Instructional teacher job resources and student achievement in mathematics.

Amy Stokes-Levine

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INSTRUCTIONAL TEACHER JOB RESOURCES AND STUDENT ACHIEVEMENT IN MATHEMATICS

By

Amy Stokes-Levine
B.S., Southern Methodist University, 2002
M.A., Bellarmine University, 2006

A Dissertation
Submitted to the Faculty of the
College of Education and Human Development of the University of Louisville
in Partial Fulfillment of the Requirements
for the Degree of

Doctor of Philosophy
in Curriculum and Instruction

Department of Teaching and Learning
University of Louisville
Louisville, Kentucky

May 2017
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A Dissertation Approved on

April 11, 2017

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Susan A. Peters
DEDICATION

This dissertation is dedicated to mathematics educators working in K-12 schools; their effort and perseverance in teaching students amidst strenuous working conditions is inspiring. My motive for pursuing this study, and this degree, was the hope of bringing attention to the need for and ways in which administrators may offer support to K-12 mathematics teachers.

This dissertation is also dedicated to my 6-month-old daughter, Tenley; may you always feel your goals and dreams are achievable, have the grit to initiate them, and persevere in your pursuit of those ideas until you find what you are called to do.
ACKNOWLEDGMENTS

I would like to thank my family for their endless support and encouragement throughout my journey becoming a teacher, growing as a researcher, and completing this study. Most importantly, I would like to thank my husband, Blake, for his confidence in me and his patience with my passion for the pursuit of this goal. Thank you for your support, your flexibility, and for making me take cookie or dance breaks when I worked too long.

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Lastly, I would like to thank my friends for understanding when it must have felt like I fell off the face of the earth, completely absorbed in my work. Thank you for being there when I finally came back around, listening even when it was boring, and believing in me. Thank you for friendships that build each other up, encourage self-reflection, and stand the test of time.
ABSTRACT

INSTRUCTIONAL TEACHER JOB RESOURCES AND STUDENT ACHIEVEMENT IN MATHEMATICS

Amy Stokes-Levine

April 11, 2017

Research shows that teachers who are supported with job resources are more engaged regardless of the level of demands (Klusmann et al., 2008). Additionally, teachers who are engaged with their work are less likely to report their intention to leave the teaching profession (Klassen et al., 2012), which is particularly important for mathematics teachers who are in high demand (Sutcher, Darling-Hammond, & Carver-Thomas, 2016). Supporting employees with job resources is a commonly accepted practice in many professional fields (e.g., Christian, Garza, & Slaughter, 2011), yet is not a common practice in education (e.g., Bidwell, 2013; Gewertz, 2014; Layton, 2015; Rentner & Kober, 2014a). Current research on teacher work engagement and job resources has focused on big ideas like access to information and supervisory support (e.g., Hakanen, Bakker, & Schaufeli, 2006). However, a more specific set of instructional job resources that support educators’ engagement on a day-to-day basis needs to be examined, as well as their relationship to student achievement. This quantitative study examined indicators of instructional teacher job resources (ITJR) and the relationship between those resources and student mathematics achievement in grades 4-9. Data from The Gates Foundation’s MET Project were used to conduct Exploratory Factor Analysis, Confirmatory Factor
Analysis, and Hierarchical Linear Modeling analyses. With the survey questions that were available in the dataset, the factors for mathematics ITJR that were identified were curriculum, professional development, instructional autonomy, and time to collaborate with colleagues. The relationship between teacher instructional autonomy and student achievement in mathematics for grades 4-8 was statistically significant, but not for grade 9. Relationship between student achievement and the other ITJR for all grades were not statistically significant. This study provides validity evidence for a 4-factor model of ITJR, which may provide administrators an operationalized understanding of how to support teachers. Specifically, administrators should look for ways to offer, communicate, and encourage instructional autonomy for their teachers given its relationship with achievement. Finally, if a model for teacher merit pay is being considered, teacher job resources such as ITJR, or at least instructional autonomy, need to be considered. Suggestions for future studies are included.
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CHAPTER 1
INTRODUCTION
Overview

**Problem Statement**

Supporting employees with job resources may be a commonly accepted practice in many professional fields (e.g., Christian, Garza, & Slaughter, 2011; Endres & Manchono-Smoak, 2008; Rich, Lepine, & Crawford, 2010), yet is not a common practice in education (e.g., Bidwell, 2013; Gewertz, 2014; Layton, 2015; Rentner & Kober, 2014a). In teacher surveys for the Measures of Effective Teaching Project (MET), teachers were asked, “Which aspect of your teaching conditions is most important to you in promoting student learning? (Select one.)” (MET, 2010, Teacher Work Conditions Survey, p. 58). Teachers’ most frequent response, 32% of responses, was *Instructional Practice and Support*. According to the survey, *Instructional Practice and Support* for teachers might include job resources such as: providing instructional coaching, working in professional learning communities to develop and align instructional practices, feeling encouraged to try new things to improve instruction, and having autonomy to make decisions about instructional delivery (i.e. pacing, materials, and pedagogy) (MET, 2010, Teacher Work Conditions Survey). However, research suggests these resources may not be provided to teachers (e.g., Bidwell, 2013; Layton, 2015; Rentner & Kober, 2014a), especially mathematics teachers (Gewertz, 2014) this lack of resources may cause teachers to be less engaged with their work (Klusmann et al., 2008), and possibly less
effective as educators (Bakker & Bal, 2010; Christian, Garza, & Slaughter, 2011; Kahn, 1990). Additionally, mathematics teachers are currently in immense demand due to issues with attrition (Sutcher, Darling-Hammond, & Carver-Thomas, 2016), making analysis of their working conditions important.

Against that background, this study examined the relationship between teacher job resources that support mathematics teachers’ instruction and student achievement.

**Research on Resources to Support Teachers**

Current research on teacher work engagement has focused on big ideas such as job control, access to information, supervisory support, innovative school climate, and social climate (e.g., Bakker & Bal, 2010; Hakanen, Bakker, & Schaufeli, 2006; Klusmann et al., 2008; Runhaar, Sanders, & Konermann, 2013). Work engagement can be undesirably impacted by job demands. Teachers have stressful job demands which have been negatively linked to exhaustion or burnout (Klusmann et al., 2008). Job demands for teachers could include disruptive pupil behaviors, work overload, poor physical work environment, and a lack of job resources (Hakanen et al., 2006). However, research shows that teachers who are supported with job resources are more engaged regardless of the level of demands (Klusmann et al., 2008) and teachers who were engaged with their work were less likely to report their intention to leave the teaching profession (Klassen et al., 2012). Clearly, job resources are important. Unfortunately, these studies did not provide detailed and specific job resource descriptions. A more specific set of job resources that support educators’ engagement on a day-to-day basis needs to be identified and examined.
Research on Resources to Support Other Professionals

Research on job resources in other professional fields (e.g., health care professionals, firefighters, dentists, and flight attendants) is more extensive and has shown that employees who are supported with job-related resources are more engaged in and productive with their work (e.g., Christian, Garza, & Slaughter, 2011; Kahn, 1992; Leiter & Maslach, 2004; Schaufeli, Salanova, González-Romá, & Bakker, 2002). Work engagement or the level of positivity felt towards one’s work (Schaufeli et al., 2002), requires job resources specific to the duties in question (Simpson, 2009).

Research conducted in other professional fields indicates that work effectiveness is significantly influenced by an employees’ level of engagement in the workplace, which is increased by job resources (Christian, Garza, & Slaughter, 2011; Kahn, 1992; Leiter & Maslach, 2004; Schaufeli et al., 2002). While research and attention are growing on work engagement in other professional fields (Lockwood, 2007), research and attention on work engagement in education as a professional field is limited even though there may be a national attrition crisis for mathematics teachers in the U.S. (Sutcher, Darling-Hammond, & Carver-Thomas, 2016).

Research Question

The purpose of this study was to build on the existing research for both work engagement and effective teaching to examine what relationship exists between mathematics’ teacher job resources and their students’ mathematics achievement. The research question posed in this study was:

What is the relationship between instructional teacher job resources (ITJR) and student achievement in mathematics?
Specifications of the Study

The resources listed below for supporting mathematics instruction for grades 4-9 are fully theorized, researched, and discussed in the Chapter 2. Using survey data from the MET Project and Hakanen et al.’s (2006) five constructs of job resources, this study posed the following questions related to the extent that these job resources support lesson development or lesson planning:

1. Curriculum materials. Did teachers believe the curriculum materials provided to them contained useful information regarding the mathematics content standards as well as information on pedagogy strategies, and anticipated student misunderstandings?

2. Professional development (PD). Were PD sessions focused on mathematics teachers' instructional needs?

3. Collaboration with peers. Were teachers able to collaborate with their peers to refine their teaching practices?

4. Time for individual and group planning. Were teachers allotted time to plan not only with other colleagues but time to plan individually during the work week?

5. Sense of job control. Did teachers feel a sense of job control from their administrators to create their own instructional plans?

In Chapter 2, I describe how these five Instructional Teacher Job Resources (ITJR) were conceptualized in light of Hakanen et al.’s research. Data from the MET Project were used to analyze student (level-1) and teacher (level-2) variables using hierarchical linear modeling (HLM) to explore the relationship between ITJR and student achievement. The
MET Project, funded by the Gates Foundation, was a multi-year study in various states to attempt to measure effective teaching.

**Delimitations**

This study includes data from mathematics teachers and their students who participated in the MET Project. The MET Project was conducted during the 2009-2011 school years and included nearly 3,000 teachers from various content areas in the following states: North Carolina, Texas, Colorado, Florida, Tennessee, and New York. However, teacher data for this study included only mathematics teachers from the 2010-2011 school year. Teacher data included survey items from the MET Project’s Teacher Working Conditions Survey that addressed the five job resources associated with lesson development or lesson planning: curriculum, PD, collaboration, planning time, and autonomy.

Student achievement data for this study came from the mathematics scores for the students in the selected teachers’ classes. Student scores on the Balanced Assessment in Mathematics end-of-course test for students in grades 4-8 and the ACT QualityCore® end-of-course test for Algebra 1 students in high school were used. I analyzed separate models for each of the grade-band outcomes.

**Definitions.** The subsequent terms are used throughout the study and are defined as follows.

*Resources:* “Things that people value and therefore strive to obtain, retain, and protect” (Hakanen, Perhonieri, Toppinen-Tanner, 2008).
Job resources: Physical, psychological, social, or organizational aspects of a job that may reduce effects of job demands and may also encourage work engagement, (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001).

Instructional teacher job resources (ITJR): Job resources that support teachers to deliver effective instruction (see effective teaching).

Effective Teaching: Providing instructional methods and practices that produce proficient results for student achievement as defined by the MET Project.

Achievement: Students’ assessment scores on their end-of-course exam for mathematics.

Work engagement: Various definitions can be found in Chapter 2; however, the most relevant definition for this study is the level of positivity felt towards one’s work.

Quality Curriculum: Instructional materials that address teachers’ needs for both their content standards and pedagogical methods.

Quality PD: Refers to professional development (PD) that deepens teachers’ content knowledge and addresses teaching methods to improve student learning.

Instructional Autonomy: Freedom for instructional decision making including teaching methods, instructional materials, pacing, sequencing, or timing while working either alone or in collaboration with colleagues. It does not include deciding what to teach as those derive from districts’ content standards.

Physical job resources: ITJR comprised of quality curriculum materials and quality PD.

Social job resources: ITJR comprised of planning time, collaboration, and autonomy for instructional freedom.
Assumptions

Due to the fact that the data for this study were collected during a previous MET study, I made assumptions that the trustworthiness of the researchers and participants align with common ethics. For instance, I assumed that end-of-course exams were administered by teaching staff in accordance with standardized testing regulations. In addition, I also assumed that teacher surveys were answered openly and honestly. Finally, I assumed that all data were reported accurately by the researchers for the MET Project.

Organization of the Dissertation

The following sections of this report are organized into chapters, a bibliography, and appendices, respectively. Chapter 2 includes a review of the literature involving work engagement and a detailed theoretical framework for the study. Chapter 3 outlines the data sources, sample, research design, and methodology for this study. Chapter 4 provides statistical results from the EFA, CFA, and HLM analyses. Lastly, Chapter 5 includes a discussion of the findings, summary, conclusions, and future implications of the study. The report concludes with a bibliography and appendices.
CHAPTER 2
LITERATURE REVIEW

Effective teaching is an issue of emerging significance in the field of education (Chetty, Friedman, & Rockoff, 2014; Darling-Hammond, 2015; Goldhaber, 2015; Stecher et al., 2016). One of the largest studies analyzing effective teaching was the Measures of Effective Teaching (MET) Project (2013), funded by The Bill and Melinda Gates Foundation. The MET Project, asserted that effective teaching can be measured and subsequently, states are now developing and implementing new rubrics to measure teacher effectiveness (Stecher et al., 2016). Other professional fields have researched effectiveness in the workplace and, in some cases, found that effectiveness is significantly influenced by an employees’ level of engagement in the workplace, which is increased by job resources (Christian, Garza, & Slaughter, 2011; Kahn, 1992; Leiter & Maslach, 2004; Schaufeli et al., 2002). However, in education little research has been conducted regarding whether teachers are engaged in their workplace or regarding ways in which teacher engagement might be increased and how such engagement relates to teacher effectiveness. We can draw upon work engagement research from other professional fields (e.g., Harter at al. 2002; Kahn, 1990; Schaufeli et al., 2002) as well as a limited collection of research specific to education (e.g., Hakanen et al., 2006; Klusmann et al., 2008), in order to develop a theoretical framework for teacher work engagement to better understand how to support teachers with their work.
Engagement in the Work Place

Engagement in the workplace was first defined by Kahn (1990) as the amount to which employees connect to their work on a personal level. He called this personal engagement. Kahn believed that the more engaged employees are with their workplace, the more notable their performance would be. According to Kahn (1990), an employee’s decision to engage at work stemmed from three psychological needs being met: meaningfulness, safety, and availability. Engagement as a predictor of performance has since been substantiated through a variety of theoretical and empirical research (e.g., Christian, Garza, & Slaughter, 2011; Harter at al. 2002; Kahn, 1992; Leiter & Maslach, 2004; Schaufeli et al., 2002). As a result of this research, engagement definitions have diverged from Kahn’s original focus to now support three additional constructs: (a) burnout (Maslach & Leiter, 1997), (b) work engagement (Schaufeli et al., 2002), and (c) employee engagement (Parker & Griffin, 2011; Shuck, Nimon, & Zigarmi, 2016).

Burnout, which has been confused with engagement (Cole, Walter, Bedeian, & O’Boyle, 2012), is often caused by job stress (Maslach & Leiter, 1997). Burnout exists on a spectrum where burnout and personal engagement reside on opposite ends and affect each other conversely (Leiter & Maslach, 2004; Maslach & Leiter, 1997). On the high end of the spectrum where workers are not burnt out but are personally engaged, employees may exhibit high energy, resilient association to their work, and have a sense of self-efficacy (Leiter & Maslach, 2004). The low end of the spectrum depicts burnt out employees who may experience symptoms of exhaustion (opposite of high energy), cynicism (opposite of resiliency), and inefficacy (opposite of self-efficacious) (Leiter & Maslach, 2004). Employees who are burned out are less likely to be engaged at work,
productive, or effective in both their personal and social work efforts (Leiter & Maslach, 2004). Employees who experience burnout may in fact leave their job altogether or remain but produce at ineffective, lower levels.

Work engagement is defined as a pervasive feeling of positivity toward one’s work as characterized by degrees of vigor, dedication, and absorption (Schaufeli et al., 2002). Vigor signifies employees having high energy, resilience, persistence, and willingness to invest effort into his/her work (Bakker, Emmerik, & Euwema, 2006). Dedication indicates employees have a sense of significance, pride, and challenge about their work (Bakker et al., 2006). Absorption denotes an employee is happily immersed in their work and may have difficulty separating oneself from their work (Bakker et al., 2006). Employees who are engaged with their work, apply themselves within the context of their job (Kahn, 1990) but does not necessarily work extra hours or volunteer for extra responsibilities (Schaufeli & Bakker, 2010).

Employee engagement has been defined as an active, work-related positive psychological state (Parker & Griffin, 2011; Shuck et al., 2016). There exists, however, confusion and inconsistencies regarding the definition of employee engagement (Shuck & Wollard, 2010). Employee engagement often is confused with work engagement and at times the terms are used interchangeably (Schaufeli & Bakker, 2010). To clarify the distinction, Schaufeli and Bakker (2010) defined employee engagement as an employees’ association to their work tasks and their work organization. Although employee engagement is not an organizational-level construct (Shuck & Wollard, 2010), each individual employee’s decisions do involve organizational-level concerns. Those with high levels of employee engagement make individual decisions about their work and
possess a willingness to adapt their behavior to achieve preferred organizational-outcomes (Shuck & Wollard, 2010). After an extensive review of the literature to analyze the inconsistencies in explanations, Shuck and Wollard (2010) determined employee engagement to be “an individual employee’s cognitive, emotional, and behavioral state directed toward desired organizational-outcomes” (p. 103).

Of these engagement constructs, work engagement is the most pertinent to this study. Although each of these constructs affects teachers on a daily basis, the focus of this study is teachers’ engagement with their work, teaching their students effectively to increase student learning, which may be reflected in student achievement scores, as measured by the MET Project. Because the terms work engagement and employee engagement sometimes are used interchangeably (Schaufeli & Bakker, 2010), only research regarding employees’ relationship with their work (teaching students) and not with their organization (relationship with their school or administration) or organizational structures (relationship with their district rules and expectations) was included in this review. While work engagement can affect many areas of teachers’ work (e.g. work with administrators, parents, teachers, or students), this study specifically focused on teachers’ efforts to design and deliver instruction to their students.

