COLLEGIALITY AS UNCERTAINTY MANAGEMENT: MULTILEVEL CONTEXTS OF COLLABORATIVE TEACHER INTERACTIONS

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ABSTRACT

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This study aims to explore how collaborative teacher interaction is contingent upon teachers' immediate classroom and school-organizational contexts as well as broader societal and policy environments. Notwithstanding the widely acknowledged connection between teacher collegiality in schools and its beneficial effects, little systematic effort has been made to understand what types of teachers, under what contextual conditions, build and/or sustain collegial relationships with other teachers. In order to understand better a range of multilevel contextual factors associated with collaborative teacher interaction, this study intends to both elaborate and test an uncertainty management perspective as a theoretical framework. In addition, four conventional perspectives – a school climate perspective, a principal instructional leadership perspective, a curriculum policy perspective, and a national culture perspective – are also considered to see if a set of primary hypotheses derived from the uncertainty management perspective is empirically supported even after a range of other plausible hypotheses are simultaneously taken into account.

Overall, the main findings from this study support an uncertainty management perspective which understands collegiality as a byproduct of the collective sensemaking of uncertainties, which reduces organizational members' feelings of discomfort with

given uncertainties and thus helps them manage those uncertainties without actually removing them completely from given situations. Extensive international and U.S. data analyzed in this study substantiate the central proposition of the uncertainty management perspective that teacher collegiality has to do with teachers' collective effort to deal with various instructional and classroom-contextual uncertainties that they confront in their teaching. This result sheds light on the possibility that lateral collegial relationships among teachers may serve as a source of information processing, sensemaking, and problem-solving, whereby teachers can better manage to go through given situations of uncertainty.

This study provides useful implications for educational policy and administration. In particular, given the fact that it is not always either possible or desirable to eliminate the sources of uncertainty in teaching, finding ways to help teachers manage the uncertainty through collaborative interaction with their colleagues is an important task for educational administrators and policy makers. Further, considering the wide variety of possible situations in which teachers confront instructional and classroom-contextual uncertainties, it is important for principals to explore various ways to actively share leadership roles and responsibilities with many teachers, so that individual teachers can become empowered agents to foster and sustain a collegial work environment.

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CHAPTER 1

INTRODUCTION

1.1. Purpose of the Study: Examining Collegiality in Context

It has been widely acknowledged that the virtues of teacher collegiality are widespread. Different stakeholders, including teachers, educational administrators, and policy makers, may have a range of reasons to believe that teacher collegiality is beneficial to various aspects of school success and improvement. Indeed, a sizable body of empirical research links collegiality among teachers to their enhanced feelings of efficacy, increased teaching quality, and greater accountability for student achievement (Bryk, Camburn, & Louis, 1999; Dunne, Nave, & Lewis, 2000; Lee & Smith, 1996; Louis & Marks, 1998; Newmann, Rutter, & Smith, 1989; Saunders, Goldenberg, & Gallimore, 2009; Stevens & Slavin, 1995; Yasumoto, Uekawa, & Bidwell, 2001). Taking the form of collaborative lesson planning, classroom observation, peer coaching, or mentoring, teacher collegiality has often been conceptualized as an important factor contributing to teacher development whereby teachers can be provided with opportunities to learn from each other; rather than dependent on external experts, teachers are expected to share and develop their expertise together, so that they can be provided with opportunities to revisit, and take advantage of, their own reflections on teaching (Cochran-Smith & Lytle, 1999; Fernandez & Yoshida, 2004; Grossman, Wineburg, &

Woolworth, 2001; McLaughlin & Talbert, 2001; Paine & Ma, 1993; Paine, Pimm, Britton, Raizen, & Wilson, 2003).

Drawing on definitions in common use in the literature, I conceptualize teacher collegiality as collaborative interaction among teachers which involves joint work concerning their core task in school, i.e., the practice of classroom teaching. Such joint work implies collective action, strong interdependence, shared responsibility, and a great degree of readiness to participate in reflective inquiry into practices (Little, 1990). While emphasizing joint work as a central feature of collegiality, I do not view collegiality as a condition for consensus and solidarity. Indeed, it is important to note that teachers frequently run into considerable conflicts over professional beliefs about teaching and learning when involved in joint work (Achinstein, 2002; de Lima, 2001); however, the contention resulting from different viewpoints can ultimately become the potential source of organizational learning if teachers can manage to embrace, rather than suppress, differences and disagreements (Achinstein, 2002; Fullan, 1993). Further, such organizational learning is more viable in a collegial atmosphere where collaborative working relationships among teachers evolve from teachers' own perceived needs, rather than from administrative imposition (Bidwell, 2001; Hargreaves, 1991). This is because collaborative working relationships as "[c]ommunities of practice rely on the voluntary participation of their members to make them useful" (Galbraith, Downey, & Kates, 2002, p. 73).

Considering that teachers' professional growth and development can be fostered by collegiality, it is not surprising that collegiality can be an important source of organizational learning (Mohr & Dichter, 2001; Rait, 1995). Since teachers are the very persons who finally interpret and implement reform (Anagnostopoulos & Rutledge, 2007; Coburn, 2001; Spillane, Reiser, & Reimer, 2002), the successful transfer of reform ideas into practice is likely to depend greatly on how well collegial working relationships have been created and sustained among teachers. It is, thus, reasonable to expect both school-based and externally-introduced reform initiatives to be implemented more effectively in schools where productive collegial relationships are the norm than in other schools which lack enough organizational capacity to elicit shared understandings among teachers. In this respect, many argue that collegiality in schools is an important prerequisite for the effective implementation of various reform initiatives (Cosner, 2009; Frank, Zhao, & Borman, 2004; Hargreaves, 1989; Little, 1993; Louis, Marks, & Kruse, 1996).

Indeed, newly emerging social psychological perspectives posit that cognition is not simply a property of an individual person, but it is distributed across people (Hutchins, 1995; Salomon, 1993). Such distributed cognition perspectives commonly suggest the possibility that teacher collegiality may help "diverse groups of teachers with different types of knowledge and expertise . . . draw upon and incorporate each other's expertise to create rich conversations and new insights into teaching and learning" (Putnam & Borko, 2000, p. 8). Similarly, images of leadership have also changed in a way that teachers are encouraged to actively engage in leadership roles. Recent literature on school organization challenges conventional conceptualizations of leadership as monopolized by administrators, emphasizing new styles of leadership, whereby leadership is shared with, and distributed among, teachers (Scribner, Sawyer, Watson, & Myers, 2007; Somech, 2005; Spillane, Halverson, & Diamond, 2004). These alternative forms of leadership are characterized by shared decision making, collaborative problem solving, and supportive relationships, which all relate to collegiality.

Notwithstanding the widely acknowledged connection between teacher collegiality in schools and its beneficial effects, little systematic effort has been made to understand what types of teachers, under what contextual conditions, build and/or sustain collegial relationships with other teachers. In terms of research design, teacher collegiality, in most studies, has typically been conceptualized and treated as an independent variable explaining a certain desirable outcome (e.g., Lee & Smith, 1996; Saunders, et al., 2009; Stevens & Slavin, 1995; Yasumoto, et al., 2001). Although those studies help us recognize various positive effects of teacher collegiality, we also need systematic investigations of what contextual factors are related to teacher collegiality; in order to understand how to promote the beneficial effects of teacher collegiality, it is an important prerequisite to develop a comprehensive knowledge base that provides insight into how the level and type of collaborative teacher interaction varies depending on various factors.

As a systematic investigation in this direction, this study explores an alternative account of teacher collegiality as a dependent variable contingent upon various factors at multiple levels of abstraction ranging from the teacher level to the national socio-cultural and policy environment level. In other words, this study is an attempt to address the following research question: Why do some teachers participate to a greater degree in collaborative interaction with their colleagues than other teachers do? Put differently, under what contextual conditions are teachers more likely to engage in collaborative interaction with other teachers? Identifying a range of multilevel factors significantly associated with teacher collegiality as a dependent variable, this study aims to provide new insights into the nature of teacher collegiality on the basis of systematic empirical evidence from extensive national and international data from multiple sources.

1.2. Significance of the Study

Collegiality among teachers is widely seen as beneficial because it helps teachers engage in reflective inquiry about teaching and learning (Bryk & Schneider, 2002; Kazemi & Franke, 2004; Lassonde & Israel, 2010; Little, Gearhart, Curry, & Judith, 2003; Slavit, Nelson, & Kennedy, 2009). Considering that it is important for each teacher to be empowered as an active and reflective educational theorist and practitioner rather than seen as just a passive agent of a curriculum package (Shulman, 2004; Silcock, 1994; Westbury, Hopmann, & Riquarts, 2000), collegiality can provide teachers with various opportunities to collaboratively produce useful local knowledge about the practice of classroom teaching. One of the most valuable benefits of collaborative teacher interaction lies in the increased opportunity provided to teachers to interact with one another regarding instructional issues; it has been well documented that teachers who regularly participate in collaborative interaction are provided with opportunities to listen to a wide range of ideas about the practice of teaching as they exchange helpful feedback with their colleagues regarding how to deal with various instructional dilemmas and constraints they are confronted with in their teaching (Dunne, et al., 2000; Fernandez & Yoshida, 2004; Grossman, et al., 2001; McLaughlin & Talbert, 2001; Paine & Ma, 1993).

As a result, teachers can develop useful local knowledge and skills that they can effectively use in their classrooms. Teachers can promote their professional growth "when they generate local knowledge of practice by working within the contexts of inquiry communities" (Cochran-Smith & Lytle, 1999, p. 250). Teacher collegiality in schools, as a form of "relational" capacity (Bryk & Schneider, 2002), may facilitate teachers to build their professional knowledge. Further, the development of teacher competence is largely acquired through collective efforts embedded in the "ethic of care" (Gilligan, 1993) in schools. In schools where collaboration is constantly fostered, the ongoing communication is likely to increase the awareness that virtually every professional in school has a range of difficult tasks to do; when this awareness is combined with the sharing of knowledge and skills, teachers find themselves "connect[ed] with each other as a result of felt interdependencies, mutual obligations, and other ties" (Sergiovanni, 1994, p. 5).

The rarity of U.S. schools engaged in meaningful collaborative work around teaching has been well documented (Akiba & LeTendre, 2009; Leonard & Leonard, 2003; Lortie, 2002; Rosenholtz, 1989). Many studies decry limited opportunities for teachers to have supportive collegial relationships through which they can share their "personal knowledge" (Clandinin, 1985) with other teachers. As an empirical attempt to explain differences among schools regarding the extent to which teacher collegiality is present, this study employs a cross-national multilevel research design. Since teaching is not only a complex non-routine practice but also a culturally embedded activity (Alexander, 2000; Anderson-Levitt, 2003; Hiebert et al., 2003; Paine & Fang, 2006; Rowan, 2002; Tobin, Hsueh, & Karasawa, 2009), the simultaneous consideration of multilevel contexts around teaching will lead to a more comprehensive understanding of factors contributing to teacher collegiality.

In order to examine a series of hypotheses derived from different theoretical perspectives, this study involves a range of empirical analyses using a large-scale quantitative dataset with an international scope. In addition, this study focuses on the case of the United States by conducting another set of within-U.S. analyses. Analyzing a series of large-scale data with an international scope can provide deeper understandings of the interplay of education and culture and produce further intriguing hypotheses, precisely because of its broader perspective (Alexander, 2001; Blömeke & Paine, 2008; Bray, Adamson, & Mason, 2007; Porter & Gamoran, 2002). Providing new empirical evidence concerning the nature of collaborative teacher interaction, this study attempts to make a unique contribution to the literature on teachers' organizational behavior in schools as well as to provide substantive implications for educational policy and administration in relation to teacher development and school improvement. I hope this study will stimulate further studies based on different sets of quantitative and qualitative data to both corroborate and reexamine the findings from this study.

CHAPTER 2

CONCEPTUAL FRAMEWORK

2.1. Theoretical Background

Research on teacher collegiality has given little analytic attention to why some teachers frequently participate in collaborative interaction with their colleagues whereas other teachers do not. Teacher collegiality has usually been treated as an independent variable that is presumed to yield some positive outcomes, irrespective of how it is conceptualized. Conceptualizing teacher collegiality as a dependent variable contingent upon a range of multilevel contextual factors has attracted little scholarly attention despite its significance for understanding not only the nature of teacher collegiality but also the ways in which teacher collegiality arises and is sustained in schools.

In order to understand better a range of multilevel contextual factors associated with collaborative teacher interaction, it is important to consider various independent variables ranging from teacher-level variables to national-contextual variables. Thus, I explain five perspectives in this study, each of which provides useful insight into teacher collegiality as a dependent variable. They represent a school climate perspective, a principal instructional leadership perspective, a curriculum policy perspective, a national culture perspective, and an uncertainty management perspective. Of course, these are not an exhaustive list of frameworks for understanding teacher collegiality in relation to contextual factors; various other perspectives may also exist that proffer different avenues to explore the contextual contingencies of teacher collegiality. Nevertheless, I believe that the five perspectives considered in this study can provoke further theoretical and empirical inquiry into the complexities involved in understanding multiple layers of social context in which collaborative relationships are formed and sustained among teachers.

In particular, this study intends to both elaborate and test an uncertainty management perspective as a theoretical framework for understanding teacher collegiality. Although there have been some conceptual and empirical studies that allude to or suggest a possible relationship between uncertainty in teaching and teacher collegiality (e.g., Bidwell, 2001; Collinson & Cook, 2007; Gamoran, Secada, & Marrett, 2000; Rowan, 1990), there has never been a systematic attempt to elucidate teachers' exposure to uncertainties in teaching as a contextual factor related to teacher collegiality. On the basis of an uncertainty management perspective, this study posits that collegiality is largely a byproduct of the collective sensemaking of uncertainties, which reduces organizational members' feelings of discomfort with given uncertainties and thus helps them manage those uncertainties without actually removing them completely from given situations. The other four perspectives, which are some of the most insightful conventional accounts of teacher collegiality as a dependent variable contingent upon certain contextual factors, are also considered to see if a set of primary hypotheses of this study derived from the uncertainty management perspective is empirically supported even after some other plausible hypotheses are simultaneously taken into account.

In what follows in this chapter, I first discuss the strengths and weaknesses of each of the four conventional perspectives. Next, I introduce the uncertainty management perspective as an alternative conceptual framework for understanding teacher collegiality. Finally, a series of primary hypotheses of this study is formulated on the basis of the uncertainty management perspective, and a range of additional plausible hypotheses are derived from each conventional perspective. It should be noted that exceptions and complexities abound within each perspective. Despite this limitation, it will be helpful to identify the main defining qualities of these varying perspectives and their underlying assumptions, so that different hypotheses can be advanced and then empirically tested and further explored.

2.1.1. School Climate Perspective

Extensive research and literature in organizational analysis has suggested that the extent to which teacher collegiality is fostered and sustained in a school depends largely on the organizational climate of the school. Although how to conceptualize and measure school climate is still in debate (Anderson, 1982; Freiberg, 1998; Hoy, Tarter, & Bliss, 1990; Marshall, 2004), a central underlying assumption that is generally shared in the school climate literature is that a school's climate is determined by a set of relatively enduring organizational characteristics of the school that is collectively perceived and experienced by teachers working in that school. Acknowledging that the climate of a school is conceptually inseparable from "teachers' [shared] perceptions of the general work environment of the school" (Hoy & Miskel, 2005, p. 185), the school climate literature commonly posits that teachers' behavior in a school is constantly influenced by the climate of the school; that is, teachers' behavioral patterns in a school are assumed to reflect the inter-subjective realities co-constructed by the teachers working in that school.

In this line of inquiry, collegial teacher behavior has been understood as an important indicator of a positive school climate. Relying on Miles' (1965) conceptualization of "organizational health" in educational organizations, Sergiovanni and Starratt (2002) emphasize that a healthy school operates as "a system of dynamic interaction characterized by a high degree of interdependence" (p. 314) and "a sense of togetherness that bonds people together" (p. 312). That is, the concept of school climate draws our attention to teachers' interpersonal work life in schools. Empirical research has also suggested that a positive school climate can facilitate collaborative interaction among teachers, particularly because teachers working in such a school climate tend to show greater willingness to invest their time and energy in contributing to the organizational goals of their school (Bryk & Schneider, 2002; Hoy, 2002; Tschannen-Moran, 2001).

Despite the popularity of school climate as a useful explanation for differences in teacher collegiality between schools, a closer look at the school climate literature reveals that it provides only partial insight into teacher collegiality. In fact, a strong association between a positive school climate and teacher collegiality would not be surprising, precisely because school climate is an organization-level variable to capture the interpersonal dimensions of teachers' work life in schools. It is widely accepted that a positive school climate comes from teachers' collective perception of their school as a workplace where teacher morale is high and organizational goals are clearly communicated and well implemented (Freiberg, 1999; Hoy & Miskel, 2005; Sergiovanni & Starratt, 2002). However, high teacher morale, clear goal focus, and many other factors that are purported to be of significance to a positive school climate are, indeed, good examples of school organizational characteristics that either presuppose or necessitate collaborative teacher behavior in one way or another. In other words, it is often hard to imagine either high teacher morale or clear goal focus without assuming the presence of teacher collegiality that helps teachers communicate effectively within a given school.

In this respect, the school climate framework for understanding teacher collegiality is not firmly grounded in a substantive explanation of who participates in collaborative teacher interaction and why. Although it appears highly plausible to speculate that there exists a strong relationship between a positive school climate and teacher collegiality, such an association per se does not provide a clear explanation of why some teachers are motivated to participate in collaborative interaction with other teachers whereas others are not. In other words, while it is clear from a school climate perspective that schools with a positive organizational climate are likely to exhibit a high level of teacher collegiality, this does not necessarily mean that teacher collegiality *arises* in a positive school climate; rather, it could just be that teacher collegiality is an integral constituent of a positive school climate.

2.1.2. Principal Instructional Leadership Perspective

Principal instructional leadership has usually been conceptualized as a blend of the principal's participation in curriculum development and her/his engagement in instructional supervision and evaluation (Blase & Blase, 1999; DiPaola & Hoy, 2007; Hallinger & Murphy, 1987). The role of a principal as an instructional leader is understood as different from that of traditional school principals. While a traditional principal is portrayed as spending the majority of her/his time dealing with administrative duties, a principal who is an instructional leader is expected to redefine her/his role to become the primary learner in a school-based inquiry community seeking excellence in teaching. In order to become an instructional leader, the principal should recognize the importance of what Blase (1987) calls "leadership competencies" for working with teachers in addition to "administrative competencies" for dealing with the technical aspects of work. That is, it becomes the principal's responsibility to work closely with teachers in an atmosphere of shared learning (Cogan, Anderson, & Krajewski, 1993; Printy, 2008; Somech, 2005).

For instance, Reitzug (1994) examined closely the instructional leadership behaviors of one principal who appreciated teachers' opinions based on their personal practical knowledge, asked inquiry-oriented questions, encouraged risk taking, and provided staff development opportunities and ideas. These instructional leadership behaviors helped teachers reflect on their own practice, consider alternative frameworks for understanding teaching and learning processes, and build teamwork among colleagues. Similarly, in their analysis of a nationally sampled dataset on school restructuring, Marks and Printy (2003) reaffirm the importance of the principal instructional leadership model in which "the principal seeks out the ideas, insights, and expertise of teachers . . . [to work] for school improvement . . . [by] shar[ing] [with teachers] responsibility for staff development, curricular development, and supervision of instructional tasks" (p. 371). In such a school setting, teachers can be empowered to "share their experiences and knowledge [with their colleagues and principal] in free-flowing, creative ways that foster new approaches to problems" (Wenger & Snyder, 2000, p. 140).

Although it appears evident that principal instructional leadership is an important factor that helps change the school into a "collaborative inquiry" community (Reitzug, 1997), one may plausibly suspect that this effect may be rather limited, especially because teachers' instructional activities are fraught with numerous complexities and uncertainties for which principals do not necessarily have something helpful to offer to teachers in terms of either clear ideas or practical solutions (Floden & Buchmann, 1993; Jackson, 1986; Labaree, 2000; Wood, Cobb, & Yackel, 1990); this accounts for why many principals frequently feel uncertain about the soundness of their judgments when they supervise teachers' instructional practices (Lortie, 2009). In this respect, Bidwell (2001) has developed an insightful hypothesis – he postulates that "teachers' problem-solving networks are likely to differentiate according to kinds of problems and kinds of pedagogical and subject matter knowledge and experience.

When faculty networks differentiate in this way, the unifying effectiveness of formal leadership should be reduced" (p. 107).

In relation to this hypothesis, Horng, Klasik, and Loeb's (2010) study is very suggestive. In their analysis of observational time-use data for all high school principals in one district in Miami, they found that while principals' time spent on school management activities was significantly associated with positive school outcomes, their time spent on day-to-day instruction-related activities was marginally related to improvements in student performance and often even negatively associated with teacher and parent assessments of the school. These findings are counterintuitive from a principal instructional leadership perspective because what these findings suggest is that principals' well-intended instructional leadership behaviors may have a fairly limited, if not negative, influence on teaching. These findings, however, seem consonant with Bidwell's (2001) hypothesis that principals' instructional leadership behaviors are likely to have only a limited effect on unifying teachers into a community of inquiry into teaching.

In sum, the central logic in the principal instructional leadership literature is, of course, useful for understanding the organizational context in which collegiality can be fostered in schools. However, the literature on schools as organizations and the literature on teachers' work in schools commonly point to the possibility that the effect of principals' instructional leadership behaviors on collegiality among teachers in schools may not be as strong as suggested in the principal instructional leadership literature; this is especially because many classroom-situational and pedagogical specifics that beget a variety of complexities and uncertainties confronted by individual teachers are likely to lead to differentiation of teacher networks "according to kinds of problems and kinds of pedagogical and subject matter knowledge and experience" (Bidwell, 2001, p. 107) rather than leading to consolidation of community solidarity in a given school. In this situation, the principal's instructional leadership behaviors may not have a strong and stable effect on unifying teachers into a cohesive inquiry community.

2.1.3. Curriculum Policy Perspective

The literature on the relationship between policy and classroom instruction suggests that the absence of a standardized national curriculum in a country may hinder teachers from engaging in collaborative interaction with other colleagues. This is because the paucity of a shared technical language and "a common technical culture" (Lortie, 2002, p. 76) in the profession of teaching is hard to be alleviated without a standardized curriculum policy as a common coherent framework for teaching and learning (Schmidt, Wang, & McKnight, 2005; Stevenson & Baker, 1991). Put differently, one may plausibly expect that the presence of a national curriculum may facilitate collaborative interaction among teachers in a given country insofar as the curriculum serves as a framework that provides teachers with a shared technical language, by which they can secure at least a certain degree of efficiency in communicating with other teachers about teaching and learning.

Further, the literature on "sensemaking" in organizations elaborated by Weick and his associates (Weick, 1995; Weick, Sutcliffe, & Obstfeld, 2005) also suggests the possibility that the presence of a national curriculum policy may be in a positive relationship with a high level of collaborative interaction among teachers in a given country. That is, teachers may often need to collaboratively make sense of the content and intention of a given curricular policy because the policy is unlikely to be free of ambiguity in terms of its language (Hill, 2001; Spillane, et al., 2002). A curricular policy is usually tied to many "reform ideals" (Kennedy, 2005, p. 17) that are often perceived by teachers as remote from everyday teaching and "classroom exigencies" (Lortie, 2002, p. 69), and such reform ideals, containing various definitions, slogans, and metaphors (Berendt, 2008; Scheffler, 1960), may conflict with one another, adding to already existing ambiguity in policy language (Green, 1994; Shulman, 2004). In this respect, it is reasonable to expect that teachers often need to help one another make sense of many aspects of a given national curriculum in order to share in the effort to respond efficiently to the curriculum policy.

In addition, previous studies of the association between governance structure and classroom instruction suggest the possibility that the amount of uncertainty in teaching may be different across countries, depending on curriculum policy arrangements (Astiz, Wiseman, & Baker, 2002; Stevenson & Baker, 1991). In particular, the presence of a standardized national curriculum in a country may function to alleviate some uncertainty perceived by teachers because the national curriculum may serve as a safety net that teachers can depend on when making various decisions. In countries with a standardized national curriculum, teaching usually occurs within a nationally prescribed range of curricular content, which is likely to reduce a certain amount of uncertainty in teaching that may exist in countries without a standardized national curriculum.

Although this curriculum policy perspective provides a useful account of the possible relationship between curricular policy arrangements and collaborative teacher interaction patterns, one may plausibly believe that this relationship may not be very strong; this is because a sizeable body of research has shown that schools are "loosely coupled organizations" (Weick, 1976) where formal structures and internal activities are often not closely connected (Deal & Celotti, 1980; Elmore, 2004; Meyer & Rowan, 1991). The curriculum policy perspective presumes a tight linkage between curricular policy arrangements and teachers' cognitive and behavioral patterns; however, this may not be the case, given the possibility that schools as organizations strive to maintain "ceremonial conformity" (Meyer & Rowan, 1991, p. 41) to the rules and values embedded in the external policy environment (DiMaggio & Powell, 1991; Scott, 2005), whereby their internal technical activities are buffered from pressures and influences from the external environment. Indeed, such a loose coupling between formal structures and internal activities is not very surprising in educational organizations around the world (Meyer & Ramirez, 2003), considering that teaching is inherently a complex and non-routine task for which teachers' professional autonomy is inevitably necessary even in the presence of central policy control over instruction (Rowan, Raudenbush, & Cheong, 1993; Shulman, 2004). Thus, one may reasonably expect the relationship between curricular policy arrangements and collaborative teacher interaction to be modest, if any.

2.1.4. National Culture Perspective

The literature on the cross-national differences in terms of individualist versus collectivist orientations also provides an important insight. According to Hofstede and his associates (Hofstede, 2001; Hofstede & Bond, 1984; Hofstede & Hofstede, 2005), a central difference between typical individualist and collectivist societies lies in whether people see themselves as an integral part of a social group with primary alliance to the group or as separate individual persons with primary responsibility for themselves and their families. In typical collectivist societies, there are a range of informal, yet socially institutionalized, ways of creating family-like ties with other persons who are not biological relatives but who are socially integrated into the same group. This accounts for why "the workplace itself may become an in-group in the emotional sense of the word . . . [which] resembles a family relationship, with mutual obligations of protection in exchange for loyalty. . . . In the individualist society, [however,] the relationship [in the workplace] . . . is primarily conceived as a business transaction" (Hofstede, 2001, p. 237).

The rarity of U.S. schools engaged in collaborative work around teaching is often understood to have resulted at least in part from the individualist culture of the nation. Leonard and Leonard (2003), for instance, attend to the possibility that the macro-level culture of individualism in the United States penetrates the culture of U.S. schools. They postulate that this is one of the factors contributing to a low level of collaborative interaction among teachers in U.S. schools. In contrast, many studies of teaching cultures in some East Asian countries, for example, have shown that teachers in those countries have benefited from their traditions whereby collaborative interaction has been institutionalized as an integral part of their work life in schools. Collaborative "lesson study" activities in Japan (Fernandez & Yoshida, 2004; Lewis, 2000) and school-based "teaching research groups" and their "public lesson" activities in China (Han & Paine, 2010; Paine & Ma, 1993) are illustrative examples here. Although it is unclear whether or not, or to what extent, these forms of collaborative teacher interaction in these countries have been sustained by their collectivist cultural orientations, it would not be unreasonable to suspect that there may be some relationship between their high levels of teacher collaboration and their collectivist orientations grounded in their cultural norms and values.

Despite the useful insight gained from this national culture perspective on teacher collegiality, there is some empirical evidence to believe that the level of teacher collegiality in schools may not be heavily dependent on national cultural contexts. In their study of teachers' working conditions and beliefs in the United States, Germany, and Japan, LeTendre and his colleagues (LeTendre, Baker, Akiba, Goesling, & Wiseman, 2001) report considerable cross-national similarities in "core teaching practices and teacher beliefs" despite "some differences in how teachers' work is organized" (p. 3).[1]

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1. Further, some sociologists argue that "education is an institution . . . that at a deeper level is strongly affixed to global norms and rules about what education is and how schools should operate" (Baker & LeTendre, 2005, p. 8). Extensive empirical studies provide substantial evidence supporting the notion that many aspects of schooling are, by and large, the

Although it is still in debate to what extent teaching is a cultural practice contextualized within individual countries (Alexander, 2000; Anderson-Levitt, 2003; Baker & LeTendre, 2005; Givvin, Hiebert, Jacobs, Hollingsworth, & Gallimore, 2005; Kim, Ham, & Paine, 2011; McEneaney & Meyer, 2000), the cross-national similarities LeTendre and his colleagues have found in teachers' core teaching practices and beliefs point to the possibility that the influence of national cultural orientations on teachers' collaborative interaction with their colleagues may be rather limited, as long as the patterns of interaction among teachers are unlikely to be detached from their core teaching practices and beliefs that may be fairly similar across countries despite cultural differences.[2]

2.1.5. Uncertainty Management Perspective: An Alternative Approach

Teaching has often been seen as an uncertain technology; instructional decisions with respect to how to promote student learning in a particular classroom environment can never be made with absolute certainty (Jackson, 1986; Lortie, 2002; McLaughlin & Talbert, 2001; Rosenholtz, 1989). Although teachers are expected to possess a set of

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embodiments of institutional rules and values that are embedded in the cultural dimension of world society (Benavot, Cha, Kamens, Meyer, & Wong, 1991; Boli & Ramirez, 1986; Cha & Ham, 2011; Ham & Cha, 2009; Meyer & Ramirez, 2003). On the basis of this line of sociological thought, LeTendre and his colleagues' findings about considerable cross-national similarities in "core teaching practices and teacher beliefs" are not very surprising. For critiques and further discussions, see Anderson-Levitt (2003), Ham, Paine, and Cha (2011), Paine and Fang (2006), and Schriewer (2003), for example.

