TITLE: Teachers' Contexts, Their Instruction and Math Achievement: Evidence from the 2018 TALIS-PISA Link Data

ABSTRACT: This study uses secondary data analysis of the 2018 TALIS-PISA link data combined with content analysis of policy and media artifacts to describe the relationship between teacher professionalization and working climate, self-efficacy, instruction, and mathematics achievement. In preliminary SEM models we identify three types of classroom instruction, Instruction Focused, Management Focused, and Comprehensive, based on a latent profile analysis of frequency of teacher behaviors. We also find that professionalization and working climate significantly predict teacher self-efficacy and instruction, but that instruction does not predict achievement when including school covariates. We also describe key differences in professionalization, climate, and math achievement between PISA link countries.

PURPOSE

Numerous empirical studies have supported the idea that teacher effectiveness influences student achievement more than any other within school factor (Stronge, 2010). The teacher effects on mathematics and science achievement are often larger compared to other subjects because students may have their only meaningful encounters with these subjects in the school setting (Nye et al., 2004). However, teachers carry out their work in a complex ecosystem of school organizations, community contexts, and sociopolitical milieu. Understanding the impact of a teachers' ecosystem on their work is an important endeavor. Teachers have been the primary focus of policy reforms and school improvement approaches that have proliferated throughout internationally. However, even with significant policy and improvement resources dedicated to improving teaching over several decades, marginalized students continue to underperform their dominant-culture peers in mathematics and science (Center for Education Policy Analysis, 2014; Horsford, 2017; The Nation's Report Card, 2020). While there is a growing body of evidence that within-school factors such as leadership school climate contribute to teacher effectiveness, there is less evidence of the effects of the broader political and policy context on teaching effectiveness. Thus, this study uses a sequential mixed methods approach with secondary data analysis of the 2018 TALIS-PISA link data followed by content analysis of policy, media, and peer-reviewed documents to address the following research questions:

- What is the relationship of teachers' perceptions of professionalization and working climate to their self-efficacy, and what is the relationship of self-efficacy to instructional behaviors?
- What is the relationship of teacher instructional behaviors to school math achievement?
- How does context of teaching, and teachers' perceptions of professionalization and working climate vary between TALIS-PISA LINK countries?

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Decades of scholarship related to effective teaching has demonstrated that what teachers do in their classrooms is more important for student achievement than their personal or professional characteristics (e.g. race/ethnicity, gender, education level, certification type) (Aaronson, et al., 2007; Goldhaber, 2002; Hattie, 2009; Stronge, 2010; Stronge et al., 2008). Quality teaching may not be equal to teacher qualities and there may be unobserved indicators of teacher quality in models that only consider teacher personal and professional characteristics (Hiebert & Morris, 2012; Kennedy, 2010; Rivkin et al., 2005). Thus, the central conception of this study is that teacher instructional practices have the most direct relationship to student learning, and teacher personal and professional characteristics, as well as their working context, may influence student achievement through their influence on instructional behaviors (see Goe, 2007 and Palardy & Rumberger, 2008). Teaching behaviors span multiple domains including instructional delivery, assessment, creating environments that support learning (see Hattie, 2009; Stronge, 2007; Stronge et al., 2011 for syntheses). More recently, teacher instructional behaviors in mathematics courses have been recognized as important components of opportunity to learn, the enacted curriculum that students experience. Differences in opportunity to learn within and between math classrooms can contribute to opportunity gaps for marginalized students (Covay Minor, 2015; Mo et al., 2013; Author et al., 2022; Colleagues & Author, 2021). However, teachers' situational context may also directly influence teacher instructional behaviors and teacher affective domains, such as satisfaction with the profession and their own school context, stress, and self-efficacy can influence each other and their instructional practices.

Teacher self-efficacy has a connection to instructional quality and behaviors (Burić & Kim, 2020; Holzberger et al., 2014; Klassen & Tze, 2014). Through the impact on instructional quality, teacher self-efficacy can affect student achievement (Caprara et al., 2006; Muijs & Reynolds, 2002), and this relationship between self-efficacy and achievement can be cyclical (Tschannen-Moran et al., 1998). Other affective domains, like collective teacher efficacy, perceptions of leadership, and job satisfaction, may, conversely influence teacher self-efficacy, creating a feedback loop for teachers within their school organizations (Dicke et al., 2019; Holzberger et al., 2014; Tschannen-Moran et al., 1998; Zee & Hooman, 2016). While teacher self-efficacy is often discussed as an individual teacher characteristic, self-efficacy, unlike some intrinsic characteristics, is context dependent and socially acquired (Holzberger et al., 2014; Tschannen-Moran & Hoy, 2001; Van den Broeck et al., 2010). Prior to the expansion of neoliberal educational reform, the context of teachers' work was primarily the school organization and the community served by the school. However, the rise of the knowledge economy as a pillar of globalization saw teachers' working contexts expand to include a host of policymakers who viewed teachers as a lever in economic development that should be influenced through accountability policies (Spring, 2011; Superfine, 2005; Superfine et al., 2012). Thus, it is the contention of this study, that affective domains like job satisfaction, perceptions of leadership, motivation, and burnout can no longer be considered as within-school effects. Rather, a conceptual framework of teacher perceptions of their work (see Figure 1) that accounts for within-school and external influences on those perceptions provides a more appropriate conceptual framework for teaching.

