Abstract Title Page

Not included in page count.

Title: Do highly qualified teachers use more effective instructional practices than other teachers: The mediating effect of instructional practices

Authors and Affiliations: So Jung Park (University of Wisconsin Madison

Abstract Body

Limit 4 pages single-spaced.

Background / Context: In 2002, the No Child Left Behind Act (NCLB) called for "highly qualified" teachers in every classroom in order to increase student outcome and provide equitable learning opportunities to all students including poor and minority students. Although the definition of a "highly qualified" teacher differs from state to state, the focus was usually on teacher characteristics such as teacher certification, degree levels, and experiences. Teachers satisfying these qualifications are assumed to be prepared for, at least, a minimum amount of content and pedagogical knowledge before they come into the classrooms.

However, research evidence suggests that the relationship between teachers' background characteristics and student achievement is still tenuous and mixed (Darling-Hammond and Youngs, 2002). Moreover, it is hard to interpret these mixed results because the mechanism by which teacher qualifications influence student achievement remains unknown. In order to understand this complex relationship, teacher effects need to be considered as a continuous process in a broader context and cannot be seen as an isolated (or disconnected) factor affecting student achievement.

Purpose / Objective / Research Question / Focus of Study: In spite of much research on the relationship between instructional practices and student outcome, not many of them consider instructional practices as a mediator between teacher background characteristics and student achievement. In this study, I tried to extend the strand of literature explaining the process by which teacher background characteristics would influence student achievement, considering instructional practices as a mediator. I hypothesize that teachers' background characteristics would influence instructional practices, which in turn would affect student achievement. Thus, teaching practices are more directly connected with student outcomes.

Using structural equation modeling (SEM), I examined direct and indirect effects of teacher background characteristics on student achievement. Indirect effect is used to describe the teacher's effects on student achievement mediated by various instructional practices. Assuming that teachers acquire the content and pedagogical knowledge from prior educational or teaching experiences, the indirect effect can show how the *knowledge* of what to teach and how to teach is connected to the *practices* of what to teach and how to teach. With this approach, the total effects of teacher quality on student achievement would be substantially less obscure.

Setting: The sample for the analyses comes from the Early Childhood Longitudinal Study-Kindergarten Cohort of 1998-1999 (ECLS-K), a nationally representative survey administered by the National Center for Educational Statistics. The ECLS-K began following kindergarten children in the fall of 1998. In the fall of 1999, survey administrators administered test instruments to all students attending a random subsample of approximately 30 percent of the schools sampled during the kindergarten year (NCES, 2002).

Population / Participants / Subjects: The target population for the study is kindergarten children attending kindergarten in 1998-99 in the United States. For this study, the 5,428 students who attended these sub-sampled schools served as the foundation for the analytical sample. Table 1 provides descriptive statistics and the source of the variables.

Intervention / Program / Practice: The purpose of this study is to examine the association between teacher professional qualifications, teaching practices, and student achievement for kindergarten and first grade students.

Regarding professional teacher qualifications, this study focuses on teachers' professional qualifications of teacher degree, experiences, and certification. Teacher's degree, experiences, and certification have been considered as important proxies for teacher quality. Many researchers and policy makers believe that these quality proxies are connected to the extensive pedagogical and content knowledge that teachers can bring to the classrooms. However, research syntheses have shown inconsistent results regarding the effect of teacher degree, experiences, and certification on students' outcomes.

Regarding instructional practices, I distinguish practices as "traditional instruction" and "reform-oriented instruction" according to assumptions about teachers' and students' roles in teaching and learning activities. In the traditional approach to classroom instruction, the teacher's role has been regarded as the active transmitter of knowledge while students are the passive receivers of information (Applebee et al., 2004). This approach in traditional classrooms is often described as one in which teachers present lectures as represented in curricula and textbooks, and students often receive drill and practice with worksheets while they are cognitively passive. On the other hand, reform-oriented instruction is student-centered rather than teacher–centered, thus emphasizing students' own thinking, exploration, and communication in the learning process (Le et al., 2009). Reform-oriented instruction is characterized by classroom activities such as cooperative learning groups, student-led discussions, and open-ended assessment techniques that are intended to promote the development of complex cognitive skills and processes (Cohen & Hill, 2000).