2. See also Anderson-Levitt's (2002) discussion and critique of LeTendre and his colleagues' findings.

specialized knowledge and skills, such a social expectation contrasts with the relatively weak core technology teachers actually have. Indeed, classroom situations are full of uncertainties, which are often not adequately explained by general theories taught in teacher preparation programs (Floden & Buchmann, 1993; Floden & Clark, 1988; Labaree, 2000).[3] The practice of teaching is, by nature, context-specific and full of situated-complexities, so that it cannot always be theorized in a generic way of explanation (Lampert, 2001; Munthe, 2007; Putnam & Borko, 2000; Wood, et al., 1990). Numerous possibilities to lose lesson momentum are the hallmark of classroom teaching (Kennedy, 2005). Teachers are always confronted with the vivid realities of classroom teaching that are often inexplicable in terms of theoretical conceptualizations of educational practice. Indeed, the practice of teaching is often seen as "the very prototype of the idiographic, individual, clinical enterprise" (Shulman, 2004, p. 139). This accounts for why teachers usually have a wider range of concerns than educational administrators and policy makers, whose attention is usually focused on a relatively small number of educational issues in the form of abstract reform ideals (Kennedy, 2005).

Although teaching is inherently an uncertain task as described above, I postulate that there is another kind of uncertainty whose amount may vary depending on instructional strategies teachers employ and classroom contexts in which teaching

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3. This may be one of the reasons why many of the formal qualification profiles of teachers such as training and certification often do not significantly matter to student performance as shown in both U.S. and international research findings (Aslam & Kingdon, 2011; Hanushek & Rivkin, 2006). However, for a different perspective, see, e.g., Kennedy, Ahn, and Choi (2008).

occurs. In this study, I conceptualize what I call "uncertainty in teaching" as a state of doubt or a feeling of incertitude about particular instructional or classroom situations as perceived by teachers. When operationalized in this way, uncertainty in teaching is likely to increase when details of given situations appear complex or unpredictable due to insufficient information, knowledge, or resources readily available to teachers. More specifically, I posit that uncertainty in teaching may come from at least two conceptually separable, yet interrelated, sources. First, an important source of uncertainty in teaching is teachers' recognition of the instructional complexities that result from their effort to use varying teaching strategies to foster students' engagement in meaningful learning experiences. For example, when teachers try to provide their students with creative learning tasks to elicit higher-order thinking and deeper understanding, teaching becomes less reducible to predictable routines, which inevitably increases what I call here instructional uncertainty. In other words, when teachers use teaching strategies that open up possibilities for students to engage in intellectually challenging questions, develop and explain their own ideas, and relate what they have learned to examples from their daily lives, teachers are likely to confront a greater amount of instructional uncertainty.[4] Another important source of uncertainty in teaching is the difficulty in effectively dealing with various complex issues arising from a range of classroom-contextual conditions and constraints. Of course, classroom teaching as a task dealing with a group of students makes teaching

4. This kind of instructional strategies is often collectively referred to as "teaching for understanding" (McLaughlin & Talbert, 1993; Wiske, 1998). See section 2.2.1 in this chapter for a further discussion.

inherently uncertain; however, I emphasize the possibility that teachers may face additional uncertainty whose amount varies depending on how certain classroom-contextual factors facilitate or constrain their teaching. For example, if teaching occurs in a classroom environment with a high level of student variability or in an environment with insufficient classroom resources to effectively promote student leaning, teachers can be faced with a variety of difficult challenges and complex class dynamics they need to deal with in their everyday teaching practice. I call such challenges and complexities classroom-contextual uncertainty in this study. That is, the amount of classroom-contextual uncertainty teachers confront may vary from one classroom to another depending on the situations of the classroom context in which teachers are positioned to implement their teaching practice.[5]

There is some sociological literature that sheds light on the relationship between the nature of teaching as a complex and uncertain task and the collegial behaviors of teachers. Rowan and his colleagues (Rowan, 1990; Rowan, et al., 1993), for instance, posit that when teaching is understood to be a complex activity, "organic" structures are likely to emerge in schools; he and his colleagues assert that teachers who recognize

5. It should be noted that there may be various ways to conceptualize the uncertainties teachers may confront in their work life (Floden & Buchmann, 1993; Labaree, 2000; Lortie, 2002; Munthe, 2007; Rosenholtz, 1989). The notion of uncertainty in teaching that this study relies on is, therefore, only one of many possible conceptualizations. Alternative avenues to frame the notion of uncertainty deserve further systematic research in order to examine how varying conceptualizations of uncertainty are similarly or differently related to collaborative teacher interaction patterns. In addition, further studies are needed to see if (or to what extent) what I have described above as sources of uncertainty in teaching really cause teachers to experience feelings of uncertainty. Qualitative case studies, accompanied by some psychological testing, would be very useful in this respect.

the complexities of teaching are more prone to form collegial networks for sharing useful information and mutual support. In their analysis of longitudinal data from a San Francisco Bay Area, Cohen, Deal, Meyer, and Scott (1979) also found that their school-level index capturing the level of "differentiation of teaching materials and students" as their "indicator of technological complexity within classrooms" (p. 23) was significantly associated with increased communication and teaming within schools. Similarly, Bidwell (2001) postulates that teachers are likely to turn to other colleague teachers for guidance and support when they are situated "in an environment of substantive uncertainty, [where] pedagogical doctrines rarely provide procedural templates of sufficient specificity to guide [their] day-to-day practice effectively" (p. 106); in other words, when they feel "unsure of their technical footing, . . . teachers who are similarly situated in a school . . . [are likely to] pool the resources of their individual training and experience in collective problem solving" (pp. 105-106).

It is worth noting that this line of sociological literature is consistent with organizational contingency theories positing that the degree of complexity of an organization's structure is contingent upon the degree of complexity of the task performed and the level of uncertainty involved in making decisions about what to do in order to successfully complete the task (Galbraith, 1973; Perrow, 1986). In March and Simon's (1993) words, collegial networks, thus, emerge due to "the limits of human intellective capacities in comparison with the complexities" (p. 190) that organizational members are faced with. According to this line of theoretical reasoning, "[i]f the complexity of the task generates uncertainty, then lateral relations between workers can serve as a source of problem-solving and processing of information as well as coordination" (E. G. Cohen, et al., 1979, p. 21). This accounts for why "[n]etworks of colleague-to-colleague consultation and advice . . . [are often] more capable of coordinating the work of colleagues than the formal administrative hierarchy" (Bidwell, 2001, p. 105).

In addition, another related body of literature in organizational analysis suggests that, when faced with complex and unpredictable situations, organizational members frequently rely on collective sensemaking, which is a collaborative process through which the link between actions and beliefs is clarified (Weick, 1995). In other words, collective sensemaking helps organizational members to link an action to a set of beliefs that are already clear. Since uncertainty can be understood as a state of doubt about particular situations as perceived by organizational members, uncertainty is likely to arise when details of situations are complex or unpredictable due to insufficient or inconsistent information available (Brashers, 2001; Perrow, 1986). If what action to take is unclear to organizational members under a given uncertain situation, collective sensemaking as part of collaborative effort to overcome individual organizational members' "bounded rationality" (March & Simon, 1993; Simon, 1991) can serve as an effective mechanism that "prevents an already uncertain world from becoming a meaningless one" (Collinson & Cook, 2007, p. 38).

In this respect, collegiality can be seen largely as a byproduct of the collective sensemaking of uncertainties, which reduces organizational members' feelings of discomfort with given uncertain situations and thus helps them manage uncertainties without actually removing them completely from given situations (Berger, 1995; Brashers, 2001). Supportive others facilitate uncertainty management as "sources of information, collaborators in information gathering, evaluators of information, or buffers against information" (Brashers, 2001, p. 485). Further, it is expected that the collective sensemaking of uncertainties allows organizational members to reduce costs because they share in the effort to respond to given uncertainties (Smith-Doerr & Powell, 2005; Williamson, 1994). Collective sensemaking, thus, can be understood as an interpretive cognitive process used by organizational members in order to share understandings, whereby learning becomes "distinctly organizational [as] it relies on the combined experiences, perspectives, and capabilities of a variety of organizational members" (Rait, 1995, p. 72).

2.2. Hypotheses

2.2.1. Primary Hypotheses

On the basis of the uncertainty management perspective, this study postulates that teacher collegiality is largely a collective response to uncertainty which teachers face in their teaching. In this regard, three primary hypotheses are examined in this study.

First of all, an important example showing the complexities teachers go through is that many teachers often do not encourage their students towards deeper intellectual engagement (Cusick, 1983; McNeil, 1986; Powell, Farrar, & Cohen, 1985). As teachers try harder to encourage their students towards deeper intellectual engagement, they are more likely to be exposed to “the uncertainties that are created when students offer unexpected ideas” (Kennedy, 2005, p. 189); this is especially the case when teachers do not have strong competence in content or pedagogical knowledge (Ball, Thames, & Phelps, 2008; Shulman, 2006; Wilson, Floden, & Ferrini-Mundy, 2001). Further, in order to help students have enough “cognitive flexibility” (Spiro, Feltovich, Jacobson, & Coulson, 1992) to avoid oversimplification of complex concepts or topics, teachers cannot rely solely on routinized teaching methods. With respect to mathematics teaching, for example, it has been well documented that teachers’ knowledge and skills exert important influences on the extent to which they utilize instructional strategies focusing on “teaching for understanding” (D. K. Cohen, McLaughlin, & Talbert, 1993; Gamoran, et al., 2000; Wiske, 1998). Unlike conventional teaching accompanied by a range of readily available routines that teachers can draw upon, teaching for understanding requires teacher knowledge that goes beyond knowing the prescribed curricular content supposed to be delivered to students; in particular, research emphasizes that teachers should have deep knowledge about how students reason mathematically (Fennema & Romberg, 1999; Hiebert & Carpenter, 1992; Prawat, Remillard, Putnam, & Heaton, 1992; Silver, Mesa, Morris, Star, & Benken, 2009).

Rather than encouraging their students towards deeper intellectual engagement, many teachers try to find “an optimal level of student engagement” (Kennedy, 2005, p. 183); from teachers’ point of view, there may be considerable advantages to conventional teaching because it helps protect them from the uncertainties that could emerge from students' unexpected responses. Indeed, as teachers put more effort to incorporate instructional strategies for teaching for understanding into their classroom teaching, they must confront greater instructional uncertainty; that is, the practice of teaching becomes inevitably more unpredictable, less reducible to predictable routines or "defensive teaching" (McNeil, 1986) practices, thereby exposing teachers to a greater extent to the notion of what Heaton (2000) calls "teaching as an improvisational activity" (p. 60) that requires "moment-to-moment responsiveness" (p. 63) in interacting with students. Consequently, teachers are likely to reach out to other colleague teachers, whereby they can not only exchange practical suggestions but also "reduce inappropriate pressures for certainty" (Floden & Buchmann, 1993, p. 380). This is why collegial networks may emerge among teachers when they try to develop and use instructional strategies for teaching for understanding. Therefore, the following hypothesis is put forth:

> Hypothesis 1: *Teachers who exert greater effort to implement teaching for understanding are more likely to engage in collaborative interaction with other teachers.*

Also, a range of classroom-contextual factors, including a low level of student performance, a high level of student heterogeneity, and a shortage or inadequacy of classroom resources, for example, are likely to lead to increased uncertainty in teaching. In particular, how to accommodate diverse students from a wide range of socioeconomic, cultural, and linguistic backgrounds inevitably involves a variety of difficult questions with regard to both curricular content and instructional methods (Gay, 2000; Ladson-Billings, 1999; Miller, Kostogriz, & Gearon, 2009), primarily because "there are few well-established techniques – codified technical knowledge – to help teachers meet students' widely varying needs" (Rosenholtz, 1989, p. 4). In a similar vein, a teacher is likely to be exposed to a high level of uncertainty in teaching if she/he teaches a classroom where students show widely varying academic performance levels (Grimmett & MacKinnon, 1992; Hallinan, 1994). In this case, the teacher is expected to make considerable extra effort in order to effectively accommodate the diverse academic needs of individual students; however, this sharply contrasts with the reality that teachers' instructional "goals must be met and relationships [with students] managed in a group context . . . [in which teachers' educational] attempts to shape children are continually constrained by the fact of 'classness'" (Lortie, 2002, p. 137).[6] Further, the shortage and inadequacy of classroom resources experienced in many schools is likely to add additional complexities to classroom teaching insofar as teachers perceive how they teach their students is negatively affected by such resource constraints (Anyon, 2001; Biddle & Berliner, 2002; D. K. Cohen, Raudenbush, & Ball, 2003). In sum, considering that teachers' uncertainty in teaching may be derived from a wide range of classroom-contextual factors, it is possible to advance the following

6. Considering that the internal schooling process "occurs within an environment of constraints, uncertainty, and change" (DeLany, 1991, p. 202), it is not surprising that dealing with students from a wide range of backgrounds is at the intersection of various variables exerting direct or indirect influences on teaching.

hypothesis:

Hypothesis 2: *Teachers who face greater classroom-contextual uncertainty are more likely to engage in collaborative interaction with other teachers.*

Finally, extending the central logic of the uncertainty management perspective, it is plausible to expect that teachers' uncertainty in teaching may arise in part from socio-cultural heterogeneity at the societal level. Considering that education is an institution on which different sectors of society impose multiple, often conflicting, purposes, "teaching performances . . . can be free of controversy only in societies which are marked by an extremely high degree of value consensus" (Lortie, 2002, p. 136). In a socio-culturally heterogeneous society, the range of the goals of schooling envisioned by different groups of people is likely to be very wide, and many of those goals may be conflicting with one another, adding further uncertainty to the complexities of teaching. This leads to the following hypothesis:

Hypothesis 3: *Teachers in countries with a higher level of socio-cultural heterogeneity are more likely to engage in collaborative interaction with other teachers.*

2.2.2. Additional Hypotheses

When testing the primary hypotheses derived from the uncertainty management perspective, it is important to control for other possibilities by simultaneously considering other plausible hypotheses as well that are based on different theoretical perspectives. This process makes it possible to see if the primary hypotheses turn out empirically supported even after some other plausible hypotheses are simultaneously taken into account. In this regard, five additional hypotheses are considered here. Each of these additional hypotheses is based on one of the aforementioned theoretical perspectives other than the uncertainty management perspective. They are the school climate perspective, the principal instructional leadership perspective, the curriculum policy perspective, and the national culture perspective.

First of all, on the basis of the school climate perspective on teacher collegiality, the extent to which collegial work relationships are fostered and sustained among teachers in a school is dependent on the organizational climate of the school. Therefore, the following hypothesis is set forth:

Hypothesis A1: *Teachers' collaborative interaction with other teachers is more likely in schools with a more positive organizational climate.*

In addition, the principal instructional leadership perspective suggests the possibility that teacher collegiality is facilitated to a greater degree in schools where principals engage more in instructional leadership roles. In this respect, the following hypothesis is derived:

Hypothesis A2: *Teachers' collaborative interaction with other teachers is more likely in* *schools where the principal's engagement in instruction-related activities is greater.*

Further, on the basis of the curriculum policy perspective on teacher collegiality, it is postulated that the presence of a standardized national curriculum may function to facilitate collaborative interaction among teachers insofar as it provides them with some shared technical language for thinking about teaching and learning.[7] Thus, the following hypothesis is formulated:

Hypothesis A3: *Teachers in countries with a more standardized national curriculum are more likely to engage in collaborative interaction with other teachers.*

At the same time, the curriculum policy perspective also suggests the possibility that the presence of a standardized national curriculum may alleviate a certain amount of uncertainty in teaching perceived by teachers. This is because curriculum

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7. In addition, one may plausibly hypothesize that curricular policy stability, as conceptualized as the degree to which the curriculum policy of a given country remain unchanged over time, may be negatively related to collaborative teacher interaction in that country. That is, in a highly stable curricular policy environment, teachers may not feel they really need to communicate much with other teachers, precisely because each teacher can anticipate fairly accurately how other teachers are thinking and feeling and what they are doing in a given situation, thereby decreasing the chances for teachers to engage in collaborative interaction. In other words, a high level of curricular policy instability as an indicator of frequent policy changes in a given country is likely to be positively related to a high level of collaborative teacher interaction. Although this study does not test this hypothesis due to the lack of available data to measure curricular policy (in)stability, a useful contribution with regard to future research would be to examine this hypothesis.

standardization may lessen a certain amount of uncertainty in teaching as the curriculum standards may serve as a set of readily available and authoritative guidelines that teachers can rely on when making various decisions about their teaching. In this respect, this possibility is in line with the central logic of the uncertainty management perspective as well. Thus, the following hypothesis is advanced:

Hypothesis A4: *The positive association between teachers' exposure to uncertainty in teaching and their engagement in collaborative interaction with other teachers (= hypotheses 1 and 2) is likely to be weaker in countries with a more standardized national curriculum.*

Finally, drawing on the national culture perspective, I consider the literature on the cross-national differences in terms of individualist versus collectivist orientations, which points to the following hypothesis regarding teacher collegiality:

Hypothesis A5: *Teachers in countries with a more individualist culture are less likely to engage in collaborative interaction with other teachers.*

2.3. Summary

On the basis of five different conceptual perspectives, a series of hypotheses has been formulated as an attempt to gain a comprehensive understanding of teacher collegiality as a dependent variable contingent upon a range of multilevel contextual factors. Three primary hypotheses of this study have been derived from an uncertainty management perspective; from this perspective, teacher collegiality is understood largely as a byproduct of the collective sensemaking of uncertainties in teaching, which reduces individual teachers' feelings of discomfort with given uncertainties and thus helps them deal with those uncertainties rather than simply trying to either ignore or eliminate them from their teaching. Four additional perspectives – a school climate perspective, a principal instructional leadership perspective, a curriculum policy perspective, and a national culture perspective – have yielded five more hypotheses, which represent some of the most popular conventional accounts of teacher collegiality as a variable dependent on certain contextual conditions. In the next chapter, I provide detailed descriptions of the data, specific measures, and analytic methods to test the hypotheses advanced in this chapter.

CHAPTER 3

DATA AND METHODOLOGY

3.1. Description of the Data

3.1.1. Sample Design and Weights

The primary data for this study are from the TIMSS 2007 eighth-grade mathematics dataset. This dataset, chiefly known for its student achievement data, also contains extensive contextual data on schools and classes, including useful information about collaborative interaction among teachers.[8] The sample design of the TIMSS 2007 eighth-grade mathematics survey was intended to provide accurate estimates of the nationally representative eighth-grade student population within each participating country.[9] In addition to data on sampled students, a large amount of information about their classes and schools was also gathered. The hierarchical nature of these units necessitated a two-stage sample design, whereby a systematic probability-proportional-to-size sample of schools was selected at the first sampling stage, and one or more intact classes of students were sampled per school with an equal probability of selection at the

8. Using an earlier TIMSS dataset, Akiba and LeTendre (2009) provide some useful descriptive information about collaborative teacher interaction in Australia, Japan, and the United States.

9. Each country was expected to include all eighth-grade students in its definition of the student population. Even in countries where some regions or school types could not be included in the operational population for some practical reasons, such exclusions were predetermined not to exceed five percent of the population (Joncas, 2008a).

second stage.[10]

Since this study is concerned primarily with collaborative teacher interaction, the teacher is the primary unit of analysis. In terms of multilevel regression modeling, teacher-level data constitute level-1 variables. The teachers selected in TIMSS 2007 were those who taught the nationally representative sample of classes within each country. In TIMSS 2007, teacher-level, classroom-level, and school-level data are virtually at the same level in terms of data structure, while student-level data are distinguished as a separate level nested within teacher/classroom/school-level data. The reason for this is that only one or two intact classes were selected per school in most cases in TIMSS 2007, and each class was taught mathematics by only one or two teachers in most cases. Therefore, although teachers, classrooms, and schools are all separate levels conceptually, it is unreasonable to treat them as separate levels in statistical analyses.

This study uses the classroom level as the data level to which teacher-level and school-level data are matched together. That is, in places where the number of cases differed between these levels, the number of cases was adjusted to be consistent with the number of classrooms in the dataset. For example, if two classes were included for a given school in the dataset, the same school-level data were matched to the two classes, resulting in the number of cases remaining two; similarly, if one of those two classrooms was taught mathematics by two teachers rather than one, the two teachers

10. While all participating countries adopted this basic two-stage sampling approach, there were some acceptable variations. The Russian Federation introduced a preliminary stage to select regions, and Singapore added a third sampling stage to subsample students within classrooms rather than selecting intact classes (Joncas, 2008a, 2008b).

were weighted so that they would represent only one case statistically, making the number of cases remain consistent with the number of classrooms.

This strategy is useful because the TIMSS 2007 dataset contains a weight variable designed to be used for analyses where the unit of analysis is the classroom. This study uses this weight variable after transforming it into a purely proportional weight variable by removing the scaling effect within each country.[11] This ensures the weighted sample corresponds to the actual sample size and, thus, yields correct standard errors in subsequent analyses. This weight variable, WEIGHT_WITHIN, is used in this study when within-nation analyses are conducted, adjusting for differential selection probabilities of individual teachers within a given country.

Although WEIGHT_WITHIN is a desirable weight variable for within-nation analyses, it has a drawback for cross-national analyses. Using WEIGHT_WITHIN would lead to biased results in cross-national analyses because results would be more sensitive to countries with larger samples of teachers. In order to avoid this problem, it is important to make each country treated equally by using an alternative weight variable. Thus, WEIGHT_WITHIN was modified into an alternative weight variable, WEIGHT_ACROSS, in order to make each country have the same sample size while ensuring that the WEIGHT_ACROSS-weighted number of cases in the cross-national dataset corresponds to the sum of the WEIGHT_WITHIN-weighted numbers of cases from individual countries. In this respect, this alternative weight variable, like

11. The TIMSS 2007 dataset does not include a weight variable for teacher-level analyses. Although there are several teacher-related weight variables in the dataset, they are all designed for using teacher-background data in student-level analyses (Foy & Olson, 2009).

WEIGHT_WITHIN, is also a proportional weight variable that does not inflate the sample size on the entire dataset level. In this study, when data are analyzed after national datasets have been combined into a single cross-national dataset, WEIGHT_ACROSS is applied to the combined dataset before analyses are conducted.

3.1.2. Units of Analysis

This study explores how collaborative teacher interaction is associated with individual teachers' immediate classroom and school contexts as well as with the broader societal and policy contexts by which they are surrounded. Thus, the research design for this study requires the simultaneous consideration of statistical relationships at both teacher and country levels. Consequently, there are two different unit-of-analysis levels, which are the teacher level and the country level. Since teachers are nested within each country in terms of the data structure, teachers constitute the level-1 data, which are clustered within individual countries at level 2.[12]

3.2. Dependent Variables: Measures of Teacher Collegiality[13]

A question in TIMSS 2007 asked eighth-grade mathematics teachers about the

12. The TIMSS 2007 dataset does not include either district-level or state-level data for the United States. With regard to future research, a useful within-U.S. analysis would be to use the School and Staffing Survey dataset compiled by the National Center for Education Statistics. In this dataset, district-level data are also available in addition to some useful data on collaborative teacher interaction.

13. For a conceptual discussion of teacher collegiality, see chapter 1 (section 1.1).

frequency of different types of collaborative interaction with other teachers. The question asked: "How often do you have the following types of interactions with other teachers?" The types of collaborative interaction given were: "discussions about how to teach a particular concept," "working on preparing instructional materials," "visits to another teacher's classroom to observe his/her teaching," and "informal observations of my classroom by another teacher." For each interaction type, teachers were asked to choose one of the following response options: "never or almost never," "2 or 3 times per month," "1-3 times per week," or "daily or almost daily." These response options were assigned with numeric values of zero, one, two, and three, respectively.

Based on these four types of collaborative interaction between teachers, two teacher collegiality measures, *collaborative lesson planning* (TCHRCOL_LESSON) and *collaborative classroom observation* (TCHRCOL_CLASS), were constructed. TCHRCOL_LESSON captures the degree to which an eighth-grade mathematics teacher regularly engages in collaborative lesson planning; that is, the mean of "discussions about how to teach a particular concept" and "working on preparing instructional materials" is used as one measure of teacher collegiality. Similarly, TCHRCOL_CLASS captures the degree to which an eighth-grade mathematics teacher regularly participates in collaborative classroom observation; this variable is the mean of "visits to another teacher's classroom to observe his/her teaching" and "informal observations of my classroom by another teacher."[14]

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14. Although these measures are based on quantitative data about how often teachers participate in certain types of collaborative interaction, these measures do not capture various

Little (1990) argues that collaborative lesson planning and classroom observation constitute strong forms of collegiality. Such joint work implies collective action, creating strong interdependence, shared responsibility, and a great degree of readiness to participate in reflective inquiry into practices. Failure and uncertainty are not hidden, but they are shared and discussed. According to some previous studies, however, weak forms of collegiality are dominant in schools (Little, 1990; Lortie, 2002); they show that collegial work practices are usually limited to giving help only when asked or pooling some existing ideas. This phenomenon has led to the emergence of what Fullan and Hargreaves (1996) call "comfortable collegiality" (as cited in Fallon & Barnett, 2009), whereby reassurance and sympathy are emphasized while close scrutiny and criticism are discouraged.

In addition, an alternative collegiality measure, *variety in collaborative teacher interaction* (TCHRCOL_VARIETY), was constructed based on the above two collaboration measures. TCHRCOL_VARIETY is an ordinal-scale variable with values of zero, one, and two, for none, low, and high variety, respectively, in collaborative interaction among eighth-grade mathematics teachers. An eighth-grade mathematics teacher belongs to the category of "high variety" if she/he participates in both TCHRCOL_LESSON and TCHRCOL_CLASS; "low variety" if she/he participates in only one of TCHRCOL_LESSON and TCHRCOL_CLASS; and "none" if she/he does not participate in either TCHRCOL_LESSON or TCHRCOL_CLASS. This alternative

qualitative aspects of teacher interaction. Therefore, a fruitful area of future research would be to explore conceptual and methodological issues concerning which qualitative aspects of teacher interaction to observe and how to adequately measure those aspects.

measure captures how various types of collaborative interaction are used by a teacher, regardless of how frequently she/he engages in collaborative interaction with other teachers.

3.3. Independent Variables

3.3.1. Primary Independent Variables

In order to test hypotheses 1 and 2 from the uncertainty management perspective, two level-1 composite variables, *uncertainty from teaching for understanding* and *uncertainty from classroom-contextual factors*, were derived from the following seven variables: *teaching for understanding*, *student achievement level*, *variation in student achievement*, *students' educational capital*, *variation in educational capital*, *proportion of language minority students*, and *shortage of classroom resources*. The description of each of these variables is as follows:[15]

Teaching for understanding (TCHUNDS): an interval variable that measures the degree to which an eighth-grade mathematics teacher tries to use instructional

15. I do not assume that uncertainty in teaching arises to the same degree from the same situations regardless of societal contexts. Thus, for the multilevel regression analyses in chapter 5, I permit all slopes and the intercept of the model to randomly vary across countries in light of the possibility of significant random differences. The comparative education literature suggests that there may be various country-specific factors that are unique to individual societies' education systems and cultures (Anderson-Levitt, 2003; Crossley & Watson, 2003; Schriewer, 2003). Despite this statistical strategy used in this study, it would be a useful future study to closely examine how the specific situations from which uncertainty arises may be different or similar across countries.

strategies to foster students' engagement in inquiry-based learning and non-routine problem solving. A question in TIMSS 2007 asked teachers, "How often do you usually ask [students] to do the following?" Four items focused on teaching for understanding: asking students to "work on problems for which there is no immediately obvious method of solution," "decide on their own procedures for solving complex problems," "explain their answers," and "relate what they are learning in mathematics to their daily lives." The response options were: "never," "some lessons," "about half the lessons," and "every or almost every lesson." These response options were given numeric values of zero, one, two, and three, respectively. The mean of these four items is used as the variable.[16]

Student achievement level (ACHIEVE): a continuous variable that measures the overall mathematics achievement level of the classroom that an eighth-grade mathematics teacher teaches. In order to construct this variable, the individual student-level mathematics achievement data from TIMSS 2007 were aggregated into the classroom level, which was then linked to the eighth-grade mathematics teacher data.[17] The mean score of mathematics achievement for a given classroom is used as the

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16. An exploratory factor analysis of these four items was conducted with the combined sample of all countries for this study after WEIGHT_ACROSS was applied to the dataset. The result showed that all items were loaded on a single factor (eigenvalue = 2.05) and all items had factor loadings exceeding 0.65 (factor loadings for the four items, in the order shown in the preceding paragraph, were 0.67, 0.79, 0.67, and 0.72), indicating a high degree of consistency among the items. Cronbach's α was 0.68.

17. At the student level, the first plausible achievement score from TIMSS 2007 was used for each student. Using different plausible achievement scores did not alter the results of the analyses presented in this study.

variable (divided by 100 to make 100 score points as a one-unit).[18]

Variation in student achievement (ACHIVAR): a continuous variable that measures the variation in mathematics achievement in the classroom that an eighth-grade mathematics teacher teaches. To construct this variable, the student-level mathematics achievement data from TIMSS 2007 were aggregated into the classroom level, which was then linked to the eighth-grade mathematics teacher data. The standard deviation of the mean score of mathematics achievement for a given classroom was changed into the coefficient of variation, which is the ratio of the standard deviation to the mean in terms of percentage.[19] This coefficient of variation is used as the variable (divided by 10 to make 10% as a one-unit).