A Model for Work Engagement. One-way an employees’ relationship to their work has been theorized is the Job Demands-Resources (JD-R) Model (Bakker, Demerouti, & Verbeke, 2004). The JD-R Model outlines two branches of work engagement: energetical (the top branch shown below) and motivational (the bottom
branch shown below).

![Diagram of Job Demands-Resources Model](image)


This model delineates two separate but related progressions of burnout and engagement (Klusmann et al., 2008). The top branch (energetical), illustrates how high job demands may lead to emotional exhaustion or burnout with negative energy toward their in-role performance. The bottom branch (motivational), shows how a lack of job resources may lead to disengaged employees who do not elect any extra-role duties. These separate branches can be related. For instance, a lack of job resources (bottom motivational branch) may contribute to job demands (top energetical branch). Depending on the contextual circumstances, the two branches of the model interact to reveal employee experiences. For example, workers can exhibit no symptoms of exhaustion (they are not burnt out) and yet not be engaged with their work. Conversely, workers who are engaged can simultaneously experience emotional exhaustion or burnout. There are situations where employees may experience both branches at the same time such as having high job
demands with little to no job resources where they may experience both exhaustion and disengagement.

**Work Engagement in Education.** As noted earlier, little research has been conducted in work engagement in education. Research validated portions of the JD-R model with teachers in Germany, namely that job demands are linked to exhaustion or burnout and job resources are linked to engagement (Klusmann et al., 2008). They found that exhaustion was related more significantly by individual-level teacher factors while engagement was linked to school-level factors. For instance, teachers’ emotional exhaustion was correlated to student discipline. On the other hand, principals’ level of support toward pedagogical issues predicted average teacher engagement. This aligns with the assertion of this study that teacher job resources are linked to teacher work engagement and, more specifically, that supporting teachers in their pedagogy may lead to higher levels of teacher engagement.

Hakanen, Bakker, and Schaufeli (2006) adapted the JD-R model proposed by Bakker, Demerouti, and Verbeke (2004) to apply to educational settings (see Figure 2).

In this model, teachers’ work conditions are delineated into two categories similar to the JD-R model: job demands and job resources (Hakanen et al., 2006). To better align with educational settings, the last construct in each row was revised as follows: In-Role performance was replaced by Ill Health and Extra-Role performance was replace by Organizational Commitment. In addition to their visual model, the researchers further explained what job demands and resources might look like for teachers. Job demands for teachers consisted of three sub-categories: disruptive pupil behaviors, work overload, and poor physical work environment. Teacher job resources comprised five sub-categories: job control, access to information, supervisory support, innovative school climate, and social climate. Along with statistically verifying the new energetical and motivational model through structural equation modeling, Hakanen et al. (2006) also found job resources to be directly associated with burnout. It was suggested that because job demands and job resources are not likely to exist independently, further crossover between the energetical and motivational processes may exist.

In addition to the JD-R model, another framework for measuring work engagement, called the Utrecht Work Engagement Scale (UWES) (Schaufeli, Bakker, & Salanova, 2006), was used to analyze teachers in Australia, Canada, China, Indonesia, and Oman (Klassen et al., 2012). The study revealed that teachers who were engaged with their work were less likely to report their intention to leave the teaching profession (Klassen et al., 2012), which is a great concern, especially for teachers of mathematics (Barnes, Crowe, & Schaefer, 2007).

Another international study on teacher work engagement differed from those previously mentioned due to its qualitative methodology. A phenomenological study in
Finland analyzed teacher work engagement by examining teachers’ reflections on their work experiences (Mäkinen, 2013). The study, however, yielded unclear conclusions about teachers’ experiences and their level of work engagement.

As mentioned previously, mathematics teachers are leaving the profession of teaching due in large part to work conditions (Sutcher, Darling-Hammond, & Carver-Thomas, 2016), yet there remains very little research on work engagement in education, especially in the United States. The MET Project (2013), conducted in the United States, while it does not specifically mention job demands and job resources, it includes constructs such as effective, or engaged, teachers.

**Theoretical Framework**

Engaged teachers are more effective teachers (Nye, Konstantopoulos, & Hedges, 2004; Rockoff, 2004) and teacher job resources have been linked to teacher work engagement (Klusmann et al., 2008). Therefore, teachers supported with job resources are more likely to be engaged teachers and may be more likely to be effective, resulting in students with higher achievement (see Figure 3).

![Diagram](image)

**Figure 3.** Conjectured relationship of teacher job resources and student achievement.

This conjecture is most like the lower motivational branch of the JD-R model (Figure 1) and addresses the research question, how are teacher job resources related to student achievement, in this study. This is not to say that the top energetical branch is not important, job demands are a concern for teachers; however, that is not the focus of this
To better understand teacher job resources, a closer look at Hakanen et al.’s (2006) categories with teacher lesson planning and pedagogy in mind is needed.

Teacher Job Resources according to Hakanen and Colleagues. Hakanen and colleagues (2006) sub-categories of job resources included: (a) access to information, (b) supervisory support, (c) innovative school climate, (d) job control, and (e) social climate. Access to information refers to an employee’s access to the disbursement of information needed for job-relevant tasks in the work place. For example, a teacher with access to information may be included in decisions regarding the adoption of new textbooks or other curriculum materials and may be informed of professional development sessions that may support their teaching materials or teaching style.

Supervisory support addresses the general communication structures that exist between peers, from administration to subordinates, and across or between units. Whether teachers feel comfortable voicing their concerns to administrators might be an example of supervisory support. For example, a teacher in a school with high supervisory support toward pedagogy may feel comfortable voicing concerns to his/her administrators about their teaching practices or materials. These teachers may feel comfortable asking for supports such as additional teaching materials, an observation, or feedback to help improve their teaching without fear of retribution.

Innovative school climate as a resource refers to how much an organization values improving work by including discussions and feedback and then follows through in implementing department or school plans. For example, in a school with an innovative school climate, teachers’ opinions on curriculum and pedagogical concerns might be sought by administrators instead of teachers needing to ask their supervisor(s).
Additionally, teachers may see follow-through from their administrators after observations on pedagogical comments or concerns.

Job control as a resource refers to the perception of control an employee has over the pace of work, order of tasks, and general influence over job tasks. For example, a teacher with pedagogical job control may choose their own pacing guide or may make changes to a district pacing guide, may choose their teaching style, and may have choice in the materials, technology, and textbooks they use with their students.

Finally, social climate refers to the extent to which the interaction with other people at their work place is relaxed and comfortable. For example, teachers in a school with a high functioning social climate may collaborate with their peers on curriculum planning and instruction. Figure 4 illustrates this author’s interpretation of how Hakanen and colleagues’ (2006) job resources might interact.

![Diagram](image)

*Figure 4. Interpreted relationship between Hakanen and colleagues’ (2006) job resources.*
Descriptions of how these resources interact with each other were not provided by Hakanen et al. (2006); the following are the theories of this author. Supervisory Support (SS) may provide teachers with Access to Information (AI). SS and AI collectively may impact each teacher’s sense of Job Control (JC), Social Climate (SC), and/or Innovative School Climate (ISC). As noted in Figure 3, all five of these job resources may potentially influence teacher’s work engagement and student achievement. The three job resources of Social Climate (SC), Innovative School Climate (ISC), and sense of Job Control (JC) for teachers and are non-directional because they may be related. Each combination of these three job resources will be discussed.

Whether teachers feel relaxed and comfortable (SC) is connected to how much their school honors teacher voice and values organizational growth (ISC). While there is overlap, they are separate constructs. For instance, SC might be relaxed because of high ISC where teacher voice is sought by administrators. On the other hand, ISC may be formed because teachers respond to a relaxed SC where they feel comfortable sharing feedback.

Whether teachers feel relaxed and comfortable (SC) is also connected to teachers’ level of perceived control over their work (JC); however, directional relationships are still not assigned. Teachers may feel comfortable in their workplace because they have a sense of job control. For instance, having freedom to make decisions for their instruction (JC) and the freedom to openly discuss ideas without fear of retribution may contribute to a relaxed social climate (SC). Conversely, it may be possible that relationships between teachers and administrators formed from a relaxed social climate lead to job control. For instance, if teachers feel comfortable with their principle enough to discuss new ideas
(SC), the administrator may be more open to suggestions which may increase teachers’ sense of job control (JC).

Lastly, the relationship between how much a school values organizational growth (ISC) and teachers’ level of perceived control over their work (JC) is also non-directional. Schools and administrators who value improving their school (ISC) may be more likely to seek and honor teachers' opinions, giving teachers a sense of influence over their work place or job (JC). Alternatively, teachers with a heightened sense of job control may share ideas with each other and administrators, which may create an environment of positive instructional norms contributing to innovative school norms (ISC).

**Additional Teacher Job Resources according to Runhaar and colleagues**. In addition to Hakanen et al.’s (2006) five categories of job resources in education, JC, AI, SS, ISC, and SC, a new job resource was proposed by Runhaar, Sanders, and Konermann (2013). This new construct, *interaction with pupils*, was found to have a positive relationship with teacher work engagement (Runhaar et al., 2013).

When considering the connection between *interaction with pupils* and Hakanen et al’s (2006) categories, the argument could be made that JC, AI, SS, ISC, and SC are actually sub-categories or supporting resources for interacting with pupils. For instance, if teachers have access to the information they need to understand their standards and work in an innovative school climate where their voices are heard and ideas are honored, they may be more prepared and encouraged to interact with pupils. Runhaar et al. (2013) defined *interaction with pupils* as working with students to develop their intellect; however, they did not address the external resources needed for teachers to interact with
pupils successfully. This goal of this study is to identify specific job resources that an administrator might supply that are related to increased student achievement. Because interaction with pupils was theorized by this author to be a possible internal result for teachers from Hakanen et al.’s (2006) job resource categories, Interaction with pupils is therefore not included as a separate factor in this study.

**Teacher job resources for day-to-day work.** The five job resources identified by Hakanen et al. (2006) reside on a macro-level view of school operations; however, the daily grind of a teacher’s workday necessitates a smaller lens, or a micro-level view, of what these resources might look like for teachers on a day-to-day basis. Although many resources may affect teachers on a day-to-day basis, this study is only concerned with teacher job resources that might promote effective teaching and ultimately relate to higher student achievement. As previously discussed, the MET Project (2013) does not specifically mention job demands and job resources as factors for effective teaching. However, several survey items from the MET study deal with issues related to job resources that may affect teacher effectiveness and ultimately student achievement. From the MET Project dataset, I identified five school-level day-to-day job resources, in addition to the five big-picture job resources, that may support effective teaching to answer the research question for this study. The identified job resources that may affect teachers’ instruction on a daily basis include: Quality Curriculum, Quality PD, Collaboration, Autonomy, and Time. The following model illustrates how these five teacher resources may connect to Hakanen and colleagues’ (2006) research (see Figure 5).
Figure 5. Theorized job resources related to the interpreted relationship between Hakanen and colleagues’ (2006) job resources.

This model illustrates that teachers in schools with SS and AI may have job resources such as quality curriculum materials that align to their content teaching standards. In addition to content alignment, teachers with both SS and AI may theoretically be more aware of curriculum materials that provide activities and ideas for student-centered instruction and provide helpful information such as potential student misconceptions and ways to scaffold instruction. Quality curriculum refers to materials that address teachers’ needs for both their content and pedagogical methods (e.g., Garland, 2014; Herbel-Eisenmann, 2007; McCrory et al., 2012; Remillard, 2005).

Additionally, in my conceptual model, I theorize that teachers with both SS and AI may be more likely than teachers in schools without SS and AI to attend PD that supports their adopted curriculum materials or pedagogical methods. Quality PD refers to PD that deepens teachers’ content knowledge and addresses teaching methods to
improve student learning (e.g., Brodie & Shalem, 2011; McCrory, 2012). In this study, I considered both curriculum and PD to be physical job resources.

Within Hakanen’s (2006) resources for SC, ISC, and JC, I theorized that three are social job resources for teachers: time, collaboration, and autonomy. The first of these is time to plan instruction. Teachers’ planning time can be used for different purposes, such as department meetings or other duties. Teachers who are in schools with an ISC and have a sense of JC theoretically may be more likely than teachers without those resources to have time during the work day that is reserved for planning. This time could be either for individual planning or for planning with their colleagues.

In my theoretical model, I contend that teachers in schools where the SC and ISC are both healthy may have more opportunities to collaborate with their colleagues than teachers in schools without these job resources. Collaboration may occur within Professional Learning Communities (PLCs) or during PD or may be the result of teachers connecting and sharing ideas. Teachers may collaborate with others in their content area or teachers with a cross-content lens.

Lastly, I theorize that teachers who are in schools with both an ISC and a relaxed SC and who have a sense of JC may be more likely to have autonomy for decisions they make in their teaching. Autonomy is most closely related to JC, but the existence of any of these three elements may signify the existence of teachers having autonomy. For example, SCs may be more relaxed because teachers are allowed to self-regulate their work (autonomy).

With SS and AI, I theorize that it is possible that teachers may experience positive change in their SC, ISC, or sense of JC so that they feel informed, heard, and have some
control over their work. For instance, with AI, teachers may find resources available to them, such as quality PD and curriculum. If SS and AI are lacking, teachers may feel diminished levels of SC, ISC, and JC if information and communication are not shared, and teachers may not have either the physical job resources, such as training, materials (quality PD and curriculum), or social job resources they need, to be as effective as they could be.

**Teacher Job Resources that Support Effective Pedagogy: A New Framework**

As previously outlined, mathematics educators are likely to benefit from supportive job resources to reduce job demands and engage in the workplace and require job resources that are specific to their needs. Teachers who are supported with curriculum materials, PD, have instructional autonomy as well as time to plan and collaborate, may be more likely to present effective instruction to students (Christian, Garza, & Slaughter, 2011). This effective instruction may lead to greater student achievement (Goldhaber, 2015). Mathematics teachers are working with misaligned curriculum, without PD that focuses on their needs, and are pressured to produce high-achieving students.

By focusing on the framework derived from Hakanen et al. (2006), I seek to analyze job resources specific to education that may increase teacher engagement at work and ultimately increase student achievement. Resources believed to be needed include but are not limited to: (a) availability to quality curriculum, (b) PD sessions that develop teacher knowledge, (c) appropriate planning time provided during the work week, (d) opportunities to collaborate with other math teachers, and (e) a feeling of autonomy from
their administrators to create or modify their instructional plans to meet their students’ needs.

With Hakanen and colleagues’ (2006) job resources as a context, the relationship shared by the five additional theorized resources, now with relation to student achievement, is shown in the framework below (Figure 6).

![Diagram of job resources associated with student achievement]

*Figure 6. Theorized job resources associated with the interpreted relationship between Hakanen and colleagues’ (2006) job resources as they relate to student achievement.*

Here, the model still indicates that SS and AI may support both physical and social teacher job resources. The model also indicates that either or both physical and social teacher job resources may support student achievement. New to this model is the possible relationship between physical and social job resources. Perhaps teachers with supportive social job resources are able to find or create physical job resources for themselves. On the other hand, it might be possible that teachers with supportive
physical job resources feel more comfortable reaching out to their colleagues or administrators to stimulate healthy social job resources for each other.

Recall Figure 3, which presented the conjectured relationship of teacher job resources and student achievement. With the specific teacher job resources identified through the MET Project in mind, the following figure shows a more detailed conjectured relationship of teacher job resources that may affect teachers’ work engagement and thus their lesson planning and instruction and ultimately student achievement (Figure 7).

![Diagram of teacher job resources and student achievement](Image)

**Figure 7.** Conjectured relationship of teacher job resources that may impact lesson planning and instruction and student achievement.

This model does not, however, account for the social and physical classification of job resources as seen in Figure 8. In the following model, the same five job resources are additionally categorized as physical and social teacher job resources.
Figure 8. Higher-order model of the conjectured relationship of teacher job resources that may impact lesson planning and instruction and student achievement.

In the following sections, each of these teacher job resources will be discussed: (a) quality curriculum, (b) quality PD, (c) planning time, (d) collaboration, and (e) autonomy.

Curriculum. Once a teacher understands their content standards and has determined what needs to be taught, curriculum materials need to be acquired or developed to help carry out their lessons (Reys, Reys, & Rubenstein, 2010). Resources and materials that help teachers deliver instruction often are referred to as curriculum; however, there is still some variation in what that entails (Flinders & Thornton, 2013). Curriculum can mean anything from overarching frameworks that guide teachers while designing their own instructional resources to scripted lessons complete with assessment materials (Remillard, 2005). Teachers may use materials presented to them, discover materials for themselves, develop their own materials, or use a hybrid of any of these sources of resources to implement the content standards required in their district. The main curriculum resource for teaching mathematics over the years has been textbooks, somewhat due to how mathematics assignments are given as well as the teacher’s comfort and confidence with the content (Nicol & Crespo, 2006; Remillard, 2005).

Implementation of these curriculum materials can fall into the following categories: formal, intended, enacted, or experienced (Remillard, 2005; Remillard & Heck, 2014). For instance, intended curriculum implementation can mean either the author’s or the teacher’s intentions for instruction (Reys et al., 2010; Remillard, 2005).
On the other hand, enacted curriculum implementation refers to what actually occurred in the classroom (Remillard, 2005). In short, curriculum materials are the tangible tools that support teachers’ goals of introducing content and practice standards to students during instructional time (Herbel-Eisenmann, 2007).

Intended curriculum and enacted curriculum can be significantly different than the curriculum described and designed by the curriculum authors (Remillard, 2005; Stein & Smith, 1998). A study analyzing mathematics curriculum implementation found teacher use of textbooks varied immensely even though those included in the study reported feeling they honored the ideas of the curriculum simply because they used a textbook that was written for their adopted standards (Remillard, 2005). Potential reasons for misused mathematics curriculum includes an underappreciated sense of how teachers might misunderstand, misrepresent, or even ignore content that is unfamiliar to them (Remillard, 2005). This is noted in part by the level of teacher familiarity with curriculum resources, influential factors toward their relationship with the materials, as well as the relationship’s effect on teacher enacted curriculum coupled with the widespread adoption of textbooks (Remillard, 2005).

