shown a significant influence of classroom instructional practices on student math achievement, this information is not easily transferred into national trends, and must be interpreted with the context of the particular study.

The purpose of this study is to examine the relationships between classroom instructional practices and student mathematics achievement among eighth grade students in the U.S. The study uses quantitative methods to engage in the secondary analysis of a large, national dataset and is meant to provide increased understanding of the relationships between classroom instructional practices and student achievement for educators and policymakers on the national level.

Research Problem

The mathematics achievement of students in the United States has been a topic garnering major concern for decades. Published reports, such as *A Nation at Risk*, have raised concerns about the educational inadequacies of high school and college graduates and called for educational reform in order to improve the ability of the U.S. to compete internationally (Gardner, 1983). The more recent *Adding it Up* report (National Research Council, 2001) also stress the need to reform and improve mathematics instruction in elementary and middle schools.

Reform efforts in mathematics education have been attempting to address these concerns for over 30 years, however. For example, beginning with *An Agenda for Action: Recommendations for School Mathematics of the 1980s* (NCTM, 1980), the National Council of Teachers of Mathematics (NCTM), an organization founded in 1920 to promote educational excellence in mathematics, has had a long history of developing standards to address the teaching and learning of mathematics. The most recent version of recommendations, *Principles and Standards for School Mathematics* (NCTM, 2000), provided educators with broad Content Standards, Process Standards, and Principles that were deemed characteristic of a high-quality mathematics program (NCTM, 2000). Most recently, the *Common Core State Standards* (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010) further attempted to define and promote reform-centered mathematics through its content standards and the *Standards for Mathematical Practice*, all of which were heavily influenced by publications such as *Principles and Standards for School Mathematics*. The current study represents the beginning steps to address a gap in the literature examining the relationship between traditional and reform instructional practices and student achievement in a national data set.

Methods

Research Questions:

1. What relationships exist between classroom instructional practices, as reported by mathematics teachers, and student background factors, as reported by students, differ on the 2015 U.S. eighth grade administration of the Trends in Mathematics and Science Study (TIMSS)?
2. What relationships exist between classroom instructional practices, as reported by mathematics teachers, and student achievement as demonstrated on the 2015 U.S. eighth grade administration of the Trends in Mathematics and Science Study (TIMSS)?

Population:
10,491 U.S. Eighth Grade Students
Sample:
7,032 Students with Data on Each Variable
Instruments:
2015 TIMSS Eighth Grade Mathematics Assessment National Data Files
2015 TIMSS Eighth Grade Mathematics Teacher Questionnaire National Data Files
Variables:
See Table 1
Data Analysis:
Programs: International Association for the Evaluation of Educational Achievement (IEA) International Database Analyzer (IDB) Version 4
IBM SPSS Statistics 23
Analyses: Chi Square Test of Independence, Partial Correlations