METHOD

This study uses a sequential mixed methods secondary data analysis to understand the policy-contextualized working climate of teachers in nine countries and the connection of teachers' perceptions of working climate to mathematics achievement. The first phase of the study, presented here, uses latent class analysis and multilevel structural equation modeling (SEM) to describe the relationship between teachers' perceptions of professionalization and working climate, self-efficacy, their instructional practices, and their schools' mathematics performance. The second phase of the study will use content analysis of policy, media, and academic literature to create a picture of the teacher professionalization policy context of the nine countries examined in the initial quantitative phase of the study.

The 2018 TALIS-PISA link data files constructed by OECD are used for the quantitative phase of this study. The TALIS is a large-scale international survey that collects the perspectives of teachers and school leaders on teaching and learning in their schools with a core focus on lower secondary education; the 2018 framework was informed by policy discourses and contemporary issues in teaching identified at recent meetings of the International Summit of the Teaching Profession (Ainley & Carstens, 2018). Nine countries, Australia, Argentina, Colombia, Czech Republic, Denmark, Georgia, Malta, Turkey, and Vietnam agreed to participate in a subsampling of 2018 PISA school data that could be linked to school-level 2018 TALIS data. The 2018 TALIS-PISA link data sets are uniquely valuable for this study of the complex ecology surrounding teachers' work, the influence of this ecology on teachers' perceptions and behaviors, and the relationship of teachers' ecological, perceptual, and behavioral experiences to school-level student achievement in mathematics as measured by PISA 2018.

The first step of the quantitative analysis focused on identifying latent profiles of instructional approaches which could be used as teacher-level predictors of school math achievement. The second step of the analysis was a construction of a teacher-level SEM model using 2018 TALIS items from the school climate, job satisfaction, and human resources issues themes (Ainley & Carstens, 2018) to develop a bi-factor latent construct of teacher professionalization, which represents perceptions of the teaching profession and influence over external educational policies, and working climate that represents teachers' autonomy over curriculum and instruction, opportunities for professional development, and influence over within-school policies, and perceptions of collegiality and professionalism within their schools. The teacher-level SEM models also include a latent construct of teacher self-efficacy, latent profiles of classroom instructional approach, and teacher covariates (gender, age group, formal math training, and teacher certification). The multilevel SEM models include PISA mathematics exam plausible values aggregated to the school level (the measure of math achievement constructed based on student PISA math exam scores) as the distal outcomes. Principal instructional leadership behaviors, school average student economic, social, and cultural status (ESCS), and resources for instruction were also included as covariates at the school-level. All analysis was conducted in Mplus with weighted data (TALIS-PISA TCHWGT) using an MLR estimation following procedures for latent profile analysis, SEM, and multilevel SEM (Muthén & Muthén, 2017). Descriptive statistics for latent variable indicator items and teacher and school covariates can be found in Appendix A Tables 2 and 3.

RESULTS

To answer our first group of research questions, we used LPA combined with SEM. First, LPA with the frequency of teacher instructional behaviors reported by teachers, reflecting specifically on math classes they taught, used as indicators revealed three types of instructional approaches which we named Instruction Focused, where instructional behaviors were emphasized over classroom management behaviors, Management Focused, where classroom management is highly emphasized, and Comprehensive classrooms where both instruction and management are emphasized, and cognitive demand is increased (e.g. asking students to think critically, deriving their own procedures for complex tasks, solving problems with no obvious solution) (Appendix A, Table 1 for items and Figure 2 for a profile). We then used SEM to examine the relationship of teacher perceptions of professionalization and working climate to self-efficacy, which was then used to predict their latent classroom profile (see Figure 3). In this teacher-level only model, we found that teacher perceptions of professionalization and working climate were significantly correlated with each other, but only perceptions of working climate significantly predicted teacher self-efficacy; teacher self-efficacy was significantly and negatively related to both Instruction and Classroom Focused instructional approaches as compared to a Comprehensive Focused approach. Teachers with higher self-efficacy were more likely to use a comprehensive and more cognitively demanding approach to math instruction. To examine our second research question, we used multilevel SEM (see Figure 4) to examine the relationship of teacher-level perceptions of professionalization and working climate to self-efficacy, self-efficacy to classroom instruction approach, and classroom instruction approach to school-level math achievement on the PISA assessment, while also including a latent construct of principal instructional leadership, school average student economic, social, and cultural status (ESCS) and a composite variable of school resources for instruction. We found no significant relationship of classroom instructional approach to school PISA math achievement, however schools where leaders principals reported higher resources for instruction had significantly higher PISA math achievement as did schools with higher average student ESCS. However, schools where principals engaged in instructional leadership had significantly lower math PISA achievement. Additionally, when included school level outcomes and covariates, the relationship of teacher professionalization to self-efficacy shifted from non-significant to significant, although the magnitude and direction of this relationship was similar to the teacher-level only SEM model.