Therefore, even if textbooks were accurately aligned to current content standards, evidence shows many teachers are not prepared to engage with the new standards as intended in textbooks (McCrorry et al., 2012). Because research has already identified issues with textbook alignment to current content standards, such as CCSS-M (Rentner & Kober, 2014a), using textbooks alone currently may not offer teachers a complete set of quality curriculum materials. Before the CCSS-M was adopted by much of the United States, each state had their own set of content standards. With content standards varying
from state to state, publishers may have had to blend content standards from different states to meet state and district textbook needs, which may have offered a clouded set of quality curriculum materials. Moreover, not all districts adopt textbooks (Broussard, 2014), and some teachers do not have access to curriculum materials; outside of textbooks, teachers may create their own materials or use easily accessible resources found online. However, this may be problematic as daily job demands leave little time for teachers to create quality resources and plans (Schmidt, Houang, & Cogan, 2002), and studies have yet to address the quality and effect of using non-researched online resources, such as Khan Academy (www.khanacademy.org), BrainPOP (www.brainpop.com), or problem generators such as KUTA (www.kutasoftware.com).

Crafting quality curriculum materials and planning resources is a needed job resource. Quality curriculum, materials that are aligned to current content standards that help teachers conceptualize these standards and are available to all teachers, is a job resource that may increase teacher clarity for instruction (Layton, 2015). Teachers in countries other than the U.S. have this form of curriculum support.

International comparative studies such as the Trends in International Mathematics and Science Study (TIMSS) have been widely reported and publicized regarding student performance, yet few mention a comparative analysis of teacher support in these same countries. One report analyzing the differences in teacher support in high-achieving countries, asserts that “American students and teachers are greatly disadvantaged by our country’s lack of a common, coherent curriculum and the texts, materials, and training that match it” (Schmidt, Houang, & Cogan, 2002, p. 1). In Singapore, for instance, a consistently high-achieving country in mathematics, textbooks offer educators tutorials
on the content for each lesson as well as insights to student misconceptions and possible questions before outlining the pedagogy of an exploratory activity that would engage students in discovery learning (Yoong & Hoe, 2009). Teachers who are not trained for new standards or new curriculum may not implement curriculum as intended; as noted earlier, intended curriculum and enacted curriculum are not the same (Remillard, 2005).

Of interest to this study, student achievement was statistically significantly higher when teachers used standards-based curriculum (Reys et al., 2003) as well as when teachers were involved in the curriculum decision-making process for their students (Waters, Marzano, & McNulty, 2003). Teachers need a clear guide of what content is to be taught, which concepts are to be emphasized, and what connections to help students make with resources for activities, practice, and assessment (Garland, 2014; McCrory et al., 2012; Waters, Marzano, & McNulty, 2003). Districts that do not provide textbooks, lesson materials such as activities or resources for student practice and assessment, or even curriculum maps submit their students’ experience with mathematics to the variance of teacher interpretation and submit their teachers to the job demand of creating or finding such resources for themselves. This is potentially an example of job demands (teaching to specific standards) without job resources (ready-to-use curriculum resources for students focused on those standards) that was predicted to decrease work engagement (Hakanen et al., 2006; Mauno, Kinnunen, & Ruokolainen, 2007; Schaufeli & Bakker, 2004).

The issues with curriculum implementation go deeper than mathematics teachers misinterpreting intentions of curriculum materials. For instance, a widely-adopted set of content standards is the CCSS-M. One of the CCSS-M authors, Jason Zimba,
acknowledged that many teachers of mathematics, parents, and even textbook publishers may not be correctly interpreting the CCSS-M content standards (Garland, 2014). Efforts to train teachers and provide support continue to be a chief concern for the success of CCSS-M as Zimba “acknowledged better standards aren’t enough” (Garland, 2014). Teachers with unclear understandings of the expectations of their content standards may lead to misinterpretations while building their lessons and delivering instruction.

**Professional Development (PD).** Research delineates four elements for effective PD for mathematics teachers: long-term delivery with ongoing support, a clear focus on teacher practices as well as content knowledge, teacher involvement in designing student learning experiences as well as teacher reflection, and a professional network for support (Garet et al., 2001). The foundation of understanding content and curriculum is paramount (Brodie & Shalem, 2011; McCrory et al., 2012), and mathematics educators need to know “both what knowledge matters and how it is manifest in practice” (McCrory et al., 2012, p. 586). In this study, quality PD is considered PD opportunities for mathematics teachers that is focused on teachers’ current mathematics content standards as well as either identifying or addressing any pedagogy areas needed for implementing curriculum that is aligned to those content standards. PD addressing adopted curriculum materials alone is not enough and must cover content knowledge as it is a key component toward the severity of misinterpretations of curriculum and overall effectiveness as a mathematics teacher (McCrory et al., 2012). Most importantly, PD has been found to increase student achievement (Yoon et al., 2007).

PD sessions often are presented for a prescribed amount of time each year to school-wide audiences focusing on generalized education concerns, leaving mathematics
teachers to deal with their most basic needs on their own time (Gewertz, 2014; Rentner & Kober, 2014a). With new content standards that demand extended content knowledge as well as conceptual connections, middle and secondary mathematics educators may not have the knowledge required to be effective teachers. A study exploring the content knowledge of middle school mathematics teachers found that the teachers sampled demonstrated only about 50% of the content knowledge required to teach middle school according to the standards at that time (Saderholm, Ronau, Brown, & Collins, 2010).

Even for the content standards currently used, the CCSS website states that the standards clearly communicate what is expected of students at each grade level which will allow teachers to be better equipped to know exactly what they need to help students learn and establish individualized benchmarks for them (CCSSO, 2010). The CCSS website also describes a new sense of flexibility to focus on the core concepts within each grade level in order to teach to a deeper understanding (CCSSO, 2010). However, the documents address elementary and some middle school concepts but scarcely provide a sense of the connections to be made within secondary mathematics or the focus points highlighting which content takes precedence for secondary topics (CCSSO, 2010); PD sessions, especially for high school teachers, would be a helpful job resource for teachers to sort through this confusion. As previously outlined, mathematics teachers need job resources that are specific for their job demands such as PD tailored to their content and pedagogical needs.

**Planning Time.** Little is written specifically about teachers’ need for time or the impact of additional planning time on teacher effectiveness or student learning, yet the nature of learning and growing as a professional, even for teachers, is incremental,
iterative, and takes time (Doerr, Goldsmith, & Lewis, 2010). Teachers need time to absorb their content standards as well as create or adapt curriculum resources, even if resources are provided (Darling-Hammond, Wei, & Andree, 2010). A research brief comparing teacher supports for U.S. teachers and teachers in high-achieving countries revealed teachers in the U.S. have 20 percent less time during their workdays to plan, collaborate, and meet with parents and students (Darling-Hammond, Wei, & Andree, 2010).

If teacher understanding (either in terms of content knowledge, or pedagogy) is low, even more time will be needed to comprehend the task of implementing the standards and understanding a variety of ways in which they can be implemented. Teachers with high teacher understanding still need time to familiarize themselves with new curriculum resources as they may be new in both form and content and both take time to comprehend (Remillard, 2005). Teachers’ need for time is an area where research is lacking, possibly due to the fact that it is common knowledge or that it is imbedded within other constructs such as planning or PD, for instance.

On a district or state level, time for curriculum implementation can be allotted by administrators if a lapse exists between introducing new standards to teachers and expecting them to implement the new standards (ASCD, 2012; NCTM, 2013). Allowing teachers time to understand the standards prior to receiving and/or creating curriculum may also increase teacher understanding; for instance, “the rapid adoption of [CCSS-M]… created a number of challenges in implementing the new standards” (ASCD, 2012, p. 12). Without ample time to absorb the expectations of both the content standards and
the curriculum materials, teachers might feel unclear, overwhelmed, and ineffective towards their objectives.

On a school level, time can be allotted to teachers during their workday to plan for instruction (ASCD, 2012; Darling-Hammond, Wei, & Andree, 2010). This planning can occur individually or collaboratively with other teachers (Darling-Hammond, Wei, & Andree, 2010). Planning time however would need to focus on instructional planning rather than attending meetings or other extraneous school duties (VanTassel-Baska & Stambaugh, 2005). In this study, time is considered as portions of the workday set aside for planning either individually or collaboratively.

**Collaboration.** Because teaching can be an isolating profession, efforts have been made over the last decade to increase collaboration among colleagues partly due to research in the business sector on professional learning communities (PLCs) (Vescio, Ross, & Adams, 2008). With the emphasis on PLCs, research on implementation, characteristics of quality, and effects of teacher collaboration have followed. Collaborating with teacher colleagues has increased both teacher learning and teacher performance growth especially when teachers receive actionable feedback for improvement (Kraft & Papay, 2014). Teachers learned at faster rates working in schools where the quality of collaboration was higher (Ronfeldt, Farmer, McQueen, & Grissom, 2015), and they were found to be more eager, energized, and innovative toward teaching all students than those in lesser quality PLCs (McLaughlin & Talbert, 1993). Quality collaboration means dialogue in PLCs is regulated by group selected norms that focus primarily on student learning and provide teachers with feedback where trust and rapport are strong (Bolam, McMahon, Stoll, Thomas, & Wallace, 2005; Vescio et al. 2008). As
illustrated in Figure 5, the quality of PLC collaboration can be influenced by school leadership (Coburn & Turner, 2011). Teachers participating in quality collaboration may be more likely to feel a sense of success, which may additionally reduce teacher attrition, keeping teachers at their schools in which they feel successful (Johnson & Birkeland, 2003).

Teacher learning can focus on teacher content knowledge, pedagogy, or student learning. Like PD, collaboration among colleagues can provide opportunities for teachers to clarify their understanding of content standards but unlike typical PD sessions, collaboration presents teachers with small group or even one-on-one opportunities to learn. Collaboration can also focus on department-adopted curriculum addressing instructional practices and resources. A third way in which teachers may learn is more data driven, focusing on ways to address students’ learning needs (Ronfeldt et al., 2015). More than infrequent PD sessions, collaboration offers teachers an ongoing and accessible source for increasing teacher learning, focusing on various ways to provide better instruction.

Most importantly, teacher collaboration has been positively linked to student achievement (Goddard, Goddard, & Tschannen-Moran, 2007; Kraft & Papay, 2014; Louis & Marks, 1998; Ronfeldt et al., 2015). Although hesitant to claim causality, researchers have suggested that the amount and quality of collaboration within a school corresponds with increased levels of student achievement (Goddard et al., 2007; Ronfeldt et al., 2015). In one study, the strength of a school’s professional community, defined as “shared values, focus on student learning, collaboration, deprivatized practice, and
reflective dialogue” (p. 539), was found to account for as much as 85% of the variance in student achievement (Louis & Marks, 1998).

Again, larger organizational structures may impact teachers’ engagement levels during collaboration time; providing time for small group collaboration alone is not enough to cause teachers to engage in professional growth but merely presents the opportunity to do so (Vescio et al., 2008). Teachers need support from their schools to foster environments such as ISC and SC where teachers collaborate by providing time and training for cultivating cooperative educator groups.

**Autonomy.** Teachers with a higher sense of autonomy provide better teaching (Porter, 1989) and are “more willing and supportive of common change” (Friedman, 1999, p. 59). Teachers’ levels of autonomy also may be linked to their levels of job tension, frustration, and anxiety (Pearson & Moomaw, 2006) and to teacher commitment, retention, and professionalism (Certo & Fox, 2002; Kim & Loadman, 1994; Pearson & Moomaw, 2006). Autonomy as both internal and external control has been found to affect teacher satisfaction (Dinham & Scott, 1996; Kim & Loadman, 1994).

Teacher autonomy has been studied in multiple ways, resulting in various interpretations of the construct. One definition of autonomy is “a means of encouraging and strengthening the power of teachers in the personal or professional senses, not just as a buffer against pressures exerted on the teacher” (Friedman, 1999, p. 60). Another definition alludes to attaining a locus of control (Pearson & Hall, 1993). Regardless of the definition, the overarching idea in autonomy studies focuses on teachers having the power to make important decisions for their work. Friedman (1999) suggests that teacher decisions fall into two categories: the “content axis” which includes pedagogical and
organizational decisions and the “level axis” which includes principle or routine decisions. Both the content and level axis of teacher decisions were found to be statistically related to teacher autonomy (Friedman, 1999).

Understandings of teacher autonomy are complicated because of the various definitions in the literature and also because each teacher perceives autonomy differently (Pearson & Moomaw, 2006). Although teachers’ personal perceptions of autonomy may vary, one reason teachers reportedly leave the teaching profession is even when they do have power to make decisions they do not feel respected for their efforts (Dinham & Scott, 1996; Pearson & Moomaw, 2006). Teacher perception of autonomy depends on “their understandings of the organizational control system” (Leiter, 1981, p. 225), which emphasizes the importance of teachers’ relationship with their administrators. In this study, autonomy refers to teachers’ instructional autonomy to make decisions regarding their lesson delivery for their students. In this study, instructional autonomy assumes teachers refer to current content standards to determine what should be taught and have professional flexibility to decide the best curriculum materials, instructional methods, pacing, and timing of that content for educating their students.

Of particular interest to this study are connections between autonomy and effective teaching. Öztürk (2012) found that when teachers in Turkey were not included in the decision-making process for selecting curriculum materials, teachers adapted the curriculum, seeking internal autonomy. Teachers in the study noted exceptional differences between the mandated curriculum and their ability to adapt the curriculum materials to meet their students’ needs, particularly different learning styles. Therefore, these instructional changes often fell short of “bridg[ing] the gap between instructional
plans and classroom realities” (p. 297). Macpherson, Brooker, Aspland, and Elliott (1999) along with Öztürk (2012) found teachers were able to more effectively use curriculum materials when they were involved in the curriculum decision-making process.

Another research connection is found between teacher autonomy and stress, work satisfaction, empowerment, and professionalism (Pearson & Moomaw, 2005). In the 2005 study, teacher autonomy was defined as curriculum autonomy and general teaching autonomy as measured by the Teaching Autonomy Scale (TAS), which included elements of instructional planning such as selection of instructional activities and materials, instructional sequencing, classroom standards of conduct, and on-the-job decision making. Curriculum autonomy was found to decrease on-the-job stress and general teaching autonomy was found to increase empowerment and professionalism, and this result was consistent across teaching levels from elementary to high school.

A review of literature on autonomy and student achievement returned studies on the effects of students having autonomy over their learning (e.g. Froiland, Davison, & Worrell, 2016; Reeve et al., 2004; Wong, Wiest, & Cusick, 2002), not whether teachers had instructional autonomy over their teaching and student achievement. The most relevant study from the search of literature used international data from the PISA 2003 exam and found that “school autonomy” and student achievement both increased when students were tested using external exit exams and that “school autonomy is more beneficial in systems with external exams” (Lüdemann, Schütz, West, & Woessmann, 2007, p. 34). In that study, school autonomy included various avenues for teachers to
participate in decision-making, one of which included determining course content (Lüdemann et al., 2007).

Summary

Teachers need job resources to be engaged in and most effective at their work (Hakanen et al., 2006; Mauno et al., 2007; Schaufeli & Bakker, 2004); however, mathematics teachers, may not have the physical or social job resources needed to be highly effective (Gewertz, 2014). Teachers endure stressful job demands (Hakanen et al., 2006); however, is the availability of job resources, among other considerations, that determines whether employees will engage at work to increase their effectiveness and productivity (Harter et al., 2002; Kahn, 1992; Leiter & Maslach, 2004; Schaufeli et al., 2002).

Teachers engaged with their work convey characteristics of vigor, dedication, and absorption (Schaufeli et al., 2002). Considerations for work engagement involve both job demands and job resources, which can contribute to teachers’ burnout or disengagement. Job demands include issues such as student behavior and work load. Although job demands are a real concern for teachers, the focus in this study in on job resources as they relate to student achievement in mathematics.

Job resources for teachers that affect their daily lesson planning and instruction have not been clearly identified in the literature. In this study, teacher job resources identified for effective teaching included quality curriculum, quality PD, time, collaboration, and autonomy. These are job resources that many mathematics teachers may not be provided (Gewertz, 2014). Districts that do not provide such resources leave their teachers to deal with job demands without job resources, a combination which may
decrease teacher work engagement and effectiveness (Hakanen et al., 2006; Mauno et. al, 2007; Schaufeli & Bakker, 2004).
CHAPTER 3

METHODOLOGY

Researchers have found that work engagement is predicted by availability to job resources (Hakanen et al. 2006; Mauno et. al, 2007; Schaufeli & Bakker, 2004). Therefore, it seems that if teachers have sufficient resources, they will be more likely to engage or remain engaged at work in the face of high job demands, and higher levels of engagement should align with higher levels of student achievement. In this study, five resources associated with lesson development or lesson planning were explored: curriculum materials containing support for mathematics content and pedagogy, professional development (PD) sessions focused on mathematics teacher needs, peer collaboration to refine teaching practices, work day planning time both individually and with colleagues, and teachers’ sense of instructional job control.