Research Design: Dunkin and Biddle (1974) identified a model for the study of classroom teaching. The model considers instructional practices as a process. According to this framework, I build a model that posits relations between presage, process, product, and context (see Figure 1). Specifically, I modeled the associations between the teacher professional qualifications (presage) and teaching practices (process), teaching practices and student achievement (product), and teacher qualifications and student achievement, while I control for student background characteristics (gender, race, SES, math pretest scores). This model predicts math achievement for kindergarten and first grade students in the United States (context). Teacher/student background variables are regarded as exogenous variables. The instructional practices are the mediator, functioning both as a response to prior stimuli but also activating subsequent outcomes as well. Student achievement is endogenous variables. It should be noted that teacher qualifications provide a both direct and indirect path to math achievement. This means that only some portions of the effects are mediated by instructional practices, but still other portions of the effects are directly connected with student outcomes.

Data Collection and Analysis:

Measures

Student math achievement. Student mathematics test information from the fall and spring of kindergarten (1998-1999) are used for the kindergarten level and the fall and spring of first grade (1999-2000) are used for the first grade level.

Instructional practices. The ECLS-K survey asks teachers "how often children in this class do several MATH activities suggested" (See table1). Then, teachers indicate "how frequently

[they] present the topic by selecting one of the following options": 'never' (coded 1), 'once a month or less' (coded 2), 'two to three times a month' (coded 3), 'one to two times a week' (coded 4), 'three to four times a week' (coded 5), or 'daily' (coded 6).

Using factor analysis (Confirmatory factor analysis), I combined information form a set of questions regarding teaching practices in a single scale. Specifically, I hypothesize that two latent variables, which represent traditional and reform-oriented mathematics instruction, explain observable indicators of teaching practices. Traditional instruction, a teacher-directed approach to instruction, is identified based on the following observed indicators regarding teaching practices: (a) using worksheets, (b) using textbooks, (c) using chalkboard, and (d) using routine practice and drill. Reform-oriented instruction emphasizes students' active role in their own learning. This latent variable is identified based on the following observed indicators: (a) counting out loud, (b) working with geometric manipulative, (c) working with counting manipulative to learn basic operations, (d) playing mathematics-related games, (e) working on mathematics problems that reflect real-life situations, (g) mixed group math work, and (h) working on problems w/several solutions.

Most of the model fit indicators (See Table 2) have, generally, good psychometric characteristics that have a relatively high standardized-factor loading—above 0.5 in the kindergarten and first grade level (convergent validity). The factor correlations are positive and moderate in size (0.53 for the kindergarten level and 0.51 for the first grade level), which suggest that the two factors may distinct each other (discriminant validity).

Teacher background characteristics. The variables for teacher background characteristics are the measures of teacher certifications, years of experience, and teacher's education level. Teacher certification (1=full of advanced certification), teaching experience (1=teaching experience is more than 5 years), teacher's education level (1=masters or above) are dichotomous variables.

Student background characteristics. The variables for student background characteristics are the measures of gender, students' race, socioeconomic status (SES), and pretest math score. Gender (female=1) and race (white as reference group) are dichotomous variables.

Structural Equation Modeling

To test the model, structural equation modeling (SEM) was used. All analyses were conducted with Mplus 6.1 (Muthén &Muthén, 2010) based on the MLR estimator (maximum likelihood parameter estimated with standard errors and a chi-square test statistic). Based on missing data patterns and the proportion of non-missing data, I assumed "missing at random" (MAR), which means that missingness is a function of observed covariates and observed outcomes. Missing data is imputed using the Expectation Maximization (EM) algorithm through the maximum likelihood (ML) method of estimation under MAR assumption.

Findings / Results: The result show that teachers with regular certification use less traditional instruction and more reform-oriented instruction compare to teachers without regular certification (See Table 2 and Table 3). Similarly, teachers with advanced degrees use less traditional and more reform-oriented instruction than BA teachers. Assuming that teachers' educational background largely influences the pedagogical knowledge of certified/ advanced degree teachers, the results may suggest that teacher education programs tend to emphasize more reform-oriented practices than traditional math instruction. However, when teachers use more traditional instruction or less reform-oriented instruction, math scores increase. As results, the total indirect effect of certification is negative 0.03, while total indirect effect of advanced degree is negative 0.06. Both are statistically significant. This means that teachers with regular certification or advanced degree use ineffective instructional practices compare to teachers not satisfying these qualification criteria.