In examining our third research question, we computed professionalization and working climate measures using the estimates from the teacher-level SEM multiplied by the mean of professionalization and climate indicator items. One-way ANOVA showed a significant difference in both mean professionalization ($F(8, 98177)= 5787.49$, $p < .001$) and mean working climate ($F(8, 98130)= 925.72$, $p < .001$) scores between TALIS-PISA link countries. Reviewing the relationship of professionalization and climate to math achievement by country revealed complexities; Georgia had the highest levels of teacher professionalization and climate measures but the second lowest achievement. In Colombia, the country with the lowest math achievement in this sample, lower working climate and higher professionalization were observed compared to other countries. However, in the Czech Republic and Denmark, the countries with the highest achievement in this sample, teacher working climate was high while professionalization was relatively low (Figure 5).

SIGNIFICANCE

Education research continually points to teachers and teaching as not only important for "achievement," but many times as a cure for the multitude of society's ills—poverty, -isms and -phobias, and, most recently, public health. It has been posited that if teachers cared more or worked harder, the world would be closer to solving these ills. However, we must interrogate the notion that teachers work in a vacuum free from politics and social tragedy. This work attempts to model the true complexity of teachers' work, their contexts, and their perceptions with an eye on reform that moves away from the view of teachers as targets for accountability and towards a humanizing view of teachers as professionals in need of appropriate supports with the hope that well-supported teachers will contribute to well-supported and cared for students and families.

Figure 1

Conceptual Model of Professionalization and Working Climate Factors Influencing Instruction and Math Achievement