Data were purchased from the Measures of Effective Teaching (MET) Project (MET Project, 2013). Files included a teacher work conditions questionnaire, student mathematics achievement scores, as well as both teacher and student demographic information. Data from this study were used to analyze student (level-1) and teacher (level-2) variables using hierarchical linear modeling (HLM) to explore the research question posed: How do teacher instructional job resources relate to student achievement in mathematics?
Sample

The MET Project, funded by the Bill and Melinda Gates Foundation, gathered data from about 3,000 teacher volunteers from 2009-2011. Teachers worked in public and independent schools in Charlotte-Mecklenburg, North Carolina; Dallas, Texas; Denver, Colorado; Hillsborough County, Florida; Memphis, Tennessee; and New York City, New York. The purpose of the MET Project and data collection was to evaluate teachers during the 2009-2010 school year for their impact on student achievement, randomly assign a classroom of students to the same participating teachers for the 2010-2011 school year, and then track students’ achievement in order to identify and measure attributes of effective teachers (MET, 2013). Although teachers of several content areas participated in the MET Project over two years, only data for mathematics teachers from the 2010-2011 school year were included in this study. There were 22 schools, 46 teachers, and 2,180 students for the 9th grade ACT QualityCore assessment with an average of almost 3 teachers per school (SD = 1.13) and an average of about 40 students in each classroom on average (SD = 18.26). The ACT QualityCore test is an exam that was developed by the ACT research and development team in collaboration with a group of teachers nationwide, and is independent from an identified set of content standards (www.act.org). There were 67 schools, 241 teachers, and 10,251 students for the 4th-8th grade Balanced Assessment in Mathematics assessment with an average of almost 5 teachers per school (SD = 2.73) and about 44 students in each classroom (SD = 18.10). The Balanced Assessment in Mathematics test is the result of an ongoing project at Harvard University Graduate School of Education from 1993 to 2003. The project generated innovative assessment tasks for mathematics and provided training for teachers.
to prepare their students. Sample tasks are freely available for teachers (hgse.balancedassessment.org/).

**Variables**

This study used data from the MET 3d-DS7 questionnaire titled Teacher Working Conditions from file MET 3d-DS7 ICPSR 34345, as well as teacher and student demographics. Teacher demographics from file da34771-0004_REST.sav included racial minority status, gender, and years of experience (see Table 1). Student demographics from file da34414-0004_REST.sav included gender, free or reduced lunch status, and underrepresented minority status (see Table 1). For each teacher and student demographic, attention was paid to issues of normality and skew. Files were linked through School ID and Teacher ID for HLM purposes.

The outcome measure was student achievement scores from one of two 2010-2011 school-year tests: the ACT QualityCore for Algebra 1 in high school (file da34309-0004_REST.sav) and the Balanced Assessment in Mathematics (BAM) for grades 4-8 (file da34309-0003_REST.sav). Models were run separately for each of these two grade bands so that the results could be analyzed for fourth through eight graders and for ninth graders separately. The achievement scores were standardized z-scores (mean close to 0 and SD close to 1) so that the results of the models could be compared. The outcome variable for student achievement in mathematics was BAM_Z_4-8 for 4<sup>th</sup>-8<sup>th</sup> and ACT_Z_9 for the 9<sup>th</sup> grade model.

Table 1

**Control Variables for Student and Teacher Participants**

<table>
<thead>
<tr>
<th>Level</th>
<th>Variable Name</th>
<th>Description</th>
<th>Coding</th>
<th>Centering</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>StGen</td>
<td>Student gender</td>
<td>0 = female, 1 = male</td>
<td>Uncentered</td>
</tr>
</tbody>
</table>
Survey items from the Teacher Working Conditions Survey addressed the five resources associated with lesson development or lesson planning previously outlined: Curriculum, PD, Collaboration, Planning Time, and Autonomy. I examined the MET survey questions and identified items that seemed to measure (a) teachers’ thoughts on the quality of the curriculum materials provided to them, (b) whether teachers have quality PD sessions that are focused on mathematics, (c) whether teachers are able to collaborate with their peers to refine their teaching practices, (d) teachers’ feeling a sense of job control from their administrators to create their own instructional plans, and (e) how much time teachers use during the day for lesson planning, the following survey questions were used. Teacher responses to survey items, which address the first four job resources, found in Table 2, along with their location in the MET codebook, were coded as follows: 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree, and 8 = don’t know, which was considered as missing data. Teacher responses to survey items on planning time found in Table 3, along with their location in the MET codebook, were coded as follows: 0 = none, 1 = less than or equal to 1 hr, 2 = more than an hour but less than or equal to 3 hours, 3 = more than 3 hours but less than or equal to 5 hours, 4 = more
than 5 hours but less than or equal to 10 hours, and 5 = more than 10 hours of planning time.

Table 2

**MET Survey Questions on Curriculum, PD, Collaboration, and Instructional Autonomy**

<table>
<thead>
<tr>
<th>Hypothesized variables for this study</th>
<th>MET Codebook page number for 3d-DS7</th>
<th>MET Survey Variable Name</th>
<th>Survey Question</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
<td>FRL21APPMATERIAL</td>
<td>Please rate how strongly you agree or disagree with the following statements using the scale: strongly disagree to strongly agree.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MET21MTLCONTENT</td>
<td>They contain useful information for me about the content I am teaching.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MET21MTLTEACH</td>
<td>They provide me with useful information about how to teach particular skills, strategies, texts, or other topics.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MET21MTLKNOW</td>
<td>They provide me with useful information about what students typically know and can do and about typical difficulties they have.</td>
</tr>
<tr>
<td>Curriculum</td>
<td></td>
<td>86</td>
<td>Sufficient resources are available for professional development in my school.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39</td>
<td>An appropriate amount of time is provided for professional development.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41</td>
<td>Professional development deepens teachers’ content knowledge.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>43</td>
<td>Professional development enhances teachers’ abilities to improve student learning.</td>
</tr>
<tr>
<td>PD</td>
<td></td>
<td>39</td>
<td>Sufficient resources are available for professional development in my school.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39</td>
<td>An appropriate amount of time is provided for professional development.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41</td>
<td>Professional development deepens teachers’ content knowledge.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>43</td>
<td>Professional development enhances teachers’ abilities to improve student learning.</td>
</tr>
<tr>
<td>Collaboration</td>
<td></td>
<td>42</td>
<td>Professional development provides ongoing opportunities for teacher to work with colleagues to refine teaching practices.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>52</td>
<td>Teachers work in professional learning communities to develop and align instructional practices.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>Teachers have time available to collaborate with colleagues.</td>
</tr>
<tr>
<td>Instructional Autonomy</td>
<td></td>
<td>53</td>
<td>Teachers are encouraged to try new things to improve instruction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>54</td>
<td>Teachers are assigned classes that maximize their likelihood of success with students.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>54</td>
<td>Teachers have the autonomy to make decisions about instructional delivery (i.e., pacing, materials and pedagogy).</td>
</tr>
</tbody>
</table>
Table 3

*MET Survey Questions on Planning Time*

<table>
<thead>
<tr>
<th>Hypothesized variables for this study</th>
<th>MET Codebook page number for 3d-DS7</th>
<th>MET Survey Variable Name</th>
<th>Survey Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning Time</td>
<td>7</td>
<td>TMT46COLLABPLN</td>
<td>In an average week, how much time do you devote to collaborative planning time during the school day (i.e., time for which you are under contract to be at the school)?</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>TMT46INDPLN</td>
<td>In an average week, how much time do you devote to individual planning time during the school day (i.e., time for which you are under contract to be at the school)?</td>
</tr>
</tbody>
</table>

**Factor Analysis**

Factor analysis was used to examine how the survey questions functioned together to form factors, using the fewest interpretable factors needed to explain correlations within each construct (McCoach, Gable, & Madura, 2013) and then to create factor scores. The sample was randomly separated in half in order to conduct first an exploratory factor analysis (EFA) followed by a confirmatory factor analysis (CFA). Assumptions of factor analysis include the presence of a large sample size, normality, linearity, absence of multicollinearity, and the absence of outliers in the data set (Stevens, 2009). Each assumption was checked for each of the randomly separated samples as well as the sample as a whole.

EFA is a technique outlined for large sample sizes; however, there are various suggestions regarding sample size. The most conservative suggestion is that 500 subjects is a very good sample size (Meyers, Gamst, & Guarino, 2006) and allows for the weakest factor-loading relationship (McCoach et al., 2013). The data used in this project included 1,611 valid cases, an appropriate sample size using the aforementioned criterion. Histograms for each question were evaluated. To further check the normality of each
questions, skewness and kurtosis were analyzed. The Kolmogorov-Smirnov and Shapiro-Wilk statistics were also used to evaluate the normality assumption. Linearity for each question was evaluated from Q-Q scatterplots.

I conducted an EFA to determine how the survey items interrelated to form factors. I used principal axis factoring (PAF) to “explain the patterns of correlations among [the] measured variables” (McCoach et al., 2013, p. 119) and used direct oblimin rotation because factors likely were correlated (McCoach et al., 2013). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy as well as the Bartlett’s test of sphericity, measuring sufficient correlation between dependent variables, were used to determine whether the EFA was an appropriate analysis to conduct.

To determine the number of factors to extract, the following criteria were examined: Kaiser’s criterion of eigenvalues greater than 1, scree plot analysis, and parallel analysis. Once I determined the number of factors to extract, I examined the pattern matrix for factor loadings higher than 0.4 and that were not double loading (McCoach et al., 2013). Based on the EFA, factors were named and defined (see Chapter 4).

These factors were used to conduct a CFA on the second half of the sample data. To conduct the CFA, the factors were represented as latent variables, with the items loading on their respective factors only and the factors being correlated. Model fit was estimated by three indices: RMSEA between 0.05 and 0.08, SRMR between 0 and 0.08, (Hooper, Coughlan, & Mullen, 2008), and CFI greater than or equal to .90 (Lance, Butts, & Michels, 2006).
The reader will recall from Chapter 2 that several job resources may be related. In fact, physical resources (quality PD and curriculum) may theoretically be combined because materials and training work in tandem where PD could support adopted curriculum (McCrory et al., 2012; Polikoff & Porter, 2014; Remillard, 2005). Therefore, two competing models (see Figure 9) were tested using CFA, (a) a model with individual factors identified from the EFA (see Table 4) representing the conceptual framework outlined in Chapter 2, and (b) a higher-order model to address the social and physical branches of job resources (see Table 5). A chi-square difference test was used to compare the higher-order model to the model with individual factors (McCoach et al., 2013).

![Diagram of job resources]

*Figure 9.* Five-factor model (left) and higher-order model (right) of the conjectured relationship of teacher job resources that may impact lesson planning and instruction and student achievement.
Table 4

**Hypothesized Five-Factor Model Independent Variables of Interest**

<table>
<thead>
<tr>
<th>Level</th>
<th>Variable Name</th>
<th>Description</th>
<th>Coding</th>
<th>Centering</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2</td>
<td>COLLAB</td>
<td>Collaboration</td>
<td>Factor scores from CFA</td>
<td>Grand-mean centered</td>
</tr>
<tr>
<td></td>
<td>PLNTIME</td>
<td>Planning Time</td>
<td>Factor scores from CFA</td>
<td>Grand-mean centered</td>
</tr>
<tr>
<td></td>
<td>CURR</td>
<td>Curriculum</td>
<td>Factor scores from CFA</td>
<td>Grand-mean centered</td>
</tr>
<tr>
<td></td>
<td>PD</td>
<td>Professional Development</td>
<td>Factor scores from CFA</td>
<td>Grand-mean centered</td>
</tr>
<tr>
<td></td>
<td>AUTON</td>
<td>Instructional Autonomy</td>
<td>Factor scores from CFA</td>
<td>Grand-mean centered</td>
</tr>
</tbody>
</table>

Table 5

**Hypothesized Higher-Order Model Independent Variables of Interest**

<table>
<thead>
<tr>
<th>Level</th>
<th>Variable Name</th>
<th>Description</th>
<th>Coding</th>
<th>Centering</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2</td>
<td>PHY</td>
<td>Physical Job Resources (Curriculum &amp; Professional Development)</td>
<td>Factor scores from CFA</td>
<td>Grand-mean centered</td>
</tr>
<tr>
<td></td>
<td>SOC</td>
<td>Social Job Resources (Collaboration, Time, &amp; Autonomy)</td>
<td>Factor scores from CFA</td>
<td>Grand-mean centered</td>
</tr>
</tbody>
</table>

**Relationship between Teacher Job Resources and Student Achievement**

To analyze the relationship of teacher job resources and student achievement, which involves students nested in classrooms that are nested in schools, a three-level hierarchical linear model was created using HLM7 software (Raudenbush et al., 2011). Accounting for the differences between classrooms and schools is important (McCoach & Adelson, 2010) because teachers had different curriculum as well as other job resources that may have affected their students’ achievement, thus violating the
assumption of independence of observations. Models were estimated using Full
Maximum Likelihood (FIML) because the sample consisted of more than 50 groups and
models were examined with differing fixed effects (Raudenbush & Bryk, 2002). Level-1
(student) and level-2 (classroom) predictor variables were analyzed with appropriately
centered data so that all variables had a meaningful 0. Cases with missing data were
deleted at the time of analysis. In each case, model selection was based on methods
outlined by Raudenbush and Bryk (2002) as well as McCoach and Black (2008) using
AIC, BIC, and the chi-square difference test.

HLM Model-Building Process

The following model-building process was conducted separately for grades 4-8
and for grade 9. For each outcome, I followed the same process but only included data
for students in the appropriate grade level(s).

The null model, which included only the outcome variable was built to determine
the intraclass correlation coefficient (ICC). The ICC measured the proportion of variance
that occurred between students within a classroom, \( \frac{\sigma^2}{\sigma^2 + \tau_{\pi} + \tau_\beta} \), between classrooms within
a school, \( \frac{\tau_{\pi}}{\sigma^2 + \tau_{\pi} + \tau_\beta} \), and between schools, \( \frac{\tau_\beta}{\sigma^2 + \tau_{\pi} + \tau_\beta} \) (McCoach & Adelson, 2010;
Raudenbush & Bryk, 2002). Following the null model, the level-1 (student-level) model
was built, which included student-level control variables, such as student gender, student
free or reduced lunch status, and underrepresented minority status. Random effects for
variables that did not vary across classes were fixed (Raudenbush & Bryk, 2002) based
on \( p > .05 \) and model fit comparisons. Next, random effects for variables that did not
vary across schools were fixed (Raudenbush & Bryk, 2002) based on \( p > .05 \) and model
fit comparisons.
Following the level-1 model, the level-2 (teacher-level) control model was built by adding teacher-level control variables, such as teacher race, teacher gender, and years of experience as predictors of the intercept (Raudenbush & Bryk, 2002). The proportion of variance explained by the level-1 and level-2 control variables was calculated by comparing the variance in the level-2 model to the null model, $\frac{\tau_{\pi 00} \beta - \tau_{\pi 00} F}{\tau_{\pi 00} \beta}$. Finally, the teacher variables of interest for the individual-factor model (i.e., COLLAB, TIME, CURR, PD, AUTON) were added to the level-2 model as predictors of the intercept. Thus, the relationship between the teacher job resource variables and student achievement could be examined while controlling for student and teacher characteristics. Additionally, I then could calculate the proportion of variance between classes and between schools in achievement that was explained by teacher job resources above and beyond the control variables.

This final process was repeated for the higher-order model factors. This allowed me to determine the relationship of physical and social job resources with student achievement while controlling for student and teacher contextual variables. Again, using the model-building process outlined by Raudenbush and Bryk (2002), I built models to examine the significance of the relationship between the teacher job resource variables of interest and student achievement while controlling for student and teacher background variables.

**Summary**

Using a large-scale secondary database, I was able to use multiple indicators to model five factors for teacher job resources: Curriculum, PD, Planning Time, Collaboration, and Autonomy. I expected to find that those factors could be grouped as
follows: (a) physical job resources needed for planning effective instruction, which included curriculum materials and PD opportunities and (b) social job resources needed for planning effective instruction, which included teachers’ planning time, collaboration, and their sense of autonomy. These factors were then used as variables of interest to examine the relationship between ITJR and student achievement using HLM. The model-building process of HLM allowed the statistical significance of these relationships to be analyzed while accounting for the clustering effect of students grouped into classes and controlling for student and teacher characteristics (McCoach & Adelson, 2010; Raudenbush & Bryk, 2002). By using this methodology, a more accurate analysis was possible than statistical techniques not accounting for the clustering effect (McCoach & Adelson, 2010).
CHAPTER 4

RESULTS

As stated in Chapter 1, this study examines the relationship between student achievement in mathematics and instructional teacher job resources (ITJR) such as curriculum materials, professional development (PD), time to collaborate with colleagues, and instructional autonomy. This chapter includes six parts: coding, normality and assumptions, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), hierarchical linear modeling (HLM) for grades 4-8, and HLM for grade 9.

Coding

Each of the 14 survey questions for teacher working conditions from MET file 3d-DS7 ICPSR 34345 were recoded to have a meaningful zero, with a Likert scale ranging from 0 (strongly disagree) to 3 (strongly agree) and “don’t know” coded as missing data. Coding for teacher working conditions relating to their time planning remained the same because it already had a meaningful zero. Control variables for both level-1 and level-2 variables were recoded as shown below in Table 6.
Table 6

<table>
<thead>
<tr>
<th>Level</th>
<th>Variable Name</th>
<th>Description</th>
<th>Original Coding</th>
<th>Recoded</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>StGen</td>
<td>Student gender</td>
<td>1 = female, 2 = male</td>
<td>0 = female, 1 = male</td>
</tr>
<tr>
<td></td>
<td>FRL</td>
<td>Free or reduced lunch status</td>
<td>1 = full-price lunch, 2 = free/reduced lunch</td>
<td>0 = full-price lunch, 1 = free/reduced lunch</td>
</tr>
<tr>
<td></td>
<td>UndMin</td>
<td>Underrepresented minority status of student</td>
<td>White, Black, Hispanic, Asian, American Indian, or other</td>
<td>0 = white or Asian, 1 = underrepresented minority</td>
</tr>
<tr>
<td>2</td>
<td>T_MinSt</td>
<td>Teacher minority status</td>
<td>White, Black, Hispanic, or other</td>
<td>0 = white, 1 = underrepresented minority</td>
</tr>
<tr>
<td></td>
<td>T_Gend</td>
<td>Teacher gender</td>
<td>1 = female, 2 = male</td>
<td>0 = female, 1 = male</td>
</tr>
<tr>
<td></td>
<td>T_Exper</td>
<td>Years of experience</td>
<td>Integers [0,24]</td>
<td>No change</td>
</tr>
</tbody>
</table>

Normality and Assumptions

It was assumed that the survey questions were administered according to the MET guidelines such that teachers answered survey questions honestly and anonymously. Lastly, it was assumed that data for teacher surveys, student and teacher demographics, and student assessment scores were entered by MET without recording errors or data entry errors.