Students' educational capital (EDCAPIT): a continuous measure that captures the overall socioeconomic background of the classroom that an eighth-grade mathematics teacher teaches. For the construction of this measure, a student-level index of educational capital was first constructed from TIMSS 2007 as done by Chudgar and Luschei (2009) using TIMSS 2003. That is, based on individual students' answers regarding a range of family possessions related to learning, the student-level sum of those family possessions was calculated from the following: "study desk," "dictionary,"

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18. Student achievement results from TIMSS are reported on a standardized scale ranging from zero to 1,000. In order to compare student achievement over time across countries, each TIMSS administration uses the same standardized scale, which has an international mean of 500 and a standard deviation of 100.

19. While the standard deviation must always be understood in the context of the mean of a given group, the coefficient of variation is a dimensionless number that makes a comparison possible regardless of varying means across groups.

“calculator,” “computer,” “internet connection” (for each of these items, “yes” = one; “no” = zero), and “books” in the home (one = “none or very few” to five = “more than 200 books”).[20] Next, this student-level information was aggregated into the classroom level. Finally, the classroom-level mean was linked to the eighth-grade mathematics teacher data. As a result, EDCAPIT is defined as an index of the overall socioeconomic status background of a given classroom that an eighth-grade mathematics teacher teaches.[21]

Variation in educational capital (EDCAVAR): a continuous variable that captures the variation in students’ socioeconomic status backgrounds in the classroom that an eighth-grade mathematics teacher teaches. For this measure, a student-level index of educational capital was first constructed from TIMSS 2007 based on individual students’ answers regarding a range of family possessions related to learning. That is, the student-level sum of those family possessions was calculated as done for the EDCAPIT variable. Next, this student-level index was aggregated into the classroom level, which was then linked to the eighth-grade mathematics teacher data. Finally, the classroom-level standard deviation of this index was changed into the coefficient of variation, i.e.,

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20. In their cross-national study of the school effect vis-à-vis the family background effect on student achievement, Chudgar and Luschei (2009) constructed basically the same index of educational capital from the TIMSS 2003 dataset, and they found the index to be “a fair proxy for the family’s economic status and parental education” (p. 637).

21. Although EDCAPIT is a rough socioeconomic status (SES) index, the national mean of this SES index is very highly correlated with the national economic development level, supporting the reliability of the index. The correlation between the national mean of EDCAPIT and the gross domestic product per capita (at purchasing power parity, 2007) is 0.76 ($p \leq .001$, $n = 29$ countries).

Table 3-1. Exploratory factor analysis of the level-1 primary independent variables

	Factor 1: Uncertainty from classroom-contextual factors (UNC_CONTEXT)	Factor 2: Uncertainty from teaching for understanding (UNC_TCHUNDS)
Students' educational capital (EDCAPIT)	-.903	.082
Variation in educational capital (EDCAVAR)	.856	.004
Student achievement level (ACHIEVE)	-.855	-.063
Variation in student achievement (ACHIVAR)	.729	.178
Shortage of classroom resources (SHORTRES)	.546	-.063
Proportion of language minority students (LANGMIN)	.505	-.471
Teaching for understanding (TCHUNDS)	.131	.874

Note . Principal component extraction with promax rotation (kappa = 4) was used. Factor loadings are sorted by size. Factor loadings greater than .50 in terms of their absolute values are indicated by dotted-line boxes. Bartlett's test of sphericity is significant at the $p < .001$ level. The correlation between factor 1 and factor 2 is -0.015. $n = 6{,}624$.

the ratio of the standard deviation to the mean in terms of percentage. This coefficient of variation is used as the variable (divided by 10 to make 10% as a one-unit).

Proportion of language minority students (LANGMIN): a continuous variable that captures the degree to which the classroom that an eighth-grade mathematics teacher teaches is populated by language minority students. Uncertainty may arise if teachers feel unsure of how to accommodate the special needs of language minority students. A question in TIMSS 2007 asked eighth-grade students, "How often do you speak [the language of the test] at home?" Students were asked to choose one of the following response options: "always," "almost always," "sometimes," or "never." The percentage of students who "never" or only "sometimes" speak the language of the test was calculated at the classroom level, which was then linked to the teacher data. Thus, the resulting variable is the percentage of language minority students in the classroom that an eighth-grade mathematics teacher teaches (divided by 10 to make 10% as a one-unit).

Shortage of classroom resources (SHORTRES): an interval variable that measures the degree to which an eighth-grade mathematics teacher perceives that her/his teaching is negatively affected by a shortage or inadequacy of classroom resources. Such resource constraints can add uncertainty to classroom teaching because teachers may feel unsure of how to teach effectively without adequate resources. A question in TIMSS 2007 asked teachers, "In your view, to what extent do the following limit how you teach the TIMSS class?"[22] The following four items were included regarding the

22. The TIMSS 2007 Teacher Questionnaire indicates on its "General Directions" page (p. 2) that the term "TIMSS class" refers to "the class that is identified on the cover of this

shortage or inadequacy of basic classroom resources: "shortage of textbooks for students' use," "shortage of other instructional equipment for students' use," "shortage of equipment for your use in demonstrations and other exercises," and "inadequate physical facilities." For each of these items, the response options were "not at all" or "not applicable," "a little," "some," and "a lot." These response options were given numeric values of zero, one, two, and three, respectively. The mean of the four items is used as the variable.[23]

Since all of these seven variables have been constructed to measure teachers' uncertainty in teaching commonly on the basis of the uncertainty management perspective, high interrelationships among the variables are expectable. An effective statistical method to examine underlying structures of variable interrelationships is exploratory factor analysis, which shows variable interrelationships with as few as possible factors (Raykov & Marcoulides, 2008). An exploratory factor analysis of the seven measures of teachers' uncertainty in teaching was conducted after WEIGHT_ACROSS was applied to the dataset. As reported in Table 3-1, two factors with an eigenvalue over 1.0 were derived from the seven variables.[24] All variables

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questionnaire, and that will be tested as part of TIMSS 2007 in your school."

23. An exploratory factor analysis of these four items was conducted with the combined sample of all countries for this study after WEIGHT_ACROSS was applied to the dataset. The result showed that all items were loaded on a single factor (eigenvalue = 2.63) and all items had factor loadings exceeding 0.70 (factor loadings for the four items, in the order shown in the preceding paragraph, were 0.71, 0.87, 0.86, and 0.79), indicating a high degree of consistency among the items. Cronbach's α was 0.83.

24. The "promax" method, an oblique rotation, was used in Table 3-1, because "in many social and behavioral research studies, . . . underlying latent variables typically tend to be related"

expect TCHUNDS were loaded heavily on factor 1 (eigenvalue = 3.38), while TCHUNDS alone was heavily loaded on factor 2 (eigenvalue = 1.03).

Recall that only TCHUNDS is a measure of the uncertainty that can stem from instruction (i.e., the core technology of teaching), whereas the other measures, ACHIEVE, ACHIVAR, EDCAPIT, EDCAVAR, LANGMIN, and SHORTRES, commonly capture the uncertainty that may arise from the classroom context. The result from the factor analysis reported in Table 3-1 also suggests the possibility that teachers' uncertainty in teaching may come from at least two conceptually separable sources: first, the instructional complexity involved in the implementation of teaching for understanding; and second, the difficulty in effectively dealing with various issues and challenges arising from a range of classroom-contextual factors. In other words, the result in Table 3-1 indicates there may be two different kinds of uncertainty in teaching, which can be called *uncertainty from teaching for understanding* (UNC_TCHUNDS) and *uncertainty from classroom-contextual factors* (UNC_CONTEXT).[25] Consequently, I use

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(Raykov & Marcoulides, 2008, p. 267) rather than they are uncorrelated. Indeed, since all of the seven variables in Table 3-1 have been constructed in this study to measure teachers' exposure to uncertainty in teaching, one may plausibly expect some correlation between the factors derived from these variables. However, the result in Table 3-1 shows that the correlation between the two factors is fairly small (r = 0.015) even when the promax method is used to allow the factors to be correlated. In addition, using an orthogonal rotation based on the "varimax" method produces almost the same result, as reported in Table A1 in the Appendix.

25. Since TCHUNDS alone is heavily loaded on factor 2 in the factor analysis reported in Table 3-1, this factor (UNC_TCHUNDS) can be seen as basically the same variable with TCHUNDS, with the correlation between the two being over 0.87. Thus, the factor label *uncertainty from teaching for understanding* does not mean that UNC_TCHUNDS captures instructional uncertainty, while TCHUNDS, or *teaching for understanding* in its full name, does not. Rather, both UNC_TCHUNDS and TCHUNDS commonly reflect the degree to which a

these two component factors as the measures of uncertainty in teaching. These factors are standardized composite variables with a mean of zero and a standard deviation of one.

In addition to these level-1 primary variables, the following variable is used as a level-2 primary variable in order to test hypothesis 3 derived from the uncertainty management perspective:

Socio-cultural heterogeneity (SOCHET): the country-level ethnic fractionalization index calculated by Alesina, Devleeschauwer, Easterly, Kurlat, and Wacziarg (2003). This index ranges theoretically from zero for no fractionalization to one for perfect fractionalization (multiplied by 10 to rescale the index to range between zero and 10). I use this index as a proxy for the degree to which a country is heterogeneous in terms of social and cultural values held by people in the country.

3.3.2. Additional Independent Variables

Pertaining to hypotheses A1 and A2, the following two additional independent variables are used at level 1:

School climate (CLIMATE): a continuous variable that measures the

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teacher exerts effort to foster students' engagement in inquiry-based learning and non-routine problem solving, which inevitably makes the teacher exposed to greater instructional uncertainty as her/his teaching becomes less reducible to predictable routines. In other words, teaching for understanding is assumed to accompany greater instructional uncertainty than conventional teaching (see chapter 2, especially sections 2.1.5 and 2.2.1). The only difference worth mentioning between UNC_TCHUNDS and TCHUNDS is that UNC_TCHUNDS is clearly distinct from UNC_CONTEXT (r = -0.015, statistically insignificant), while TCHUNDS is slightly correlated with UNC_CONTEXT (r = 0.131, $p \leq .001$).

organizational climate of the school where an eighth-grade mathematics teacher works. A question in TIMSS 2007 asked teachers, "How would you characterize each of the following within your school?" The following four items were included regarding the school climate: "teachers' job satisfaction," "teachers' understanding of the school's curricular goals," "teachers' degree of success in implementing the school's curriculum," and "teachers' expectations for student achievement." For each of these items, the response options were "very low," "low," "medium," "high," and "very high." These response options were given numeric values of one, two, three, four, and five, respectively. The mean of the four items is used as the variable.[26]

Principal's instructional leadership (PRINLEAD): a continuous variable that captures the degree to which an eighth-grade mathematics teacher's school principal spends time on instructionally relevant activities. A question in TIMSS 2007 asked the principal of each sampled school, "By the end of this school year, approximately what percentage of time in your role as principal will you have spent on these activities?" The following three pertained to instructionally relevant activities: "developing curriculum and pedagogy," "supervising and evaluating teachers and other staff," and "teaching." The sum of the percentages allocated to these activities is used as the variable (divided by 10 to make 10% as a one-unit).

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26. An exploratory factor analysis of these four items was conducted with the combined sample of all countries for this study after WEIGHT_ACROSS was applied to the dataset. The result showed that all items were loaded on a single factor (eigenvalue = 2.27) and all items had factor loadings exceeding 0.70 (factor loadings for the four items, in the order shown in the preceding paragraph, were 0.73, 0.78, 0.82, and 0.67), indicating a high degree of consistency among the items. Cronbach's α was 0.74.

In addition, with respect to hypotheses A3, A4, and A5, the following two additional independent variables are used at level 2:

Curriculum standardization (CURRSTD): a country-level index of curriculum standardization based on data from the TIMSS 2007 Mathematics Curriculum Questionnaire.[27] This variable ranges from one for low standardization to six for high standardization.[28]

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27. For the value for each country, see Table 4-1 in chapter 4. One = The country does not have "a national curriculum that covers mathematics instruction at the eighth grade of formal schooling" and does not have either prescribed curricular "materials" or "mandated or recommended textbooks." Two = The country does not have "a national curriculum that covers mathematics instruction at the eighth grade of formal schooling" but does have either prescribed curricular "materials" or "mandated or recommended textbooks." Three = The country does not have "a national curriculum that covers mathematics instruction at the eighth grade of formal schooling" but does have both prescribed curricular "materials" and "mandated or recommended textbooks." Four = The country has "a national curriculum that covers mathematics instruction at the eighth grade of formal schooling" but does not have either prescribed curricular "materials" or "mandated or recommended textbooks." Five = The country has "a national curriculum that covers mathematics instruction at the eighth grade of formal schooling" and also has either prescribed curricular "materials" or "mandated or recommended textbooks." Six = The country has "a national curriculum that covers mathematics instruction at the eighth grade of formal schooling" and also has both prescribed curricular "materials" and "mandated or recommended textbooks."

28. For example, the value for the United States is two, indicating a fairly low degree of curricular standardization. According to the TIMSS 2007 Mathematics Curriculum Questionnaire, the United States does not have "a national curriculum that covers mathematics instruction at the eighth grade of formal schooling," but the country does have "mandated or recommended textbooks" in most states, in the sense that state education agencies and local school districts "publish a list of preferred/recommended texts" in alignment with their own curriculum standards. One might argue that the United States has a fairly standardized curriculum within each state; however, Schmidt and his colleagues note that "even with the presence of well-defined state standards and, more recently, the increasing presence of corresponding state assessments, local districts still maintain de facto control of their curriculum" (Schmidt, Cogan, Houang, & McKnight, 2011, p. 400). Unfortunately, the lack of state-level and district-level information in the TIMSS 2007 dataset did not allow the construction of a more

Individualist culture (INDVCUL): the individualism index by Hofstede and Hofstede (2005). This country-level index captures the extent to which people in a given society tend to give emphasis on goals and interests of individuals rather than those of groups (divided by 10 to rescale the index to range between zero and 10).[29]

3.3.3. Control Variables

In addition to the primary and additional independent variables described above, the following four variables are also entered into the regression equation at level 1, as these variables might influence teacher behavior in schools:

Teacher workload (WORKLOAD): a continuous measure of school-level teacher shortage. This variable is used in this study as a proxy for individual teachers' workload in a given school.[30] A question in TIMSS 2007 asked principals how difficult it was "to fill eighth-grade teaching vacancies for this school year" for the subject area of "mathematics." The response options were "no vacancies," "easy to fill vacancies," "somewhat difficult," and "very difficult." These response options were given numeric values of zero, one, two, and three, respectively.

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accurate measure of curricular standardization for this study.

29. This index is frequently used in the international management literature, but it has been rarely used in the education literature. One recent exception is Chiu, Chow, and Mcbride-Chang's (2007) study, which found that compared to students in individualist societies, achievement scores of students in collectivist cultures were linked more strongly to schoolmates' use of meta-cognitive strategies.

30. This is based on the logic that individual teachers' workload in a given school becomes greater as the school's teacher shortage level becomes higher, assuming that the amount of total work in that school remains constant. Unfortunately, there is no direct measure of teacher workload in the TIMSS 2007 dataset.

Teacher experience (TCHREXP): a continuous variable of how many years an eighth-grade mathematics teacher has been in the profession of teaching according to TIMSS 2007 (divided by 5 to make 5 years as a one-unit).

Mathematics major (MATHMJR): a binary variable indicating whether or not an eighth-grade mathematics teacher majored in mathematics or mathematics education during her/his post-secondary education. If an eighth-grade mathematics teacher majored in either mathematics or mathematics education according to TIMSS 2007, the teacher was coded one; otherwise, the teacher was coded zero.

Female teacher (FEMALE): a binary variable indicating whether an eighth-grade mathematics teacher is female or male according to TIMSS 2007. Female teachers were coded one, and male teachers were coded zero.

In addition to these level-1 control variables, the following two control variables are also considered at level 2, as they have been widely used as basic indicators of country-level characteristics that might affect educational policy and practice:

Public expenditure on education (EDEXPN): the amount of public expenditure on education as a percentage of gross domestic product (2007). Public expenditure on education consists of local, regional, and national governments' expenditure on education plus subsidies to private education. This variable is available from the World Bank's World Development Indicators dataset.

Economic development (GDPCAP): the gross domestic product per capita (2007) adjusted by purchasing power parity (divided by 5,000 to make $5,000 as a one-unit). This variable comes from the World Development Indicators dataset compiled by the

Table 3-2. Summary of variable definitions and data sources

	Definition	Source
Dependent variables		
TCHRCOL_LESSON: Collaborative lesson planning	The degree to which an eighth-grade mathematics teacher regularly participates in collaborative lesson planning.	TTE
TCHRCOL_CLASS: Collaborative classroom observation	The degree to which an eighth-grade mathematics teacher regularly participates in collaborative classroom observation.	TTE
TCHRCOL_VARIETY: Variety in collaborative teacher interaction	The extent to which an eighth-grade mathematics teacher regularly engages in multiple types of collaborative interaction with other teachers.	TTE
Level-1 variables		
UNC_TCHUNDS: Uncertainty from teaching for understanding	The factor score for the degree to which an eighth-grade mathematics teacher confronts uncertainties due to her/his effort to use instructional strategies to foster students' engagement in inquiry-based learning and non-routine problem solving.	T31
UNC_CONTEXT: Uncertainty from classroom-contextual factors	The factor score for the degree to which an eighth-grade mathematics teacher confronts uncertainties due to various complex issues arising from a range of classroom-contextual conditions and constraints.	T31
TCHUNDS: Teaching for understanding	The degree to which an eighth-grade mathematics teacher uses instructional strategies to foster students' engagement in inquiry-based learning and non-routine problem solving.	TTE
ACHIEVE: Student achievement level	The overall mathematics achievement level of the classroom that an eighth-grade mathematics teacher teaches.	TST
ACHIVAR: Variation in student achievement	The variation in mathematics achievement in the classroom that an eighth-grade mathematics teacher teaches.	TST

Table 3-2. (cont'd)

	Definition	Source
Level-1 variables, cont'd		
EDCAPIT: Students' educational capital	The overall socioeconomic background of the classroom that an eighth-grade mathematics teacher teaches.	TST
EDCAVAR: Variation in educational capital	The variation in students' socioeconomic backgrounds in the classroom that an eighth-grade mathematics teacher teaches.	TST
LANGMIN: Proportion of language minority students	The degree to which the classroom that an eighth-grade mathematics teacher teaches is populated by language minority students.	TST
SHORTRES: Shortage of classroom resources	The degree to which an eighth-grade mathematics teacher perceives that her/his teaching is negatively affected by a shortage or inadequacy of classroom resources.	TTE
CLIMATE: School climate	Teachers' perception of the degree to which teacher morale is high and organizational goals are clearly communicated and well implemented.	TTE
PRINLEAD: Principal's instructional leadership	The degree to which an eighth-grade mathematics teacher's school principal spends time on instructionally relevant activities.	TSC
WORKLOAD: Teacher workload	The degree of school-level teacher shortage as a proxy for individual teachers' workload in a given school.	TSC
TCHREXP: Teacher experience	How long an eighth-grade mathematics teacher has been in the profession of teaching.	TTE
MATHMJR: Mathematics major	Whether or not an eighth-grade mathematics teacher majored in mathematics or mathematics education during her/his post-secondary education.	TTE
FEMALE: Female teacher	Whether an eighth-grade mathematics teacher is female or male.	TTE

Table 3-2. (cont'd)

	Definition	Source
Level-2 variables		
SOCHET: Socio-cultural heterogeneity	The country-level ethnic fractionalization index as a proxy for the degree to which a country is heterogeneous in terms of social and cultural values held by people in the country.	ALE
CURRSTD: Curriculum standardization	The degree to which a country is characterized as having a standardized curriculum for eighth-grade mathematics.	TCU
INDVCUL: Individualist culture	The degree to which people in a given country tend to give emphasis on goals and interests of individuals rather than those of groups.	HOF
EDEXPN: Public expenditure on education	The amount of public expenditure on education as compared to gross domestic product.	WDI
GDPCAP: Economic development	The gross domestic product per capita adjusted by purchasing power parity.	WDI
U.S.-specific variables		
Course taught	The mathematics course that an eighth-grade mathematics teacher teaches to a given class of students.	UST
School type	Whether a school is a public school, a religiously affiliated private school, or an independent or unspecified private school.	UST
Free or reduced-price lunch	The proportion of students at a given school who are eligible to receive free or reduced-price lunches through the National School Lunch Program.	UST

Note . ALE = Alesina et al., 2003. HOF = Hofstede & Hofstede, 2005. T31 = Table 3-1. TCU = TIMSS Curriculum Questionnaire 2007. TSC = TIMSS School Questionnaire 2007. TST = TIMSS Student Questionnaire 2007. TTE = TIMSS Teacher Questionnaire 2007. UST = U.S. National TIMSS 2007. WDI = World Development Indicators 2007.

World Bank.

3.3.4. U.S.-Specific Contextual Variables

Three U.S.-specific variables are from the supplementary U.S. national TIMSS dataset prepared by the National Center for Educational Statistics. This dataset is designed to be linkable to the TIMSS 2007 international dataset compiled by the International Association for the Evaluation of Educational Achievement. The variables are as follows:

Course taught: a categorical variable indicating which mathematics course an eighth-grade mathematics teacher teaches to a given class of students. The courses were categorized into basic eighth-grade mathematics, algebra, geometry, and other courses. This variable is used in light of the possibility that there may be significant differences in collaborative interaction among teachers depending on courses they teach.

School type: a categorical variable indicating whether a school is a public school, a religiously affiliated private school, or an independent or unspecified private school. This variable is used because many people frequently attribute differences in various aspects of school culture to school types.

Proportion of free or reduced-price lunch recipients: the percentage of students at a given school who are eligible to receive free or reduced-price lunches through the National School Lunch Program.[31] This is a widely used measure of school-level

31. Since the National School Lunch Program is a federally assisted meal program operating in public and nonprofit private schools, data for this variable are available only for

poverty (divided by 10 to make 10% as a one-unit).

3.4. Descriptive Statistics

The definitions and data sources of all dependent and independent variables used in this study are summarized in Table 3-2. This study uses multilevel data from 29 countries for which all level-1 and level-2 variables are available.[32] These countries are from a variety of geographic regions of the world and represent a range of cultural and economic contexts.[33] Table 3-3 represents the descriptive statistics for all variables in the combined sample of 29 countries to which WEIGHT_ACROSS has been applied. In addition, Table 3-4 shows the descriptive statistics for the WEIGHT_WITHIN-applied U.S. data. Recall that both weight variables are proportional weight variables without any scaling effect (i.e., they do not artificially inflate the size of the sample).

3.5. Analytic Approaches

This study first examines the overall cross-national patterns in collaborative

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these types of schools.

32. The 29 countries are as follows: Australia, Bulgaria, Chinese Taipei, Colombia, the Czech Republic, Egypt, England, Ghana, Hong Kong, Hungary, Indonesia, Iran, Israel, Italy, Japan, Kuwait, Lebanon, Malaysia, Norway, Romania, the Russian Federation, Saudi Arabia, Scotland, Singapore, South Korea, Sweden, Thailand, Turkey, and the United States.

33. See Table 4-1 in chapter 4 for national characteristics of these countries (i.e., values of level-2 variables for each country).

Table 3-3. Descriptive statistics for variables

	Mean	(*SD*)	Min.	Max.	*n*
Dependent variables					
TCHRCOL_LESSON	1.388	(.765)	.000	3.000	6785
TCHRCOL_CLASS	.486	(.641)	.000	3.000	6747
TCHRCOL_VARIETY					
None	.059	…	.000	1.000	6743
Low variety	.476	…	.000	1.000	6743
High variety	.464	…	.000	1.000	6743
Level-1 independent variables					
UNC_TCHUNDS	.000	(1.000)	-3.306	2.886	6624
UNC_CONTEXT	.000	(1.000)	-2.548	3.851	6624
TCHUNDS	1.686	(.582)	.000	3.000	6725
ACHIEVE	4.672	(.936)	1.897	7.451	7080
ACHIVAR	1.442	(.565)	.000	4.562	7080
EDCAPIT	6.619	(1.662)	1.081	10.000	7079
EDCAVAR	2.403	(1.039)	.000	9.321	7079
LANGMIN	1.972	(2.889)	.000	10.000	7079
SHORTRES	.921	(.806)	.000	3.000	6671
CLIMATE	3.653	(.596)	1.000	5.000	6791
PRINLEAD	5.027	(1.584)	.000	10.000	6655
WORKLOAD	.827	(.952)	.000	3.000	6793
TCHREXP	3.077	(2.178)	.000	10.000	6538
MATHMJR	.822	…	.000	1.000	6689
FEMALE	.559	…	.000	1.000	6795
Level-2 independent variables					
SOCHET	3.083	(2.316)	.020	7.351	29
CURRSTD	4.621	(1.474)	1.000	6.000	29
INDVCUL	4.534	(2.577)	1.300	9.100	29
EDEXPN	4.569	(1.155)	2.594	6.745	29
GDPCAP	4.984	(3.109)	.273	10.981	29

Table 3-4. Descriptive statistics for variables used in within-U.S. analyses

	Mean	(*SD*)	Min.	Max.	*n*
Dependent variables					
TCHRCOL_LESSON	1.236	(.901)	.000	3.000	477
TCHRCOL_CLASS	.269	(.508)	.000	3.000	477
TCHRCOL_VARIETY					
None	.163	…	.000	1.000	477
Low variety	.576	…	.000	1.000	477
High variety	.261	…	.000	1.000	477
Independent variables					
UNC_TCHUNDS	.057	(.849)	-2.341	2.205	482
UNC_CONTEXT	-.725	(.588)	-2.548	.809	482
TCHUNDS	1.681	(.574)	.250	3.000	484
ACHIEVE	5.086	(.627)	2.593	7.178	532
ACHIVAR	.918	(.305)	.000	1.945	532
EDCAPIT	7.567	(1.062)	4.000	10.000	531
EDCAVAR	1.993	(.874)	.000	5.533	531
LANGMIN	.845	(1.335)	.000	7.500	530
SHORTRES	.390	(.510)	.000	2.500	485
CLIMATE	3.882	(.647)	1.500	5.000	484
PRINLEAD	4.700	(1.774)	.500	8.500	437
WORKLOAD	.984	(1.067)	.000	3.000	464
TCHREXP	2.812	(2.097)	.000	9.000	480
MATHMJR	.698	…	.000	1.000	481
FEMALE	.703	…	.000	1.000	487
U.S.-specific independent variables					
Course taught					
Basic 8th-grade math	.200	…	.000	1.000	532
Algebra	.739	…	.000	1.000	532
Geometry	.016	…	.000	1.000	532
Others	.045	…	.000	1.000	532
School type					
Public school	.884	…	.000	1.000	520
Private, religious	.076	…	.000	1.000	520
Private, others	.040	…	.000	1.000	520
Free or reduced-price lunch	4.289	(2.813)	.000	10.000	486

teacher interaction by comparing the aggregated country-level data across the 29 countries in the sample. These patterns are, then, analyzed vis-à-vis variations in level-2 variables. This preliminary analysis will provide a broad picture of the relationships between a range of country-level contextual variables and collaborative teacher interaction. Next, a series of multilevel modeling analyses is conduced (Raudenbush & Bryk, 2002), whereby both level-1 and level-2 variables are simultaneously considered to explain collaborative interaction among teachers. Using this analytic approach is aimed at providing a more comprehensive and accurate understanding of how teacher collegiality is associated with various factors at multiple levels of social context. Considering the hierarchical structure of the data where teachers (i.e., the level-1 unit) are clustered within countries (i.e., the level-2 unit), using multilevel modeling is an effective approach, whereby differential variance between countries is taken into account to yield improved estimates of regression coefficients and standard errors. Finally, I also conduct a set of similar analyses using only the U.S. portion of the TIMSS 2007 dataset. In these analyses, I examine collaborative teacher interaction as a function of level-1 variables to examine the case of the United States, where teachers' engagement in meaningful collaborative work around teaching has been reported to be the exception rather than the norm (Bryk & Schneider, 2002; Fullan & Hargreaves, 1996; Lortie, 2002; Rosenholtz, 1989).[34]

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34. Conducting within-U.S. analyses is also beneficial for another important reason. The cross-national multilevel analyses of teacher collegiality in this study are based on the assumption that the meaning of collaborative teacher interaction described in the TIMSS 2007 Teacher Questionnaire is reasonably constant across countries in the sample. However, there are

varying perspectives on this assumption. For example, while some sociological perspectives highlight the embeddedness of education in world-cultural models (Baker & LeTendre, 2005; LeTendre, et al., 2001; Meyer & Ramirez, 2003), many studies suggest that educational practices are often fundamentally local cultural activities (Alexander, 2000; Anderson-Levitt, 2003; Britton, Paine, Pimm, & Raizen, 2003). Although the collaborative teacher interaction types included in the TIMSS 2007 Teacher Questionnaire seem to be relatively low-inference generic descriptions, conducting within-U.S. analyses will provide opportunities to analyze the data without the need for assuming the validity of this assumption.

CHAPTER 4

DESCRIPTIVE AND PRELIMINARY ANALYSES

4.1. Analyses of Aggregated Country-Level Data

Figure 4-1 compares across countries eighth-grade mathematics teachers' engagement in collaborative lesson planning, i.e., the country-means of TCHRCOL_LESSON. Recall that TCHRCOL_LESSON is an index that captures the degree to which an eighth-grade mathematics teacher engages in collaborative lesson planning, ranging from zero for no engagement to three for the highest level of engagement.[35] As shown in Figure 4-1, the country-mean of TCHRCOL_LESSON varies considerably, ranging from 0.96 in Czech Republic to 2.03 in Kuwait. The United States is 1.24, ranked 22nd among the 29 countries in the sample. Similarly, Figure 4-2 shows a cross-national comparison of eighth-grade mathematics teachers' engagement in collaborative classroom observation. That is, this figure reports the country-means of TCHRCOL_CLASS, an index that captures the degree to which an eighth-grade mathematics teacher regularly participates in collaborative classroom observation, which ranges from zero for no participation to three for the highest level of

35. See chapter 3 (section 3.2) for more details about how TCHRCOL variables (i.e., TCHRCOL_LESSON, TCHRCOL_CLASS, and TCHRCOL_VARIETY) were constructed for measures of teacher collegiality. See Table 3-3 in chapter 3 for the descriptive statistics for these variables.