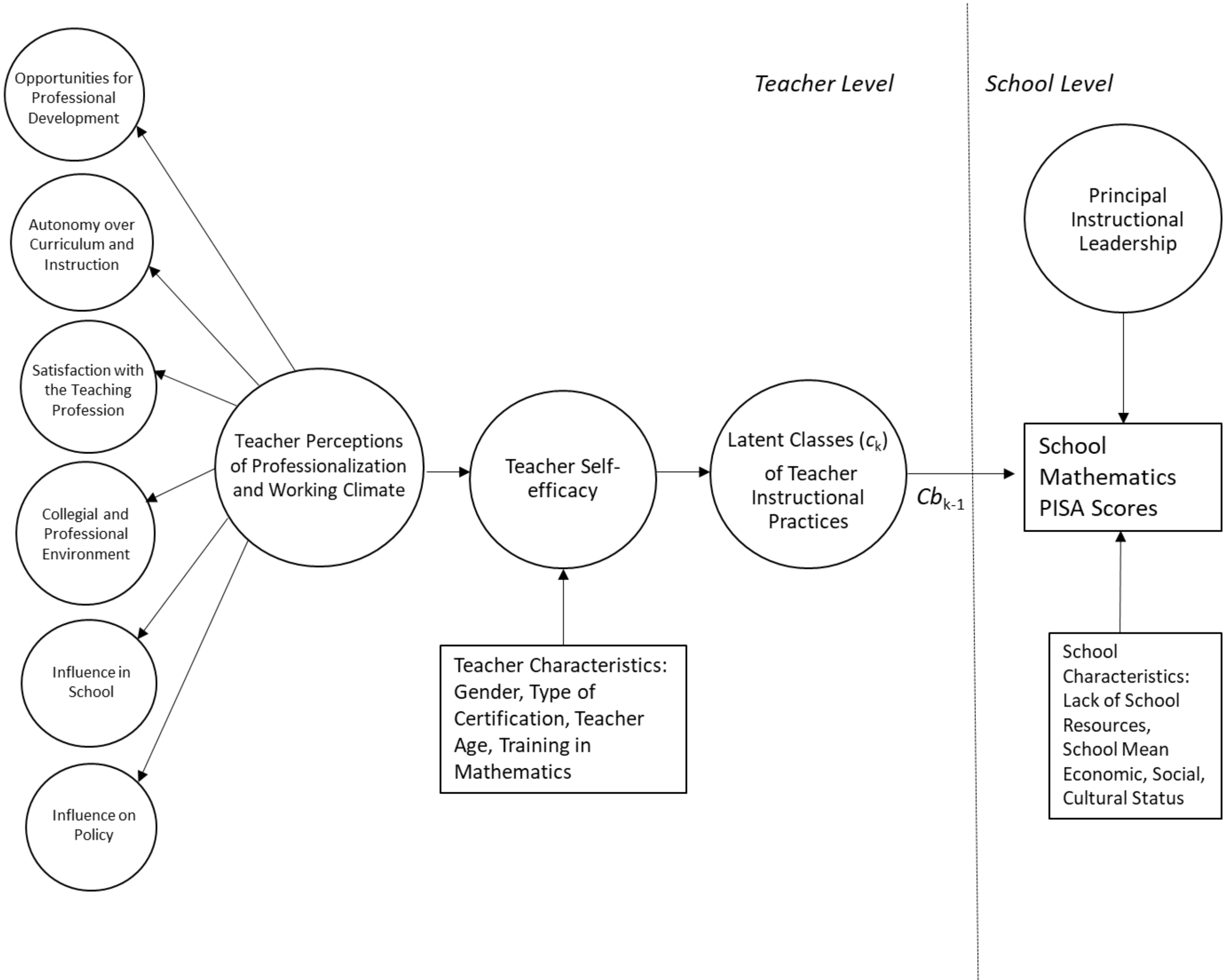


Figure 2

Latent Profile Analysis of Math Teacher Classroom Instructional Behaviors

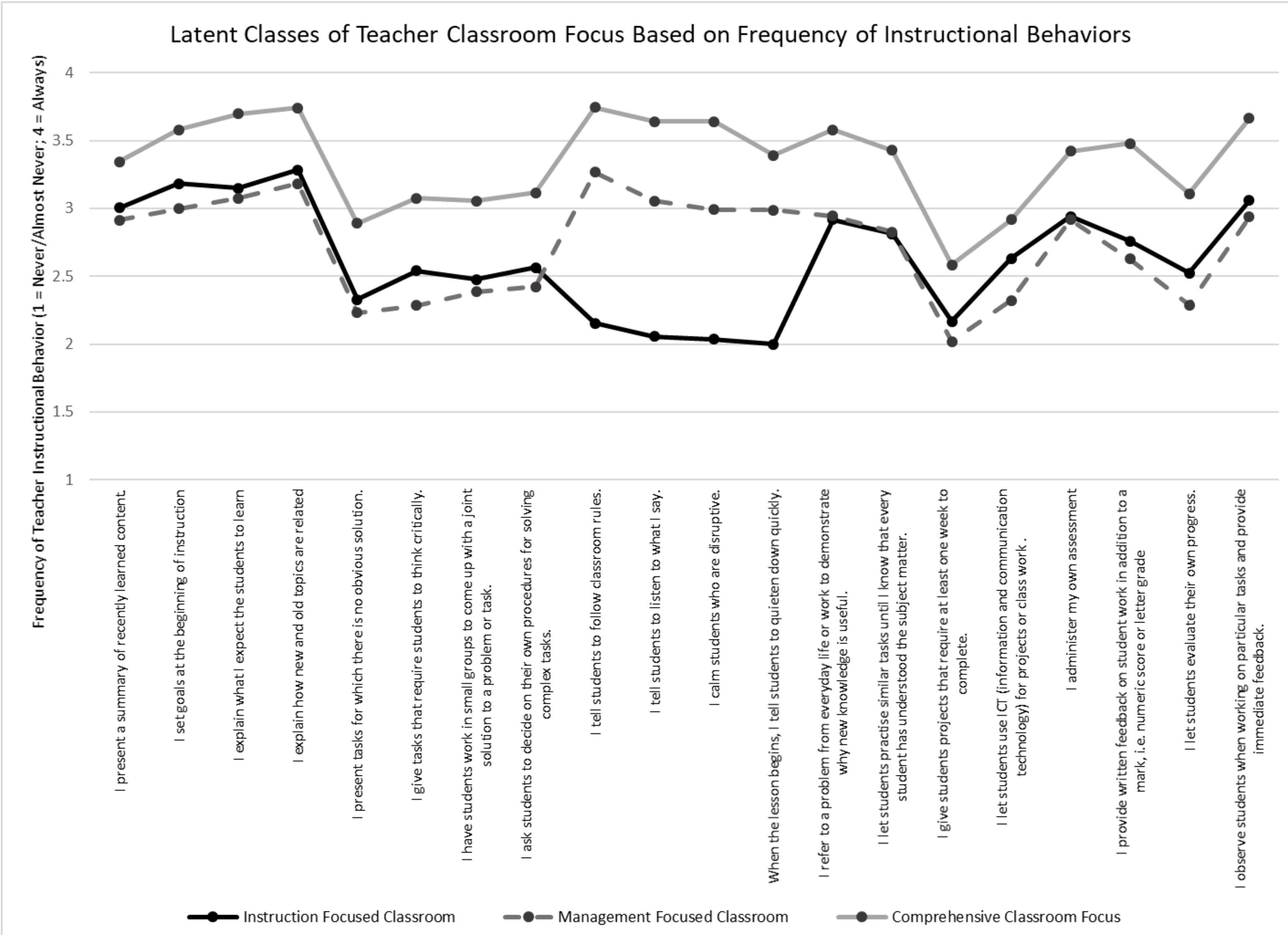


Figure 3

Teacher-level Structural Equation Model of the Relationship of Perceptions of Professionalization and Working Climate to Self-efficacy and Latent Class of Classroom Instructional Approach