Data were not normally distributed, as expected due to the categorical and bimodal nature of the data. For instance, teacher survey items were comprised of four categorical choices of strongly disagree, disagree, agree, and strongly agree. Similarly, data on FRL, provided by MET, were dichotomous; students either were or were not identified as students on free and reduced lunch. Because of the categorical and dichotomous nature of the data and because it was assumed the data were entered correctly and without error, outliers were not removed (Stevens, 2009).
Exploratory Factor Analysis (EFA)

The sample of questions from the teacher working conditions survey was randomly split and 49% or 1,024 of the 2,089 cases comprised the EFA sample. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (.874) as well as the Bartlett’s test of sphericity (4955.625(120), \( p < .001 \)), which measures whether there is sufficient correlation between dependent variables, indicated that the EFA was an appropriate analysis to conduct. Kaiser’s criterion of eigenvalues greater than 1 indicated four factors should remain, the parallel analysis indicated three factors should remain, and the scree plot analysis indicated one factor should remain. Without consistent criteria for determining the number of factors to retain, each of the models for a four-factor, three-factor, and one-factor EFA were examined, with all analyses using principle axis factoring and direct oblimin rotation.

**Four-factor EFA.** As shown in Table 7, most of the survey items had a factor loading of |.400| or higher and were retained. These items each loaded clearly onto one of the four factors with no cross loadings and collectively explained 50.5% of the variance. The four factors operationally define Curriculum, Professional Development (PD), Autonomy, and Time to Collaborate. Time to Collaborate consisted of items that relate to two ideas discussed in Chapter 2, Time to Plan and Teacher Collaboration. Survey questions retained for Time to Collaborate contained only questions on time to plan collaboratively and not on individual planning time. Other than planning collaboratively, survey questions on planning time did not load on any factors with loadings greater than |.400| and thus were not retained.
Correlations across the subscales were also calculated. Autonomy and PD were the highest correlated (.543) and Time to Collaborate and Curriculum were the lowest correlated (.186).

Table 7

Pattern Matrix for the Four-Factor EFA

<table>
<thead>
<tr>
<th>Factor</th>
<th>Survey Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>Sufficient resources are available for professional development in my school.</td>
<td>.890</td>
<td>-0.103</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>An appropriate amount of time is provided for professional development.</td>
<td></td>
<td>.807</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional development provides ongoing opportunities for teachers to work with colleagues to refine teaching practices.</td>
<td>.580</td>
<td>.101</td>
<td>.232</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional development enhances teachers’ abilities to improve student learning.</td>
<td>.562</td>
<td></td>
<td>.289</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional development deepens teachers’ content knowledge.</td>
<td>.524</td>
<td>.126</td>
<td>-.117</td>
<td>.267</td>
</tr>
<tr>
<td>Curriculum</td>
<td>They provide me with useful information about how to teach particular skills, strategies, texts, or other topics.</td>
<td></td>
<td>.984</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>They provide me with useful information about what students typically know and can do and about typical difficulties they have.</td>
<td></td>
<td>.760</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>They contain useful information for me about the content I am teaching.</td>
<td></td>
<td></td>
<td>.687</td>
<td></td>
</tr>
<tr>
<td>Time to Collaborate</td>
<td>In an average week, how much time do you devote to collaborative planning time during the school day (i.e., time for which you are under contract to be at the school)?</td>
<td>.784</td>
<td>-.169</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers have time available to collaborate with colleagues.</td>
<td>.185</td>
<td>.451</td>
<td>.135</td>
<td></td>
</tr>
<tr>
<td>Autonomy</td>
<td>Teachers have the autonomy to make decisions about instructional delivery (i.e., pacing, materials and pedagogy).</td>
<td></td>
<td></td>
<td>.681</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers are assigned classes that maximize their likelihood of success with students.</td>
<td></td>
<td></td>
<td>.617</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers are encouraged to try new things to improve instruction.</td>
<td>.204</td>
<td></td>
<td>.546</td>
<td></td>
</tr>
<tr>
<td>Survey Items Not Retained</td>
<td>Teachers have sufficient access to appropriate instructional materials.</td>
<td>.298</td>
<td>.123</td>
<td>.211</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers work in professional learning communities to develop and align instructional practices.</td>
<td>.271</td>
<td>.261</td>
<td>.202</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In an average week, how much time do you devote to individual planning time during the school day (i.e., time for which you are under contract to be at the school)?</td>
<td>.245</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Several survey questions loaded on variables not anticipated. For instance, MET survey question, “Professional development provides ongoing opportunities for teacher to work with colleagues to refine teaching practices,” (item PDL21COLLEAGUE) loaded on PD instead of collaboration, as hypothesized. The formation of the new variable, Time to Collaborate, meant all of the items that loaded on Time to Collaborate were expected to load on other variables. As shown in Table 7, not all items loaded on one of the four factors, such as individual planning time.

Three-factor EFA. As shown in Table 8, all but one of the survey items had a factor loading of |.400| or higher and were retained. These items each loaded clearly onto one of the three factors with no cross loadings and collectively explained 45.8% of the variance. In this solution, Curriculum and Time to Collaborate remained, but PD and Autonomy collapsed into one factor. Although this variable might be considered to operationalize a construct named “Professionalism,” the term professionalism is a construct that is defined in education differently than professional development and autonomy (Hargreaves, 1999; Sykes, 1999). Therefore, the three factors for this model were Curriculum, Time to Collaborate, and PD + Instructional Autonomy. Again, items that were hypothesized to indicate individual planning time did not load on any factor. Correlations across the subscales were also calculated. PD + Instructional Autonomy and Curriculum were the highest correlated (.497) and, as before, Time to Collaborate and Curriculum were the lowest correlated (.166).
Table 8

*Pattern Matrix for the Three-Factor EFA*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Survey Question</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - PD + Instructional Autonomy</td>
<td>Professional development enhances teachers’ abilities to improve student learning.</td>
<td>.819</td>
<td>-.111</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional development provides ongoing opportunities for teachers to work with colleagues to refine teaching practices.</td>
<td>.777</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional development deepens teachers’ content knowledge.</td>
<td>.767</td>
<td>-.160</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sufficient resources are available for professional development in my school.</td>
<td>.744</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>An appropriate amount of time is provided for professional development.</td>
<td>.693</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers are encouraged to try new things to improve instruction.</td>
<td>.639</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers are assigned classes that maximize their likelihood of success with students.</td>
<td>.539</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers have the autonomy to make decisions about instructional delivery (i.e., pacing, materials and pedagogy).</td>
<td>.473</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers have sufficient access to appropriate instructional materials.</td>
<td>.472</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers work in professional learning communities to develop and align instructional practices.</td>
<td>.436</td>
<td>.253</td>
<td></td>
</tr>
<tr>
<td>2 - Curriculum</td>
<td>They provide me with useful information about how to teach particular skills, strategies, texts, or other topics.</td>
<td>.966</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>They provide me with useful information about what students typically know and can do and about typical difficulties they have.</td>
<td>.737</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>They contain useful information for me about the content I am teaching.</td>
<td>.672</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - Time to Collaborate</td>
<td>In an average week, how much time do you devote to collaborative planning time during the school day (i.e., time for which you are under contract to be at the school)?</td>
<td>.739</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers have time available to collaborate with colleagues.</td>
<td>.288</td>
<td>.459</td>
<td></td>
</tr>
<tr>
<td>Not Retained</td>
<td>In an average week, how much time do you devote to individual planning time during the school day (i.e., time for which you are under contract to be at the school)?</td>
<td>.242</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Factor loading values less than |.100| were suppressed from the table. Factor loadings greater than or equal to |.400| were bolded as retained items.

**One-factor EFA.** As shown in Table 9, all but two of the survey items had a factor loading of |.400| or higher and were retained, and the factors collectively explained 32.4% of the variance. All survey questions regarding Curriculum, PD, Instructional
Autonomy, and Time to Collaborate were combined for the EFA with one factor retained. Items that were hypothesized to indicate individual planning time did not load on the factor.

Table 9

*Pattern Matrix for a One-Factor EFA*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Survey Question</th>
<th>Factor 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Professional development provides ongoing opportunities for teachers to work</td>
<td>.775</td>
</tr>
<tr>
<td></td>
<td>with colleagues to refine teaching practices.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professional development enhances teachers’ abilities to improve student learning.</td>
<td>.745</td>
</tr>
<tr>
<td></td>
<td>Professional development deepens teachers’ content knowledge.</td>
<td>.720</td>
</tr>
<tr>
<td></td>
<td>Sufficient resources are available for professional development in my school.</td>
<td>.696</td>
</tr>
<tr>
<td></td>
<td>An appropriate amount of time is provided for professional development.</td>
<td>.679</td>
</tr>
<tr>
<td></td>
<td>Teachers are encouraged to try new things to improve instruction.</td>
<td>.638</td>
</tr>
<tr>
<td></td>
<td>Teachers are assigned classes that maximize their likelihood of success with students.</td>
<td>.566</td>
</tr>
<tr>
<td></td>
<td>Teachers work in professional learning communities to develop and align</td>
<td>.551</td>
</tr>
<tr>
<td></td>
<td>instructional practices.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Instructional materials] provide me with useful information about how to teach</td>
<td>.521</td>
</tr>
<tr>
<td></td>
<td>particular skills, strategies, texts, or other topics.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers have sufficient access to appropriate instructional materials.</td>
<td>.516</td>
</tr>
<tr>
<td></td>
<td>[Instructional materials] contain useful information for me about the content I</td>
<td>.498</td>
</tr>
<tr>
<td></td>
<td>am teaching.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers have the autonomy to make decisions about instructional delivery (i.e.,</td>
<td>.485</td>
</tr>
<tr>
<td></td>
<td>pacing, materials and pedagogy).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Instructional materials] provide me with useful information about what students</td>
<td>.482</td>
</tr>
<tr>
<td></td>
<td>typically know and can do and about typical difficulties they have.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers have time available to collaborate with colleagues.</td>
<td>.469</td>
</tr>
<tr>
<td>Retained</td>
<td>In an average week, how much time do you devote to collaborative planning time</td>
<td>.228</td>
</tr>
<tr>
<td></td>
<td>during the school day (i.e., time for which you are under contract to be at the school)?</td>
<td></td>
</tr>
<tr>
<td>Not Retained</td>
<td>In an average week, how much time do you devote to individual planning time</td>
<td>.103</td>
</tr>
<tr>
<td></td>
<td>during the school day (i.e., time for which you are under contract to be at the school)?</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Factor loadings greater than or equal to |.400| were bolded as retained items.

**EFA decision.** Table 10 presents the MET survey questions, organized by their original hypothesized variables, and indicates factor loadings for each solution or whether they were eliminated.
Table 10

**MET Survey Items as Selected for each EFA Model**

<table>
<thead>
<tr>
<th>Survey Question from the MET Project</th>
<th>Hypothesized Categories</th>
<th>Four-Factor Model</th>
<th>Three-Factor Model</th>
<th>One-Factor Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers have sufficient access to appropriate instructional materials.</td>
<td>CURR</td>
<td>-</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>They contain useful information for me about the content I am teaching.</td>
<td>CURR</td>
<td>CURR</td>
<td>CURR</td>
<td>ITJR</td>
</tr>
<tr>
<td>They provide me with useful information about how to teach particular skills, strategies, texts, or other topics.</td>
<td>CURR</td>
<td>CURR</td>
<td>CURR</td>
<td>ITJR</td>
</tr>
<tr>
<td>They provide me with useful information about what students typically know and can do and about typical difficulties they have.</td>
<td>CURR</td>
<td>CURR</td>
<td>CURR</td>
<td>ITJR</td>
</tr>
<tr>
<td>Sufficient resources are available for professional development in my school.</td>
<td>PD</td>
<td>PD</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>An appropriate amount of time is provided for professional development.</td>
<td>PD</td>
<td>PD</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>Professional development deepens teachers’ content knowledge.</td>
<td>PD</td>
<td>PD</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>Professional development enhances teachers’ abilities to improve student learning.</td>
<td>PD</td>
<td>PD</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>Professional development provides ongoing opportunities for teacher to work with colleagues to refine teaching practices.</td>
<td>CLB</td>
<td>PD</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>Teachers work in professional learning communities to develop and align instructional practices.</td>
<td>CLB</td>
<td>-</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>Teachers have time available to collaborate with colleagues.</td>
<td>CLB</td>
<td>TIME</td>
<td>TIME</td>
<td>ITJR</td>
</tr>
<tr>
<td>Teachers are encouraged to try new things to improve instruction.</td>
<td>AUTON</td>
<td>AUTON</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>Teachers are assigned classes that maximize their likelihood of success with students.</td>
<td>AUTON</td>
<td>AUTON</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>Teachers have the autonomy to make decisions about instructional delivery (i.e., pacing, materials and pedagogy).</td>
<td>AUTON</td>
<td>AUTON</td>
<td>PD+A</td>
<td>ITJR</td>
</tr>
<tr>
<td>In an average week, how much time do you devote to collaborative planning time during the school day (i.e., time for which you are under contract to be at the school)?</td>
<td>PLANNING TIME</td>
<td>TIME</td>
<td>TIME</td>
<td>-</td>
</tr>
<tr>
<td>In an average week, how much time do you devote to individual planning time during the school day (i.e., time for which you are under contract to be at the school)?</td>
<td>PLANNING TIME</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note.* CURR refers to Curriculum, PD refers to Professional Development, CLB refers to Collaboration, AUTON refers to Autonomy, PLANNING TIME refers to Time to Plan during the work day, TIME refers to the merged variable of Time to Collaborate, PD+A refers to Professional Development plus Autonomy, and ITJR refers to Instructional Teacher Job Resources. A dash is used to indicate when survey items were not retained.
The four-factor solution made the most theoretical sense of the three solutions that were tested and explained the most variance (50.5%) among the three models. However, given that different criteria recommended different number of factors, I chose to test the model fit of all three solutions to further validate the decision to retain four factors.

**Confirmatory Factor Analysis (CFA)**

To test the fit of the three models from the EFA, I conducted a CFA on the second half of the sample data, \( n = 1,065 \). Due to the discrepancy in criteria for EFA factor retention and to increase validity, each of the factor solutions (four, three, and one factors) were analyzed.

The four-factor model (see Figure 10, bottom) included factors for PD (five items), Curriculum (three items), Time to Collaborate (two items), and Autonomy (three items) and did not include the three items that did not have factor loadings of \(|.400|\) or higher. The three-factor model (see Figure 10, top right) included factors for PD + Autonomy (10 items), Curriculum (three items), and Time to Collaborate (two items) and did not include the one item that did not have a factor loading of \(|.400|\) or higher. Finally, the one-factor model (see Figure 10, top left) retained 14 of the 16 survey items that had factor loadings of \(|.400|\), all as indicators of the latent factor Instructional Teacher Job Resources. Table 11 presents the model fit indices for each of these models.
Figure 10. CFA diagrams for the One-Factor (top left), Three-Factor (top right), and Four-Factor Models (bottom).

Table 11

<table>
<thead>
<tr>
<th>CFA Model Fit Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factors Retained</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>
3 Items related to PD & Autonomy are joined
          .096 (.091-.102)  1041.99  .865  945.99(87) *
1 All factors merged          .150 (.145-.156)  2015.380 .701  1931.38(77) *

Note. CURR refers to the job resource of curriculum, PD refers to Professional Development, TIME refers to Time to Collaborate with colleagues, and AUTON refers to instructional autonomy. * p < .001

Between the fundamental models with either four, three, or one factors, the model with four factors was preferred with the lowest root mean square error of approximation (RMSEA) and Akaike information criterion (AIC) scores and highest comparative fit index (CFI) scores. Both the RMSEA and CFI indicate adequate model fit (Stevens, 2009). Standardized regression weights for the four-factor model are in Table 12. The final teacher-level variables for the individual-factor job resources model to be used in HLM were TIME for time to work collaboratively with colleagues (two items), CURR for curriculum job resources (three items), PD for professional development (five items), and AUTON for instructional autonomy (three items). Each of these variables were created from their CFA factor scores, which is explained in a following section.

Table 12

<table>
<thead>
<tr>
<th>MET Survey Items</th>
<th>Factor</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDL21DEEPEFFECT</td>
<td>--- PD</td>
<td>.750</td>
</tr>
<tr>
<td>PDL21ENHANCE</td>
<td>--- PD</td>
<td>.835</td>
</tr>
<tr>
<td>PDL21COLLEAGUE</td>
<td>--- PD</td>
<td>.813</td>
</tr>
<tr>
<td>PDL21TIME</td>
<td>--- PD</td>
<td>.682</td>
</tr>
<tr>
<td>PDL21SUFFRES</td>
<td>--- PD</td>
<td>.728</td>
</tr>
<tr>
<td>MET21MTLCONTENT</td>
<td>--- CURR</td>
<td>.764</td>
</tr>
<tr>
<td>MET21MTLKNOW</td>
<td>--- CURR</td>
<td>.739</td>
</tr>
<tr>
<td>MET21MTLTEACH</td>
<td>--- CURR</td>
<td>.917</td>
</tr>
<tr>
<td>IPL21TRYNEW</td>
<td>--- AUTON</td>
<td>.749</td>
</tr>
<tr>
<td>IPL21MAXSUCCESS</td>
<td>--- AUTON</td>
<td>.611</td>
</tr>
<tr>
<td>IPL21AUTONOMY</td>
<td>--- AUTON</td>
<td>.604</td>
</tr>
<tr>
<td>TML21COLLAB</td>
<td>--- TIME</td>
<td>.773</td>
</tr>
<tr>
<td>TMT46COLLABPLN</td>
<td>--- TIME</td>
<td>.435</td>
</tr>
</tbody>
</table>
Higher-Order Models

After determining that theoretically as well as statistically the four-factor model was the best model, I also tested two higher-order models. In one model, HO, there was one higher-order factor that explained all four of the job resource factors. In the other model, HO2, there were two higher-order factors: Autonomy and Time to Collaborate were indicators of Social ITJR and Curriculum and PD were indicators of Physical ITJR. Table 13 shows the model fit indices for these two models, which were used to make the final high-order model selection.