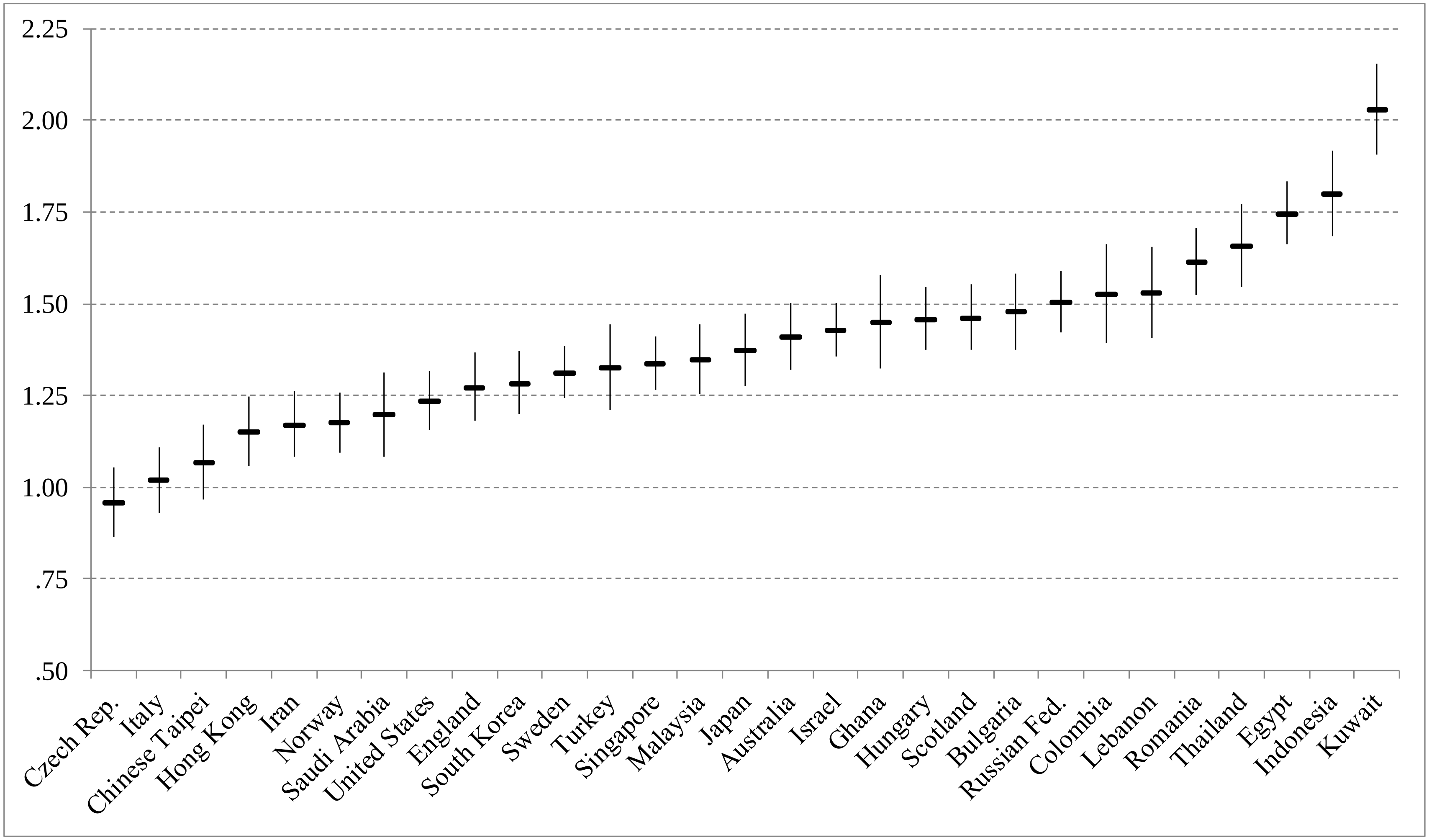

Figure 4-1. Eighth-grade mathematics teachers' engagement in collaborative lesson planning, by country (i.e., country-mean of TCHRCOL_LESSON with the 95% confidence interval). *Note*. The index theoretically ranges from 0.0 for no engagement to 3.0 for the highest level of engagement.

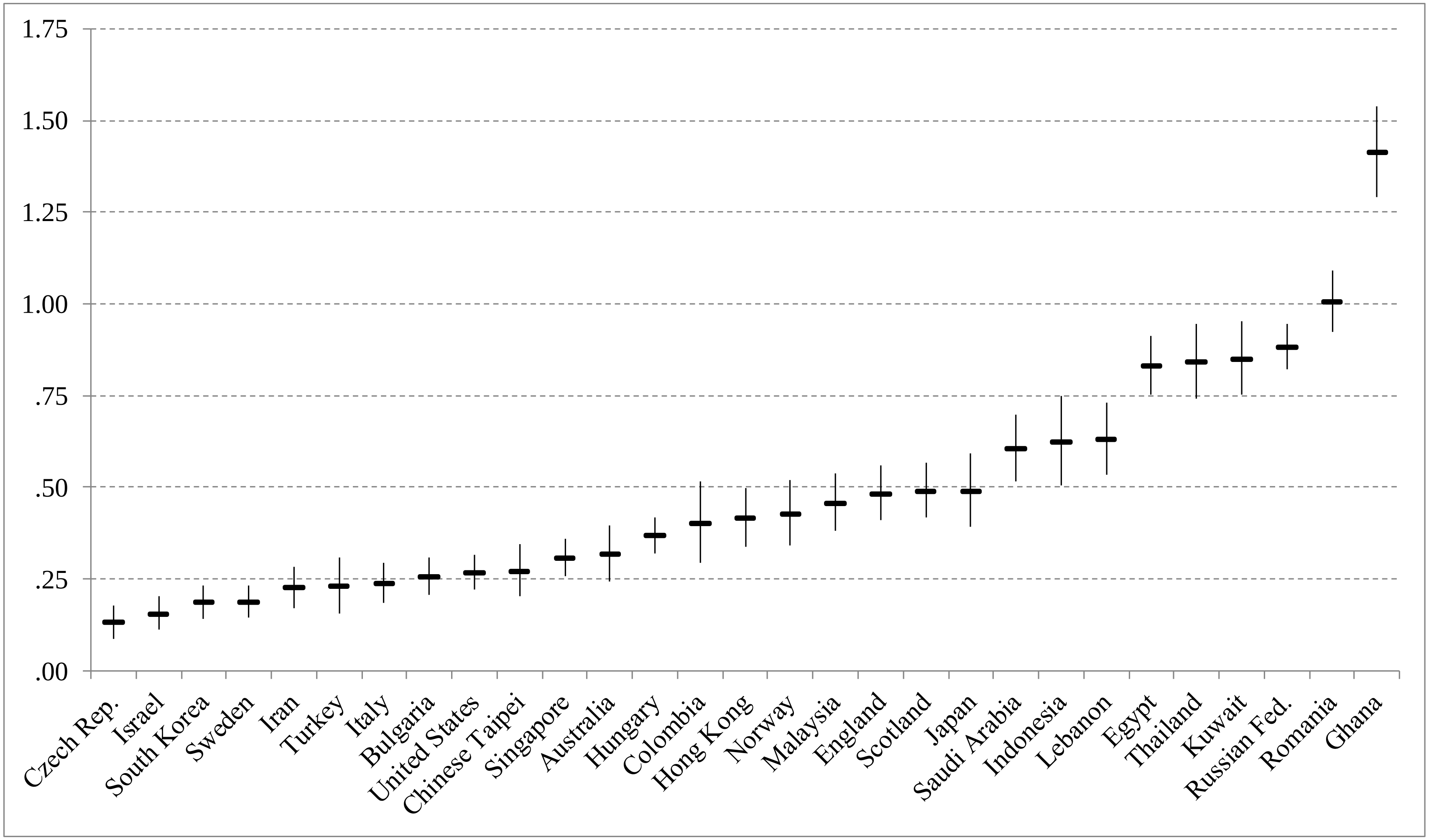

Figure 4-2. Eighth-grade mathematics teachers' engagement in collaborative classroom observation, by country (i.e., country-mean of TCHRCOL_CLASS with the 95% confidence interval). *Note*. The index theoretically ranges from 0.0 for no engagement to 3.0 for the highest level of engagement.

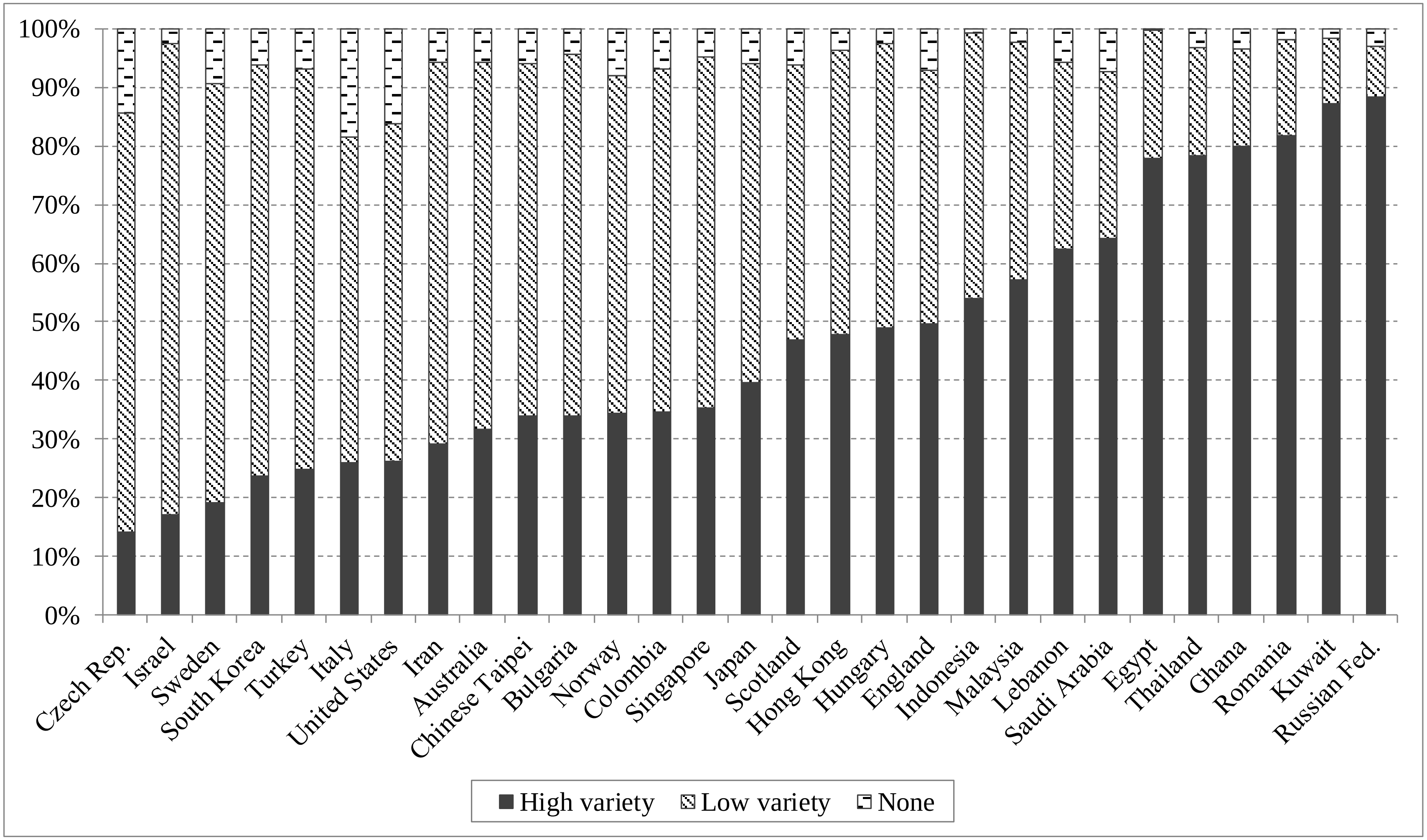

Figure 4-3. Variety in collaborative interaction among eighth-grade mathematics teachers, by country (i.e., country-level breakdown of TCHRCOL_VARIETY).

participation. As shown in this figure, there is considerable cross-national variation in country-means of TCHRCOL_CLASS, ranging from 0.13 in Czech Republic to 1.42 in Ghana. The United States is 0.27, ranked 21st among the 29 countries in the sample.

Figure 4-3 provides an alternative description of cross-national variation in collaborative interaction among eighth-grade mathematics teachers on the basis of TCHRCOL_VARIETY, an ordinal variable capturing how various types of collaborative interaction are used by the teacher, regardless of how frequently she/he engages in collaborative interaction with other teachers. Teachers are categorized into three different groups, depending on whether they engage in both collaborative lesson planning and collaborative classroom observation (i.e., high variety), only collaborative lesson planning or only classroom observation (i.e., low variety), or neither of these (i.e., none). As shown in Figure 4-3, there is substantial variation in the country-level breakdown of TCHRCOL_VARIETY. For example, 88.3% of eighth-grade mathematics teachers belong to the "high variety" category in the Russian Federation, while only 13.9% belong to the same category in Czech Republic. The United States is ranked 23rd among the 29 countries in the sample in terms of the percentage of eighth-grade mathematics teachers who belong to the "high variety" category, with the percentage being 26.0%. In terms of the percentage who fall into the "none" category, the United States is 16.4%, which is second only to 18.5% in Italy, meaning that 16.4% of U.S. eighth-grade mathematics teachers never engage in either collaborative lesson planning or collaborative classroom observation. In sum, compared to other countries, the United States is characterized as having a very high proportion of eighth-grade mathematics

Table 4-1. Level-2 variables: Values by country

	SOCHET	CURRSTD	INDVCUL	EDEXPN	GDPCAP
Australia	.929	1	9.0	4.651	7.271
Bulgaria	4.021	4	3.0	4.135	2.308
Chinese Taipei	2.744	6	1.7	4.350	6.194
Colombia	6.014	1	1.3	4.052	1.708
Czech Rep.	3.222	4	5.8	4.607	4.907
Egypt	1.836	6	3.8	3.685	1.011
England	1.211	4	8.9	5.559	7.156
Ghana	6.733	6	2.0	5.437	.273
Hong Kong	.620	6	2.5	3.520	8.487
Hungary	1.522	5	8.0	5.417	3.852
Indonesia	7.351	3	1.4	3.534	.748
Iran	6.684	3	4.1	5.492	2.197
Israel	3.436	5	5.4	6.359	5.306
Italy	1.145	4	7.6	4.317	6.350
Japan	.119	6	4.6	3.449	6.707
Kuwait	6.604	5	3.8	3.760	9.673
Lebanon	1.314	6	3.8	2.594	2.145
Malaysia	5.880	5	2.6	4.533	2.709
Norway	.586	4	6.9	6.745	10.981
Romania	3.069	6	3.0	4.365	2.533
Russian Fed.	2.452	5	3.9	3.872	3.362
Saudi Arabia	1.800	6	3.8	6.416	4.525
Scotland	1.211	5	8.9	5.559	7.156
Singapore	3.857	6	2.0	2.795	10.565
South Korea	.020	5	1.8	4.211	5.237
Sweden	.600	4	7.1	6.673	7.686
Thailand	6.338	5	2.0	4.004	1.558
Turkey	3.200	6	3.7	2.863	2.633
United States	4.901	2	9.1	5.535	9.292

Note . For correlations between the variables, see Table A2 in the Appendix.

teachers who do not engage in any type of collaborative teacher interaction while having a very low proportion of eighth-grade mathematics teachers who regularly engage in multiple types of collaborative teacher interaction.

In order to examine the relationship between national contexts and cross-national variations illustrated in Figures 4-1, 4-2, and 4-3, a range of country-level variables were used. They are *socio-cultural heterogeneity* (SOCHET), *curriculum standardization* (CURRSTD), *individualist culture* (INDVCUL), *public expenditure on education* (EDEXPN), and *economic development* (GDPCAP). The values for these variables are presented in Table 4-1.[36] Table 4-2 shows bivariate correlations between each of these variables and the country-means of TCHRCOL_LESSON, TCHRCOL_CLASS, and TCHRCOL_VARIETY.[37] Notable is that both TCHRCOL_LESSON and TCHRCOL_CLASS, when aggregated to country-level means, are significantly positively correlated with SOCHET, which is consistent with hypothesis 3 from the uncertainty management perspective that teachers in countries with a higher level of socio-cultural heterogeneity are more likely to engage in collaborative interaction with other teachers.

In addition, both TCHRCOL_CLASS and TCHRCOL_VARIETY, when aggregated to country-level means, are significantly positively correlated with

36. See chapter 3 (section 3.3) for detailed descriptions of these variables. For correlations between these variables, see Table A2 in the Appendix.

37. TCHRCOL_VARIETY, an ordinal-scale variable coded two, one, or zero for "high variety," "low variety," and "none," respectively, was treated as an interval-scale variable when aggregated to the country level in Table 4-2.

Table 4-2. Pearson's bivariate correlations between country-means of TCHRCOL and level-2 variables ($n = 29$)

	Country mean of TCHRCOL_LESSON	
	r	
SOCHET	.403	*
CURRSTD	.049	
INDVCUL	-.273	
EDEXPN	-.320	+
GDPCAP	-.317	+
	Country mean of TCHRCOL_CLASS	
	r	
SOCHET	.315	+
CURRSTD	.352	+
INDVCUL	-.319	+
EDEXPN	-.135	
GDPCAP	-.390	*
	Country mean of TCHRCOL_VARIETY	
	r	
SOCHET	.284	
CURRSTD	.415	*
INDVCUL	-.373	*
EDEXPN	-.249	
GDPCAP	-.373	*

+$p \leq .10$; *$p \leq .05$.

Table 4-3. Ordinary least squares regressions for country-means of TCHRCOL, with all level-2 variables entered into the equation ($n = 29$)

	Y = Country mean of TCHRCOL_ LESSON		*Y* = Country mean of TCHRCOL_ CLASS		*Y* = Country mean of TCHRCOL_ VARIETY	
	B	β	*B*	β	*B*	β
SOCHET	.043 +	.423	.050 +	.381	.038	.349
	(.024)		(.029)		(.024)	
CURRSTD	.021	.133	.098 *	.477	.087 *	.502
	(.035)		(.042)		(.035)	
INDVCUL	.019	.203	.017	.147	.012	.125
	(.026)		(.031)		(.026)	
EDEXPN	-.063	-.304	.004	.016	-.021	-.094
	(.044)		(.053)		(.043)	
GDPCAP	-.012	-.155	-.026	-.269	-.019	-.228
	(.016)		(.019)		(.016)	
Intercept	1.419 ***		-.089		1.017 **	
	(.321)		(.387)		(.319)	
R^2	.27		.34		.37	

Note. *B* = Unstandardized coefficients with standard errors in parentheses. β = standardized coefficients.
+$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

CURRSTD and significantly negatively correlated with INDVCUL, which are in line with hypotheses A3 and A5 from the curriculum policy perspective and the national culture perspective, respectively. That is, these results appear to substantiate the possibility that teachers in countries with the presence of a more standardized national curriculum, and in countries with a less individualist culture, are more likely to engage in collaborative interaction with other teachers. Further, as shown in Table 4-3, the significant positive association between socio-cultural heterogeneity and both TCHRCOL_LESSON and TCHRCOL_CLASS aggregated to national-level means remains to be statistically significant even when all other country-level contextual variables are held constant. Table 4-3 also shows that the significant positive connection between curriculum standardization and both national-level aggregated TCHRCOL_CLASS and TCHRCOL_VARIETY persists even after all other country-level contextual variables are controlled for.

4.2. Analyses of Multilevel Data

Although providing useful preliminary information, analyses of the aggregated national-level data reported in Tables 4-2 and 4-3 ignore within-nation variation in each country, which is problematic because within-nation variation may vary across countries. For more accurate analyses, the multilevel nature of the data structure should be taken into account. One possible statistical method in this regard is hierarchical (generalized) linear modeling (Raudenbush & Bryk, 2002). Based on this method, the unconditional model (i.e., the simplest possible hierarchical linear model) is as follows, which is equivalent to a one-way analysis of variance with random effects.

At level 1, for teacher i in country j,

$$\text{TCHRCOL}_{ij} = \beta_{0j} + r_{ij},$$

where β_{0j} is the mean outcome for country j, and r_{ij} is a random error which is assumed to be normally distributed with a mean of zero and a variance, σ squared.

At level 2,

$$\beta_{0j} = \gamma_{00} + u_{0j},$$

where each country-mean of TCHRCOL, β_{0j}, is represented as a function of the grand mean, γ_{00}, plus a random error, u_{0j}, which is assumed to be normally distributed with a mean of zero and a variance, τ_{00}.

Here, the intra-class correlation, ρ, which is the proportion of the variance in TCHRCOL that exists at level 2 (i.e., between countries) rather than at level 1 is calculated by:

$$\rho = \tau_{00} \,/\, (\tau_{00} + \sigma^2),$$

where ρ can theoretically range from zero to one. A higher ρ coefficient indicates a

Table 4-4. Unconditional hierarchical (generalized) linear models for TCHRCOL

	Yij = TCHRCOL_LESSON			Yij = TCHRCOL_CLASS			Yij = η(m)ij for TCHRCOL_VARIETY		
Fixed effect	Coeff. (SE)			Coeff. (SE)			Coeff. (SE)		OR
Intercept, γ_{00}	1.405 *** (.051)			.512 *** (.059)			-.022 (.193)		.979
Threshold difference, $\delta(2)$							3.223 *** (.130)		25.115
Random effect	Var.	df	χ^2	Var.	df	χ^2	Var.	df	χ^2
Intercept, u_{0j}	.061	28	670.4 ***	.094	28	1866.5 ***	.929	28	1274.4 ***
Level-1 random error, r_{ij}	.534			.323					
Intraclass correlation	ρ			ρ			ρ		
	.103			.225			.220		

Note. OR = odds ratios.
***$p \leq .001$.

greater degree of importance of level-2 contextual information when explaining the variance in the dependent variable.[38]

As reported in Table 4-4, 10.3% of the variance in TCHRCOL_LESSON, 22.5% of the variance in TCHRCOL_CLASS, and 22.0% of the variance in TCHRCOL_VARIETY lie between countries, indicating that collaborative classroom observation is more than twice more contingent upon national contexts than is collaborative lesson planning. In addition, Table 4-4 also shows that the average country-mean of TCHRCOL_LESSON is 1.405, which is almost three times greater than the average country mean of TCHRCOL_CLASS, which is 0.512. That is, on average across the countries in the sample, teachers engage in collaborative lesson planning to an almost three times greater extent than in collaborative classroom observation.

To examine how significantly each country-level contextual variable is associated with the three dependent variables, some additional preliminary analyses were conducted using multilevel linear regressions where only one level-2 variable was entered into the model for each time. That is, at level 1, for teacher *i* in country *j*,

$$\text{TCHRCOL}_{ij} = \beta_{0j} + r_{ij},$$

38. Since TCHRCOL_VARIETY is an ordinal-scale variable, the intra-class correlation cannot be calculated based on the same unconditional model for TCHRCOL_LESSON and TCHROL_CLASS. Thus, the intra-class correlation for TCHRCOL_VARIETY was calculated based on the unconditional multilevel ordinal logistic regression model as explained by O'Connell and her colleagues (O'Connell, Goldstein, Rogers, & Peng, 2008). For details about the multilevel ordinal logistic regression used in this study, see chapter 5 (section 5.1).

and at level 2,

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{level-2 variable})_j + u_{0j},$$

where the level-2 variable is one of SOCHET, CURRSTD, INDVCUL, EDEXPN, or GDPCAP for models I through V, respectively.

As reported in Tables 4-5 and 4-6, SOCHET at level 2 is significantly positively related to both TCHRCOL_LESSON and TCHRCOL_CLASS at level 1, meaning that collaborative teacher interaction, as a form of either collaborative lesson planning or collaborative classroom observation, is significantly more likely in countries of higher socio-cultural heterogeneity, which is consistent with hypothesis 3 derived from the uncertainty management perspective. In addition, CURRSTD is significantly positively associated with TCHRCOL_CLASS in line with hypothesis A3, suggesting that teachers in countries with a more standardized national curriculum are more likely to engage in collaborative classroom observation. INDVCUL has a significant negative relationship with TCHRCOL_CLASS, indicating that teachers in countries with a more individualist culture are less likely to engage in collaborative classroom observation, as suggested by hypothesis A5.

With regard to TCHRCOL_VARIETY, hierarchical generalized linear modeling was used based on the cumulative probability model for ordinal data (Raudenbush & Bryk, 2002, pp. 317-325). The coefficients in Table 4-7 indicate the amount of increase in the predicted ordered log odds of moving to the next higher level in the dependent

Table 4-5. Bivariate associations between TCHRCOL_LESSON and level-2 variables: Coefficients ($\gamma 01$, df =27) from multilevel linear regressions

	I			II			III			IV			V		
	Coeff.	(*SE*)		Coeff.	(*SE*)		Coeff.	(*SE*)		Coeff.	(*SE*)		Coeff.	(*SE*)	
SOCHET	.049	(.019)	**												
CURRSTD				-.011	(.025)										
INDVCUL							-.026	(.016)							
EDEXPN										-.076	(.030)	*			
GDPCAP													-.023	(.021)	
Intercept, $\gamma 00$	1.391	(.041)	***	1.406	(.050)	***	1.391	(.047)	***	1.392	(.045)	***	1.395	(.054)	***

*$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

Table 4-6. Bivariate associations between TCHRCOL_CLASS and level-2 variables: Coefficients ($\gamma 01$, df =27) from multilevel linear regressions

	I			II			III			IV			V		
	Coeff.	(*SE*)		Coeff.	(*SE*)		Coeff.	(*SE*)		Coeff.	(*SE*)		Coeff.	(*SE*)	
SOCHET	.046	(.024)	+												
CURRSTD				.062	(.032)	+									
INDVCUL							-.037	(.019)	+						
EDEXPN										-.008	(.048)				
GDPCAP													-.035	(.022)	
Intercept, $\gamma 00$	.499	(.051)	***	.508	(.056)	***	.493	(.051)	***	.511	(.063)	**	.498	(.054)	***

+$p \leq .10$; **$p \leq .01$; ***$p \leq .001$.

Table 4-7. Bivariate associations between TCHRCOL_VARIETY and level-2 variables: Coefficients ($\gamma 01$, df=27) from multilevel ordinal logistic regressions

	I			II			III			IV			V		
	Coeff. [OR]	(*SE*)		Coeff. [OR]	(*SE*)		Coeff. [OR]	(*SE*)		Coeff. [OR]	(*SE*)		Coeff. [OR]	(*SE*)	
SOCHET	.133 [1.142]	(.067)	+												
CURRSTD				.233 [1.263]	(.077)	**									
INDVCUL							-.124 [.883]	(.054)	*						
EDEXPN										-.124 [.883]	(.141)				
GDPCAP													-.081 [.922]	(.070)	
Intercept, $\gamma 00$	-.059	(.177)		-.039	(.182)		-.087	(.181)		-.042	(.191)		-.057	(.198)	
TD, $\delta(2)$	3.225	(.129)	***	3.228	(.127)	***	3.232	(.126)	***	3.228	(.129)	***	3.230	(.127)	***

Note. OR = odds ratios. TD = threshold difference.

+$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

variable TCHRCOL_VARIETY by a one-unit increase in an independent variable. Again, consistent with hypothesis 3, SOCHET is significantly positively associated with TCHRCOL_VARIETY. In addition, CURRSTD appears to have a significant positive relationship with TCHRCOL_VARIETY, while INDVCUL has a significantly negative relationship; these results are again in accordance with hypotheses A3 and A5, respectively.

4.3. Discussion

A series of preliminary analyses presented in this chapter suggests that there is considerable cross-national variation in eighth-grade mathematics teachers' engagement in collaborative teacher interaction. According to the unconditional multilevel modeling of the data, about 10 to 23% of the variance in collaborative teacher interaction appears to be attributable to national contextual factors, depending on how to measure collaborative teacher interaction. The United States, when compared to other countries, is characterized as having a very high proportion of eighth-grade mathematics teachers who do not engage in any type of collaborative teacher interaction while having a very low proportion of eighth-grade mathematics teachers who regularly engages in multiple types of collaborative teacher interaction.

Very interesting is that, regardless of how to measure collaborative teacher interaction, the results from the multilevel bivariate regressions indicate that teachers in countries of higher socio-cultural heterogeneity are significantly more likely to engage in collaborative teacher interaction. This finding gives credence to the uncertainty management perspective in which collaborative teacher interaction is understood as a collective response to uncertainty; it seems that teachers in a socio-culturally more heterogeneous society are more likely to confront various complex issues in teaching due to a lower level of value consensus at the societal level, which appears to necessitate a higher level of engagement in collaborative interaction with their colleague teachers.