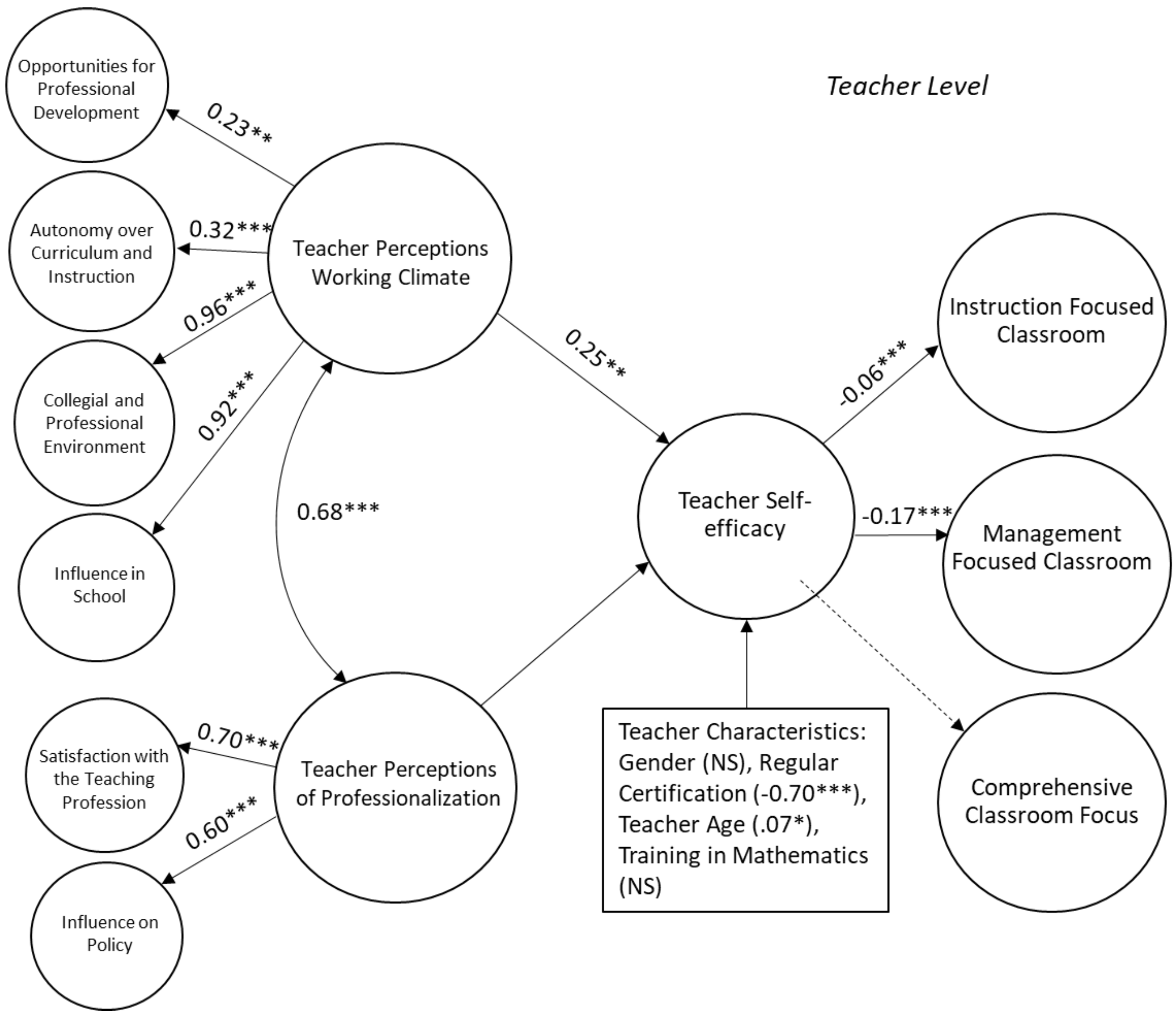


Figure 4

Multilevel Structural Equation Model of the Relationship of Perceptions of Professionalization and Working Climate to Self-efficacy and Latent Class of Classroom Instructional Approach at the Teacher-level Predicting School Mathematics PISA Achievement at the School-level