Unlike certification and degree levels, experienced teachers use more traditional as well as more reform-oriented practices compared to early career teachers. Moreover, the magnitude of the effect is larger for traditional practices. This result may suggest that pedagogical knowledge through experiences may guide teachers to use a wide range of instructional practices, or their classroom management ability might help to use more wide range of instructions. Therefore, the total indirect effect of experience is 0.08, which is statistically significant, and the largest coefficient among the qualification criteria.

Taken together, the results show that the mediating effect of instructional practices are negative for certification and advanced degrees, while it is positive for teaching experiences. Specifically, the results suggest that highly qualified teachers are more likely to use reform-oriented practices. But the reform-oriented practices are negatively associated with kindergarteners math outcomes. That weaken the effect of highly qualified teachers is their teaching practices.

The results can be interpreted in several different ways. One way to interpret this is that teacher preparation programs might be encouraging teachers to use reform-oriented instruction, although it is less effective pedagogy for kindergarteners' math achievement. In fact, many studies argue that the traditional forms of instruction work better than reform-oriented instruction for young leaners (Mayer et al., 2004; Kirschner et al., 2006). When kids have little prior knowledge, the integration of prior knowledge and new information may generate a heavy working memory load, which is detrimental to kid's learning (Mayer et al., 2004; Kirschner et al., 2006). Second, it might be fidelity problem rather than the effect of pedagogy itself. In other words, reform-oriented practices can be used effectively, but teachers might not fully understand how to apply them. In fact, studies suggested that teacher education programs stress reform-oriented instruction, but it is often too theoretical, not tangible (Cook et al. (2002)). Although theoretical principles of reform-oriented instruction are stressed in many teacher education programs, the concepts central to these principles may not be fully understood among teachers or even among the university professors who teach teachers. In this situation, education coursework is too theoretical and the concept of reform-oriented instruction is not tangible. Moreover, it is hard to observe reform-oriented practices because university professors' instruction is often inconsistent with the professor's pedagogy. Cook et al. (2002) suggest that teachers often develop a pseudo-concept regarding reform-oriented instruction. Third, this can be related to the assessment itself. The test may not be aligned with reform-oriented practices, or the knowledge from reform-oriented instruction might benefit when kids are getting older (Hmelo-Silver, 2007; Hamilton et al., 2003).

Conclusions: Taken together, the research findings provide valid information for education leaders regarding how teaching practices are related to teacher preparation and to what extent teacher preparation and teaching practices are associated with student achievement in mathematics. This focus on teaching processes seeks to open up "highly qualified" teachers to include teacher professional qualifications, as well as teaching practices. Teaching processes will give more implication to policy makers about what kind of training teachers have and how to use teacher training to improve teacher instruction.

Appendices

Appendix A. References

Applebee, A., Langer, J., Nystrand, M., & Gamoran, A. (2003). Discussion-based approaches to developing understanding: Instruction and achievement in middle and high school english. *American Educational Research Journal, 40*, 685–730.

Cohen, D., & Hill, H. (2000). Instructional policy and classroom performance: The mathematics reform in california. *The Teachers College Record, 102*(2), 294-343.

Cook, L. S., Smagorinsky, P., Fry, P. G., Konopak, B., & Moore, C. (2002). Problems in developing a constructivist approach to teaching: One teacher's transition from teacher preparation to teaching. *The Elementary School Journal,* , 389-413.

Darling-Hammond, L., & Youngs, P. (2002). Defining" highly qualified teachers": What does" scientifically-based research" actually tell us? *Educational Researcher, 31*(9), 13-25.

Dunkin, M. J., & Biddle, B. J. (1974). *The study of teaching.* Holt, Rinehart & Winston.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75.

Hamilton, L. S., McCaffrey, D. F., Stecher, B. M., Klein, S. P., Robyn, A., & Bugliari, D. (2003). Studying large-scale reforms of instructional practice: An example from mathematics and science. *Educational Evaluation and Policy Analysis, 25*(1), 1.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to kirschner, sweller, and clark (2006). *Educational Psychologist, 42*(2), 99.

Le, V. N., Lockwood, J., Stecher, B. M., Hamilton, L. S., & Martinez, J. F. (2009). A longitudinal investigation of the relationship between teachers' self-reports of reform-oriented instruction and mathematics and science achievement. *Educational Evaluation and Policy Analysis, 31*(3), 200

Mayer, R. E. (2004). Should there be a three-strikes rule against pure discovery learning. *American Psychologist, 59*(1), 14-19.