Table 13

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>RMSEA</th>
<th>AIC</th>
<th>CFI</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>HO</td>
<td>Job Resources (JRs)</td>
<td>.083 (.076-.090)</td>
<td>593.72</td>
<td>.920</td>
<td>507.72(61) *</td>
</tr>
<tr>
<td>HO2</td>
<td>SOC &amp; PHY JRs</td>
<td>.083 (.077-.090)</td>
<td>590.71</td>
<td>.921</td>
<td>502.71(60) *</td>
</tr>
</tbody>
</table>

*Note. SOC refers to the Social job resources comprised of Time to Collaborate and Instructional Autonomy. PHY refers to the Physical job resources comprised of Curriculum and Professional Development.

* $p < .001$

Between the higher-order models, HO2 was slightly preferred with slightly lower AIC values. The final teacher-level variables for the higher-order ITJR model to be used in HLM were PHY for Physical ITJR (Curriculum and Professional Development) and SOC for Social ITJR (Time to Collaborate and Autonomy). Regression weights for this model are in Table 14. Both of the higher-order variables, PHY and SOC, were created from their CFA factor scores.
### Higher-Order Model Standardized Regression Weights

<table>
<thead>
<tr>
<th>MET Survey Items</th>
<th>Factor</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>PHY</td>
<td>.790</td>
</tr>
<tr>
<td>CURR</td>
<td>PHY</td>
<td>.545</td>
</tr>
<tr>
<td>TIME</td>
<td>SOC</td>
<td>.573</td>
</tr>
<tr>
<td>AUTON</td>
<td>SOC</td>
<td>.786</td>
</tr>
<tr>
<td>PDL21DEEPEFFECT</td>
<td>PD</td>
<td>.751</td>
</tr>
<tr>
<td>PDL21ENHANCE</td>
<td>PD</td>
<td>.835</td>
</tr>
<tr>
<td>PDL21COLLEAGUE</td>
<td>PD</td>
<td>.813</td>
</tr>
<tr>
<td>PDL21TIME</td>
<td>PD</td>
<td>.681</td>
</tr>
<tr>
<td>PDL21SUFFRES</td>
<td>PD</td>
<td>.727</td>
</tr>
<tr>
<td>MET21MTLCONTENT</td>
<td>CURR</td>
<td>.764</td>
</tr>
<tr>
<td>MET21MTLKNOW</td>
<td>CURR</td>
<td>.739</td>
</tr>
<tr>
<td>MET21MTLTEACH</td>
<td>CURR</td>
<td>.917</td>
</tr>
<tr>
<td>IPL21TRYNEW</td>
<td>AUTON</td>
<td>.749</td>
</tr>
<tr>
<td>IPL21MAXSUCCESS</td>
<td>AUTON</td>
<td>.612</td>
</tr>
<tr>
<td>IPL21AUTONOMY</td>
<td>AUTON</td>
<td>.604</td>
</tr>
<tr>
<td>TML21COLLAB</td>
<td>TIME</td>
<td>.769</td>
</tr>
<tr>
<td>TMT46COLLABPLN</td>
<td>TIME</td>
<td>.438</td>
</tr>
</tbody>
</table>

*Note. Physical refers to Physical ITJR_s comprised of CURR and PD. Social refers to Social ITJR_s comprised of AUTON and TIME. PD refers to Professional Development, CURR refers to Curriculum, AUTON refers to Autonomy, and TIME refers to Time to Collaborate.*

### Factor Scores

Factor scores were then created for the following variables: Curriculum, PD, Time to Collaborate, Autonomy, Physical, and Social. Factor scores report each factor as a weighted sum of each survey item. Weighted output factors on each survey item from the CFA were applied to each teachers’ responses, which created job resource scores that were specific for each teacher. These continuous factor scores were then used in HLM as the level-2 variables of interest.

Histograms and boxplots were analyzed for normality for the factor scores, as well as statistical normality tests. These indicated that each factor score, comprised of
categorical and bimodal data, had issues with normality (see Table 15). Linearity for each question was evaluated from Q-Q scatterplots. Questions appeared to be relatively linear.

Table 15

<table>
<thead>
<tr>
<th>Variable</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Kolmogorov-Smirnov</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY</td>
<td>-.255</td>
<td>.607</td>
<td>.045(1611)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SOC</td>
<td>-.282</td>
<td>.684</td>
<td>.055(1611)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CURR</td>
<td>-.459</td>
<td>.819</td>
<td>.170(1611)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PD</td>
<td>-.404</td>
<td>.782</td>
<td>.106(1611)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>AUTON</td>
<td>-.311</td>
<td>.563</td>
<td>.069(1611)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>TIME</td>
<td>-.306</td>
<td>-.183</td>
<td>.080(1611)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*Note.* PHY and SOC refer to Physical and Social ITJR, respectively. CURR refers to the job resource of curriculum, PD refers to Professional Development, TIME refers to Time to Collaborate with colleagues, and AUTON refers to instructional autonomy.

**Hierarchical Linear Modeling**

I analyzed a three-level hierarchical linear model (HLM; Raudenbush & Bryk, 2002) to examine whether students’ achievement in mathematics was related to teacher work conditions, while controlling for student and teacher information. I used HLM version 7 statistical software. Data were at three levels. Level 1 included data pertaining to students, such as students’ mathematical achievement and student control variables (i.e., gender, underrepresented minority status, and free or reduced lunch status). Level-2 data included teacher data addressing ITJR (i.e., Curriculum materials, PD, Time to Collaborate with colleagues, and Instructional Autonomy) as well as teacher control variables (i.e., gender, minority status, and years of experience). Although the analyses did not include any variables at level-3, the third level was needed in order to account for clustering at the school level, which violated the assumption of independence (McCoach...
Adelson, 2010). Students were linked to their teachers, and teachers were linked to their schools for the three-level HLM model. Separate analyses were run for the Balanced Assessment in Mathematics (BAM) z-scores for 4-8th grade students and ACT QualityCore® z-scores for 9th grade students. The HLM model results for ITJRs and student achievement in mathematics are reported according to the assessment, with BAM models and results reported first, followed ACT models and results. Models are presented in the following order: null, level-1 control, level-2 control, ITJR individual-factors, and ITJR higher-order factors.

**Results for student achievement on BAM, grades 4–8.**

**Null Model.** Achievement in mathematics on the BAM was the outcome variable. The null model included only the students’ assessment score for achievement in mathematics, given by:

\[
BAM_Z_{4-8} = \gamma_{000} + r_{0jk} + u_{00k} + e_{ijk}
\]

For this model, \(BAM_Z_{4-8} - 8_{ijk}\) was the value of each student’s mathematical achievement score, with student \(i\) being in classroom \(j\) and in school \(k\). The parameter \(\gamma_{000}\) represents the grand mean of students’ mathematics achievement scores. The parameter \(r_{0jk}\) represents the random classroom effect, or the deviation of classroom \(jk\)’s mean from the school mean. The parameter \(u_{00k}\) represents the random school effect, or the deviation of school \(k\)’s mean from the grand mean. The parameter \(e_{ijk}\) indicated the random student effect, or the deviation of each student’s assessment score from the classroom mean, which was assumed to be normally distributed with a mean of zero and variance of \(\sigma^2\).
The variance in achievement scores between students within classes for 4th-8th grade students was $\sigma^2 = 0.596$. The variance in achievement scores between classes within schools was $\tau_{\pi00} = 0.118$. The variance in achievement scores between schools was $\tau_{\beta00} = 0.166$ for 4th-8th grade.

The ratio of variance among students within classes to the total variance, or the intra-class correlation (ICC), was $ICC_{BAm} = \frac{\sigma^2}{\sigma^2 + \tau_{\pi} + \tau_{\beta}} = .678$. The ICC for the ratio of between-group variance among classes within schools to the total variance was as follows: $ICC_{BAm} = \frac{\tau_{\pi}}{\sigma^2 + \tau_{\pi} + \tau_{\beta}} = .134$. The ICC for the ratio of between-group variance among schools to the total variance was as follows: $ICC_{BAm} = \frac{\tau_{\beta}}{\sigma^2 + \tau_{\pi} + \tau_{\beta}} = .189$.

According to the ICC calculations, approximately 67.8% of the variance in student achievement scores on the BAM test was attributable to students within classes. Approximately 13.4% of the variability in BAM assessment scores was between classes within schools. Variance in assessment scores between schools was found to be approximately 18.9% for 4th-8th graders who took the BAM test. Furthermore, BAM assessment scores statistically significantly varied between schools ($\tau_{\beta00} = 0.167, p < .001$). Sufficient variation in student scores between schools existed for the BAM test scores to merit a three-level HLM model.

**Level-1 Control Model.** All student (level-1) control variables were added to the model. The reader will recall the student control variables were student gender (STGEN), whether a student receives free or reduced lunch (FRL), and student minority status (UNDMIN). In the initial model, the slopes for these variables were allowed to
vary randomly at both the class and school levels, and any slopes that did not statistically significantly vary were fixed one at a time. Multiple iterations of models were generated for the purpose of fixing slopes one at a time, whenever significance is noted, the $p$-values are from the most current model iteration. Relationships between student achievement and student free or reduced lunch status ($r_2 = 0.028, p = .002$) as well as student underrepresented minority status ($r_3 = 0.031, p < .001$) statistically varied across classes. The relationship between student gender and student achievement did not vary across classes ($r_1 = 0.004, p > .500$) and was fixed. The relationship between underrepresented minority status and student achievement statistically varied across schools ($u_{30} = 0.015, p = .009$). Relationships between student achievement and free or reduced lunch status ($u_{20} = 0.007, p = .399$) as well as student gender ($u_{10} = 0.005, p = .153$) did not vary across schools and were fixed, respectively, one at a time.

The final level-1 control model for the BAM assessment, where $BAM_{Z,4 - 8}ijk$ the BAM assessment z-score for student $i$ in classroom $j$ in school $k$, was as follows:

**Level-1 Model**

$$BAM_{Z,4 - 8}ijk = \pi_{0jk} + \pi_{1jk} * (STGEN_{ijk}) + \pi_{2jk} * (FRL_{ijk}) + \pi_{3jk} * (UNDMIN_{ijk}) + e_{ijk}$$

**Level-2 Model**

$$\pi_{0jk} = \beta_{00k} + r_{0jk}$$

$$\pi_{1jk} = \beta_{10k}$$

$$\pi_{2jk} = \beta_{20k} + r_{2jk}$$

$$\pi_{3jk} = \beta_{30k} + r_{3jk}$$

**Level-3 Model**
\[ \beta_{00k} = \gamma_{000} + u_{00k} \]

\[ \beta_{10k} = \gamma_{100} \]

\[ \beta_{20k} = \gamma_{200} \]

\[ \beta_{30k} = \gamma_{300} + u_{30k} \]

Table 16 shows the final estimation of the fixed effects as well as the final estimation of level-1, level-2, and level-3 variance components. The proportion of variance explained by the level-1 control variables within classes, between classes \(\left( \frac{\tau_{\pi_{00}B} - \tau_{\pi_{00}F}}{\tau_{\pi_{00}B}} \right)\) and between schools \(\left( \frac{\tau_{\beta_{00}B} - \tau_{\beta_{00}F}}{\tau_{\beta_{00}B}} \right)\) were calculated by comparing the variance in the level-1 model to the null model. Student control variables accounted for about 4% of the variance between students within classes, 40% of the variance between classes, and about 32% of the variance between schools in 4th – 8th grade student achievement scores for the BAM assessment.

Table 16

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>(p)-value</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, (\pi_0)</td>
<td></td>
<td></td>
<td></td>
<td>.554</td>
</tr>
<tr>
<td>For INTRCPT2, (\beta_{00})</td>
<td></td>
<td></td>
<td></td>
<td>.648</td>
</tr>
<tr>
<td>INTRCPT3, (\gamma_{000})</td>
<td>0.360</td>
<td>0.050</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For STGEN slope, (\pi_1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, (\beta_{10})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, (\gamma_{100})</td>
<td>-0.061</td>
<td>0.015</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For FRL slope, (\pi_2)</td>
<td></td>
<td></td>
<td></td>
<td>.232</td>
</tr>
<tr>
<td>For INTRCPT2, (\beta_{20})</td>
<td>-0.239</td>
<td>0.023</td>
<td>&lt; .001</td>
<td></td>
</tr>
</tbody>
</table>
### Random Effect

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>0.071</td>
<td>137</td>
<td>380.220</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>FRL slope, $r_2$</td>
<td>0.028</td>
<td>200</td>
<td>264.244</td>
<td>.002</td>
</tr>
<tr>
<td>UNDMIN slope, $r_3$</td>
<td>0.016</td>
<td>137</td>
<td>182.922</td>
<td>.006</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>0.570</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT1/INTRCPT2, $u_{00}$</td>
<td>0.114</td>
<td>63</td>
<td>220.866</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>UNDMIN/INTRCPT3, $u_{30}$</td>
<td>0.015</td>
<td>63</td>
<td>92.575</td>
<td>.009</td>
</tr>
</tbody>
</table>

*Note.* STGEN refers to student gender, FRL refers to the socioeconomic status of students noting whether students received a free or reduced lunch, and UNDMIN refers to the underrepresented minority status of the student.

This model shows that the expected z-score for a white or Asian, female student who is not on free or reduced lunch is $\gamma_{000} = 0.360$. Each student control characteristic negatively relates to student achievement, controlling for the other variables in the model. That is, male students are expected to earn a z-score of 0.061 less than their female peers, $p < .001$ ($\gamma_{100}$). Students who receive free or reduced lunch are expected to earn a z-score 0.239 less than their peers who do not receive free or reduced lunch, $p < .001$ ($\gamma_{200}$). Students who identify as an underrepresented racial group are expected to earn a z-score of 0.199 points less than their peers who identify as white or Asian, $p < .001$ ($\gamma_{300}$).
**Level-2 Control Model.** Following the final level-1 control model, the level-2 (teacher-level) control model was built by adding teacher-level control variables as predictors of the intercept. The reader will recall the teacher control variables were: teacher gender (T_GEND), teacher minority status (T_MINST), and years of experience (T_EXPER). First, the slopes for these variables were allowed to vary across schools. Relationships between student achievement and teacher minority status ($u_{02} = 0.029$, $p = .237$), teacher gender ($u_{01} = 0.014$, $p > .500$), and years of experience ($u_{03} = 0.00004$, $p = .096$) did not vary across schools and were fixed, respectively, one by one. Because multiple iterations of models were generated when fixing slopes one at a time, the $p$-values noted are from the most current model iteration. Next, the estimation of fixed effects were analyzed for teacher gender, minority status, and experience. As shown in Table 17, Teacher minority status was the only teacher control variable that was statistically significantly related to student achievement on the BAM assessment ($\beta_01 = -0.199$, $p < .001$). Teacher gender and years of experience were not related to student achievement, controlling for other variables in the model ($\beta_01 = -0.022$, $p = .679$; and $\beta_03 = 0.005$, $p = .125$, respectively). Therefore, I removed those control variables from the model for a more parsimonious control model. The final level-2 control model for the BAM assessment, where $BAM\_Z\_4 - 8_{ijk}$ was the BAM assessment $z$-score for student $i$ in classroom $j$ in school $k$, was as follows:

**Level-1 Model**

$$BAM\_Z\_4 - 8_{ijk} = \pi_{0jk} + \pi_{1jk} \times (STGEN_{ijk}) + \pi_{2jk} \times (FRL_{ijk}) + \pi_{3jk} \times (UNDMIN_{ijk}) + \epsilon_{ijk}$$

**Level-2 Model**

\[ \pi_{0jk} = \beta_{00k} + \beta_{01k} \times (T_{MINST_jk}) + r_{0jk} \]

\[ \pi_{1jk} = \beta_{10k} \]

\[ \pi_{2jk} = \beta_{20k} + r_{2jk} \]

\[ \pi_{3jk} = \beta_{30k} + r_{3jk} \]

**Level-3 Model**

\[ \beta_{00k} = \gamma_{000} + u_{00k} \]

\[ \beta_{01k} = \gamma_{010} \]

\[ \beta_{10k} = \gamma_{100} \]

\[ \beta_{20k} = \gamma_{200} \]

\[ \beta_{30k} = \gamma_{300} + u_{30k} \]

Table 17 shows the final estimation of the fixed effects as well as the final estimation of level-1, level-2, and level-3 variance components. The proportion of variance between classes \( \frac{\tau_{\pi 00B} - \tau_{\pi 00F}}{\tau_{\pi 00B}} \) and between schools \( \frac{\tau_{\beta 00B} - \tau_{\beta 00F}}{\tau_{\beta 00B}} \) explained by the teacher control variables, above and beyond the student control variables, were calculated by comparing the variance in the level-2 control model to the level-1 control model. Teacher control variables accounted for essentially 0% of the variance between classes and about 19% of the variance between schools in student achievement scores for the BAM assessment.
Table 17

*Final Estimation of the Fixed and Random Effects for the Final Level-2 Control Model for BAM*

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>p-value</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Level-1</td>
</tr>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, $\beta_{00}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{000}$</td>
<td>0.421</td>
<td>0.050</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For T_MINST, $\beta_{01}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{010}$</td>
<td>-0.199</td>
<td>0.055</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For STGEN slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, $\beta_{10}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{100}$</td>
<td>-0.061</td>
<td>0.015</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For FRL slope, $\pi_2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, $\beta_{20}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{200}$</td>
<td>-0.240</td>
<td>0.023</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For UNDMIN slope, $\pi_3$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, $\beta_{30}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{300}$</td>
<td>-0.200</td>
<td>0.028</td>
<td>&lt; .001</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>0.070</td>
<td>136</td>
<td>382.524</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>FRL slope, $r_2$</td>
<td>0.027</td>
<td>200</td>
<td>264.281</td>
<td>.002</td>
</tr>
<tr>
<td>UNDMIN slope, $r_3$</td>
<td>0.016</td>
<td>137</td>
<td>182.996</td>
<td>.005</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>0.570</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT1/INTRCPT2, $u_{00}$</td>
<td>0.093</td>
<td>63</td>
<td>193.791</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>UNDMIN/INTRCPT2, $u_{30}$</td>
<td>0.014</td>
<td>63</td>
<td>91.459</td>
<td>.011</td>
</tr>
</tbody>
</table>

*Note.* STGEN refers to student gender, FRL refers to the socioeconomic status of students noting whether students received a free or reduced lunch, and UNDMIN refers to the underrepresented minority status of the student.
This model shows the relationship between teacher minority status and student achievement on the BAM test after controlling for student minority status, gender, and free/reduced lunch status. Controlling for student variables, the expected z-score for students who had white teachers is $\gamma_{000} = 0.421$. Holding student characteristics constant, students in classes where the teacher identifies as an underrepresented minority, are expected to earn a z-score of 0.199 points lower than their peers with white teachers, $p < .001$ ($\gamma_{010}$).