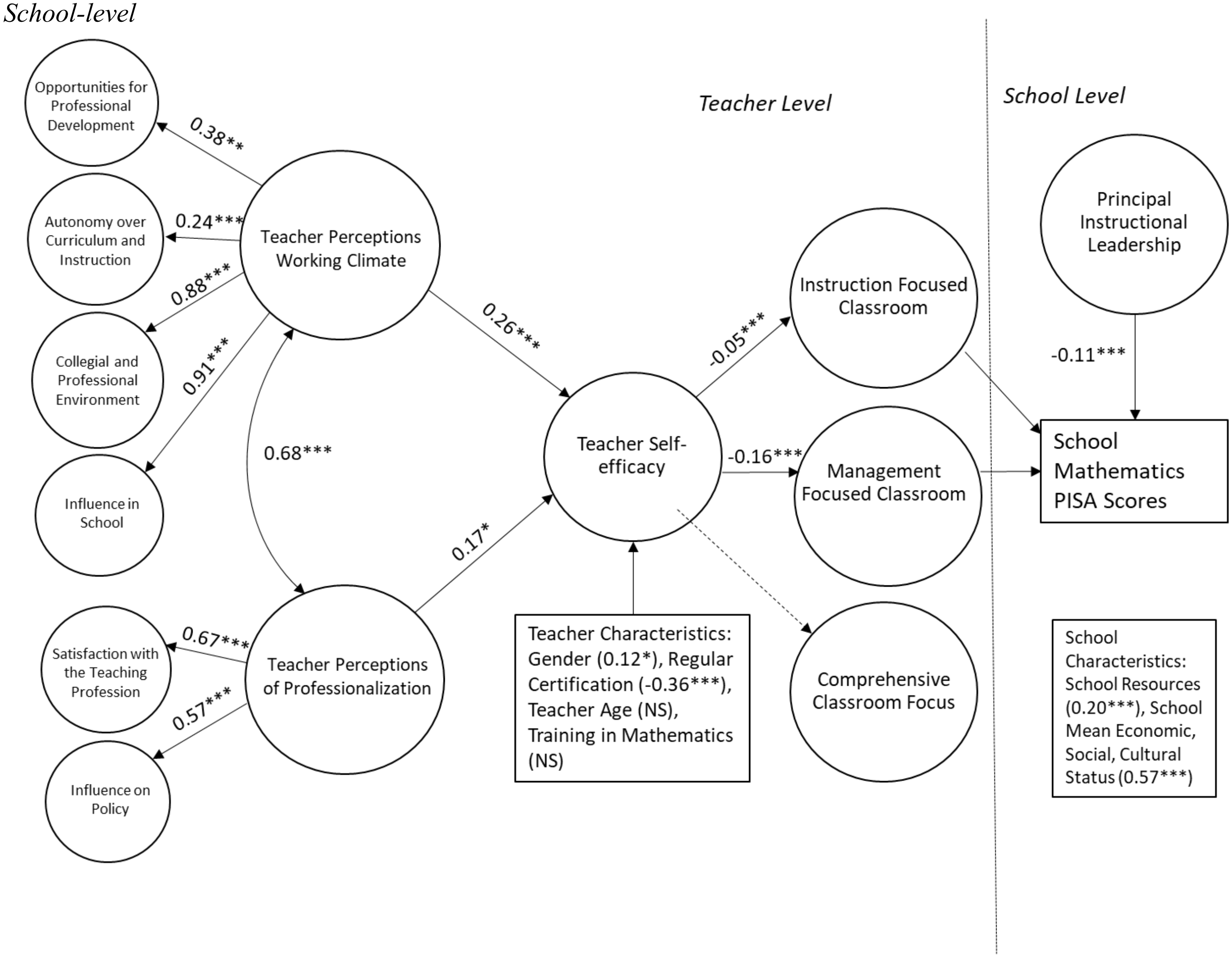
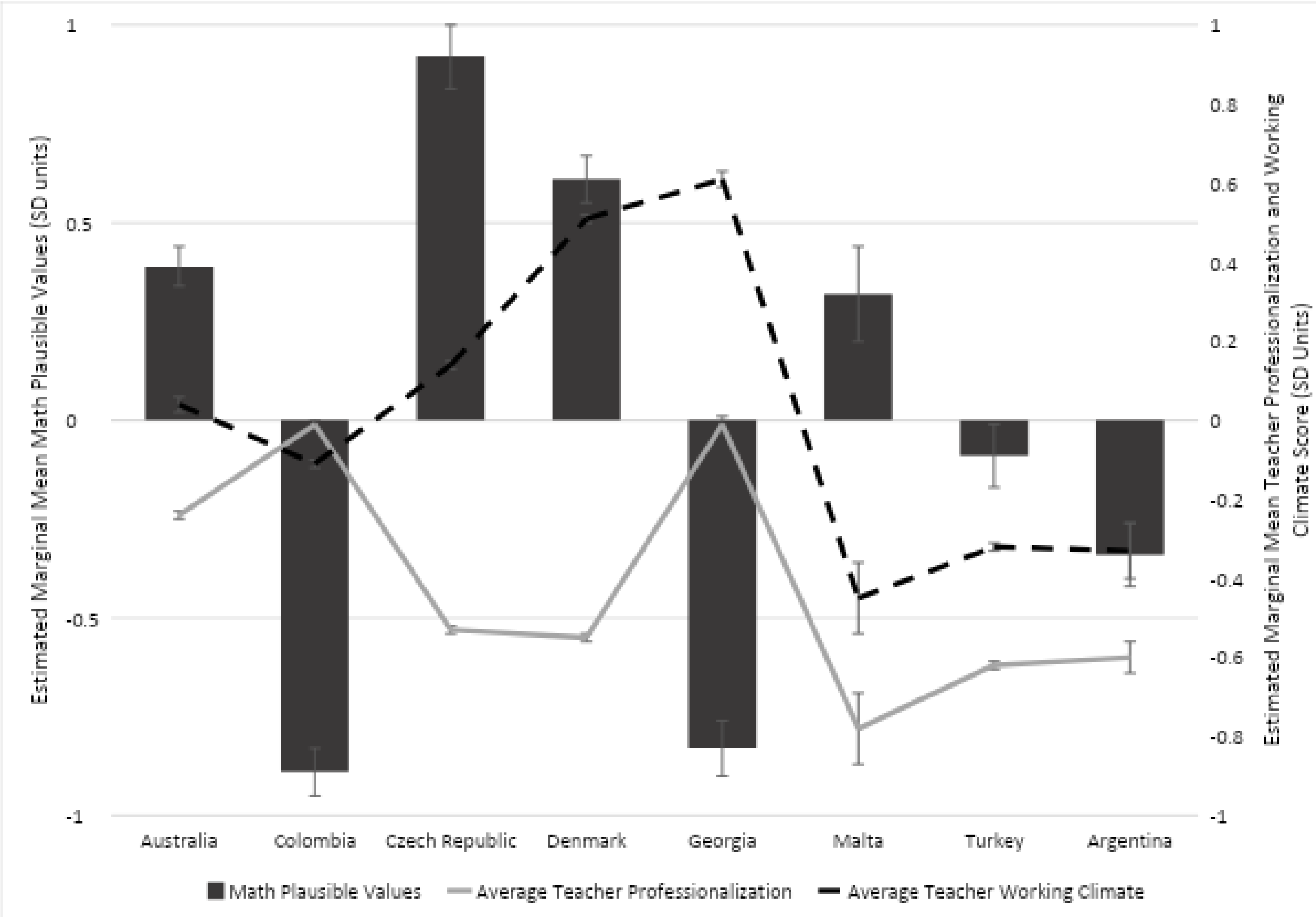