Also notable in the results from multilevel bivariate regressions is that teachers in countries with a more standardized national curriculum appear more likely to engage in collaborative classroom observation; further, they are likely to participate in more varied types of collaborative interaction. This result, supporting the curriculum policy perspective, substantiates the hypothesis that the presence of a standardized national curriculum may facilitate collaborative teacher interaction insofar as such a curriculum provides teachers with some shared technical language for thinking about teaching and learning. In addition, in line with the national culture perspective, teachers in countries with a more individualist culture appear less likely to engage in collaborative classroom observation; also, they are less likely to participate in multiple types of collaborative interaction.

In the next chapter, another set of multilevel modeling analyses is conducted in order to see if the significant effects found in the preliminary bivariate analyses in this chapter persist even when a range of other variables are held constant. These further analyses, although more complex in terms of statistical modeling, will provide more accurate and comprehensive information about all three primary and five additional hypotheses.

CHAPTER 5

MULTILEVEL MODELING ANALYSES

5.1. Model Specification

Building upon the extensive preliminary analyses conducted in the previous chapter, a series of more elaborate and comprehensive analyses is carried out in this chapter based on the multilevel modeling approach elaborated by Raudenbush and Bryk (2002). These analyses aim at testing all three main and five additional hypotheses simultaneously, with a range of other variables held constant.[39]

At level 1, for teacher *i* in country *j*, TCHRCOL_{ij} is a function of UNC_TCHUNDS_{ij} and UNC_CONTEXT_{ij} as the primary independent variables and CLIMATE_{ij} and PRINLEAD_{ij} as additional independent variables; in addition, WORKLOAD_{ij}, TCHREXP_{ij}, MATHMJR_{ij}, and FEMALE_{ij} are also entered into the equation as control variables. Thus, the level-1 model is specified as follows:

$$\text{TCHRCOL}_{ij} = \beta_{0j} + \beta_{1j}(\text{UNC\_TCHUNDS})_{ij} + \beta_{2j}(\text{UNC\_CONTEXT})_{ij}$$

$$+ \beta_{3j}(\text{CLIMATE})_{ij} + \beta_{4j}(\text{PRINLEAD})_{ij}$$

$$+ \beta_{5j}(\text{WORKLOAD})_{ij} + \beta_{6j}(\text{TCHREXP})_{ij}$$

39. See chapter 2 (section 2.2) for all these hypotheses derived from different theoretical perspectives.

$$+ \beta_{7j}(\text{MATHMJR})_{ij} + \beta_{8j}(\text{FEMALE})_{ij} + r_{ij},$$

where β_{0j} is the mean outcome for country j, and β_{aj} for $1 \leq a \leq 8$ is the slope for each level-1 variable; r_{ij} is a random error.

At level 2, the intercept, β_{0j}, is modeled as a function of SOCHET$_j$, CURRSTD$_j$, INDVCUL$_j$, EDEXPN$_j$; in addition, CURRSTD$_j$ × EDEXPN$_j$ is also entered into the equation as an interaction term, given the possibility that a national curriculum is likely to be implemented with greater impact on practice when the amount of public educational funding is greater. Thus, the intercept is specified as follows:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{SOCHET})_j + \gamma_{02}(\text{CURRSTD})_j + \gamma_{03}(\text{INDVCUL})_j$$

$$+ \gamma_{04}(\text{EDEXPN})_j + \gamma_{05}(\text{CURRSTD} \times \text{EDEXPN})_j + u_{0j},$$

where γ_{00} is a constant; γ_{0b} for $1 \leq b \leq 4$ is the slope for each level-2 variable, and γ_{05} is the slope for the interaction term, CURRSTD$_j$ × EDEXPN$_j$. A random error, u_{0j}, was added to the model in light of the possibility that the mean of TCHRCOL may vary randomly between countries due to some country-specific factors that are unique to individual societies.

In addition, the slopes for UNC_TCHUNDS$_{ij}$ and UNC_CONTEXT$_{ij}$, which are β_{1j} and β_{2j}, are treated randomly varying as a function of CURRSTD$_j$ to test hypothesis A4; EDEXPN$_j$ and CURRSTD$_j$ × EDEXPN$_j$ are also entered into the equation, given the possibility that a national curriculum is likely to be implemented with greater impact on practice when the amount of public educational funding is larger. The remaining β's, with no cross-level interaction hypothesized, are treated simply as random. One might want these slopes to be treated as fixed, but I permit them to randomly vary across countries in light of the possibility of significant random differences in relationships; as suggested by a large body of comparative education literature, there may be various country-specific factors that are unique to individual societies' education systems and cultures (Anderson-Levitt, 2003; Crossley & Watson, 2003; Schriewer, 2003).[40] Thus, the slopes are specified as follows:[41]

$$\beta_{pj} = \gamma_{p0} + \gamma_{p1}(\text{CURRSTD})_j + \gamma_{p2}(\text{EDEXPN})_j$$

$$+ \gamma_{p3}(\text{CURRSTD} \times \text{EDEXPN})_j + u_{pj} \quad \text{for } 1 \le p \le 2,$$

$$\beta_{qj} = \gamma_{q0} + u_{qj} \quad \text{for } 3 \le q \le 8,$$

All level-1 and level-2 independent variables are grand-mean-centered, which makes the intercept, β_{0j}, more interpretable (Raudenbush & Bryk, 2002). The intercept is now defined as the expected TCHRCOL value when all independent variables are set

40. Since all slopes are permitted to randomly vary in the model, the resultant reduction in the degrees of freedom at level 1 corresponding to the level-2 sample size results in reduced statistical power (for a related discussion, see Bickel (2007), especially chapter 5). Thus, I report results significant at $p \le 0.10$ in addition to $p \le 0.05$, $p \le 0.01$, and $p \le 0.001$.

41. Treating all slopes as fixed, however, does not change much the results reported in this chapter. Compare Tables 5-1, 5-2, and 5-3 presented in this chapter with Tables A3, A4, and A5 in the Appendix.

equal to their grand means, as expressed as (X_{ij} – $\bar{X}$..) for each level-1 variable and as (W_j – $\bar{W}$.) for each level-2 variable. Thus, one may interpret the intercept as the expected degree of collaborative teacher interaction as measured by TCHRCOL for a typical teacher in a typical country in the sample.

This hierarchical linear model, however, is not appropriate when the dependent variable is TCHRCOL_VARIETY because this is an ordinal-scale variable with only three levels (i.e., "high variety," "low variety," and "none"), while TCHRCOL_LESSON and TCHRCOL_CLASS are treated as interval-scale variables in this study. Thus, multilevel ordinal logistic regression, as a form of hierarchical generalized linear modeling, is used as an alternative statistical method as suggested by O'Connell and her colleagues (O'Connell, et al., 2008) and Raudenbush and Bryk (2002). Specifically, let

$$P(R_{ij} = 1) = \text{Prob}(\text{TCHRCOL\_VARIETY}_{ij} = \text{"high variety"}),$$

$$P(R_{ij} = 2) = \text{Prob}(\text{TCHRCOL\_VARIETY}_{ij} = \text{"low variety"}),$$

$$P(R_{ij} = 3) = \text{Prob}(\text{TCHRCOL\_VARIETY}_{ij} = \text{"none"}),$$

and let

$$P(R_{ij} \leq m) = P(R_{ij} = 1) + \ldots + P(R_{ij} = m).$$

Then, the level-1 model is specified as

$$\eta_{(m)ij} = ln[P(R_{ij} \leq m) \ / \ P(R_{ij} > m)]$$

$$= \beta_{0j} + \beta_{1j}(\text{UNC\_TCHUNDS})_{ij} + \beta_{2j}(\text{UNC\_CONTEXT})_{ij}$$

$$+ \beta_{3j}(\text{CLIMATE})_{ij} + \beta_{4j}(\text{PRINLEAD})_{ij} + \beta_{5j}(\text{WORKLOAD})_{ij}$$

$$+ \beta_{6j}(\text{TCHREXP})_{ij} + \beta_{7j}(\text{MATHMJR})_{ij} + \beta_{8j}(\text{FEMALE})_{ij}$$

$$+ D_{(2)ij}\delta_{(2)},$$

where $D_{(2)ij}$ is a dummy variable indicating whether $m = 2$ (then, $D_{(2)ij} = 1$) or not (i.e., if $m = 1$, $D_{(2)ij} = 0$), and $\delta_{(2)}$ is the threshold difference which equals $\eta_{(2)ij} - \eta_{(2)ij}$.[42]

At level 2, the intercept, β_{0j}, and the slopes, β_{kj} for $0 \leq k \leq 8$, remain the same as specified earlier. That is,

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{SOCHET})_j + \gamma_{02}(\text{CURRSTD})_j + \gamma_{03}(\text{INDVCUL})_j$$

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42. When the dependent variable has M categories, only $M - 1$ cumulative probabilities are of interest because $P(R_{ij} \leq M) = 1$ in all studies. Since $M = 3$ in this study, $P(R_{ij} \leq 3) = 1$ is redundant. Note that when the number of categories of the dependent variable is M and the number of level-1 independent variables is N, the level-1 model can be generalized into the following form:

$$\eta_{(m)ij} = \beta_{0j} + \sum_{n=1}^{N} \beta_{(n)j}X_{(n)ij} + \sum_{m=2}^{M-1} D_{(m)ij}\delta_{(m)},$$

where $D_{(m)ij}$ is an indicator for the mth category, and $\delta_{(m)}$ is the threshold difference which equals $\eta_{(m-1)ij} - \eta_{(m)ij}$. See O'Connell, Goldstein, Rogers, and Peng (2008), and Raudenbush and Bryk (2002) for more details and discussions.

$$+ \gamma_{04}(\text{EDEXPN})_j + \gamma_{05}(\text{CURRSTD} \times \text{EDEXPN})_j + u_{0j},$$

$$\beta_{pj} = \gamma_{p0} + \gamma_{p1}(\text{CURRSTD})_j + \gamma_{p2}(\text{EDEXPN})_j$$

$$+ \gamma_{p3}(\text{CURRSTD} \times \text{EDEXPN})_j + u_{pj} \quad \text{for } 1 \leq p \leq 2,$$

$$\beta_{qj} = \gamma_{q0} + u_{qj} \quad \text{for } 3 \leq q \leq 8,$$

where, as in the earlier multilevel model for TCHRCOL_LESSON and TCHRCOL_CLASS, all level-1 and level-2 independent variables are grand-mean-centered.

5.2. Results

Tables 5-1 and 5-2 report the results from multilevel linear regressions for TCHRCOL_LESSON and TCHRCOL_CLASS, respectively. In each table, model I includes only those variables that pertain to the three primary hypotheses in this study, while model II includes all variables as specified above. A very clear pattern is that UNC_TCHUNDS is significantly positively associated with both TCHRCOL_LESSON and TCHRCOL_CLASS, indicating that teachers who face greater instructional uncertainty due to their effort to implement teaching for understanding are more likely to engage in collaborative interaction with other teachers. This significant pattern persists even when all additional hypotheses are simultaneously taken into account. Since UNC_TCHUNDS is a standardized factor score with a mean of zero and a

Table 5-1. Multilevel linear regressions for TCHRCOL_LESSON

Fixed effect	I Coeff.	I (*SE*)			II Coeff.	II (*SE*)	
Intercept, γ_{00}	1.417	(.045)	***		1.406	(.039)	***
SOCHET, γ_{01}	.066	(.019)	**		.054	(.020)	**
CURRSTD, γ_{02}					.042	(.023)	+
INDVCUL, γ_{03}					.034	(.022)	
EDEXPN, γ_{04}					-.116	(.042)	**
CURRSTD × EDEXPN, γ_{05}					.104	(.029)	**
UNC_TCHUNDS, γ_{10}	.126	(.013)	***		.103	(.015)	***
× CURRSTD, γ_{11}					.005	(.011)	
× EDEXPN, γ_{12}					.016	(.011)	
× CURRSTD × EDEXPN, γ_{13}					-.018	(.009)	*
UNC_CONTEXT, γ_{20}	-.009	(.026)			.031	(.025)	
× CURRSTD, γ_{21}					.007	(.016)	
× EDEXPN, γ_{22}					.017	(.022)	
× CURRSTD × EDEXPN, γ_{23}					-.023	(.016)	
CLIMATE, γ_{30}					.165	(.030)	***
PRINLEAD, γ_{40}					.009	(.008)	
WORKLOAD, γ_{50}					-.006	(.012)	
TCHREXP, γ_{60}					.004	(.008)	
MATHMJR, γ_{70}					.054	(.036)	
FEMALE, γ_{80}					.063	(.039)	

Random effect	I Var.	I *df*	I χ^2		II Var.	II *df*	II χ^2	
Intercept, u_{0j}	.054	27	220.1	***	.038	23	98.5	***
UNC_TCHUNDS, u_{1j}	.002	28	42.1	*	.004	25	44.2	**
UNC_CONTEXT, u_{2j}	.011	28	73.9	***	.013	25	60.4	***
CLIMATE, u_{3j}					.013	28	65.0	***
PRINLEAD, u_{4j}					.001	28	43.2	*
WORKLOAD, u_{5j}					.001	28	30.1	
TCHREXP, u_{6j}					.001	28	82.7	***
MATHMJR, u_{7j}					.009	28	32.7	
FEMALE, u_{8j}					.028	28	83.5	***
Level-1 random error, r_{ij}	.519				.488			

Note. All independent variables are grand-mean-centered. Coeff. = Unstandardized coefficients with robust standard errors in parentheses.
+$p \le .10$; *$p \le .05$; **$p \le .01$; ***$p \le .001$.

Table 5-2. Multilevel linear regressions for TCHRCOL_CLASS

Fixed effect	I Coeff.	I (*SE*)		II Coeff.	II (*SE*)	
Intercept, $\gamma 00$	.487	(.055)	***	.478	(.048)	***
SOCHET, $\gamma 01$	.026	(.026)		-.007	(.011)	
CURRSTD, $\gamma 02$				.080	(.021)	***
INDVCUL, $\gamma 03$				-.002	(.015)	
EDEXPN, $\gamma 04$				.043	(.027)	
CURRSTD × EDEXPN, $\gamma 05$				.009	(.026)	
UNC_TCHUNDS, $\gamma 10$	.068	(.010)	***	.058	(.011)	***
× CURRSTD, $\gamma 11$				-.013	(.005)	*
× EDEXPN, $\gamma 12$				-.014	(.008)	
× CURRSTD × EDEXPN, $\gamma 13$				-.007	(.006)	
UNC_CONTEXT, $\gamma 20$	.077	(.019)	***	.097	(.016)	***
× CURRSTD, $\gamma 21$				-.004	(.007)	
× EDEXPN, $\gamma 22$				-.019	(.017)	
× CURRSTD × EDEXPN, $\gamma 23$				-.030	(.012)	*
CLIMATE, $\gamma 30$				.086	(.016)	***
PRINLEAD, $\gamma 40$				.016	(.007)	*
WORKLOAD, $\gamma 50$				.006	(.013)	
TCHREXP, $\gamma 60$				.013	(.006)	*
MATHMJR, $\gamma 70$				.027	(.038)	
FEMALE, $\gamma 80$				.006	(.022)	

Random effect	I Var.	I *df*	I χ^2		II Var.	II *df*	II χ^2	
Intercept, u0j	.090	27	664.4	***	.059	23	230.6	***
UNC_TCHUNDS, u1j	.001	28	45.8	*	.002	25	40.5	*
UNC_CONTEXT, u2j	.005	28	76.0	***	.004	25	53.9	***
CLIMATE, u3j					.002	28	36.9	
PRINLEAD, u4j					.001	28	43.4	*
WORKLOAD, u5j					.002	28	50.2	**
TCHREXP, u6j					.001	28	60.8	***
MATHMJR, u7j					.022	28	63.2	***
FEMALE, u8j					.008	28	42.5	*
Level-1 random error, $r$ij	.312				.298			

Note. All independent variables are grand-mean-centered. Coeff. = Unstandardized coefficients with robust standard errors in parentheses.

*$p \le .05$; **$p \le .01$; ***$p \le .001$.

standard deviation of one, the multilevel regression coefficients can be interpreted as the amount of expected increase in TCHRCOL when there is a one-standard-deviation increase in UNC_TCHUNDS. After all other hypotheses are taken into account, a one-standard-deviation increase in UNC_TCHUNDS is significantly linked to an expected increase in TCHRCOL_LESSON by 0.103, which is equivalent to 13.5% of one standard deviation of TCHRCOL_LESSON because the standard deviation of TCHRCOL_LESSON is 0.765 as reported in Table 3-3 in chapter 3. Similarly, a one-standard-deviation increase in UNC_TCHUNDS is significantly related to an expected increase in TCHRCOL_CLASS by 0.058 with all other things in the model held constant, which translates into 9.0% of one standard deviation of TCHRCOL_CLASS because the standard deviation of TCHRCOL_CLASS is 0.641 as shown in Table 3-3 in chapter 3. These results strongly support hypothesis 1 that teachers who exert greater effort to implement teaching for understanding are significantly more likely to engage in collaborative interaction with their colleague teachers.

With respect to the effect of UNC_CONTEXT, Table 5-2 reports that, with all other things in the model held constant, a one-standard-deviation increase in this variable is significantly associated with an expected increase in TCHRCOL_CLASS by 0.097, which represents 15.1% of one standard deviation of TCHRCOL_CLASS. Although UNC_CONTEXT does not appear to have a significant effect on TCHRCOL_LESSON as shown in Table 5-1, the significant positive association found between UNC_CONTEXT and TCHRCOL_CLASS provides some evidence to substantiate the relationship between teachers' exposure to complexities and difficulties emerging from classroom contexts and their engagement in collaborative interaction with their colleague teachers. This result partly supports hypothesis 2 that teachers who face greater classroom-contextual uncertainty are more likely to engage in collaborative interaction with other teachers.

Regarding the effect of national-level socio-cultural heterogeneity, it has a significant positive effect on TCHRCOL_LESSON after all other things in the model are controlled for as shown in Table 5-1. A one-unit increase in SOCHET at level 2 is significantly related to an expected increase in TCHRCOL_LESSON at level 1 by 0.054. Since the standard deviation of SOCHET is 2.316 as reported in Table 3-3 in chapter 3, it is possible to say that a one-standard-deviation increase in SOCHET is related to an increase in TCHRCOL_LESSON by $0.054 \times 2.316 = 0.125$, which translates into 16.3% of one standard deviation of TCHRCOL_LESSON. Such a significant effect of SOCHET, however, does not exist on TCHRCOL_CLASS as shown in Table 5-2. It appears that teachers in countries characterized by socio-cultural heterogeneity tend to participate to a greater degree in collaborative lesson planning although not necessarily in collaborative classroom observation. In this respect, hypothesis 3 is partly supported, in which teachers in countries with a higher level of socio-cultural heterogeneity are expected to be more likely to engage in collaborative interaction with other teachers.

Concerning the five additional hypotheses, the significant positive association of CLIMATE with both TCHRCOL_LESSON and TCHRCOL_CLASS is very strong as reported in Tables 5-1 and 5-2. Teachers' collaborative interaction with other teachers appears to be more likely in schools with a more positive organizational climate, as suggested by hypothesis A1. Further, the effect of PRINLEAD is significant on TCHRCOL_CLASS although not on TCHRCOL_LESSON. This result partly supports hypothesis A2, in which it was expected that teachers' collaborative interaction with other teachers is more likely in schools where the principal's engagement in instruction-related activities is greater.

In addition, as indicated in Tables 5-1 and 5-2, CURRSTD at level 2 is also significantly positively connected to both TCHRCOL_LESSON and TCHRCOL_CLASS, supporting hypothesis A3 that teachers in countries with a more standardized national curriculum are more likely to engage in collaborative interaction with other teachers. It is also important to note that there is a cross-level interaction effect between CURRSTD at level 2 and UNC_TCHUNDS at level 1 on TCHRCOL_CLASS as shown in Table 5-2; further, similar cross-level interaction effects exist not only between the level-2 interaction term CURRSTD × EDEXPN and UNC_TCHUNDS at level 1 on TCHRCOL_LESSON, but also between the same level-2 interaction term and UNC_CONTEXT at level 1 on TCHRCOL_CLASS as reported in Tables 5-1 and 5-2, respectively. These significant cross-level interaction effects substantiate hypothesis A4 that the positive association between teachers' exposure to uncertainty in teaching and their engagement in collaborative interaction with other teachers is likely to be weaker in countries with a more standardized national curriculum. These results are also in alignment with the uncertainty management perspective in light of the possibility that the presence of a standardized national curriculum may alleviate a certain amount of uncertainty in teaching as the curriculum may serve as a safety net that teachers can depend on when making various decisions about their teaching.

Finally, Tables 5-1 and 5-2 show that the effect of INDVCUL at level 2 is not statistically significant on either TCHRCOL_LESSON or TCHRCOL_CLASS. Although a significant negative bivariate association exists between INDVCUL and TCHRCOL_CLASS as reported in Table 4-6 in chapter 4, such a significant effect disappears as other variables are introduced in the model. Thus, hypothesis A5 is not supported. It appears that a teacher's engagement in collaborative interaction with other colleague teachers is fairly independent of her/his country's individualist-collectivist cultural norms. However, this result does not preclude the possibility that teacher interaction may differ qualitatively, although not quantitatively, depending on varying individualist-collectivist cultural norms across countries.[43]

Table 5-3 reports the results from multilevel ordinal logistic regressions for TCHRCOL_VARIETY. The coefficients in this table indicate the amount of increase in the predicted ordered log odds of moving to the next higher level in TCHRCOL_VARIETY by a one-unit increase in an independent variable, with all other things in the model held constant. Similar to the findings reported in Tables 5-1 and 5-2, both UNC_TCHUNDS and UNC_CONTEXT are significantly positively related to

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43. See, e.g., Wang, Strong, and Odell's (2004) study, in which they found some qualitative differences between Chinese and U.S. mentor-novice conversations. For example, their data showed that U.S. mentor-novice pairs paid substantial attention to individual students, but their discussion about student issues was not very well connected to their reflections on teaching. Chinese mentor-novice pairs, on the other hand, talked much about subject matter in relation to teaching and student learning, but they tended to discuss students in groups or categories.

Table 5-3. Multilevel ordinal logistic regressions for TCHRCOL_VARIETY

	I				II			
Fixed effect	Coeff.	(*SE*)	OR		Coeff.	(*SE*)	OR	
Intercept, $\gamma 00$	-.019	(.214)	.981		-.038	(.181)	.963	
SOCHET, $\gamma 01$	.090	(.078)	1.094		.043	(.063)	1.044	
CURRSTD, $\gamma 02$					.323	(.084)	1.382	***
INDVCUL, $\gamma 03$					.076	(.070)	1.079	
EDEXPN, $\gamma 04$					-.139	(.150)	.870	
CURRSTD × EDEXPN, $\gamma 05$					.088	(.100)	1.092	
UNC_TCHUNDS, $\gamma 10$	.257	(.041)	1.293	***	.232	(.045)	1.262	***
× CURRSTD, $\gamma 11$					-.040	(.024)	.961	
× EDEXPN, $\gamma 12$					-.074	(.028)	.929	*
× CURRSTD × EDEXPN, $\gamma 13$					-.034	(.022)	.966	
UNC_CONTEXT, $\gamma 20$	.213	(.079)	1.237	**	.358	(.071)	1.430	***
× CURRSTD, $\gamma 21$					.011	(.031)	1.011	
× EDEXPN, $\gamma 22$					-.027	(.057)	.974	
× CURRSTD × EDEXPN, $\gamma 23$					-.116	(.033)	.890	**
CLIMATE, $\gamma 30$					.457	(.073)	1.579	***
PRINLEAD, $\gamma 40$					.117	(.028)	1.124	***
WORKLOAD, $\gamma 50$					.062	(.042)	1.064	
TCHREXP, $\gamma 60$					.013	(.028)	1.013	
MATHMJR, $\gamma 70$					.168	(.083)	1.182	*
FEMALE, $\gamma 80$					-.005	(.084)	.995	
Threshold difference, $\delta(2)$	3.258	(.127)	25.994	***	3.329	(.130)	27.907	***
Random effect	Var.	*df*	χ^2		Var.	*df*	χ^2	
Intercept, $u0j$	1.206	27	620.6	***	.839	23	223.1	***
UNC_TCHUNDS, $u1j$	.020	28	53.5	**	.039	25	46.8	**
UNC_CONTEXT, $u2j$	.085	29	77.8	***	.059	25	43.6	**
CLIMATE, $u3j$					.062	28	44.8	*
PRINLEAD, $u4j$					.010	28	46.3	*
WORKLOAD, $u5j$					.018	29	36.6	
TCHREXP, $u6j$					.011	29	79.0	***
MATHMJR, $u7j$					.088	29	28.1	
FEMALE, $u8j$					.099	29	39.7	+

Note. All independent variables are grand-mean-centered. Coeff. = Unstandardized ordered logit coefficients with robust standard errors in parentheses. OR = odds ratios.
+$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

TCHCOL_VARIETY. The ordered log-odds estimate for the effect of UNC_TCHUNDS is 0.232, which translates into exp(0.232) = 1.262 in terms of the odds ratio. Since one unit equals one standard deviation in UNC_TCHUNDS, it is possible to say that, for a one-standard-deviation increase in UNC_TCHUNDS, we can expect to see a 26.2% (= (1.262 – 1) × 100) increase in the odds of moving to the next higher level in TCHRCOL_VARIETY, after all other things in the model are taken into account. Similarly, the ordered log-odds estimate for the effect of UNC_CONTEXT is 0.358, which is equivalent to exp(0.358) = 1.430 in terms of the odds ratio. This means that a one-standard-deviation increase in UNC_CONTEXT corresponds to a 43.0% (= (1.430 – 1) × 100) increase in the odds of moving to the next higher level in TCHRCOL_VARIETY, after all other things in the model are controlled for. Thus, hypotheses 1 and 2 are corroborated.

However, the effect of national-level socio-cultural heterogeneity is insignificant in Table 5-3. That is, different from hypothesis 3, teachers' engagement in collaborative interaction appears to be fairly independent of the socio-cultural homogeneity-heterogeneity dimension of national context. Although there is a significant positive bivariate relationship between SOCHET and TCHRCOL_VARIETY as reported in Table 4-7 in chapter 4, the effect of SOCHET does not remain significant when a range of other variables are introduced in the model.

In addition, both CLIMATE and PRINLEAD are significantly positively related to TCHRCOL_VARIETY. In accordance with hypotheses A1 and A2, it appears that teachers are likely to engage in more varied types of collaborative interaction with other teachers if they work in a school where its organizational climate is more positive and/or principal instructional leadership is stronger. Also, the effect of CURRSTD is significantly positive, meaning that teachers in countries with a more standardized national curriculum are likely to collaborate with other teachers through more various types of collaborative interaction, which supports hypothesis A3. Further, there is a significant cross-level interaction effect between UNC_CONTEXT at level 1 and CURRSTD × EDEXPN at level 2, in alignment with hypothesis A4. That is, the positive association between teachers' exposure to classroom-contextual uncertainty and the range of collaborative interaction types in which they engage is likely to be weaker in countries with a more standardized national curriculum. Finally, INDVCUL is not in a significant relationship with TCHRCOL_VARIETY, indicating that how various the types of collaborative interaction in which a teacher participates is fairly independent of her/his country's individualist-collectivist cultural norms. This result does not support hypothesis A5 that teachers in countries with a more individualist culture would be less likely to engage in collaborative interaction with other teachers.

5.3. Discussion

The results from a series of multilevel regression analyses presented in this chapter support the possibility that, as expected from the uncertainty management perspective discussed in chapter 2, teacher collegiality may be related with teachers' collective effort to deal with uncertainties with which they are confronted in their teaching. The results suggest that teachers who place greater emphasis on instructional strategies to implement teaching for understanding, and thus confront greater instructional uncertainty, are more likely to engage in both collaborative lesson planning and collaborative classroom observation; in addition, they also tend to participate in more various types of collaborative interaction. Similarly, teachers who face greater classroom-contextual uncertainty tend to engage to a greater degree in collaborative classroom observation, and they are more likely to collaborate with other teachers through multiple types of collaborative interaction.

Further, teachers in countries with a higher level of socio-cultural heterogeneity are more likely to engage in collaborative lesson planning with other teachers. Considering that a higher level of socio-cultural heterogeneity of a country is likely to indicate a lower degree of societal-level value consensus with respect to various aspects of schooling as a social institution, it is not surprising from the uncertainty management perspective that teachers in socio-culturally more heterogeneous countries tend to collaborate to a greater degree with their colleague teachers in order to collectively manage the consequent uncertainty.

In addition, also notable is the strong and significant effect of school climate on collaborative interaction among teachers. Regardless of how to measure collaborative teacher interaction, the results from a series of multilevel regression analyses presented in this chapter substantiate a consistently strong positive association between school climate and teachers' engagement in collaborative interaction with their colleagues. Another clear pattern is the significant effect of national curriculum standardization on teachers' engagement in collaborative interaction, no matter how their collaborative interaction is measured. It appears that a standardized national curriculum may facilitate collaborative interaction among teachers insofar as it provides them with some shared technical language about teaching and learning.

At the same time, some results in this chapter indicate that the effect of teachers' exposure to uncertainty in teaching on their engagement in collaborative interaction with other teachers is likely to lessen in the presence of a highly standardized national curriculum. This sheds light on the possibility that the presence of a standardized national curriculum may alleviate a certain amount of uncertainty in teaching perceived by teachers to the degree to which the standardized curriculum may serve as a safety net that teachers can depend on when making various decisions about how to deal with a variety of uncertainties they confront in their classroom teaching.