Results

Table 3
Chi-Square Tests of Independence

Variable	GENDER	HOMERES	HOMESUPP	PARENTED
EXPLCON	X(3)=.35, *p*=.95	X(6)=11.57, *p*=0.7	X(9)=4.85, *p*=.85	X(12)=28.76, *p*=.004
EXPLSOL	X(3)=3.17, *p*=.37	X(6)=40.45, *p*<.001	X(9)=4.99, *p*=.84	X(12)=42.00, *p*<.001
MEMORIZE	X(3)=.53, *p*=.912	X(6)=77.46, *p*<.001	X(9)=13.02, *p*=.16	X(12)=39.09, *p*<.001
GUIDANCE	X(3)=5.53, *p*=.14	X(6)=25.04, *p*<.001	X(9)=15.89, *p*=.07	X(12)=21.47, *p*=.04
WHOLE	X(3)= 1.21, *p*=.75	X(6)=25.70, *p*<.001	X(9)=21.78, *p*=.01	X(12)=25.95, *p*=.01
OCCUPPIED	X(3)=1.96, *p*=.58	X(6)=28.31, *p*<.001	X(9)=9.95, *p*=.35	X(12)=14.48, *p*=.13
NOTOBVIOUS	X(3)=.96, *p*=.81	X(6)=15.37, *p*=0.2	X(9)=18.41, *p*=.03	X(12)=29.12, *p*=.004
TESTQUIZ	X(3)=7.85, *p*=.05	X(6)=39.40, *p*<.001	X(9)=12.09, *p*=.21	X(12)=47.81, *p*<.001
MIXEDGROUP	X(3)=.27, *p*=.97	X(6)=183.93, *p*<.001	X(9)=40.06, *p*<.001	X(12)=117.91, *p*<.001
SAMEGROUP	X(3)=4.20, *p*=.24	X(6)=39.89, *p*<.001	X(9)=5.93, *p*=.75	X(12)=30.32, *p*=.003
CALCULATOR	X(2)=.03, *p*=.99	X(4)=17.11, *p*=.002	X(6)=33.23, *p*<.001	X(8)=16.04, *p*=.04
COMPUTER	X(1)=.87, *p*=.44	X(2)=2.52, *p*=.28	X(3)=2.78, *p*=.43	X(4)=.94, *p*=.05

NOTE: Significance determined at p<.05
SOURCE: International Association for the Evaluation of Educational Achievement, Trends in International Mathematics and Science Study (TIMSS), 2015 Mathematics Assessment.

Results, cont.

Table 3

Math Plausible Values and Classroom Instructional Practices Correlation Coefficients

		EXP SOL	MEMORI ZE	GUIDAN CE	WHOLE	OCCUP IED	NOTOBV IOUS	TESTQ UIZ	MIXED GROUP	SAMEG ROUP	CALCU LATOR	COMP UTER
PVMATH 1	Correlation	-.058	-.048	-.055	-.011	-.004	-.012	-.010	-.101	.014	.060	.014
	Significance (2-tailed)	.000	.000	.000	.370	.716	.324	.393	.000	.245	.000	.247
	df	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032
PVMATH 2	Correlation	-.048	-.035	-.048	-.008	.000	-.014	-.001	-.106	.014	.061	.008
	Significance (2-tailed)	.000	.004	.000	.512	.986	.253	.930	.000	.234	.000	.504
	df	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032
PVMATH 3	Correlation	-.047	-.037	-.051	-.004	.000	-.013	-.010	-.105	.107	.068	.010
	Significance (2-tailed)	.000	.002	.000	.747	.993	.282	.421	.000	.145	.000	.414
	df	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032
PVMATH 4	Correlation	-.046	-.031	-.050	-.006	-.003	-.011	-.006	-.103	.017	.068	.011
	Significance (2-tailed)	.000	.009	.000	.592	.834	.341	.635	.000	.145	.000	.376
	df	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032
PVMATH 5	Correlation	-.043	-.035	-.049	-.002	-.001	-.011	-.010	-.106	.011	.074	.007
	Significance (2-tailed)	.000	.004	.000	.849	.950	.352	.410	.000	.345	.000	.577
	df	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032	7032

NOTE: *Control variables include PARENTED, HOMESUPP, HOMERES, and GEN\SEX OF STUDENT*
SOURCE: International Association for the Evaluation of Educational Achievement, Trends in International Mathematics and Science Study (TIMSS), 2015 Mathematics Assessment.

Conclusions

This study represents preliminary investigations of the data set, with the results indicating relationships between classroom instructional practices, student background factors, and student achievement. For instance, the results of the Chi Square Tests of Independence reveal a significant relationship between the highest level of education of a student's parent and all but one classroom instructional practice (a teacher asking students to work while the teacher was occupied with other tasks). Additionally, the correlation coefficients reveal positive, but weak, correlations between three classroom practices (having students work in homogeneous groups. allowing the use of a calculator during class, and having a computer or tablet available during class) and student achievement at each plausible value when controlling for student background factors. Although no causal results can be inferred from these correlations, further research into these results will seek to describe the extent of each relationships by level of reported classroom practice and the degree to which each level of reported classroom practice is related to student achievement.