**ITJR (Individual-Factor) Final Model.** Finally, the relationship between the ITJR variables and student achievement could be examined while controlling for student and teacher characteristics by adding the teacher variables of interest for the individual-factor ITJR model (TIME, CURR, PD, AUTON) to the level-2 model as predictors of the intercept.

The slope of PD was the only ITJR slope that varied across schools. The relationships between student achievement and instructional autonomy ($u_{04} = 0.024, p = .124$), curriculum ($u_{02} = 0.011, p > .500$), and time to collaborate ($u_{05} = 0.005, p = .314$) did not vary across classes and were fixed, one by one, in the model. Because multiple iterations of models were generated when fixing slopes one at a time, the $p$-values noted are from the most current model iteration. The final individual-factor model, where $BAM_{Z \_4} - 8_{ijk}$ was the BAM assessment z-score for student $i$ in classroom $j$ in school $k$, was as follows:

Level-1 Model

$$BAM_{Z \_4} - 8_{ijk} = \pi_{0jk} + \pi_{1jk} \ast (STGEN_{ijk}) + \pi_{2jk} \ast (FRL_{ijk}) + \pi_{3jk} \ast (UNDMIN_{ijk}) + e_{ijk}$$
Level-2 Model

\[ \pi_{0jk} = \beta_{00k} + \beta_{01k} \cdot (T_{MINST_{jk}}) + \beta_{02k} \cdot (CURR_{jk}) + \beta_{03k} \cdot (PD_{jk}) + \beta_{04k} \cdot (AUTON_{jk}) + \beta_{05k} \cdot (TIME_{jk}) + r_{0jk} \]

\[ \pi_{1jk} = \beta_{10k} \]

\[ \pi_{2jk} = \beta_{20k} + r_{2jk} \]

\[ \pi_{3jk} = \beta_{30k} + r_{3jk} \]

Level-3 Model

\[ \beta_{00k} = \gamma_{000} + u_{00k} \]

\[ \beta_{01k} = \gamma_{010} \]

\[ \beta_{02k} = \gamma_{020} \]

\[ \beta_{03k} = \gamma_{030} + u_{03k} \]

\[ \beta_{04k} = \gamma_{040} \]

\[ \beta_{05k} = \gamma_{050} \]

\[ \beta_{10k} = \gamma_{100} \]

\[ \beta_{20k} = \gamma_{200} \]

\[ \beta_{30k} = \gamma_{300} + u_{30k} \]

Table 18 shows the final estimation of the fixed effects as well as the final estimation of level-1, level-2, and level-3 variance components. After controlling for student and teacher characteristics, teacher instructional Autonomy was the only ITJR that was statistically significantly related to student achievement, \( p = .024 \) (\( \gamma_{040} = 0.225, p = .024 \)). For each unit increase in teacher autonomy, there was an expected increase in student achievement on the BAM assessment z-score by 0.225 points, \( p < .05 \) (\( \gamma_{040} \)). The remaining ITJR variables were not statistically related to student
achievement for grades 4-8: Curriculum ($\gamma_{020} = -0.102, p = .122$), PD ($\gamma_{030} = -0.022, p = .806$), and Time to Collaborate ($\gamma_{050} = -0.082, p = .217$).

The proportion of variance between classes ($\frac{\tau_{\pi00B} - \tau_{\pi00F}}{\tau_{\pi00B}}$) and between schools ($\frac{\tau_{\beta00B} - \tau_{\beta00F}}{\tau_{\beta00B}}$) explained by the individual ITJR factors, above and beyond the student and control variables, was calculated by comparing the variances in this model to the level-2 control model. The ITJR factors (CURR, PD, TIME, and AUTON) accounted for about 20% of the variance between classes and almost 11% of the variance between schools in student achievement scores for the BAM assessment, above and beyond the control variables.

Table 18

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>p-value</th>
<th>Reliability Level-1</th>
<th>Reliability Level-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td>.510</td>
<td>.556</td>
</tr>
<tr>
<td>For INTRCPT2, $\beta_{00}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{000}$</td>
<td>0.431</td>
<td>0.048</td>
<td>&lt; .001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For T_MINST, $\beta_{01}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{010}$</td>
<td>-0.228</td>
<td>0.054</td>
<td>&lt; .001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For CURR, $\beta_{02}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{020}$</td>
<td>-0.102</td>
<td>0.064</td>
<td>.122</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For PD, $\beta_{03}$</td>
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<td></td>
<td></td>
<td>.240</td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{030}$</td>
<td>-0.022</td>
<td>0.090</td>
<td>.806</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For AUTON, $\beta_{04}$</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{040}$</td>
<td>0.225</td>
<td>0.095</td>
<td>.024</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For TIME, $\beta_{05}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.082</td>
<td>0.065</td>
<td>.217</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
For STGEN slope, $\pi_1$
For INTRCPT2, $\beta_{10}$
INTRCPT3, $\gamma_{100}$  
-0.061  0.015  < .001

For FRL slope, $\pi_2$
For INTRCPT2, $\beta_{20}$
INTRCPT3, $\gamma_{200}$  
-0.241  0.023  < .001

For UNDMIN slope, $\pi_3$
For INTRCPT2, $\beta_{30}$
INTRCPT3, $\gamma_{300}$  
-0.196  0.027  < .001

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>0.056</td>
<td>75</td>
<td>256.417</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>FRL slope, $r_2$</td>
<td>0.027</td>
<td>194</td>
<td>255.859</td>
<td>.002</td>
</tr>
<tr>
<td>UNDMIN slope, $r_3$</td>
<td>0.018</td>
<td>137</td>
<td>183.137</td>
<td>.005</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>0.570</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT1/INTRCPT2, $u_{00}$</td>
<td>0.082</td>
<td>57</td>
<td>145.054</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>INTRCPT1/PD, $u_{03}$</td>
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<td>57</td>
<td>85.411</td>
<td>.009</td>
</tr>
<tr>
<td>UNDMIN/INTRCPT2, $u_{30}$</td>
<td>0.012</td>
<td>57</td>
<td>84.317</td>
<td>.011</td>
</tr>
</tbody>
</table>

Note. STGEN refers to student gender, FRL refers to the socioeconomic status of students noting whether students received a free or reduced lunch, and UNDMIN refers to the underrepresented minority status of the student.

To determine how much of the variance was explained by autonomy because it was the only statistically significant predictor of achievement, AUTON was removed from the full level-2 ITJR model, and variability between classes $\left(\frac{\tau_{\beta_{00B}} - \tau_{\beta_{00F}}}{\tau_{\beta_{00B}}}\right)$ and between schools $\left(\frac{\tau_{\beta_{00B}} - \tau_{\beta_{00F}}}{\tau_{\beta_{00B}}}\right)$ was compared in the models with and without AUTON. In
these formulas, the full model refers to the level-2 model with all four ITJR variables and the baseline model refers to the level-2 model without instructional autonomy. The proportion of variance between classes that teacher autonomy explains, above and beyond student and teacher control variables and other job resources is 0%. The proportion of variance between schools that teacher autonomy explains for student achievement, above and beyond student and teacher control variables and other job resources, is 5%.

**ITJR (Higher Order) Final Model.** To analyze the higher-order relationship of ITJR (Physical and Social) with student achievement while controlling for student and teacher contextual variables, the higher-order ITJR variables (PHY and SOC) were added to the model as predictors of the intercept in place of the individual-factor ITJR factors.

The relationship between student achievement and physical ITJR ($u_{02} = 0.123, p > .500$) did not vary across classes and was fixed in the model. The relationship between student achievement and social ITJR ($u_{03} = 0.147, p = .005$) statistically varied across classes. Because multiple iterations of models were generated when fixing slopes one at a time, the $p$-values noted are from the most current model iteration. The final higher-order, level-2 model for the BAM assessment was as follows:

**Level-1 Model**

$$BAM.Z.4 - 8_{ijk} = \pi_{0jk} + \pi_{1jk} \ast (STGEN_{ijk}) + \pi_{2jk} \ast (SES_{ijk}) + \pi_{3jk} \ast (UNDMIN_{ijk}) + e_{ijk}$$

**Level-2 Model**

$$\pi_{0jk} = \beta_{00k} + \beta_{01k} \ast (T\_RACE_{jk}) + \beta_{02k} \ast (PHY_{jk}) + \beta_{03k} \ast (SOC_{jk}) + r_{0jk}$$

$$\pi_{1jk} = \beta_{10k}$$

$$\pi_{2jk} = \beta_{20k} + r_{2jk}$$
\[ \pi_{3jk} = \beta_{30k} + r_{3jk} \]

Level-3 Model

\[ \beta_{00k} = \gamma_{000} + u_{00k} \]

\[ \beta_{01k} = \gamma_{010} \]

\[ \beta_{02k} = \gamma_{020} \]

\[ \beta_{03k} = \gamma_{030} + u_{03k} \]

\[ \beta_{10k} = \gamma_{100} \]

\[ \beta_{20k} = \gamma_{200} \]

\[ \beta_{30k} = \gamma_{300} + u_{30k} \]

Table 19 shows the final estimation of the fixed effects as well as the final estimation of level-1, level-2, and level-3 variance components.

The proportion of variance explained by the higher-order level-2 ITJR variables, above and beyond the student and teacher control variables, between classes and between schools were calculated by comparing the variance in the higher-order level-2 model to the level-2 control model respectively, \( \frac{\tau_{\pi00B} - \tau_{\pi00F}}{\tau_{\pi00B}} = 0.222 \) and \( \frac{\tau_{\beta00B} - \tau_{\beta00F}}{\tau_{\beta00B}} = -0.004 \). Teacher job resources (PHY and SOC) accounted for about 22% of the variance between classes and 0% of the variance between schools in student achievement scores for grades 4-8, above and beyond the control variables.
Table 19

*Final Estimation of the Fixed Effects for the Final Higher-Order Level-2 Model for BAM*

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>p-value</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level-1</td>
<td>Level-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT1, $\pi_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, $\beta_{00}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{000}$</td>
<td>0.432</td>
<td>0.049</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For T_MINST, $\beta_{01}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{010}$</td>
<td>-0.220</td>
<td>0.054</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For PHY, $\beta_{02}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{020}$</td>
<td>0.386</td>
<td>0.266</td>
<td>.156</td>
<td></td>
</tr>
<tr>
<td>For SOC, $\beta_{03}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{030}$</td>
<td>-0.375</td>
<td>0.324</td>
<td>.251</td>
<td></td>
</tr>
<tr>
<td>For STGEN slope, $\pi_1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, $\beta_{10}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{100}$</td>
<td>-0.061</td>
<td>0.015</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For FRL slope, $\pi_2$</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, $\beta_{20}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{200}$</td>
<td>-0.240</td>
<td>0.023</td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>For UNDMIN slope, $\pi_3$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, $\beta_{30}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, $\gamma_{300}$</td>
<td>-0.200</td>
<td>0.027</td>
<td>&lt; .001</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>0.055</td>
<td>77</td>
<td>242.789</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>FRL slope, $r_2$</td>
<td>0.027</td>
<td>194</td>
<td>255.784</td>
<td>.002</td>
</tr>
<tr>
<td>UNDMIN slope, $r_3$</td>
<td>0.017</td>
<td>137</td>
<td>183.017</td>
<td>.005</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>0.570</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coefficient</td>
<td>SE</td>
<td>t Value</td>
<td>p Value</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------</td>
<td>----</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>INTRCPT1/INTRCPT2, $u_{00}$</td>
<td>0.093</td>
<td>57</td>
<td>165.945</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>INTRCPT1/SOC, $u_{03}$</td>
<td>0.147</td>
<td>57</td>
<td>88.174</td>
<td>.005</td>
</tr>
<tr>
<td>UNDMIN/INTRCPT2, $u_{30}$</td>
<td>0.013</td>
<td>57</td>
<td>86.846</td>
<td>.007</td>
</tr>
</tbody>
</table>

Note. STGEN refers to student gender, FRL refers to the socioeconomic status of students noting whether students received a free or reduced lunch, and UNDMIN refers to the underrepresented minority status of the student. SOC refers to the Social job resources comprised of Time to Collaborate and Instructional Autonomy. PHY refers to the Physical job resources comprised of Curriculum and Professional Development.

Neither physical ($\gamma_{020} = 0.386, p = .156$) or social ($\gamma_{030} = -0.375, p = .251$) ITJR were found to have a statistically significant relationship with student achievement for grades 4-8.

**Results for student achievement on ACT, grade 9.**

**Null Model.** Achievement in mathematics on the ACT QualityCore® was the outcome variable. The null model included only the students’ assessment score for achievement in mathematics, given by:

$$ACT_{Z9i,j,k} = \gamma_{000} + r_{0jk} + u_{00k} + e_{ijkl}$$

For this model, $ACT_{Z9i,j,k}$ was the value of each student’s mathematical achievement score, with student $i$ being in classroom $j$ and in school $k$. The parameter $\gamma_{000}$ represents the grand mean of students’ mathematics achievement scores. The parameter $r_{0jk}$ represents the random classroom effect, or the deviation of classroom $jk$’s mean from the school mean. The parameter $u_{00k}$ represents the random school effect, or the deviation of school $k$’s mean from the grand mean. The parameter $e_{ijkl}$ indicated the random student effect, or the deviation of each student’s assessment score from the classroom
mean, which was assumed to be normally distributed with a mean of zero and variance of $\sigma^2$.

The variance in achievement scores between students within teachers and schools for 9th grade students was $\sigma^2 = 0.665$. The variance in achievement scores between classes within schools was $\tau_{\pi 00} = 0.076$ for 9th grade. The variance in achievement scores between schools was $\tau_{\beta 00} = 0.019$ for 9th grade.

The ratio of between group variance among students within classes to the total variance, or the intra-class correlation (ICC), was $ICC_{ACT} = \frac{\sigma^2}{\sigma^2 + \tau_{\pi} + \tau_{\beta}} = .875$. The ICC for the ratio of between group variance among classes within schools to the total variance was $ICC_{ACT} = \frac{\tau_{\pi}}{\sigma^2 + \tau_{\pi} + \tau_{\beta}} = .100$. The ICC for the ratio of between group variance among schools to the total variance was $ICC_{ACT} = \frac{\tau_{\pi}}{\sigma^2 + \tau_{\pi} + \tau_{\beta}} = .025$.

According to the ICC calculations, approximately 87.5% of the variance in student achievement scores on the ACT QualityCore test was attributable to students within classes. Approximately 10% of the variability in ACT QualityCore assessment scores was between classes within schools. Variance in assessment scores between schools was found to be approximately 2.5% for 9th graders who took the ACT QualityCore test. The small variation between schools for ACT test scores ($\tau_{\beta} = 0.019, p = .077$) indicated a two-level model may be justified for the 9th grade model.

For uniformity and because of the 2.5% of variability at the school level (Roberts, 2007), the analysis proceeded using a three-level model for 9th grade ACT QualityCore® scores, consistent with the models for the 4th-8th grade BAM scores.
Level-1 Control Model. All student (level-1) control variables were added to the model. The reader will recall the student control variables were student gender (STGEN), whether a student receives free or reduced lunch (FRL), and student minority status (UNDMIN). The slopes for these variables were allowed to vary randomly at both the class and school levels. Multiple iterations of models were generated for the purpose of fixing slopes one at a time, whenever significance is noted, the $p$-values are from the most current model iteration. First, I examined the random effects across classes. The relationship between student underrepresented minority status and student achievement statistically varied across classes ($r_3 = 0.033, p = .025$). The relationships between student achievement and student free or reduced lunch status ($r_2 = 0.011, p > .500$) and student gender ($r_1 = 0.002, p > .500$) did not vary across classes and were fixed one at a time. Next, random effects for the slopes of student control variables were analyzed across schools. The relationships between student achievement and student free or reduced lunch status ($u_{20} = 0.001, p > .500$), student gender ($u_{10} = 0.003, p > .500$), and student underrepresented minority status ($u_{30} = 0.015, p = .349$) did not vary across schools and were fixed, respectively, one at a time. The final level-1 control model for the ACT assessment, where $ACT\_Z\_9_{ijk}$ the ACT assessment z-score for student $i$ in classroom $j$ in school $k$, was as follows:

Level-1 Model

$ACT\_Z\_9_{ijk} = \pi_{0jk} + \pi_{1jk} \times (STGEN_{ijk}) + \pi_{2jk} \times (FRL_{ijk}) + \pi_{3jk} \times (UNDMIN_{ijk}) + \epsilon_{ijk}$

Level-2 Model

$\pi_{0jk} = \beta_{00k} + r_{0jk}$
\[ \pi_{1jk} = \beta_{10k} \]
\[ \pi_{2jk} = \beta_{20k} \]
\[ \pi_{3jk} = \beta_{30k} + r_{3jk} \]

Level-3 Model
\[ \beta_{00k} = \gamma_{000} + u_{00k} \]
\[ \beta_{10k} = \gamma_{100} \]
\[ \beta_{20k} = \gamma_{200} \]
\[ \beta_{30k} = \gamma_{300} \]

Table 20 shows the final estimation of the fixed effects and the level-1, level-2, and level-3 variance components. The proportion of variance explained by the level-1 control variables within classes, between classes \( \left( \frac{\tau_{\pi00B} - \tau_{\pi00F}}{\tau_{\pi00B}} \right) \) and between schools \( \left( \frac{\tau_{\beta00B} - \tau_{\beta00F}}{\tau_{\beta00B}} \right) \) was calculated by comparing the variance in the level-1 model to the null model. Student control variables accounted for about 2% of the variance between students within classes, 0% of the variance between classes, and about 16% of the variance between schools in 9th grade student achievement scores.