Finally, it is very interesting that the results reported in this chapter do not support the popular hypothesis that collaborative teacher interaction is highly dependent on the degree to which the country has a collectivist culture as opposed to an individualist culture.[44] Of course, this insignificant effect does not preclude the possibility that teacher interaction may differ qualitatively depending on varying individualist-collectivist cultural norms across countries; however, it appears that, when a range of other factors are taken into account simultaneously, the effect of

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44. For example, Leonard and Leonard (2003) discuss the possibility that the culture of U.S. schools, embedded in the macro-culture of individualism in the United States, contributes to a low level of teacher collaboration. See also, e.g., Hofstede (2001) and Schein (1985) for further discussions.

societal individualism does not remain significant. Despite the popular assumption that the macro-culture of individualism in the United States is one of the important factors leading to a low level of collaboration among teachers in U.S. schools, this assumption is not corroborated by the results in this chapter.

In the next chapter, a set of regression analyses is performed based on the U.S.-only data in order to examine the case of the United States. Although the results reported in the present chapter provide valuable information about the nature of collaborative teacher interaction based on a hierarchically-structured international dataset, another series of analyses, conducted with all level-1 variables used in this chapter and some additional U.S.-specific contextual variables, will proffer further insights into collaborative teacher interaction within the context of the United States.

CHAPTER 6

ANALYSES OF THE CASE OF THE UNITED STATES

6.1. Within-U.S. Analyses

In this chapter, I conduct a series of analyses using the U.S. portion of the data to examine the case of the United States, where teachers' engagement in meaningful collaborative work around teaching has been reported to be the exception rather than the norm (Bryk & Schneider, 2002; Fullan & Hargreaves, 1996; Lortie, 2002; Rosenholtz, 1989). While the results reported in chapters 4 and 5 provide valuable information about the nature of collaborative teacher interaction based on a multinational dataset, this chapter aims to proffer further useful insights into collaborative teacher interaction within the context of the United States. As discussed in chapter 3, the availability of some additional U.S.-specific TIMSS data prepared by the National Center for Educational Statistics makes it possible to undertake a more fine-grained examination of collaborative interaction among U.S. teachers.

Tables 6-1 and 6-2 report the results from multiple regressions for TCHRCOL_LESSON and TCHRCOL_CLASS, respectively. Four different models are reported in each table. Model I includes all level-1 variables used in multilevel modeling in chapter 5 and two additional U.S.-specific variables, which are the *course taught* and the *school type*. Model II is identical to model I except that UNC_TCHUNDS and UNC_CONTEXT are replaced with the seven variables from which these two

Table 6-1. Ordinary least squares regressions for TCHRCOL_LESSON: The case of the United States

	I				II			
	B	(*SE*)	β		*B*	(*SE*)	β	
UNC_TCHUNDS	.171	(.052)	.163	***				
UNC_CONTEXT	.071	(.081)	.047					
TCHUNDS					.271	(.077)	.176	***
ACHIEVE					.064	(.117)	.043	
ACHIVAR					-.071	(.178)	-.023	
EDCAPIT					.029	(.080)	.034	
EDCAVAR					.126	(.075)	.121	+
LANGMIN					.034	(.036)	.049	
SHORTRES					-.051	(.085)	-.030	
CLIMATE	.206	(.070)	.145	**	.190	(.072)	.134	**
PRINLEAD	.005	(.025)	.010		.010	(.026)	.020	
WORKLOAD	.076	(.041)	.089	+	.072	(.041)	.085	+
TCHREXP	-.054	(.021)	-.125	**	-.051	(.021)	-.119	**
MATHMJR	.021	(.095)	.011		.034	(.096)	.017	
FEMALE	.194	(.097)	.096	*	.205	(.097)	.101	*
Course taught								
Basic math (ref.)								
Algebra	-.086	(.106)	-.042		-.101	(.107)	-.049	
Geometry	.416	(.354)	.059		.347	(.365)	.049	
Others	.045	(.265)	.009		.050	(.269)	.009	
School type								
Public (ref.)								
Private, religious	-.759	(.153)	-.254	***	-.729	(.158)	-.245	***
Private, others	-.498	(.224)	-.110	*	-.486	(.235)	-.108	*
Free or reduced-price lunch								
Intercept	.520	(.293) +			-.690	(.763)		
R^2		.18				.20		
n		392				392		

Note. *B* = Unstandardized coefficients with standard errors in parentheses. β = standardized coefficients. Ref. = reference category.
$+p \leq .10$; $*p \leq .05$; $**p \leq .01$; $***p \leq .001$.

Table 6-1. (cont'd)

	III				IV			
	B	(*SE*)	β		*B*	(*SE*)	β	
UNC_TCHUNDS	.162	(.053)	.152	**				
UNC_CONTEXT	.081	(.100)	.053					
TCHUNDS					.265	(.081)	.169	***
ACHIEVE					.050	(.123)	.034	
ACHIVAR					-.120	(.196)	-.038	
EDCAPIT					.022	(.090)	.025	
EDCAVAR					.138	(.080)	.129	+
LANGMIN					.035	(.038)	.050	
SHORTRES					-.037	(.089)	-.022	
CLIMATE	.223	(.073)	.156	**	.206	(.074)	.144	**
PRINLEAD	-.003	(.026)	-.006		.002	(.026)	.004	
WORKLOAD	.090	(.043)	.106	*	.087	(.043)	.102	*
TCHREXP	-.059	(.021)	-.138	**	-.054	(.022)	-.126	**
MATHMJR	.059	(.098)	.030		.074	(.099)	.038	
FEMALE	.209	(.100)	.103	*	.215	(.100)	.106	*
Course taught								
Basic math (ref.)								
Algebra	-.081	(.109)	-.040		-.093	(.111)	-.045	
Geometry	.424	(.362)	.061		.347	(.372)	.050	
Others	.072	(.278)	.013		.065	(.283)	.012	
School type								
Public (ref.)								
Private, religious	-.702	(.168)	-.225	***	-.678	(.173)	-.217	***
Private, others	.008	(.353)	.001		.043	(.356)	.006	
Free or reduced-price lunch	-.002	(.021)	-.006		-.007	(.023)	-.023	
Intercept	.468	(.330)			-.590	(.861)		
R^2		.17				.18		
n		377				377		

composite factors have been constructed as presented in Table 3-1 in chapter 3. Finally, models III and IV are identical to models I and II, respectively, except that one additional U.S.-specific contextual variable, the *proportion of free or reduced-price lunch recipients*, is added to these models as a measure of school-level poverty.[45] It should be noted that models III and IV have a slightly smaller sample size than models I and II because data for this newly added variable are available only for public and nonprofit private schools.[46]

A very clear pattern is the significant effect of UNC_TCHUNDS across different models. With all other things held constant, UNC_TCHUNDS is in a significant positive relationship with both TCHRCOL_LESSON and TCHRCOL_CLASS, indicating that teachers who face greater instructional uncertainty due to their effort to implement teaching for understanding tend to engage to a greater degree in both collaborative lesson planning and collaborative classroom observation. The standardized regression coefficient for UNC_TCHUNDS in model I in Table 6-1 indicates that, for a one-standard-deviation increase in UNC_TCHUNDS, we can expect an increase in TCHRCOL_LESSON by 16.3% of one standard deviation. This is higher than the estimate of 13.5% based on the international data analyzed in chapter 5. Similarly, model I in Table 6-2 indicates that, for a one-standard-deviation increase in UNC_TCHUNDS, the amount of expected increase in TCHRCOL_CLASS is 19.7% of

45. For detailed information about these U.S.-specific variables, see chapter 3 (section 3.3.4).

46. That is, the National School Lunch Program operates in public and nonprofit private schools.

Table 6-2. Ordinary least squares regressions for TCHRCOL_CLASS: The case of the United States

	I				II			
	B	(*SE*)	β		*B*	(*SE*)	β	
UNC_TCHUNDS	.116	(.029)	.197	***				
UNC_CONTEXT	.197	(.046)	.232	***				
TCHUNDS					.190	(.044)	.220	***
ACHIEVE					-.099	(.066)	-.119	
ACHIVAR					.027	(.101)	.016	
EDCAPIT					-.055	(.045)	-.116	
EDCAVAR					-.017	(.043)	-.028	
LANGMIN					-.004	(.020)	-.009	
SHORTRES					.115	(.049)	.121	*
CLIMATE	.090	(.040)	.114	*	.107	(.041)	.134	**
PRINLEAD	.003	(.014)	.009		.000	(.015)	.002	
WORKLOAD	-.025	(.024)	-.053		-.025	(.024)	-.053	
TCHREXP	.004	(.012)	.018		.005	(.012)	.020	
MATHMJR	-.012	(.054)	-.011		-.015	(.055)	-.014	
FEMALE	.029	(.055)	.026		.028	(.056)	.025	
Course taught								
Basic math (ref.)								
Algebra	.012	(.061)	.011		.020	(.061)	.017	
Geometry	.797	(.202)	.200	***	.736	(.208)	.185	***
Others	.393	(.151)	.133	**	.372	(.153)	.126	*
School type								
Public (ref.)								
Private, religious	-.017	(.087)	-.010		-.021	(.090)	-.013	
Private, others	.332	(.128)	.131	**	.336	(.134)	.133	**
Free or reduced-price lunch								
Intercept	-.007	(.167)			.374	(.435)		
R^2		.16				.17		
n		392				392		

Note. *B* = Unstandardized coefficients with standard errors in parentheses. β = standardized coefficients. Ref. = reference category.

+$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

Table 6-2. (cont'd)

	III			IV		
	B	(*SE*)	β	*B*	(*SE*)	β
UNC_TCHUNDS	.093	(.029)	.161 **			
UNC_CONTEXT	.155	(.055)	.189 **			
TCHUNDS				.138	(.044)	.163 **
ACHIEVE				-.024	(.068)	-.030
ACHIVAR				.103	(.108)	.060
EDCAPIT				-.048	(.049)	-.102
EDCAVAR				.005	(.044)	.009
LANGMIN				-.024	(.021)	-.065
SHORTRES				.128	(.049)	.140 **
CLIMATE	.105	(.040)	.136 **	.122	(.041)	.159 **
PRINLEAD	.000	(.014)	.001	-.002	(.015)	-.006
WORKLOAD	-.028	(.023)	-.060	-.027	(.024)	-.060
TCHREXP	.001	(.012)	.004	.001	(.012)	.002
MATHMJR	-.022	(.053)	-.021	-.033	(.054)	-.031
FEMALE	.084	(.055)	.077	.082	(.055)	.075
Course taught						
Basic math (ref.)						
Algebra	.004	(.060)	.003	.000	(.061)	.000
Geometry	.776	(.198)	.206 ***	.704	(.204)	.187 ***
Others	.336	(.152)	.115 *	.279	(.155)	.096 +
School type						
Public (ref.)						
Private, religious	-.012	(.092)	-.007	.000	(.095)	.000
Private, others	.239	(.193)	.062	.252	(.195)	.066
Free or reduced-price lunch	.017	(.011)	.100	.018	(.012)	.104
Intercept	-.164	(.181)		-.202	(.472)	
R^2		.14			.16	
n		377			377	

one standard deviation. This is much higher than the estimate of a 9.0% increase based on the international data analyzed in chapter 5. These results suggest the possibility that the effect of teachers' effort to implement teaching for understanding on their engagement in collaborative interaction is stronger in the United States than in a majority of other countries.[47] Thus, hypothesis 1 is strongly supported.

Another related finding is the significant association between UNC_CONTEXT and TCHRCOL_CLASS, indicating that teachers who face greater classroom-contextual uncertainty tend to engage to a greater degree in collaborative classroom observation. As reported in model I in Table 6-2, a one-standard-deviation increase in UNC_CONTEXT is significantly associated with an expected increase in TCHRCOL_CLASS by 23.2% of one standard deviation. Again, this is higher than the estimate of a 15.1% increase based on the international data analyzed in chapter 5. Although UNC_CONTEXT does not appear to have a significant effect on TCHRCOL_LESSON as shown in model I in Table 6-1, model II in the same table indicates that EDCAVAR has a significantly positive relationship with TCHRCOL_LESSON. This means that teachers confronted with greater student heterogeneity in terms of socioeconomic background tend to engage more in collaborative lesson planning. With all other things in the model held constant, a one-standard-deviation increase in EDCAVAR is significantly associated with an expected increase in TCHRCOL_LESSON by 12.1% of one standard deviation. These results

47. This possibility is substantiated by the results from a set of further analyses conducted in the next section of this chapter (section 6.2).

provide evidence to substantiate the relationship between teachers' exposure to classroom-contextual uncertainties and their engagement in collaborative interaction with other colleague teachers. Thus, hypothesis 2 is largely supported, in which teachers who face greater classroom-contextual uncertainty are expected to exhibit greater engagement in collaborative interaction with other teachers.

In addition to these findings supporting the primary hypotheses of this study, a noticeable pattern shown in Tables 6-1 and 6-2 is the significant effect of CLIMATE on both TCHRCOL_LESSON and TCHRCOL_CLASS. Such a significant relationship is evident across all models in Tables 6-1 and 6-2, with the standardized regression coefficients ranging from 0.134 to 0.156 in Table 6-1 and from 0.114 to 0.159 in Table 6-2. These results mean that, for every one-standard-deviation increase in CLIMATE, one can expect an increase in TCHRCOL_LESSON by at least about 13% of one standard deviation and an increase in TCHRCOL_CLASS by at least about 11% of one standard deviation, after various other things are controlled for. This supports hypothesis A1 that teachers' collaborative interaction with other teachers is more likely in schools with a more positive organizational climate.

It is also notable that there are some teacher characteristics that are significantly related to teachers' engagement in collaborative lesson planning. As reported in Table 6-1, with all other things in the model held constant, female teachers tend to engage more in collaborative lesson planning than male teachers, introducing the possibility that male teachers are isolated from their colleagues to a greater degree than are female teachers. Further, it appears that teachers who have been in the profession of teaching for a longer period of years tend to engage less in collaborative lesson planning. One plausible explanation on the basis of the uncertainty management perspective is that the amount of uncertainty felt by a teacher in a given complex situation may be gradually reduced as she/he stays longer in the profession of teaching; this is because teachers with more experience tend to have a greater amount of "situated knowledge and expertise in teaching" (Leinhardt, 1988), with which they can better manage their uncertainty without seeking help from other teachers. Finally, teachers with more workload appear to engage to a greater extent in collaborative lesson planning. This result seems counterintuitive because one might plausibly expect heavy workload to be a factor that deters teachers from engaging in collaborative interaction with other teachers. However, from the uncertainty management perspective, this result is not surprising, for it is very likely that teachers confront a greater amount of task uncertainty as their workload becomes heavier; in other words, they may want to deal with the uncertainty caused by the complexity and diversity of tasks by collaborating with their colleagues.

Also, some difference is observed among eighth-grade mathematics teachers in their engagement in collaborative classroom observation depending on which mathematics subject one teaches. With all other things in the model being equal, geometry teachers appear to participate to a greater degree in collaborative classroom observation than teachers who teach basic eighth-grade mathematics, while no significant difference is observed between algebra teachers and basic eighth-grade mathematics teachers. Although it is unclear why such a significant difference is found, this result points to the possibility that there may be varying degrees of collegiality among teachers depending on certain characteristics of the curricular content they teach.[48]

With respect to the effect of the school type, teachers working in religiously-affiliated private schools appear to engage to a significantly lesser degree in collaborative lesson planning when compared to teachers working in public schools, as reported in Table 6-1; in addition, they do not participate to a greater degree in collaborative classroom observation as shown in Table 6-2. These results contrast with the popular belief that private schools are more likely to be places where teachers collaboratively build and sustain professional communities than are public schools. Although further investigation is necessary, one possible explanation may be that teachers working in religiously-affiliated private schools already share a relatively clear teaching philosophy, which lessens the perceived need to seek help or advice from other teachers.[49]

Finally, all these patterns reported in models I and II in Tables 6-1 and 6-2 do not

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48. Although further systematic studies are needed to substantiate this possibility, it is notable that the standardized regression coefficient for "geometry" is even greater than that for CLIMATE in all models in Tables 6-1 and 6-2. Given the strong and stable relationship between a positive school climate and collaborative teacher interaction, an even stronger association observed between geometry teaching and the level of engagement in collaborative teacher interaction is very interesting. It would be a useful future study to examine this relationship more closely.

49. As another possibility, teachers working in religiously-affiliated private schools may have significantly more extra duties at school other than classroom teaching, resulting in different forms or patterns of collaborative teacher interaction that are not adequately captured by the notion of collaborative lesson planning or collaborative classroom observation.

change even if the proportion of free or reduced-price lunch recipients, a school-level poverty measure, is newly introduced to each model. Both the statistical significance level and the magnitude of effect of each independent variable little differ between model I and model III and between model II and model IV in either table.[50] It appears that after controlling for a range of classroom-level socioeconomic contextual variables, school-level poverty is not a significant factor related to collaborative teacher interaction patterns.

Table 6-3 reports the results from a set of ordinal logistic regressions for TCHRCOL_VARIETY. The coefficients in this table indicate the amount of increase in the predicted ordered log odds of moving to the next higher level in TCHRCOL_VARIETY by a one-unit increase in an independent variable, with the other things in the model held constant. Similar to the findings reported in Tables 6-1 and 6-2, both UNC_TCHUNDS and UNC_CONTEXT are significantly positively related to TCHCOL_VARIETY. That is, in accordance with hypotheses 1 and 2, it appears that teachers who face greater instructional uncertainty and/or classroom-contextual uncertainty are likely to participate in more varied types of collaborative teacher

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50. In models II and IV of Tables 6-1, 6-2, and 6-3, ACHIEVE, ACHIVAR, EDCAPIT, EDCAVAR, LANGMIN, and SHORTRES, which are considerably inter-correlated to one another as evident in the factor analysis reported in Table 3-1 in chapter 3 where they all are heavily loaded on UNC_CONTEXT, appear to have statistically less significant effects than expected from the uncertainty management perspective. This seems to be largely due to the multicollinearity among these variables. If one of these variables is entered into a regression equation at a time, with all other things remaining unchanged in the model, the effects of these variables become more discernible, especially in the regressions for TCHRCOL_CLASS. See Table A7 in the Appendix.

Table 6-3. Ordinal logistic regressions for TCHRCOL_VARIETY: The case of the United States

	I				II			
	B	(*SE*)	OR		*B*	(*SE*)	OR	
UNC_TCHUNDS	.418	(.129)	1.518	***				
UNC_CONTEXT	.532	(.202)	1.702	**				
TCHUNDS					.704	(.194)	2.023	***
ACHIEVE					-.442	(.292)	.643	
ACHIVAR					-.282	(.443)	.755	
EDCAPIT					-.180	(.202)	.835	
EDCAVAR					-.093	(.189)	.911	
LANGMIN					.026	(.088)	1.027	
SHORTRES					.112	(.212)	1.119	
CLIMATE	.509	(.175)	1.663	**	.527	(.179)	1.695	**
PRINLEAD	.048	(.062)	1.049		.036	(.063)	1.037	
WORKLOAD	.102	(.102)	1.107		.103	(.102)	1.108	
TCHREXP	-.076	(.051)	.927		-.077	(.052)	.926	
MATHMJR	-.333	(.233)	.717		-.286	(.237)	.751	
FEMALE	.417	(.240)	1.517	+	.428	(.243)	1.535	+
Course taught								
Basic math (ref.)								
Algebra	-.274	(.261)	.760		-.212	(.264)	.809	
Geometry	2.398	(.938)	11.005	**	2.332	(.969)	10.295	*
Others	.887	(.659)	2.427		1.014	(.673)	2.758	
School type								
Public (ref.)								
Private, religious	-2.264	(.398)	.104	***	-2.272	(.413)	.103	***
Private, others	.801	(.544)	2.227		.792	(.578)	2.207	
Free or reduced-price lunch								
Threshold 1	-.469	(.721)			-2.833	(1.963)		
Threshold 2	2.740	(.736) ***			.406	(1.959)		
Nagelkerke R^2		.27				.28		
n		392				392		

Note. *B* = Unstandardized ordered logit coefficients with standard errors in parentheses. OR = odds ratios. Ref. = reference category.
$+p \le .10$; $*p \le .05$; $**p \le .01$; $***p \le .001$.

Table 6-3. (cont'd)

	III				IV			
	B	(*SE*)	OR		*B*	(*SE*)	OR	
UNC_TCHUNDS	.351	(.131)	1.421	**				
UNC_CONTEXT	.275	(.242)	1.316					
TCHUNDS					.577	(.198)	1.780	**
ACHIEVE					-.353	(.301)	.703	
ACHIVAR					-.227	(.478)	.797	
EDCAPIT					-.056	(.222)	.946	
EDCAVAR					-.031	(.196)	.969	
LANGMIN					-.026	(.091)	.974	
SHORTRES					.146	(.217)	1.158	
CLIMATE	.571	(.179)	1.770	***	.585	(.183)	1.796	***
PRINLEAD	.013	(.063)	1.013		.007	(.064)	1.007	
WORKLOAD	.117	(.104)	1.124		.115	(.104)	1.122	
TCHREXP	-.094	(.052)	.910	+	-.093	(.053)	.911	+
MATHMJR	-.283	(.236)	.753		-.254	(.241)	.775	
FEMALE	.575	(.245)	1.776	*	.549	(.247)	1.732	*
Course taught								
Basic math (ref.)								
Algebra	-.322	(.264)	.725		-.266	(.267)	.766	
Geometry	2.224	(.947)	9.242	*	2.197	(.973)	8.995	*
Others	.899	(.668)	2.458		.914	(.683)	2.495	
School type								
Public (ref.)								
Private, religious	-1.976	(.419)	.139	***	-1.995	(.432)	.136	***
Private, others	1.392	(.841)	4.024	+	1.384	(.852)	3.990	+
Free or reduced-price lunch	.097	(.051)	1.102	+	.083	(.055)	1.086	
Threshold 1	.274	(.797)			-1.032	(2.126)		
Threshold 2	3.488	(.824) ***			2.191	(2.132)		
Nagelkerke R^2		.24				.25		
n		377				377		

interaction. The ordered log-odds estimate for the effect of UNC_TCHUNDS is 0.418, which translates into exp(0.418) = 1.518 in terms of the odds ratio. Thus, it is possible to say that, for every one-unit increase in UNC_TCHUNDS, we can expect a 51.8% (=(1.518 – 1) × 100) increase in the odds of moving to the next higher level in TCHRCOL_VARIETY, with all other things in the model held constant. Also, the ordered log-odds estimate for the effect of UNC_CONTEXT is 0.532, which is equivalent to exp(0.532) = 1.702 in terms of the odds ratio. This means that a one-unit increase in UNC_CONTEXT is associated with a 70.2% (= (1.702 – 1) × 100) increase in the odds of moving to the next higher level in TCHRCOL_VARIETY, after all other things in the model are controlled for. In addition, also notable is the significant positive association of CLIMATE with TCHRCOL_VARIETY. As expected by hypothesis A1, it appears that teachers are likely to engage in more various types of collaborative interaction with their colleague teachers when they work in schools where teacher morale is high and organizational goals are clearly communicated and well implemented.

6.2. Comparison with Other Countries

Figures 6-1 and 6-2 show standardized beta coefficients for UNC_TCHUNDS and UNC_CONTEXT estimated by ordinary least squares regressions conduced within each country in the sample. Each within-nation analysis includes all other level-1 variables (i.e., school climate, principal's instructional leadership, teacher workload,

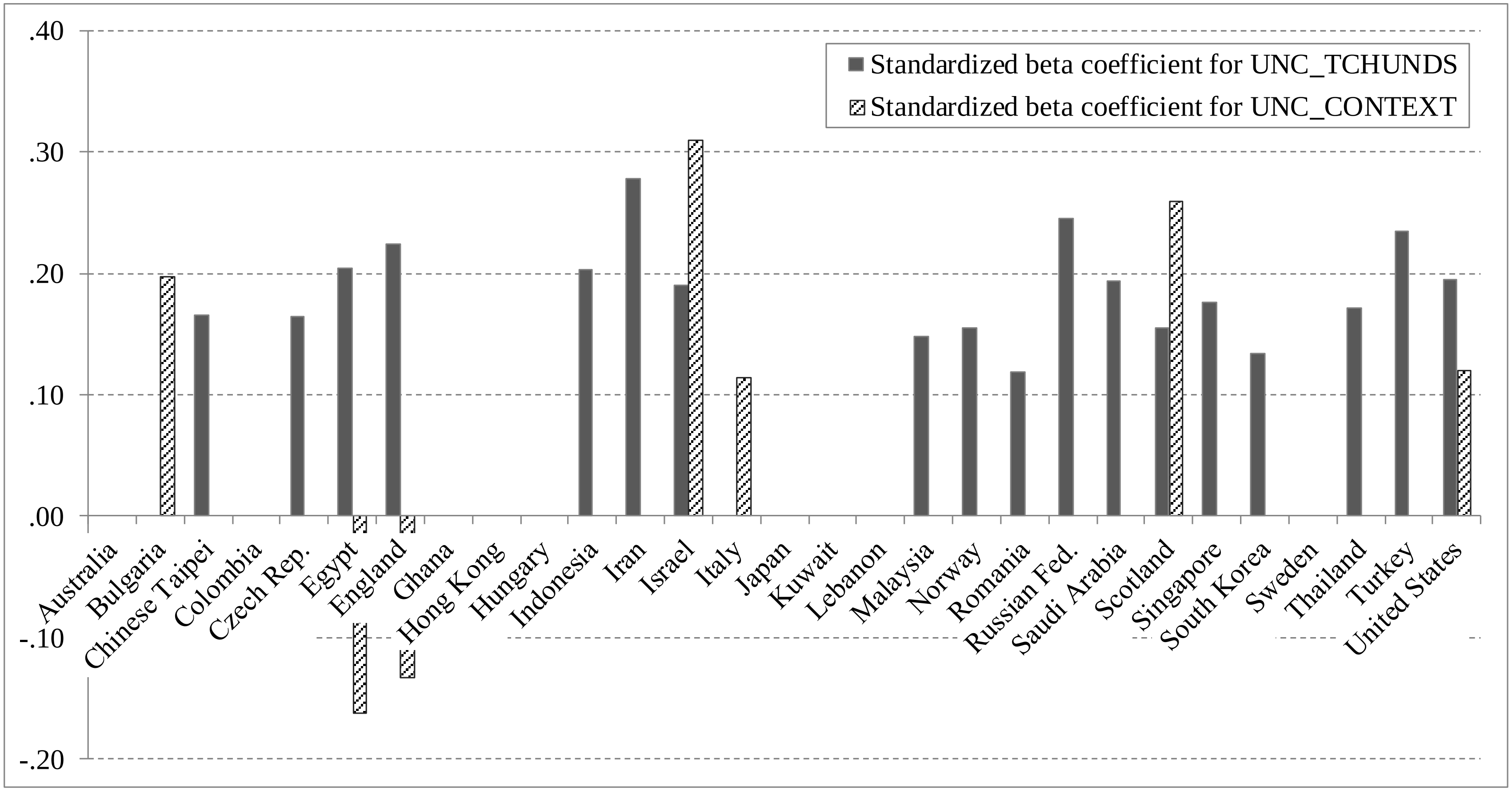

Figure 6-1. Within-nation ordinary least squares regressions for TCHRCOL_LESSON: Standardized coefficients for UNC_TCHUNDS and UNC_CONTEXT. *Note* . Independent variables included in the model are CLIMATE, PRINLEAD, WORKLOAD, TCHREXP, MATHMJR, and FEMALE, in addition to UNC_TCHUNDS and UNC_CONTEXT. Statistically insignificant results are not reported. Full results are available in Table A8 in the Appendix.