Muthén, L., & Muthén, B. (2010). Mplus version 6.1. *Muthen & Muthen,* National Center for Education Statistics. (2002). User's manual for the ECLS-K first grade restricted-use data files and electronic codebook (No. NCES 2002-128). Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Appendix B. Tables and Figures
Not included in page count.

Figure 1. Structural Relationship between Professional Teacher Qualification, Teaching Practices, and Student Outcomes

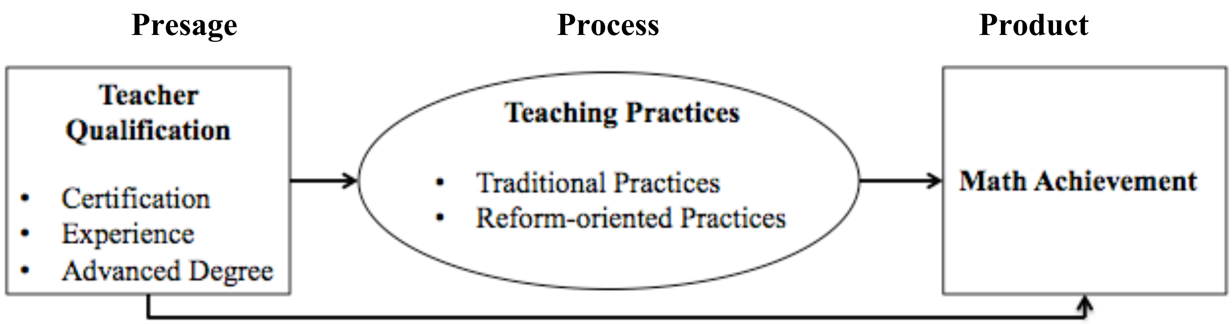

Table 1. Variable Description

Variables	M	SD	Source (ECLS-K)
Achievement Test Score			
Kindergarten			
1998 fall math achievement (IRT)	19.84	7.38	C1RMSCAL
1999 spring math achievement (IRT)	27.81	8.98	C2RMSCAL
First Grade			
1999 fall math achievement (IRT)	32.80	9.55	C3RMSCAL
1999 spring math achievement (IRT)	43.47	9.24	C4RMSCAL
Student Characteristics			
Socioeconomic status (SES)	.02	.802	WKSESL
Female	.51	.500	GENDER=1
White	.56	.497	RACE=1
Black	.15	.356	RACE=2
Hispanic	.17	.374	RACE=5
Asian	.05	.226	RACE=3 or 4
Other	.04	.255	RACE= 6, 7, or 8
Teacher Characteristics			
Kindergarten (1998-1999)			
Master's degree or higher (Fall)	.35	.476	B1HGHSTD=3, 4, or 5
More than 5 years experience (Fall)	.86	.343	B1YRSPRE+B1YRSKIN+ B1YRSFST+B1YRS2T5+ B1YRS6PL>5
Full certification (Fall)	.80	.402	B1TYPCER=4 or 5
Master's degree or higher (Spring)	.34	.472	B2HGHSTD =3, 4, or 5
More than 5 years experience (Spring)	.86	.349	B2YRST >5
Full certification (Spring)	.80	.397	B2TYPCER=4 or 5
First Grade			
Master's degree or higher (Spring)	.38	.484	B4HGHSTD =3, 4 or 5
More than 5 years experience (Spring)	.78	.417	B4YRST>5
Full Certification (Spring)	.87	.333	B4TYPCER=4 or 5
Instructional Practices			
* The following variables are recoded to 1=0/20 (0), 2=0.5/20(0.025), 3=2.5/20(0.125), 4=6/20(0.3), 5=14/20(0.7), 6=20/20 (1).			
Kindergarten			
% time using math textbook	20	35.0	A2MTHTXT
% time doing math on chalkboard	25	32.8	A2CHLKBD
% time doing math worksheets	48	36.3	A2MTHSHT