Figure 5

Differences in Teacher Perceptions of Professionalization and Working Climate and PISA Average Mathematics Achievement Between 2018 TALIS-PISA Link Countries



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Appendix A

Table 1

Decriptive Statistics for Mathematics Course Instructional Behaviors

How often do you do the following?	N	Min	Max	Mean	SD
I present a summary of recently learned content.	98419	1	4	3.07	0.67
I set goals at the beginning of instruction	98434	1	4	3.21	0.69
I explain what I expect the students to learn	98381	1	4	3.28	0.64
I explain how new and old topics are related	98243	1	4	3.37	0.61
I present tasks for which there is no obvious solution.	98457	1	4	2.45	0.89
I give tasks that require students to think critically.	98329	1	4	2.58	0.79
I have students work in small groups to come up with a joint solution to a problem or task.	98424	1	4	2.60	0.75
I ask students to decide on their own procedures for solving complex tasks.	98401	1	4	2.66	0.72
I tell students to follow classroom rules.	98370	1	4	3.14	0.82
I tell students to listen to what I say.	98325	1	4	2.99	0.88
I calm students who are disruptive.	98324	1	4	2.95	0.86
When the lesson begins, I tell students to quieten down quickly.	98302	1	4	2.87	0.89
I refer to a problem from everyday life or work to demonstrate why new knowledge is useful.	98394	1	4	3.12	0.66
I let students practise similar tasks until I know that every student has understood the subject matter.	98363	1	4	3.00	0.65
I give students projects that require at least one week to complete.	98168	1	4	2.21	0.75
I let students use ICT (information and communication technology) for projects or class work .	98379	1	4	2.57	0.86
I administer my own assessment	98451	1	4	3.07	0.74
I provide written feedback on student work in addition to a mark	98416	1	4	2.91	0.87
I let students evaluate their own progress.	98250	1	4	2.58	0.77
I observe students when working on particular tasks and provide immediate feedback.	98443	1	4	3.18	0.67

Note. TALIS item TT3G37, "What is the primary subject of the target class," was used to select teacher instructional behaviors for mathematics classes, and only teachers for these courses were included in the final data set used for latent profile and SEM analysis

Table 2

Descriptive Statistics and Reliabilities of Latent Constructs

	N	Min	Max	Mean	SD
Autonomy Over Curriculum and Instruction (α = 0.83); "Control over areas of planning and teaching…"					
Determining course content	98316	1	4	3.07	0.86
Selecting teaching methods	98264	1	4	3.38	0.62
Assessing students learning	98283	1	4	3.30	0.62
Disciplining students	98267	1	4	3.16	0.69
Determining amount of homework to be assigned	98253	1	4	3.28	0.64
Satisfaction With the Profession (α = 0.80); "How you generally feel about your job…"					
The advantages of being a teacher clearly outweigh the disadvantages	98143	1	4	3.00	0.72
If I could decide again, I would still choose to work as a teacher	98096	1	4	3.09	0.83
I regret that I decided to become a teacher‡	98091	1	4	3.37	0.72
I wonder if it would have been better to choose another profession‡	98050	1	4	2.85	0.91
I think that the teaching profession is valued in society	98117	1	4	2.44	0.97
All in all I am satisfied with my job	98126	1	4	3.27	0.61
I am satisfied w the salary I receive	98178	1	4	2.22	0.87
I am satisfied w the terms of my teaching contract/employment	98122	1	4	2.74	0.78
Opportunities for Professional Development (α = 0.76); " The following present barriers to your participation in professional development…"					
I do not have the pre-requisites	98086	1	4	3.33	0.85
PD is too expensive	98309	1	4	2.48	0.89
There is a lack of employer support	98324	1	4	2.49	0.88
PD conflicts with my work schedule	98220	1	4	2.51	0.85
I do not have time because of family responsibilities	98031	1	4	2.84	0.86
There is no relevant PD offered	98368	1	4	2.70	0.84
There are no incentives for participation in PD	98250	1	4	2.38	0.94
Teachers Influence in School (α = 0.73); " To what extent do you agree..."					
School provides staff w. opp. to actively participate in sch decisions	97959	1	4	2.93	0.70
School encourages staff to lead new initiatives	97830	1	4	3.13	0.65
Teachers Influence on External Policy (α = 0.82); To what extent do you agree..."					
Agree Teachers views valued by policymakers	97987	1	4	2.09	0.87
Agree Teachers can influence educ. policy	97937	1	4	2.45	0.95
Agree Teachers are valued by the media	98100	1	4	2.24	0.93
Teacher Self-efficacy (α = 0.88); "In your teaching, to what extent can you..."					
Get students to believe they can do well in school work	98368	1	4	3.39	0.62
Help students value learning	98335	1	4	3.46	0.64
Craft good questions for students	98295	1	4	3.41	0.61