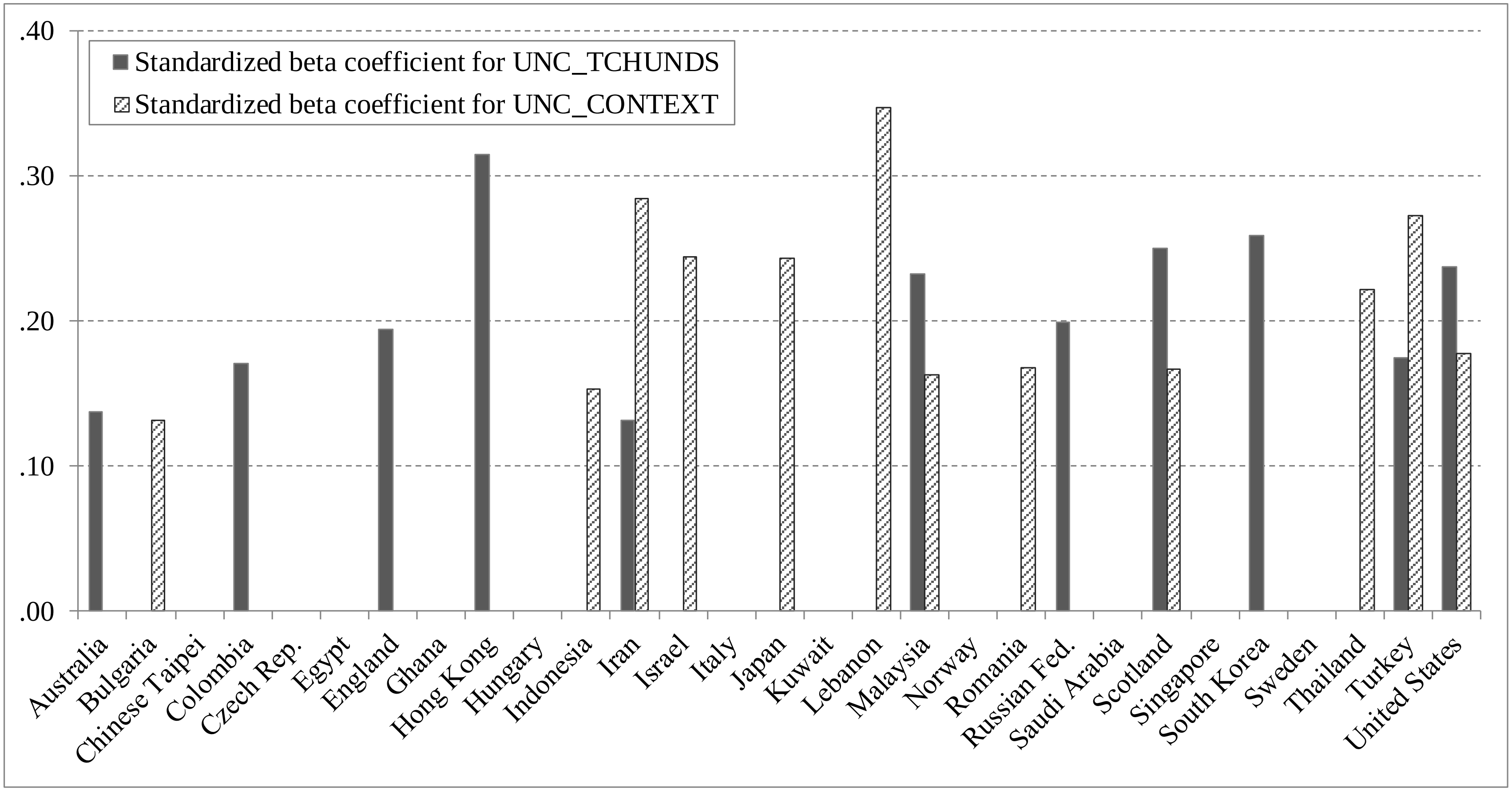

Figure 6-2. Within-nation ordinary least squares regressions for TCHRCOL_CLASS: Standardized coefficients for UNC_TCHUNDS and UNC_CONTEXT. *Note* . Independent variables included in the model are CLIMATE, PRINLEAD, WORKLOAD, TCHREXP, MATHMJR, and FEMALE, in addition to UNC_TCHUNDS and UNC_CONTEXT. Statistically insignificant results are not reported. Full results are available in Table A9 in the Appendix.

teacher experience, mathematics major, and female teacher) as control variables in order to allow a cross-national comparison of the extent to which teachers' exposure to uncertainty in teaching is significantly related to collaborative lesson planning and collaborative classroom observation, even after a range of factors are taken into account.[51] The results reported in Figures 6-1 and 6-2 indicate that one or both of UNC_TCHUNDS and UNC_CONTEXT are significantly positively associated with collaborative lesson planning and/or collaborative classroom observation in a majority of countries in the sample, which is in accordance with the results obtained from the multilevel modeling analyses conduced in chapter 5. A very interesting finding is that the United States is one of only two countries where both of these uncertainty measures are significantly positively connected to both collaborative lesson planning and collaborative classroom observation, after all the aforementioned control variables are included in the regression model. Such a robust relationship between these uncertainty measures and collaborative teacher interaction within the context of the United States suggests that the uncertainty management perspective is very important in explaining the case of the United States.

Similarly, Figure 6-3 reports ordered odds ratios for UNC_TCHUNDS and UNC_CONTEXT estimated by ordinal logistic regressions conduced within each country, after all other level-1 variables are also included in the model. The patterns shown in Figure 6-3 are not very different from those in Figures 6-1 and 6-2. In most of

51. In order to make the regression model identical across all countries in the sample, the U.S.-specific variables used in the previous section (section 6.1) were not used here when analyzing the U.S. data.

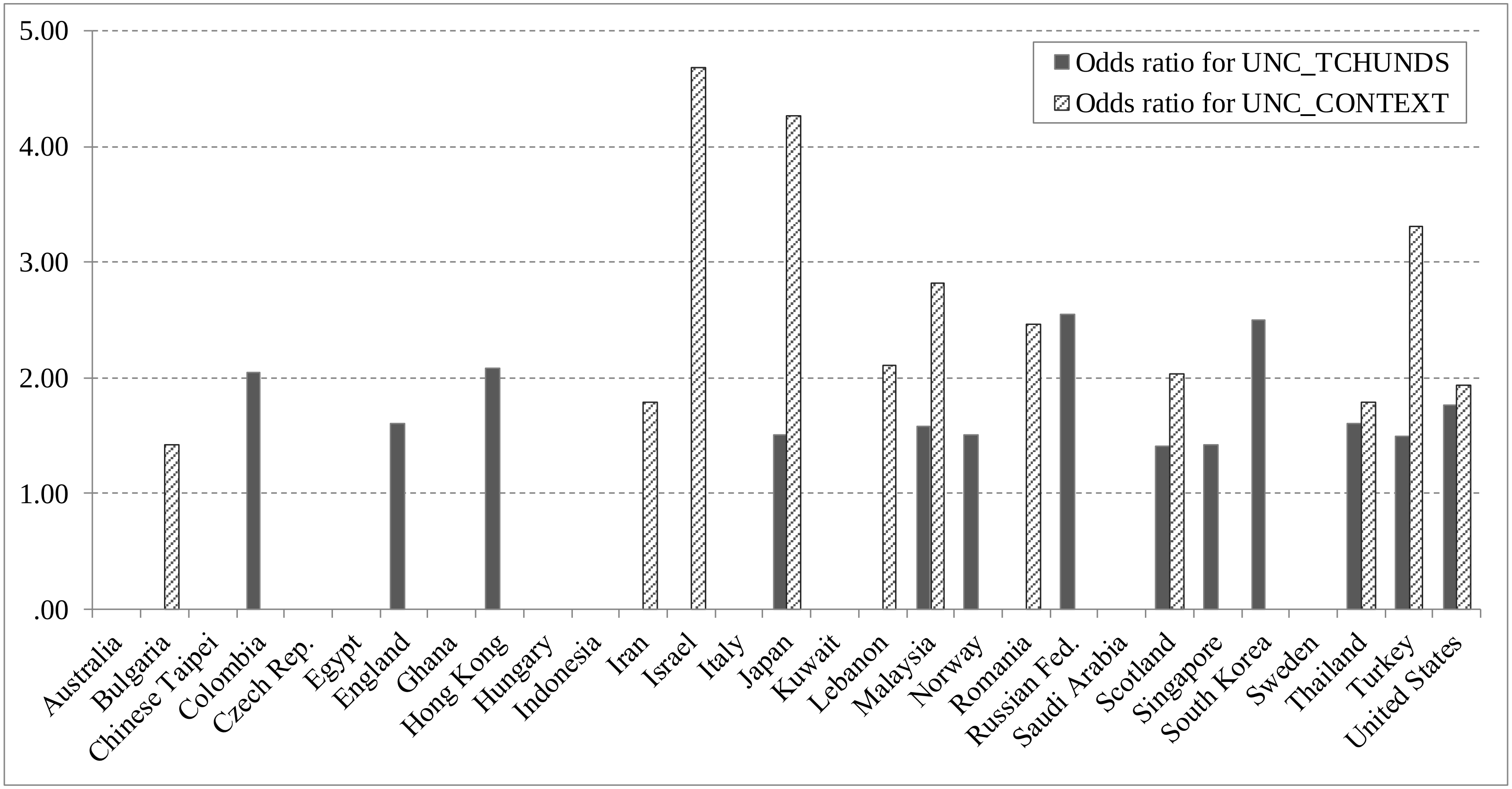

Figure 6-3. Within-nation ordinal logistic regressions for TCHRCOL_VARIETY: Odds ratios for UNC_TCHUNDS and UNC_CONTEXT. *Note* . Independent variables included in the model are CLIMATE, PRINLEAD, WORKLOAD, TCHREXP, MATHMJR, and FEMALE, in addition to UNC_TCHUNDS and UNC_CONTEXT. Statistically insignificant results are not reported. Full results are available in Table A10 in the Appendix.

the countries in the sample, teachers' exposure to uncertainty from teaching for understanding and/or uncertainty from classroom-contextual factors is in significant positive relationships with the extent to which they regularly engage in multiple types of collaborative interaction with other teachers. All significant odds ratios are greater than one, indicating that no country in the sample shows a significantly negative association of either UNC_TCHUNDS or UNC_CONTEXT with the degree to which teachers collaborate through varied types of teacher interaction. In addition, the United States is one of only six countries where both of these uncertainty measures turn out to be significantly positive, after all other level-1 variables are taken into account. This result once again highlights the importance of the uncertainty management perspective to understand the nature of collaborative interaction among teachers within the context of the United States.

Overall, teachers in many countries in the sample appear to exhibit a greater level of engagement in collaborative interaction with other teachers as the level of uncertainty they face in their teaching becomes higher. The significant relationship between teachers' exposure to uncertainty in teaching and their participation in collaborative interaction with other teachers is particularly strong in the United States compared to many other countries in the sample. Such a strong relationship observed in the United States sheds light on the uncertainty management perspective in which collaborative interaction among teachers is understood as a collective effort to make sense of, and lessen, their feelings of discomfort with the perceived elements of uncertainty in their teaching, whereby they can better manage to go through given situations of uncertainty rather than simply choosing to either avoid or ignore those situations.

6.3. Discussion

The results from a series of regression analyses presented in this chapter are not very different the findings from the international data reported in chapter 5. The U.S.-only data analyzed in the present chapter also give credence to the uncertainty management perspective in which teacher collegiality is assumed to be related with teachers' collective effort to deal with uncertainties in their teaching. The results in this chapter shed light on the possibility that teachers who exert greater effort to implement teaching for understanding and thus confront greater instructional uncertainty may engage to a greater degree in both collaborative lesson planning and collaborative classroom observation; in addition, these teachers seem to collaborate with other teachers through more various types of interaction. Similarly, teachers who face greater classroom-contextual uncertainty appear to be more likely to engage in collaborative classroom observation, and they tend to participate in more various types of collaborative interaction.

In addition, comparison of these results with the findings from the multilevel cross-national analyses conducted in chapter 5 suggests that the magnitude of the significant effect of teachers' exposure to uncertainty in teaching, in terms of either instructional uncertainty or classroom-contextual uncertainty, is larger in the United

States than in most other countries in the sample; this is further substantiated by direct comparison of the case of the United States with other countries in the sample. Although further research is needed to explain why this is the case, this result reaffirms the significance of the uncertainty management perspective to unravel the nature of collaborative teacher interaction within the context of the United States.

Also noticeable is the significant and persistent association of school climate with collaborative teacher interaction. Regardless of how to measure collaborative teacher interaction, the results from a series of regression analyses presented in this chapter indicate a strong relationship between school climate and teachers' engagement in collaborative interaction with their colleagues. However, the results reported in this chapter do not show a significant effect of principal instructional leadership. This insignificant effect contrasts with the findings from the multilevel cross-national analyses performed in chapter 5, where a significant positive connection was found between principal instructional leadership and both collaborative classroom observation and variety in collaborative interaction. The insignificant effect of principal instructional leadership in the United States may be in part because many principals do not have strong confidence in their knowledge about the practice of teaching; as shown in Lortie's (2009) analysis of principals' perception of difficulties in their tasks, principals in the United States frequently feel uncertain about the soundness of their judgments when they supervise teachers' instructional practices. Considering the limited amount of useful instructional suggestions principals can actually provide to teachers, principals' instructional leadership behaviors are unlikely to have a strong and sustained effect on unifying teachers into a cohesive inquiry community.[52]

52. To clarify why the effect of principal instructional leadership is insignificant in the U.S.-only data while significant in the international data, it would be a useful future study to closely examine how the effect of principal instructional leadership varies depending on various factors, including principal characteristics and school-level and national-level contextual variables.

CHAPTER 7

CONCLUSION AND DISCUSSION

7.1. Summary of the Findings

The primary aim of this study was to explore how collaborative teacher interaction is contingent upon teachers' immediate classroom and school contexts as well as broader societal and policy environments. Although much research has identified "the collaboration associated with a professional community of teachers as a key element of successful schools" (Darling-Hammond, 2010, p. 261), little systematic effort has been made to understand what types of teachers, under what contextual conditions, are likely to show a greater tendency to build and/or sustain collegial relationships with other teachers. In order to develop concrete ideas about formulating administrative and policy strategies to promote the beneficial effects of teacher collegiality, it is important to have a comprehensive knowledge base about how the level and type of collaborative teacher interaction varies depending on various factors at multiple levels ranging from teacher-level variables capturing individual characteristics to national-level contextual variables describing socio-cultural and policy environments.

In order to understand better a range of multilevel contextual factors associated with collaborative teacher interaction, I considered various independent variables based on five different conceptual perspectives – a school climate perspective, a principal instructional leadership perspective, a curriculum policy perspective, a national culture perspective, and an uncertainty management perspective. In particular, this study intended to both elaborate and test an uncertainty management perspective as a theoretical framework for understanding teacher collegiality. The other four perspectives, which are some of the most promising conventional accounts of teacher collegiality as a dependent variable, were also considered to see if a set of primary hypotheses derived from the uncertainty management perspective is empirically supported even after some other plausible hypotheses are simultaneously taken into account.

The data for this study came primarily from the TIMSS 2007 eighth-grade mathematics dataset. This quantitative dataset, chiefly known for its student achievement data across various countries, also contains extensive contextual information about schools and classes, including useful data on collaborative teacher interaction. This dataset was linked to a set of national-level contextual data from multiple sources.[53] In order to examine a series of hypotheses derived from the five different perspectives, this study first involved a range of descriptive and cross-national multilevel analyses. Then, another set of within-U.S. analyses was conducted to examine closely the case of the United States, where teachers' engagement in meaningful collaborative work around teaching has been known to be the exception

53. For a summary of the variables used in this study and their data sources, see Table 3-2 in chapter 3. See also Tables 3-3 and 3-4 for the descriptive statistics of the variables.

rather than the norm (Bryk & Schneider, 2002; Fullan & Hargreaves, 1996; Lortie, 2002; Rosenholtz, 1989).

Overall, the findings from this study support an uncertainty management perspective which understands collegiality largely as a byproduct of the collective sensemaking of uncertainties.[54] With this view of uncertainty, collegiality is assumed to reduce organizational members' feelings of discomfort with given uncertain situations and thus help them manage those situations. Extensive international and U.S.-only data analyzed in the present study give credence to the view that teacher collegiality has to do with teachers' collective effort to deal with various uncertainties they face in their teaching. This sheds light on the possibility that lateral collegial relationships among teachers may serve as a source of information processing, sensemaking, and problem-solving, whereby teachers can better manage to go through given situations of uncertainty rather than simply trying to avoid those situations.

Indeed, much literature has shown that the practice of teaching is, by nature, context-specific and full of situated-complexities, so that it cannot always be theorized in a generic way of explanation (Lampert, 2001; Munthe, 2007; Putnam & Borko, 2000; Wood, et al., 1990); further, teachers are always confronted with the vivid realities of classroom teaching that are often inexplicable in terms of theoretical conceptualizations of educational practice (Floden & Buchmann, 1993; Floden & Clark, 1988; Kennedy, 2005; Labaree, 2000). Although it is important to understand teaching as an inherently

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54. For a summary of all statistical results of the present study, see Table A11 in the Appendix.

uncertain task, this study postulates that the amount of uncertainty teachers confront in their classroom teaching may vary depending on the instructional strategies they try to incorporate into their teaching practice and the classroom contexts in which they are positioned to implement their teaching, which this study conceptualizes as instructional and classroom-contextual uncertainty, respectively.

More specifically, it appears that teachers who exert greater effort to implement instructional strategies to promote students' engagement in inquiry-based learning and understanding tend to engage to a greater degree in collaborative interaction with their colleague teachers. Unlike conventional teaching accompanied by a range of readily available routines that teachers can draw upon, an alternative way of teaching that may be called "teaching for understanding" (D. K. Cohen, et al., 1993; Gamoran, et al., 2000; Wiske, 1998) requires teacher knowledge that goes beyond knowing the prescribed curricular content supposed to be delivered to students (Hiebert & Carpenter, 1992; McLaughlin & Talbert, 1993). From teachers' point of view, there are, in fact, considerable advantages to conventional teaching in the sense that it may help protect them from instructional uncertainties that could emerge from unexpected ideas and responses from students; this accounts for why many teachers often try to find "an optimal level of student engagement" (Kennedy, 2005, p. 183) rather than encouraging students towards deeper intellectual engagement (Silver, et al., 2009). As teachers put greater emphasis on teaching for understanding, they must confront greater instructional uncertainty because teaching becomes inevitably less reducible to predictable routines. As a result, it is likely that these teachers engage to a greater degree in collaborative interaction with their colleagues in order to share in the effort to manage the consequent uncertainty in teaching. Both across countries and in the United States, the findings from this study indicate that the greater the effort teachers put on incorporating instructional strategies for teaching for understanding into their classroom teaching, the more they tend to engage in collaborative interaction with other teachers.[55]

In a similar vein, the findings from this study also indicate that classroom-contextual uncertainty, as measured by a composite factor score derived from a wide range of variables that capture teachers' exposure to complex instructional environments, is in a significant positive relationship with collaborative interaction among teachers. A range of classroom-contextual factors, such as a low level of student performance, a high level of student heterogeneity, and a shortage or inadequacy of

55. In the United States, teaching for understanding is a set of reform-oriented instructional strategies (National Council of Teachers of Mathematics, 2000, 2007; National Research Council, 2002). Given the possibility that the extent to which teaching for understanding has been part of a reform movement may differ depending on educational systems and traditions, the amount of instructional uncertainty perceived by teachers may vary across countries for a given degree of effort to use teaching for understanding. Indeed, different magnitudes of the effect of UNC_TCHUNDS (uncertainty from teaching for understanding) in different countries, as shown in Figures 6-1, 6-2, and 6-3 in chapter 6, appear to be in line with this possibility; in this respect, it would be a valuable future study to examine how the meaning of teaching for understanding as perceived by teachers is qualitatively different and/or similar across countries. Despite this possibility, however, the multilevel analysis reported in Table A6 (in the Appendix) shows that the association between teaching for understanding and collaborative teacher interaction remains strong even when all variables are centered at their country means to estimate teacher-level relationships net of country-level effects; this result is not surprising, considering that if teachers use instructional strategies to open up possibilities for students to engage in intellectually challenging tasks through inquiry-based learning, teachers inevitably confront a greater amount of instructional uncertainty than they would while using conventional teaching. For a related discussion, see chapter 2, especially sections 2.1.5 and 2.2.1.

classroom resources, for example, are likely to lead to increased uncertainty in teaching, resulting in a variety of difficult questions with regard to both curricular content and instructional methods (Hallinan, 1994; Ladson-Billings, 1999; Miller, et al., 2009). A series of both cross-national multilevel analyses and within-U.S. analyses conducted for this study shows that teachers who face greater classroom-contextual uncertainty are likely to participate to a greater degree in collaborative classroom observation; they also tend to collaborate with their colleagues through more varied types of collaborative teacher interaction.

The uncertainty management perspective is further supported by the result that teachers in countries with a higher level of socio-cultural heterogeneity are likely to engage more in collaborative lesson planning with other teachers. Considering that education is an institution on which different sectors of society impose multiple, often conflicting, purposes, "teaching performances . . . can be free of controversy only in societies which are marked by an extremely high degree of value consensus" (Lortie, 2002, p. 136). In a socio-culturally heterogeneous society, the range of the goals of schooling envisioned by different groups of people is likely to be very wide, and many of those goals are likely to be conflicting with one another, adding further uncertainty to the complexities of teaching. That is, since a higher level of socio-cultural heterogeneity of a country is likely to indicate a lower degree of societal-level value consensus on various aspects of teaching and learning, it is not surprising from the uncertainty management perspective that teachers in such national contexts are more likely to collaborate with their colleagues in order to collectively deal with various complexities and difficulties emanating from divergent social norms and values about what schooling is and what teaching should look like.

Many findings from this study also provide evidence to support some conventional perspectives on collaborative teacher interaction. Extensive research and literature in organizational analysis has suggested that the extent to which teacher collegiality is fostered and sustained in a school depends largely on the organizational climate of the school (Bryk & Schneider, 2002; Hoy, 2002; Sergiovanni & Starratt, 2002; Tschannen-Moran, 2001). The results from a series of both cross-national multilevel analyses and within-U.S. analyses performed in this study substantiate a strong positive relationship between school climate and all measures of teachers' engagement in collaborative interaction with their colleagues.[56]

Another noticeable pattern is the significant positive connection between national curriculum standardization and all measures of collaborative teacher interaction. This result supports the conventional perspective that a standardized national curriculum may facilitate collaborative interaction among teachers insofar as it provides them with some shared technical language about teaching and learning (Lortie, 2002; Schmidt, et al., 2005; Stevenson & Baker, 1991). Also, some cross-level interaction effects found in the multilevel analyses of the data suggest that the effect of teachers' exposure to uncertainty in teaching on their engagement in collaborative interaction with other teachers is likely to lessen in the presence of a highly standardized national

56. This finding, however, does not necessarily indicate that teacher collegiality arises as a consequence of a positive school climate; rather, it could just be that teacher collegiality is an integral constituent of a positive school climate, as discussed in detail in chapter 2 (section 2.1.1).

curriculum. This gives credence to the possibility that curriculum standardization may alleviate a certain amount of uncertainty in teaching as the curriculum standards may serve as a set of readily available and authoritative guidelines that teachers can rely on when making various decisions about their teaching.

This study's findings about the effect of principal instructional leadership are mixed. One the one hand, the findings from the cross-national multilevel data provide some evidence to support the conventional perspective in which principal instructional leadership is seen as an important factor that helps make the school a collaborative inquiry community (Printy, 2008; Reitzug, 1997; Somech, 2005). When operationalized as the degree to which a school principal spends time on instructionally relevant activities, principal instructional leadership is significantly positively related to the degree to which teachers engage in collaborative classroom observation as well as to the extent that teachers collaborate through various types of interaction. On the other hand, such a significant effect of principal instructional leadership is not observed in within-U.S. analyses. This insignificant effect of principal instructional leadership may be in part attributable to the fact that many principals do not have strong confidence in their knowledge about the practice of teaching; principals in the United States frequently feel uncertain about the soundness of their judgments when they supervise teachers' instructional practices (Lortie, 2009). Given the limited amount of practical instructional suggestions principals can actually provide to teachers, principals' instructional leadership behaviors are unlikely to have a strong and sustained effect on unifying teachers into a cohesive inquiry community.

In addition, it is very interesting that the results reported in this study do not provide convincing evidence to support the popular hypothesis that collaborative teacher interaction is highly dependent on the degree to which the country has a collectivist culture as opposed to an individualist culture (Hofstede, 2001; Leonard & Leonard, 2003).[57] When a range of other factors are simultaneously taken into account, the effect of societal individualism does not remain statistically significant. This result suggests that the popular view of the macro-culture of individualism in the United States as one of the decisive factors leading to a low level of collaborative teacher interaction in U.S. schools needs further investigation.

7.2. Implications for Educational Policy and Administration

A growing body of research suggests that teachers' learning can continue to be generative over time if it is done in collaborative ways, as illustrated by "lesson study" groups in Japan (Fernandez & Yoshida, 2004; Lewis, 2000) and school-based "teaching research groups" in China (Han & Paine, 2010; Paine & Ma, 1993), for example.

57. It is important to note that this result does not preclude the possibility that teacher interaction may differ qualitatively depending on varying individualist-collectivist cultural norms across countries. For example, in their study of mentor-novice conversations, Wang, Strong, and Odell (2004) observed important qualitative differences between Chinese and U.S. teachers in terms of conversational foci and forms. However, their findings, based on only four Chinese teachers and four U.S. teachers, do not allow us to determine whether their findings really reflect some cultural differences or simply individual differences. Further systematic research is needed to examine how various aspects of collaborative teacher interaction, such as the kinds of information exchanged during collaborative interaction and the discursive strategies used to exchange information, differ depending on national cultural contexts.

However, the paucity of U.S. schools engaged in meaningful collaborative work around teaching has been well documented; many studies decry limited opportunities for teachers to have supportive collegial relationships through which they can share their knowledge about the practice of teaching with other teachers (Akiba & LeTendre, 2009; Bryk & Schneider, 2002; Darling-Hammond, 2010; Paine, et al., 2003). The cross-national data analyzed in this study also show that the United States, when compared to other countries, is characterized as having a very high proportion of teachers who do not engage in any type of collaborative teacher interaction while having a very low proportion of teachers who regularly participate in multiple types of collaborative teacher interaction.

The main findings from this study point to the possibility that teachers' exposure to uncertainty in their classroom teaching is significantly related to their engagement in collaborative interaction with other colleague teachers. It is important to note that teachers' exposure to uncertainty in teaching is not necessarily negative; rather, "uncertainty is an essential driving force in teaching" (Floden & Buchmann, 1993, p. 380) because recognition of uncertainty in teaching makes teachers "stop and think and want to find out more. . . . Being aware of the uncertainties [involved in] teaching . . . can be an attitude towards the profession of teaching" (Munthe, 2007, p. 17). In this respect, providing teachers with the necessary administrative and professional support for them to become "professionally creative and autonomous" (Shulman, 2004, p. 151) enough to develop and use instructional strategies to implement teaching for understanding will help them better recognize and inquire into various kinds of instructional uncertainty.

This, in turn, is likely to contribute to an increase in teachers' motivation to engage in collegial interaction with other teachers in order to collaboratively manage the resultant uncertainty rather than simply trying to eliminate possible sources of uncertainty from their classroom teaching.[58]

With regard to the case of the United States, the degree of emphasis teachers place on teaching for understanding appears to have a strong positive relationship with their engagement in collaborative interaction; further, its effect size is similar to or greater than the effect size of school climate when school climate is operationalized as teachers' perception of the degree to which teacher morale is high and organizational goals are clearly communicated and well implemented. Depending on regression models, the expected increase in collaborative teacher interaction ranges from about 11% to 16% of one standard deviation for every one-standard-deviation increase in school climate, while the increase ranges from about 15% to 22% for every one-standard-

58. In this respect, educational policy makers need to ruminate on what kinds of federal, state, and district policies can create institutional environments where teachers are provided with high-quality learning opportunities pertinent to instructional strategies to promote students' engagement in inquiry-based learning and understanding. Indeed, policy discourses on school curricula around the world are shifting their emphasis "from authoritative structures of fact and skill and discipline to . . . broadened individual participation in . . . a rationalized knowledge system that functions as an umbrella of understanding and comprehension" (McEneaney & Meyer, 2000, p. 207). Sustained policy efforts to translate these policy discourses into professional development opportunities would stimulate collaborative teacher interaction as a collective effort to manage instructional uncertainty. Similarly, teacher preparation programs could do more to prepare future teachers to become "scholar teachers" (Leung, 2001) as well as competent practitioners, who have rigorous content knowledge in addition to extensive general and pedagogy-related knowledge (Kim, et al., 2011); this would help teachers to become more perceptive of instructional uncertainty, thereby leading to a greater degree of collaborative interaction with other colleague teachers as a collective effort to make sense of, and lessen, their feelings of discomfort with their perceived elements of uncertainty in teaching.

deviation increase in teachers' effort to implement teaching for understanding. Compared to the large amount of research and literature about the relationship between school climate and teacher collegiality (Hoy, 2002; Sergiovanni & Starratt, 2002; Tschannen-Moran, 2001), the paucity of a similar kind of research focusing on instructional uncertainty is very striking, given that its effect size appears to be no less than that of school climate.

Also, the main findings from this study shed new light on the beneficial effect of teacher collegiality. In addition to the widely acknowledged linkage of teacher collegiality to their enhanced feelings of efficacy, increased teaching quality, and greater accountability for student achievement (Bryk, et al., 1999; Lee & Smith, 1996; Newmann, et al., 1989; Stevens & Slavin, 1995; Yasumoto, et al., 2001), the findings from this study provide extensive evidence to support the possibility that teacher collegiality may arise as a collective effort to manage uncertainty in teaching. Given the fact that it is not always either possible or desirable to eliminate the sources of uncertainty in teaching (Floden & Buchmann, 1993; Jackson, 1986; Lampert, 2001; Munthe, 2007; Shulman, 1987), finding ways to help teachers manage the uncertainty through collaborative interaction with their colleagues is an important task for educational administrators and policy makers.

Finally, educational administrators need to ponder how to help teachers sustain and expand already-existing informal network ties among teachers. As suggested by the main findings from this study, teachers are likely to establish collegial networks with other colleague teachers as a collective response to uncertainty in teaching. Given the wide variety of possible situations in which teachers confront instructional and/or classroom-contextual uncertainty, it is important for educational administrators to find ways to actively share leadership roles and responsibilities with many teachers, so that individual teachers can become empowered agents to foster and sustain a collegial work environment in which they may "informally discuss problems they face, share ideas, help one another in preparing lessons, exchange tips, and provide other support to one another" (Sergiovanni & Starratt, 2002, p. 247).

7.3. Suggestions for Future Research

This study relies primarily on data from the TIMSS 2007 survey to introduce and substantiate the uncertainty management perspective on teacher collegiality. One may replicate similar analyses based on data from earlier and future TIMSS surveys to see to what extent similar results are reproduced. Another useful source of data that can be used to conduct related studies is the OECD Teaching and Learning International Survey. A similar analysis based on this dataset would provide a valuable opportunity to examine if the result patterns observed in the present study are corroborated in a different international dataset as well. In addition, since this study focuses only on eighth-grade mathematics teachers, a potentially fruitful area of research would also be to explore how the relationships between various contextual factors and collaborative teacher interaction patterns are dependent upon subject areas and grade and school levels.

One methodological limitation of this study arises from the cross-sectional nature of the TIMSS dataset, which makes causal inference difficult because it is usually not possible to identify and measure all confounding variables and include each as a covariate in a quantitative model (Frank, 2000; Schneider, Carnoy, Kilpatrick, Schmidt, & Shavelson, 2007). Thus, the availability of reliable large-scale quantitative datasets that can possibly be used to carry out longitudinal studies of teacher collegiality needs to be scrutinized. In this respect, one possibility is to use the School and Staffing Survey compiled by the National Center for Education Statistics. This U.S. dataset, as a longitudinal one, contains some useful data on collaborative teacher interaction as well as extensive information about individual teachers and their schools and districts. Alternatively, one may want to collect a small-scale longitudinal dataset that is specifically designed to examine the effect of various contextual factors on collaborative teacher interaction.