% time counting out loud	90	21.4	A2OUTLOU
% time for geometric manipulative	47	32.4	A2GEOMET
% time for counting manipulative	62	31.0	A2MANIPS
% time for math related games	51	32.9	A2MTHGME
% time solving real life math	38	34.3	A2REALLI
% time on mixed group math work	49	39.8	A2MXMATH
% time solving math w/partner	29	30.8	A2PRTNRS
First Grade			
% time for routine practice or drill	58	34.2	A4DRILL
% time using math textbook	60	42.1	A4MTHTXT
% time doing math on chalkboard	46	36.4	A4CHLKBD
% time doing math worksheets	71	32.4	A4MTHSHT
% time counting out loud	69	34.0	A4OUTLOU
% time for geometric manipulative	30	27.9	A4GEOMET
% time for counting manipulative	57	32.4	A4MANIPS
% time for math related games	42	30.0	A4MTHGME
% time solving real life math	48	32.9	A4REALLI
% time on mixed group math work	47	37.9	A4MXMATH
% time on problem w/sev solutions	36	33.8	A4SEVSOL

Table 2. MRL Parameter Estimates for Direct Effects (Kindergarten)

Parameter	Unstandardized	SE	Standardized
Measurement Model			
Traditional instruction by			
Math worksheets	1.00	0.00	0.48
Math textbook	0.77	0.04	0.40
Chalkboard	1.15	0.08	0.64
Reform-oriented instruction by			
Counting out loud	1.00	0.00	0.64
Geometric manipulative	0.93	0.03	0.54
Counting manipulative	1.31	0.03	0.76
Math related games	1.26	0.04	0.72
Solving real life math	1.01	0.04	0.58
Mixed group math work	1.15	0.04	0.56
Direct Effects			
Traditional instruction on			
Advanced Degree	-2.49***	0.79	-0.06
Experiences	11.91***	1.19	0.30
Full Certification	-5.75***	1.13	-0.13
Reform-oriented instruction on			
Advanced Degree	3.06***	0.62	0.07
Experiences	10.59***	0.96	0.24
Full Certification	4.18***	0.84	0.09
Math achievement on			
Traditional Instruction	0.09***	0.01	0.16
Reform-oriented Instruction	-0.03***	0.01	-0.06
1998 fall math achievement (IRT)	0.59***	0.02	0.56
Gender	0.26	0.20	0.01
Hispanic	-2.35***	0.27	-0.09
Asian	-1.40*	0.60	-0.03
Black	-2.14***	0.30	-0.08
Other	-2.82***	0.34	-0.07
Socioeconomic status	1.98***	0.14	0.17
Advanced Degree	-0.21	0.24	-0.01
Experiences	0.84**	0.28	0.04
Full Certification	0.45	0.31	0.02
Variance and Covariance			
Reform with Traditional	169.74	10.67	0.53

Counting manipulation with Geometric manipulation	188.75	11.76	0.31
Math textbook with Math worksheet	303.17	22.89	0.30
Math game with geometric manipulation	159.49	11.52	0.24
R-square			
Counting out loud	0.40	0.01	
Geometric manipulative	0.30	0.01	
Counting manipulative	0.58	0.01	
Math related games	0.52	0.01	
Math worksheets	0.23	0.02	
Math textbook	0.16	0.02	
Chalkboard	0.41	0.03	
Solving real life math	0.33	0.01	
Mixed group math work	0.31	0.01	
1999 spring math achievement (IRT)	0.47	0.01	
Traditional Instruction	0.075	0.01	
Reform-oriented Instruction	0.098	0.01	
Model Fit Index			
Chi-Square (1788.076, df=114, p=0.000)			
CFI=0.901			
RMSEA==0.052 (90 percent C.I. 0.050, 0.054)			
SRMR=0.032			

* p<0.05, ** p<0.01, *** p<0.001

Table 3. Effects Decomposition of Math Achievement Factors

Causal variable	Unst.	SE	St
Advanced degree			
Total effect	-0.53*	0.23	-0.02
Total indirect	-0.32***	0.09	-0.01
Traditional	-0.23**	0.08	-0.01
Reform	-0.09**	0.03	0.00
Direct	-0.21	0.24	-0.01
Experience			
Total effect	1.60***	0.25	0.07
Total indirect	0.76***	0.14	0.03
Traditional	1.08***	0.18	0.05
Reform	-0.32***	0.10	-0.01
Direct	0.84**	0.28	0.04
Full certification			
Total effect	-0.19	0.29	-0.01
Total indirect	-0.64***	0.14	-0.03
Traditional	-0.52***	0.12	-0.02
Reform	-0.13**	0.04	-0.01
Direct	0.45	0.31	0.02

*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$