Control disruptive behaviour in the classroom	98156	1	4	3.40	0.66
Motivate students who show low interest in school work	98211	1	4	3.29	0.71
Make my expectations about student behaviour clear	98294	1	4	3.42	0.62
Help students think critically	98387	1	4	3.25	0.67
Get students to follow classroom rules	98225	1	4	3.50	0.59
Calm a student who is disruptive or noisy	98179	1	4	3.42	0.65
Use a variety of assessment strategies	98293	1	4	3.18	0.69
Provide an alternative explanation for example when students are confused	98304	1	4	3.47	0.60
Vary instructional strategies in my classroom	98121	1	4	3.20	0.66
Support student learning through the use of digital technology	98280	1	4	2.86	0.84
Collegial and Professional Environment (α = 0.80); "To what extent to you agree..."					
Most teachers strive to develop new ideas for teaching	98543	1	4	3.10	0.74
Most teachers are open to change	98538	1	4	2.98	0.72
Teachers search for new ways to solve problems	98520	1	4	3.03	0.70
Most teachers provide practical support to each other	98230	1	4	3.02	0.71
How often you...teach jointly as a team in the same class	88239	1	5	1.96	1.26
...observe other teachers classes and provide feedback	89471	1	5	2.51	1.54
...engage in joint activities	93508	1	5	2.49	1.22
...exchange teaching materials with colleagues	79271	1	5	3.40	1.35
…work with other teachers in this school	82645	1	5	3.51	1.21
... attend team conferences	90957	1	5	3.18	1.22
... take part in collaborative professional learning	90440	1	5	2.92	1.20
School has a culture of shared responsibility for school issues	97854	1	4	2.92	0.65
There is a collaborative school culture characterised by mutual support	97673	1	4	2.95	0.65
Staff share a common set of beliefs about teaching and learning	97825	1	4	3.09	0.61
Staff enforce rules for stud behaviour consistently via the sch	97969	1	4	2.93	0.70
Teachers and students usually get on well with each other	98441	1	4	3.24	0.57
Most teachers believe that the students well-being is important	98380	1	4	3.33	0.57
Most teachers are interested in what students have to say	98417	1	4	3.12	0.57
If a student needs extra assistance, the school provides it.	98342	1	4	3.16	0.61
Teachers can rely on each other	98279	1	4	3.08	0.70
Principal Instructional Leadership (α = 0.73); "How frequently did you engage in the following activities in the past 12 months..."					
I collaborated with teachers to solve classroom discipline problems	96832	1	4	2.95	0.78
I observed instruction in the classroom	96791	1	4	2.71	0.76
I provided feedback to teachers based on my observations	96761	1	4	2.80	0.67
Supporting co-operation among teachers to develop new teaching practices	96804	1	4	2.88	0.65
Ensuring teachers take responsibility for improving their tch skills	97085	1	4	2.96	0.62

Notes. All statistics are weighted with TALIS teacher final weight. ‡ item was reversed coded.

Table 3

Descriptive Statistics of Teacher and School Covariates Included in SEM Models

	N	Minimum	Maximum	Mean	SD
School Mean Math Plausible Value 9	68163.97	259.93	662.83	432.67	74.86
School Mean Math Plausible Value 1	68163.97	255.19	660.02	434.69	74.02
School Mean Math Plausible Value 2	68163.97	274.96	650.78	433.17	73.87
School Mean Economic, Social, and Cultural Status†	98442.77	-5.00	1.42	-1.35	1.15
Gender (1 = female, 2 = male)	98859.53	1	2	1.47	0.50
Teacher Age Groups	98773.76	1	6	3.54	1.07
Mathematics was included in formal education and training	98679.92	0	1	0.83	0.37
Teacher has a regular certification*	89421.4	0	1	0.89	0.31
School Resources‡	96930.2	1	3	2.16	0.70

*Notes. † Variable is group mean centered at the school level using student ESCS measure in PISA. *Recoded from TALIS item TT3G04. ‡Variable is reverse coded T3PLACRE composite variable from the TALIS teacher survey where the 1 = a problem, 3 = not a problem for the new variable)*