Finally, future studies need to examine how collaborative teacher interaction patterns differ qualitatively depending on various factors. Although this study uses measures of collaborative teacher interaction constructed based on quantitative data about how often teachers participate in certain types of interaction with other teachers, these measures do not capture various qualitative aspects of teacher interaction. Qualitative data on what kinds of information are actually exchanged during collaborative teacher interaction and what specific discursive strategies are used to exchange information, for example, would allow deeper analyses. Conceptual and methodological issues concerning which qualitative aspects of teacher interaction to observe and how to adequately measure those aspects need further systematic exploration.

APPENDIX

APPENDIX

Additional Analyses

Table A1. Exploratory factor analysis of the level-1 primary independent variables: Orthogonal rotation

	Factor 1: Uncertainty from classroom-contextual factors (UNC_CONTEXT)	Factor 2: Uncertainty from teaching for understanding (UNC_TCHUNDS)
EDCAPIT	-.901	.098
ACHIEVE	-.857	-.048
EDCAVAR	.856	-.012
ACHIVAR	.734	.165
SHORTRES	.544	-.073
LANGMIN	.489	-.480
TCHUNDS	.159	.871

Note . Principal component extraction with varimax rotation was used. Factor loadings are sorted by size. Each dotted-line box indicates the factor on which a given variable is loaded to a greater degree. Bartlett's test of sphericity is significant at the $p < .001$ level. $n = 6{,}624$.

Table A2. Pearson's bivariate correlations between level-2 variables ($n = 29$)

	CURRSTD	INDVCUL	EDEXPN	GDPCAP
SOCHET	-.231	-.458 **	-.126	-.424 *
CURRSTD		-.358 +	-.247	-.072
INDVCUL			.526 **	.481 **
EDEXPN				.234

+$p \leq .10$; *$p \leq .05$; **$p \leq .01$.

Table A3. Multilevel linear regressions for TCHRCOL_LESSON, with all slopes fixed at level 2

Fixed effect	i Coeff.	i (*SE*)		ii Coeff.	ii (*SE*)	
Intercept, $\gamma 00$	1.400	(.044)	***	1.381	(.038)	***
SOCHET, $\gamma 01$	.056	(.021)	**	.043	(.020)	*
CURRSTD, $\gamma 02$				.011	(.023)	
INDVCUL, $\gamma 03$				.030	(.024)	
EDEXPN, $\gamma 04$				-.128	(.054)	*
CURRSTD × EDEXPN, $\gamma 05$				.050	(.038)	
UNC_TCHUNDS, $\gamma 10$	.126	(.013)	***	.113	(.014)	***
× CURRSTD, $\gamma 11$				.000	(.012)	
× EDEXPN, $\gamma 12$				.009	(.013)	
× CURRSTD × EDEXPN, $\gamma 13$				-.009	(.011)	
UNC_CONTEXT, $\gamma 20$	-.014	(.024)		.034	(.024)	
× CURRSTD, $\gamma 21$				.003	(.019)	
× EDEXPN, $\gamma 22$				.019	(.027)	
× CURRSTD × EDEXPN, $\gamma 23$				-.018	(.020)	
CLIMATE, $\gamma 30$				.164	(.030)	***
PRINLEAD, $\gamma 40$				.011	(.007)	
WORKLOAD, $\gamma 50$				-.010	(.013)	
TCHREXP, $\gamma 60$				.005	(.008)	
MATHMJR, $\gamma 70$				.045	(.034)	
FEMALE, $\gamma 80$				.044	(.038)	

Random effect	i Var.	i *df*	i χ^2	ii Var.	ii *df*	ii χ^2
Intercept, u0j	.052	27	645.4 ***	.032	23	406.6 ***
Level-1 random error, $r$ij	.524			.510		

Note. All independent variables are grand-mean-centered. Coeff. = Unstandardized coefficients with robust standard errors in parentheses.
*$p \le .05$; **$p \le .01$; ***$p \le .001$.

Table A4. Multilevel linear regressions for TCHRCOL_CLASS, with all slopes fixed at level 2

	i			ii		
Fixed effect	Coeff.	(*SE*)		Coeff.	(*SE*)	
Intercept, $\gamma 00$	.479	(.049)	***	.466	(.042)	***
SOCHET, $\gamma 01$	.029	(.025)		.031	(.022)	
CURRSTD, $\gamma 02$				.101	(.034)	**
INDVCUL, $\gamma 03$				.018	(.022)	
EDEXPN, $\gamma 04$				-.014	(.059)	
CURRSTD × EDEXPN, $\gamma 05$				.070	(.038)	+
UNC_TCHUNDS, $\gamma 10$	.065	(.010)	***	.058	(.009)	***
× CURRSTD, $\gamma 11$				-.011	(.006)	+
× EDEXPN, $\gamma 12$				-.009	(.009)	
× CURRSTD × EDEXPN, $\gamma 13$				-.012	(.007)	+
UNC_CONTEXT, $\gamma 20$	.076	(.017)	***	.106	(.016)	***
× CURRSTD, $\gamma 21$				-.001	(.008)	
× EDEXPN, $\gamma 22$				-.009	(.018)	
× CURRSTD × EDEXPN, $\gamma 23$				-.024	(.013)	+
CLIMATE, $\gamma 30$				.085	(.016)	***
PRINLEAD, $\gamma 40$				.014	(.007)	*
WORKLOAD, $\gamma 50$				.006	(.011)	
TCHREXP, $\gamma 60$				.012	(.006)	*
MATHMJR, $\gamma 70$				.011	(.026)	
FEMALE, $\gamma 80$				-.008	(.020)	

Random effect	Var.	*df*	χ^2		Var.	*df*	χ^2	
Intercept, u_{0j}	.071	27	1483.7	***	.047	23	950.2	***
Level-1 random error, r_{ij}	.314				.307			

Note. All independent variables are grand-mean-centered. Coeff. = Unstandardized coefficients with robust standard errors in parentheses.
+$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

Table A5. Multilevel ordinal logistic regressions for TCHRCOL_VARIETY, with all slopes fixed at level 2

	i				ii			
Fixed effect	Coeff.	(*SE*)	OR		Coeff.	(*SE*)	OR	
Intercept, $\gamma 00$	-.113	(.184)	.893		-.154	(.168)	.858	
SOCHET, $\gamma 01$	.089	(.073)	1.093		.112	(.084)	1.118	
CURRSTD, $\gamma 02$					.345	(.116)	1.412	**
INDVCUL, $\gamma 03$					.097	(.093)	1.101	
EDEXPN, $\gamma 04$					-.215	(.214)	.806	
CURRSTD × EDEXPN, $\gamma 05$					.258	(.138)	1.294	+
UNC_TCHUNDS, $\gamma 10$	.250	(.042)	1.283	***	.228	(.042)	1.256	***
× CURRSTD, $\gamma 11$					-.037	(.032)	.963	
× EDEXPN, $\gamma 12$					-.062	(.033)	.940	+
× CURRSTD × EDEXPN, $\gamma 13$					-.044	(.030)	.957	
UNC_CONTEXT, $\gamma 20$	.231	(.067)	1.260	***	.371	(.067)	1.449	***
× CURRSTD, $\gamma 21$					-.003	(.032)	.997	
× EDEXPN, $\gamma 22$					.014	(.063)	1.014	
× CURRSTD × EDEXPN, $\gamma 23$					-.150	(.035)	.860	***
CLIMATE, $\gamma 30$					.430	(.070)	1.537	***
PRINLEAD, $\gamma 40$					.092	(.026)	1.096	***
WORKLOAD, $\gamma 50$					.047	(.041)	1.048	
TCHREXP, $\gamma 60$					.017	(.023)	1.017	
MATHMJR, $\gamma 70$					.128	(.076)	1.137	+
FEMALE, $\gamma 80$					-.062	(.084)	.939	
Threshold difference, $\delta(2)$	3.240	(.126)	25.540	***	3.277	(.124)	26.500	***
Random effect	Var.	*df*	χ^2		Var.	*df*	χ^2	
Intercept, $u0j$	.832	27	1141.3	***	.597	23	747.4	***

Note. All independent variables are grand-mean-centered. Coeff. = Unstandardized ordered logit coefficients with robust standard errors in parentheses. OR = odds ratios.
$+p \leq .10$; $**p \leq .01$; $***p \leq .001$.

Table A6. Multilevel linear regressions for TCHRCOL, with all variables centered at their country means

Fixed effect	Yij = TCHRCOL_LESSON Coeff.	(*SE*)		Yij = TCHRCOL_CLASS Coeff.	(*SE*)	
Intercept, γ_{00}	-.003	(.005)		-.011	(.006)	+
UNC_TCHUNDS, γ_{10}	.111	(.015)	***	.062	(.011)	***
UNC_CONTEXT, γ_{20}	.033	(.024)		.102	(.020)	***
CLIMATE, γ_{30}	.160	(.030)	***	.086	(.016)	***
PRINLEAD, γ_{40}	.008	(.008)		.015	(.007)	*
WORKLOAD, γ_{50}	-.007	(.012)		.006	(.013)	
TCHREXP, γ_{60}	.005	(.009)		.013	(.006)	*
MATHMJR, γ_{70}	.054	(.035)		.035	(.039)	
FEMALE, γ_{80}	.065	(.040)		.008	(.022)	

Random effect	Var.	*df*	χ^2	Var.	*df*	χ^2
Intercept, u_{0j}	.000	28	12.0	.000	28	17.4
UNC_TCHUNDS, u_{1j}	.003	28	44.6 *	.001	28	44.1 *
UNC_CONTEXT, u_{2j}	.010	28	60.8 ***	.006	28	60.7 ***
CLIMATE, u_{3j}	.013	28	65.2 ***	.002	28	36.9
PRINLEAD, u_{4j}	.001	28	43.2 *	.001	28	43.3 *
WORKLOAD, u_{5j}	.001	28	30.3	.002	28	50.3 **
TCHREXP, u_{6j}	.001	28	82.9 ***	.001	28	60.9 ***
MATHMJR, u_{7j}	.009	28	32.8	.022	28	63.6 ***
FEMALE, u_{8j}	.028	28	83.8 ***	.007	28	42.7 *
Level-1 random error, r_{ij}	.486			.298		

Note. All dependent and independent variables are country-mean-centered.
+$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

Table A7. Ordinary least squares regressions for TCHRCOL_CLASS: The case of the United States: Additional models

	i-a				i-b			
	B	(*SE*)	β		*B*	(*SE*)	β	
TCHUNDS	.194	(.044)	.224	***	.138	(.044)	.163	**
ACHIEVE	-.166	(.044)	-.199	***	-.092	(.049)	-.115	+
ACHIVAR								
EDCAPIT								
EDCAVAR								
LANGMIN								
SHORTRES								
CLIMATE	.084	(.040)	.105	*	.102	(.040)	.131	**
PRINLEAD	.003	(.014)	.011		.001	(.014)	.003	
WORKLOAD	-.024	(.023)	-.050		-.025	(.024)	-.054	
TCHREXP	.004	(.012)	.015		-.001	(.012)	-.003	
MATHMJR	-.011	(.054)	-.010		-.024	(.054)	-.023	
FEMALE	.029	(.055)	.026		.084	(.055)	.077	
Course taught								
Basic math (ref.)								
Algebra	.027	(.061)	.023		.002	(.061)	.002	
Geometry	.809	(.197)	.211	***	.739	(.195)	.204	***
Others	.429	(.151)	.145	**	.365	(.153)	.125	*
School type								
Public (ref.)								
Private, religious	-.063	(.085)	-.038		-.040	(.092)	-.024	
Private, others	.253	(.126)	.100	*	.212	(.194)	.055	
Free or reduced-price lunch					.024	(.011)	.140	*
Intercept	.395	(.268)			-.047	(.310)		
R^2		.16				.14		
n		393				378		

Note. *B* = Unstandardized coefficients with standard errors in parentheses. β = standardized coefficients. Ref. = reference category.
$+p \leq .10$; $*p \leq .05$; $**p \leq .01$; $***p \leq .001$.

Table A7. (cont'd)

	ii-a				ii-b			
	B	(*SE*)	β		*B*	(*SE*)	β	
TCHUNDS	.178	(.044)	.205	***	.128	(.044)	.151	**
ACHIEVE								
ACHIVAR	.173	(.086)	.101	*	.159	(.091)	.093	+
EDCAPIT								
EDCAVAR								
LANGMIN								
SHORTRES								
CLIMATE	.075	(.040)	.094	+	.103	(.040)	.132	**
PRINLEAD	.011	(.014)	.040		.004	(.014)	.013	
WORKLOAD	-.015	(.024)	-.032		-.023	(.023)	-.051	
TCHREXP	.005	(.012)	.023		.000	(.012)	.000	
MATHMJR	-.036	(.054)	-.033		-.038	(.054)	-.036	
FEMALE	.035	(.056)	.030		.092	(.055)	.084	+
Course taught								
Basic math (ref.)								
Algebra	-.006	(.061)	-.005		-.015	(.060)	-.014	
Geometry	.681	(.197)	.178	***	.712	(.192)	.197	***
Others	.387	(.153)	.131	**	.345	(.153)	.118	*
School type								
Public (ref.)								
Private, religious	-.099	(.085)	-.059		-.045	(.092)	-.027	
Private, others	.253	(.128)	.099	*	.205	(.194)	.053	
Free or reduced-price lunch					.029	(.010)	.168	**
Intercept	-.554	(.207) **			-.667	(.207) ***		
R^2		.13				.13		
n		393				378		

Table A7. (cont'd)

	iii-a				iii-b			
	B	(*SE*)	β		*B*	(*SE*)	β	
TCHUNDS	.182	(.043)	.210	***	.135	(.044)	.160	**
ACHIEVE								
ACHIVAR								
EDCAPIT	-.096	(.027)	-.201	***	-.070	(.034)	-.148	*
EDCAVAR								
LANGMIN								
SHORTRES								
CLIMATE	.084	(.040)	.106	*	.099	(.040)	.128	**
PRINLEAD	.002	(.015)	.006		.000	(.014)	.001	
WORKLOAD	-.019	(.023)	-.040		-.022	(.023)	-.048	
TCHREXP	.002	(.012)	.009		-.001	(.012)	-.003	
MATHMJR	-.003	(.054)	-.003		-.018	(.054)	-.017	
FEMALE	.036	(.056)	.032		.089	(.055)	.081	
Course taught								
Basic math (ref.)								
Algebra	.001	(.061)	.001		-.007	(.060)	-.006	
Geometry	.681	(.198)	.171	***	.679	(.195)	.180	***
Others	.421	(.151)	.143	**	.366	(.153)	.125	*
School type								
Public (ref.)								
Private, religious	.000	(.089)	.000		-.006	(.093)	-.003	
Private, others	.372	(.131)	.147	**	.264	(.195)	.069	
Free or reduced-price lunch					.017	(.012)	.102	
Intercept	.300	(.258)			.054	(.328)		
R^2		.15				.13		
n		392				377		

Table A7. (cont'd)

	iv-a				iv-b			
	B	(*SE*)	β		*B*	(*SE*)	β	
TCHUNDS	.177	(.044)	.205	***	.131	(.044)	.154	**
ACHIEVE								
ACHIVAR								
EDCAPIT								
EDCAVAR	.071	(.031)	.122	*	.062	(.034)	.107	+
LANGMIN								
SHORTRES								
CLIMATE	.074	(.040)	.093	+	.098	(.040)	.126	*
PRINLEAD	.010	(.014)	.034		.003	(.014)	.012	
WORKLOAD	-.017	(.024)	-.037		-.024	(.024)	-.052	
TCHREXP	.004	(.012)	.018		.000	(.012)	.001	
MATHMJR	-.022	(.055)	-.020		-.026	(.054)	-.025	
FEMALE	.031	(.056)	.027		.089	(.055)	.081	
Course taught								
Basic math (ref.)								
Algebra	-.010	(.061)	-.008		-.017	(.060)	-.016	
Geometry	.652	(.201)	.164	***	.675	(.195)	.179	***
Others	.383	(.152)	.130	**	.339	(.153)	.116	*
School type								
Public (ref.)								
Private, religious	-.052	(.089)	-.031		-.013	(.093)	-.008	
Private, others	.300	(.129)	.119	*	.248	(.195)	.065	
Free or reduced-price lunch					.025	(.010)	.148	**
Intercept	-.532	(.198)	**		-.623	(.197)	**	
R^2		.14				.13		
n		392				377		

Table A7. (cont'd)

	v-a				v-b			
	B	(*SE*)	β		*B*	(*SE*)	β	
TCHUNDS	.166	(.044)	.193	***	.124	(.044)	.146	**
ACHIEVE								
ACHIVAR								
EDCAPIT								
EDCAVAR								
LANGMIN	.027	(.019)	.069		-.013	(.021)	-.034	
SHORTRES								
CLIMATE	.070	(.040)	.089	+	.098	(.040)	.127	*
PRINLEAD	.014	(.014)	.048		.004	(.014)	.014	
WORKLOAD	-.012	(.024)	-.026		-.018	(.024)	-.039	
TCHREXP	.005	(.012)	.021		-.002	(.012)	-.009	
MATHMJR	-.033	(.055)	-.029		-.037	(.054)	-.035	
FEMALE	.038	(.056)	.034		.090	(.055)	.082	
Course taught								
Basic math (ref.)								
Algebra	-.011	(.061)	-.010		-.029	(.060)	-.026	
Geometry	.591	(.199)	.148	**	.596	(.193)	.158	**
Others	.405	(.154)	.137	**	.345	(.154)	.118	*
School type								
Public (ref.)								
Private, religious	-.103	(.085)	-.061		-.031	(.093)	-.019	
Private, others	.256	(.128)	.101	*	.223	(.195)	.058	
Free or reduced-price lunch					.036	(.010)	.208	***
Intercept	-.394	(.185) *			-.503	(.187) **		
R^2		.13				.12		
n		392				377		

Table A7. (cont'd)

	vi-a				vi-b			
	B	(*SE*)	β		*B*	(*SE*)	β	
TCHUNDS	.168	.044	.194	***	.120	.043	.141	**
ACHIEVE								
ACHIVAR								
EDCAPIT								
EDCAVAR								
LANGMIN								
SHORTRES	.130	.048	.136	**	.131	.048	.142	**
CLIMATE	.095	.041	.119	*	.121	.041	.156	**
PRINLEAD	.012	.014	.042		.003	.014	.011	
WORKLOAD	-.015	.023	-.031		-.024	.023	-.052	
TCHREXP	.006	.012	.025		.000	.012	.002	
MATHMJR	-.047	.054	-.042		-.045	.053	-.042	
FEMALE	.029	.056	.026		.088	.055	.081	
Course taught								
Basic math (ref.)								
Algebra	-.012	.061	-.011		-.018	.059	-.016	
Geometry	.551	.189	.144	**	.591	.183	.163	***
Others	.321	.154	.108	*	.274	.155	.093	+
School type								
Public (ref.)								
Private, religious	-.103	.085	-.062		-.031	.092	-.019	
Private, others	.274	.128	.108	*	.227	.193	.059	
Free or reduced-price lunch					.029	.010	.170	**
Intercept	-.492	.188 **			-.615	.189 ***		
R^2		.14				.14		
n		393				378		

Table A8. Within-nation regressions for TCHRCOL_LESSON: Ordinary least squares regression coefficients for UNC_TCHUNDS and UNC_CONTEXT, after controlling for all other level-1 variables

	UNC_TCHUNDS				UNC_CONTEXT				
	B	(*SE*)	β		*B*	(*SE*)	β		*n*
Australia	-.010	(.056)	-.013		.130	(.115)	.088		210
Bulgaria	.029	(.068)	.030		.187	(.072)	.196	**	210
Chinese Taipei	.140	(.074)	.166	+	-.119	(.096)	-.108		139
Colombia	.142	(.110)	.121		-.119	(.118)	-.099		117
Czech Rep.	.155	(.069)	.165	*	.147	(.140)	.079		185
Egypt	.164	(.057)	.204	**	-.184	(.082)	-.162	*	187
England	.234	(.081)	.224	**	-.164	(.098)	-.134	+	184
Ghana	-.011	(.081)	-.012		-.145	(.117)	-.119		139
Hong Kong	.021	(.100)	.024		.004	(.114)	.004		102
Hungary	.048	(.069)	.045		-.031	(.086)	-.024		244
Indonesia	.139	(.060)	.203	*	.024	(.109)	.019		129
Iran	.181	(.046)	.278	***	.049	(.066)	.058		195
Israel	.155	(.050)	.190	**	.371	(.082)	.309	***	243
Italy	-.031	(.058)	-.034		.201	(.112)	.114	+	277
Japan	-.036	(.071)	-.036		.006	(.150)	.003		207
Kuwait	.018	(.084)	.026		-.091	(.233)	-.053		82
Lebanon	.032	(.115)	.029		.159	(.164)	.102		105
Malaysia	.098	(.057)	.147	+	.097	(.098)	.082		159
Norway	.144	(.069)	.155	*	.131	(.172)	.056		188
Romania	.110	(.061)	.119	+	.032	(.070)	.032		227
Russian Fed.	.269	(.067)	.246	***	-.009	(.078)	-.007		264
Saudi Arabia	.144	(.068)	.194	*	-.040	(.127)	-.028		124
Scotland	.145	(.064)	.155	*	.382	(.095)	.259	***	211
Singapore	.140	(.049)	.176	**	.019	(.068)	.018		314
South Korea	.122	(.063)	.134	*	.216	(.154)	.098		222
Sweden	.056	(.049)	.060		-.061	(.124)	-.026		390
Thailand	.108	(.053)	.172	*	.102	(.068)	.128		145
Turkey	.198	(.069)	.235	**	.124	(.098)	.119		128
United States	.205	(.052)	.195	***	.180	(.077)	.119	*	392

Note. *B* = Unstandardized coefficients with standard errors in parentheses. β = standardized coefficients. Independent variables included in the model are CLIMATE, PRINLEAD, WORKLOAD, TCHREXP, MATHMJR, and FEMALE, in addition to UNC_TCHUNDS and UNC_CONTEXT. Each row is a separate analysis.
+$p \le .10$; *$p \le .05$; **$p \le .01$; ***$p \le .001$.

Table A9. Within-nation regressions for TCHRCOL_CLASS: Ordinary least squares regression coefficients for UNC_TCHUNDS and UNC_CONTEXT, after controlling for all other level-1 variables

	UNC_TCHUNDS			UNC_CONTEXT			
	B	(*SE*)	β	*B*	(*SE*)	β	*n*
Australia	.085	(.044)	.137 *	.135	(.089)	.117	208
Bulgaria	.031	(.032)	.065	.060	(.034)	.131 +	208
Chinese Taipei	.008	(.054)	.014	.047	(.070)	.061	137
Colombia	.159	(.091)	.171 +	.093	(.098)	.099	117
Czech Rep.	.013	(.035)	.027	-.003	(.071)	-.003	185
Egypt	.011	(.057)	.015	.109	(.082)	.104	187
England	.165	(.066)	.194 **	.122	(.079)	.124	182
Ghana	-.020	(.077)	-.023	.110	(.111)	.095	139
Hong Kong	.241	(.083)	.315 **	.047	(.094)	.053	98
Hungary	.034	(.041)	.055	-.003	(.052)	-.004	239
Indonesia	-.013	(.062)	-.019	.186	(.113)	.153 +	129
Iran	.054	(.030)	.131 +	.151	(.044)	.284 ***	194
Israel	-.007	(.034)	-.013	.190	(.055)	.244 ***	240
Italy	.028	(.036)	.049	-.052	(.069)	-.047	277
Japan	.082	(.070)	.083	.503	(.146)	.242 ***	207
Kuwait	.026	(.057)	.058	-.017	(.158)	-.015	81
Lebanon	.091	(.092)	.103	.427	(.127)	.346 ***	104
Malaysia	.125	(.046)	.232 **	.155	(.078)	.162 *	159
Norway	.080	(.081)	.073	.014	(.202)	.005	188
Romania	.052	(.054)	.062	.151	(.062)	.167 *	227
Russian Fed.	.156	(.049)	.199 **	.062	(.058)	.073	262
Saudi Arabia	.007	(.062)	.012	-.148	(.115)	-.125	124
Scotland	.196	(.058)	.250 ***	.205	(.086)	.166 *	210
Singapore	.032	(.036)	.057	-.018	(.050)	-.024	314
South Korea	.133	(.034)	.259 ***	-.098	(.082)	-.079	222
Sweden	-.004	(.028)	-.007	.035	(.070)	.027	389
Thailand	.064	(.051)	.111	.161	(.066)	.221 *	145
Turkey	.101	(.049)	.175 *	.193	(.070)	.272 **	128
United States	.140	(.029)	.237 ***	.150	(.044)	.177 ***	392

Note . *B* = Unstandardized coefficients with standard errors in parentheses. β = standardized coefficients. Independent variables included in the model are CLIMATE, PRINLEAD, WORKLOAD, TCHREXP, MATHMJR, and FEMALE, in addition to UNC_TCHUNDS and UNC_CONTEXT. Each row is a separate analysis.
+$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

Table A10. Within-nation regressions for TCHRCOL_VARIETY: Ordinal logistic regression coefficients for UNC_TCHUNDS and UNC_CONTEXT, after controlling for all other level-1 variables

	UNC_TCHUNDS			UNC_CONTEXT			
	B	(*SE*)	OR	*B*	(*SE*)	OR	*n*
Australia	.116	(.168)	1.123	.289	(.343)	1.335	208
Bulgaria	.146	(.173)	1.157	.346	(.183)	1.414 +	208
Chinese Taipei	.157	(.235)	1.171	.001	(.308)	1.001	137
Colombia	.714	(.313)	2.042 *	.105	(.323)	1.111	117
Czech Rep.	.319	(.237)	1.375	.462	(.480)	1.588	185
Egypt	-.176	(.239)	.839	.294	(.330)	1.342	187
England	.473	(.232)	1.606 *	.417	(.278)	1.517	182
Ghana	-.203	(.250)	.817	-.319	(.360)	.727	139
Hong Kong	.731	(.401)	2.076 +	.590	(.441)	1.804	98
Hungary	.071	(.200)	1.073	.125	(.253)	1.133	239
Indonesia	.142	(.180)	1.152	.361	(.324)	1.435	129
Iran	.060	(.156)	1.061	.581	(.233)	1.788 **	194
Israel	.059	(.198)	1.061	1.543	(.336)	4.677 ***	240
Italy	-.139	(.149)	.870	-.050	(.288)	.951	277
Japan	.414	(.205)	1.512 *	1.448	(.448)	4.256 ***	207
Kuwait	.290	(.390)	1.336	-1.295	(1.112)	.274	81
Lebanon	.403	(.308)	1.496	.744	(.424)	2.105 +	104
Malaysia	.455	(.200)	1.576 *	1.033	(.358)	2.810 **	159
Norway	.406	(.212)	1.502 +	.224	(.518)	1.251	188
Romania	-.154	(.236)	.857	.900	(.287)	2.458 **	227
Russian Fed.	.935	(.310)	2.547 **	.435	(.388)	1.546	261
Saudi Arabia	-.104	(.203)	.901	-.467	(.378)	.627	124
Scotland	.346	(.183)	1.414 +	.707	(.277)	2.027 **	210
Singapore	.354	(.149)	1.425 *	.099	(.207)	1.104	313
South Korea	.915	(.228)	2.498 ***	.147	(.525)	1.158	222
Sweden	.124	(.143)	1.132	-.328	(.366)	.721	389
Thailand	.474	(.215)	1.606 *	.579	(.294)	1.784 *	145
Turkey	.405	(.240)	1.500 +	1.197	(.360)	3.309 ***	128
United States	.565	(.123)	1.759 ***	.654	(.182)	1.924 ***	392

Note. *B* = Unstandardized ordered logit coefficients with standard errors in parentheses. OR = odds ratios. Independent variables included in the model are CLIMATE, PRINLEAD, WORKLOAD, TCHREXP, MATHMJR, and FEMALE, in addition to UNC_TCHUNDS and UNC_CONTEXT. Each row is a separate analysis.
$+p \leq .10$; $*p \leq .05$; $**p \leq .01$; $***p \leq .001$.

Table A11. Summary of results, by hypothesis

		Hypothesized relationship w/ collaborative interaction	Num. of effects	Results					
				Statistically significant				Statistically insignificant	
				Positive		Negative			
H-1	Uncertainty (from teaching for understanding)	Positive	12	12	(6)	0	(0)	0	(0)
H-2	Uncertainty (from classroom-contextual factors)	Positive	12	7	(3)	0	(0)	5	(3)
H-3	Socio-cultural heterogeneity	Positive	15	9		0		6	
H-A1	School climate	Positive	15	15	(12)	0	(0)	0	(0)
H-A2	Principal's instructional leadership	Positive	15	2	(0)	0	(0)	13	(12)
H-A3	Curriculum standardization	Positive	12	9		0		3	
	× Public expenditure on education	Positive	3	1		0		2	
H-A4	Uncertainty × Curriculum standardization	Negative	6	0		1		5	
	× Public expenditure on education	Negative	6	0		3		3	
H-A5	Individualist culture	Negative	12	0		4		8	

Note . Results from U.S.-only data are in parentheses.

Source . Tables 4-2, 4-3, 4-5, 4-6, 4-7, 5-1, 5-2, 5-3, 6-1, 6-2, and 6-3.

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