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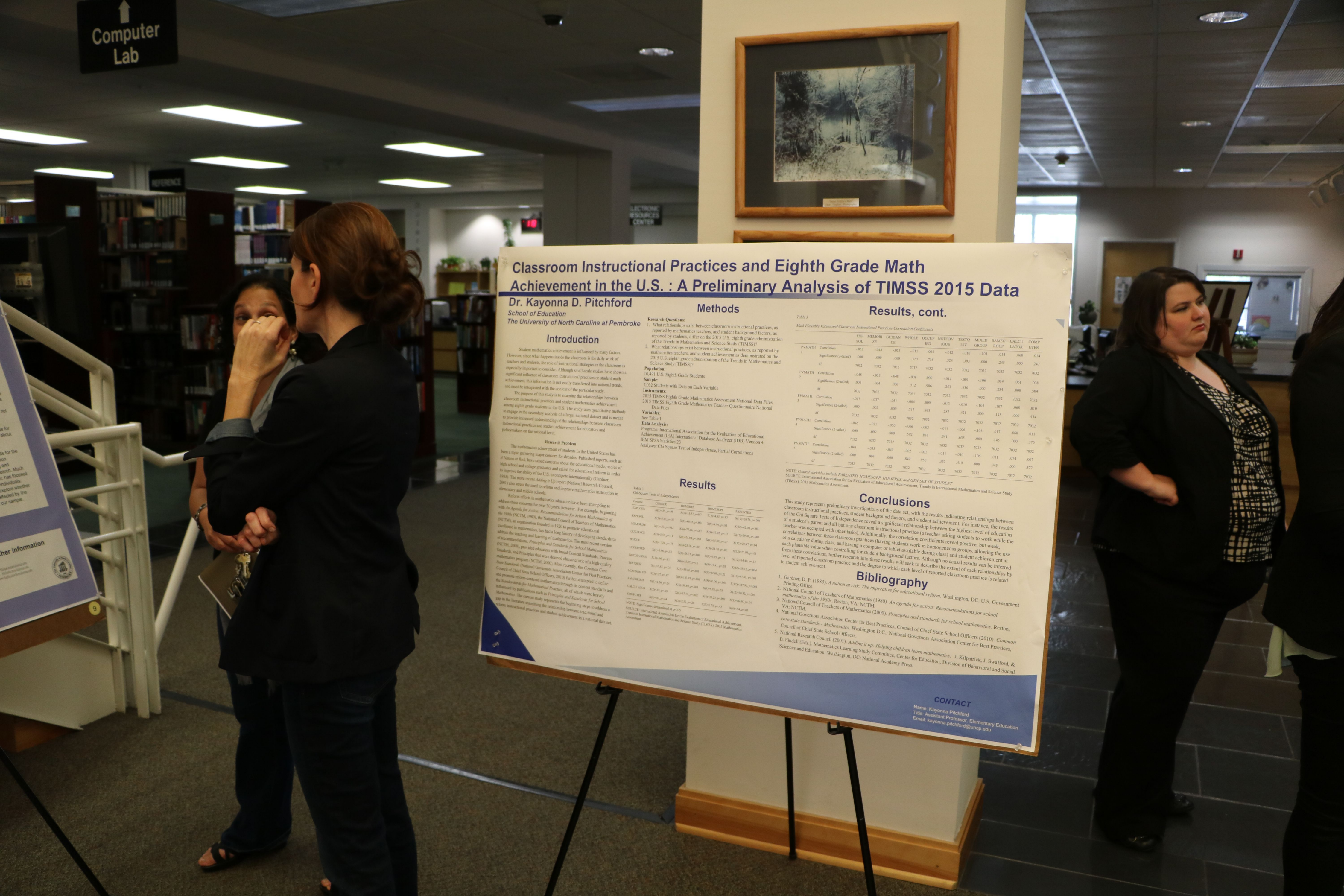
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