Table 20

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>p-value</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, ( \pi_0 )</td>
<td>( \gamma_{000} )</td>
<td>0.142</td>
<td>0.071</td>
<td>0.058</td>
</tr>
<tr>
<td>For INTRCPT2, ( \beta_{00} )</td>
<td>( \gamma_{000} )</td>
<td>-.114</td>
<td>0.035</td>
<td>.001</td>
</tr>
</tbody>
</table>

84
For INTRCPT2, $\beta_{10}$

**INTRCPT3, $\gamma_{100}$**

For FRL slope, $\pi_2$

For INTRCPT2, $\beta_{20}$

**INTRCPT3, $\gamma_{200}$**

-0.101 0.043 0.020

For UNDMIN slope, $\pi_3$

For INTRCPT2, $\beta_{30}$

**INTRCPT3, $\gamma_{300}$**

-0.076 0.054 0.173

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>$\chi^2$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1, $r_0$</td>
<td>0.089</td>
<td>20</td>
<td>122.545</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>UNDMIN slope, $r_3$</td>
<td>0.033</td>
<td>41</td>
<td>60.455</td>
<td>.025</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>0.653</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT1/INTRCPT2, $u_{00}$</td>
<td>0.016</td>
<td>21</td>
<td>30.073</td>
<td>.090</td>
</tr>
</tbody>
</table>

*Note.* STGEN refers to student gender, FRL refers to the socioeconomic status of students noting whether students received a free or reduced lunch, and UNDMIN refers to the underrepresented minority status of the student.

Although not significant, this model shows that the expected $z$-score for a white or Asian female student who is not on free or reduced lunch is $\gamma_{000} = 0.142$, $p = .058$.

Each student control characteristic negatively relates to student achievement, controlling for the other variables in the model. That is, male students are expected to earn a $z$-score of 0.114 less than their female peers, $p = .001$ ($\gamma_{100}$). Students who receive free or reduced lunch are expected to earn a $z$-score 0.101 less than their peers who are not receiving free or reduced lunch, $p = .020$ ($\gamma_{200}$). Students who identify as an underrepresented racial group are expected to earn a $z$-score of 0.076 points less than their peers who identify as white or Asian, $p < .173$ ($\gamma_{300}$).
**Level-2 Control Model.** Following the final level-1 control model, the level-2 (teacher-level) control model was built by adding teacher-level control variables as predictors of the intercept. The reader will recall the teacher control variables were: teacher gender (T_GEND), teacher minority status (T_MINST), and years of experience (T_EXPER). First, the slopes for these variables were allowed to vary across schools. Because multiple iterations of models were generated when fixing slopes one at a time, the $p$-values noted are from the most current model iteration. When all teacher control variables were allowed to vary, there were too few degrees of freedom to compute their significance. The relationship between the ITJR variable and student achievement with the largest $p$-value, teacher minority status ($\beta_{02} = 0.060, p = .574$) was fixed first, after which the other $p$-values could be calculated. After fixing the slope of teacher minority status, the relationships between student achievement and the slopes of gender ($u_{01} = 0.052, p > .500$) and years of experience ($u_{03} = 0.0003, p = .051$) did not vary across schools and were fixed, respectively, one by one. Next, the estimation of fixed effects were analyzed for teacher gender, minority status, and experience. Teacher gender, minority status, and years of experience were not related to student achievement, controlling for other variables in the model ($\beta_{01} = 0.072, p = .461; \beta_{02} = 0.027, p = .792; $ and $\beta_{03} = 0.004, p = .642$, respectively). Therefore, I removed all teacher-level control variables from the model for a more parsimonious control model. Consequently, the final level-2 control model for the ACT assessment, where $ACT\_Z\_9_{ijk}$ was the ACT assessment $z$-score for student $i$ in classroom $j$ in school $k$, was identical to the final level-1 control model.
**ITJR (Individual-Factor) Final Model.** Finally, the relationship between the ITJR variables and student achievement could be examined while controlling for student (and teacher) characteristics by adding the teacher variables of interest for the individual-factor ITJR model (TIME, CURR, PD, AUTON) to the level-2 model as predictors of the intercept.

When all of the individual-factor ITJR variables were allowed to vary, there were too few degrees of freedom to compute their significance. Because multiple iterations of models were generated when fixing slopes one at a time, the $p$-values noted are from the most current model iteration. The relationship between the ITJR variable and student achievement with the largest $p$-value, PD ($\beta_{02} = 0.005, p = .971$) was fixed first, after which the other $p$-values could be calculated. After fixing the slope of professional development, the relationships between student achievement and the slopes of instructional autonomy ($u_{03} = 0.093, p > .500$), curriculum ($u_{01} = 0.002, p > .500$), and time to collaborate ($u_{04} = 0.018, p = .076$) did not vary across schools and were fixed respectively, one by one, in the model. The final individual-factor model, where $ACT\_Z\_9_{ijk}$ was the ACT assessment z-score for student $i$ in classroom $j$ in school $k$, was as follows:

**Level-1 Model**

\[
ACT\_Z\_9_{ijk} = \pi_{0jk} + \pi_{1jk} \ast (STGEN_{ijk}) + \pi_{2jk} \ast (FRL_{ijk}) + \pi_{3jk} \ast (UNDMIN_{ijk}) + e_{ijk}
\]

**Level-2 Model**

\[
\begin{align*}
\pi_{0jk} &= \beta_{00k} + \beta_{01k} \ast (CURR_{jk}) + \beta_{02k} \ast (PD_{jk}) + \beta_{03k} \ast (AUTON_{jk}) + \beta_{04k} \ast (TIME_{jk}) + r_{0jk} \\
\pi_{1jk} &= \beta_{10k}
\end{align*}
\]
\[ \pi_{2jk} = \beta_{20k} \]

\[ \pi_{3jk} = \beta_{30k} + r_{3jk} \]

Level-3 Model

\[ \beta_{00k} = \gamma_{000} + u_{00k} \]

\[ \beta_{01k} = \gamma_{010} \]

\[ \beta_{02k} = \gamma_{020} \]

\[ \beta_{03k} = \gamma_{030} \]

\[ \beta_{04k} = \gamma_{040} \]

\[ \beta_{10k} = \gamma_{100} \]

\[ \beta_{20k} = \gamma_{200} \]

\[ \beta_{30k} = \gamma_{300} \]

Table 2 shows the final estimation of the fixed effects as well as the final estimation of level-1, level-2, and level-3 variance components. None of the individual-factor ITJR were found to have a statistically significant relationship with student achievement: curriculum (\( \gamma_{020} = 0.225, p = .068 \)), professional development (\( \gamma_{030} = 0.017, p = .905 \)), instructional autonomy (\( \gamma_{040} = -0.079, p = .670 \)), or time to collaborate (\( \gamma_{050} = -0.039, p = .747 \)).

The proportion of variance between classes \( \left( \frac{\tau_{\pi00B}}{\tau_{\pi00F}} \right) \) and between schools \( \left( \frac{\tau_{\beta00B}}{\tau_{\beta00F}} \right) \) explained by the individual-factor ITJR variables, above and beyond the control variables, was calculated by comparing the variances in this model to the level-2 control model. The ITJR (CURR, PD, TIME, and AUTON) accounted for about 11% of
the variance between classes and about 24% of the variance between schools in student achievement scores for the ACT assessment, above and beyond the control variables.

Table 21

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>p-value</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, (\pi_0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, (\beta_{00})</td>
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</tr>
<tr>
<td>INTRCPT3, (\gamma_{000})</td>
<td>0.139</td>
<td>0.069</td>
<td>0.054</td>
<td></td>
</tr>
<tr>
<td>For CURR, (\beta_{02})</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, (\gamma_{020})</td>
<td>0.225</td>
<td>0.117</td>
<td>0.068</td>
<td></td>
</tr>
<tr>
<td>For PD, (\beta_{03})</td>
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<td></td>
</tr>
<tr>
<td>INTRCPT3, (\gamma_{030})</td>
<td>0.017</td>
<td>0.139</td>
<td>0.905</td>
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</tr>
<tr>
<td>For AUTON, (\beta_{04})</td>
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<tr>
<td>INTRCPT3, (\gamma_{040})</td>
<td>-0.079</td>
<td>0.181</td>
<td>0.670</td>
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</tr>
<tr>
<td>For TIME, (\beta_{05})</td>
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<tr>
<td>INTRCPT3, (\gamma_{050})</td>
<td>-0.039</td>
<td>0.119</td>
<td>0.747</td>
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<tr>
<td>For STGEN slope, (\pi_1)</td>
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</tr>
<tr>
<td>For INTRCPT2, (\beta_{10})</td>
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</tr>
<tr>
<td>INTRCPT3, (\gamma_{100})</td>
<td>-0.115</td>
<td>0.035</td>
<td>0.001</td>
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<tr>
<td>For FRL slope, (\pi_2)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, (\beta_{20})</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, (\gamma_{200})</td>
<td>-0.100</td>
<td>0.043</td>
<td>0.020</td>
<td></td>
</tr>
<tr>
<td>For UNDMIN slope, (\pi_3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For INTRCPT2, (\beta_{30})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT3, (\gamma_{300})</td>
<td>-0.072</td>
<td>0.054</td>
<td>0.198</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>(\chi^2)</th>
<th>p-value</th>
</tr>
</thead>
</table>

89
### ITJR (Higher Order) Final Model

To analyze the higher-order relationship of ITJR (Physical and Social) with student achievement while controlling for student and teacher contextual variables, the higher-order ITJR variables (PHY and SOC) were added to the model, as predictors of the intercept, in place of the individual-factor ITJR variables.

The relationships between student achievement and both physical ITJR ($u_{02} = 0.147, p > .500$) and social ITJR ($u_{01} = 0.007, p = .149$) did not vary across schools and were fixed, one by one, in the model. Because multiple iterations of models were generated when fixing slopes one at a time, the $p$-values noted are from the most current model iteration. The final higher-order, level-2 model for the ACT assessment was as follows:

#### Level-1 Model

$$ACT_{Z_i} = \pi_{0jk} + \pi_{1jk} \times (STGEN_{ij}) + \pi_{2jk} \times (SES_{ijk}) + \pi_{3jk} \times (UNDMIN_{ijk}) + e_{ijk}$$

#### Level-2 Model

$$\pi_{0jk} = \beta_{00k} + \beta_{01k} \times (PHY_{ijk}) + \beta_{02k} \times (SOC_{jk}) + r_{0jk}$$

$$\pi_{1jk} = \beta_{10k}$$

---

<table>
<thead>
<tr>
<th></th>
<th>$r_0$</th>
<th>16</th>
<th>109.740</th>
<th>&lt; .001</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRCPT1</td>
<td>0.079</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNDMIN slope</td>
<td>0.033</td>
<td>41</td>
<td>60.370</td>
<td>.026</td>
</tr>
<tr>
<td>level-1, $e$</td>
<td>0.653</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRCPT1/INTRCPT2, $u_{00}$</td>
<td>0.012</td>
<td>21</td>
<td>28.598</td>
<td>.124</td>
</tr>
</tbody>
</table>

*Note. STGEN refers to student gender, FRL refers to the socioeconomic status of students noting whether students received a free or reduced lunch, and UNDMIN refers to the underrepresented minority status of the student. PD refers to Professional Development, CURR refers to Curriculum, AUTON refers to Instructional Autonomy, and TIME refers to Time to Collaborate.*
\[ \pi_{2jk} = \beta_{20k} \]
\[ \pi_{3jk} = \beta_{30k} + r_{3jk} \]

Level-3 Model
\[ \beta_{00k} = \gamma_{000} + u_{00k} \]
\[ \beta_{01k} = \gamma_{010} \]
\[ \beta_{02k} = \gamma_{020} \]
\[ \beta_{10k} = \gamma_{100} \]
\[ \beta_{20k} = \gamma_{200} \]
\[ \beta_{30k} = \gamma_{300} \]

Table 22 shows the final estimation of the fixed effects and the level-1, level-2, and level-3 variance components. Neither physical \((\gamma_{020} = -0.479, p = .336)\) nor social \((\gamma_{030} = 0.665, p = .252)\) ITJR were found to have a statistically significant relationship with student achievement for grade 9.

The proportion of variance between classes \(\left(\frac{\tau_{\pi00B} - \tau_{\pi00F}}{\tau_{\pi00B}}\right)\) explained by the higher-factor ITJR variables was calculated by comparing the variances in this model to the level-2 control model. The higher-order ITJR (PHY and SOC) accounted for about 2% of the variance between classes and 0% of the variance between schools in student achievement scores for the ACT assessment.

Table 22

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>(p)-value</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>For INTRCPT1, (\pi_0)</td>
<td>0.134</td>
<td>0.074</td>
<td>.083</td>
<td>.580</td>
</tr>
</tbody>
</table>
For \( \text{INTRCPT2} \), \( \beta_{00} \)
\[
\text{INTRCPT3}, \gamma_{000}
\]
For \( \text{PHY} \), \( \beta_{02} \)
\[
\text{INTRCPT3}, \gamma_{020} -0.479 \quad 0.487 \quad .336
\]
For \( \text{SOC} \), \( \beta_{03} \)
\[
\text{INTRCPT3}, \gamma_{030} \quad 0.665 \quad 0.565 \quad .252
\]
For \( \text{STGEN} \) slope, \( \pi_1 \)
For \( \text{INTRCPT2} \), \( \beta_{10} \)
\[
\text{INTRCPT3}, \gamma_{100} -0.113 \quad 0.035 \quad .001
\]
For \( \text{FRL} \) slope, \( \pi_2 \)
For \( \text{INTRCPT2} \), \( \beta_{20} \)
\[
\text{INTRCPT3}, \gamma_{200} -0.101 \quad 0.043 \quad .020
\]
For \( \text{UNDMIN} \) slope, \( \pi_3 \)
For \( \text{INTRCPT2} \), \( \beta_{30} \)
\[
\text{INTRCPT3}, \gamma_{300} -0.071 \quad 0.054 \quad .199
\]

<table>
<thead>
<tr>
<th>Random Effect</th>
<th>Variance Component</th>
<th>d.f.</th>
<th>( \chi^2 )</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{INTRCPT1}, r_0 )</td>
<td>0.087</td>
<td>18</td>
<td>122.793</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>( \text{UNDMIN} ) slope, ( r_3 )</td>
<td>0.032</td>
<td>41</td>
<td>60.342</td>
<td>.026</td>
</tr>
<tr>
<td>level-1, ( e )</td>
<td>0.653</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{INTRCPT1}/\text{INTRCPT2}, u_{00} )</td>
<td>0.024</td>
<td>21</td>
<td>35.864</td>
<td>.022</td>
</tr>
</tbody>
</table>

*Note.* \( \text{STGEN} \) refers to student gender, \( \text{FRL} \) refers to the socioeconomic status of students noting whether students received a free or reduced lunch, and \( \text{UNDMIN} \) refers to the underrepresented minority status of the student. \( \text{SOC} \) refers to the Social job resources comprised of Time to Collaborate and Instructional Autonomy. \( \text{PHY} \) refers to the Physical job resources comprised of Curriculum and Professional Development.

**Summary**

With the survey questions that were available in the dataset, the factors for mathematics Instructional Teacher Job Resources (ITJR) that were identified were (a)
quality curriculum, (b) quality professional development, (c) instructional autonomy, and (d) time to collaborate with colleagues. The EFA and CFA provided validity evidence for a four-factor model that fit the data well (RMSEA (.084), AIC (590.216), CFI (.921), and $\chi^2$ 500.22(59), $p < .001$). The main difference between the hypothesized five-factor model that included (a) quality curriculum, (b) quality professional development, (c) instructional autonomy, (d) collaborating with colleagues, and (e) planning time and the confirmed four-factor model was that variables for Time to Plan and Collaborating with Colleagues were merged to become Time to Collaborate.

Accounting for the cluster effect of students nested in classrooms nested in schools using an HLM model, I found a statistically significant positive relationship between teacher instructional autonomy and student achievement for grades 4-8 after controlling for student and teacher characteristics, $\gamma_{040} = 0.225$, $p = .024$. For each unit increase in teacher autonomy, there was an expected increase in student achievement on the BAM assessment $z$-score by 0.22 points for grades 4-8, $p < .05$. The relationship between teacher instructional autonomy and student achievement in mathematics for grades 4-8 was statistically significant, but not for grade 9. Relationships between student achievement and the other ITJR for all grades were not statistically significant. The proportion of variance that teacher instructional autonomy explains, above and beyond student and teacher control variables and other job resources is 0% between classes and 5% between schools. Significance was not found for any other relationships between student achievement and the other ITJR for all other grades using this data set. Aside from Instructional Autonomy, a fair amount of variance was collectively explained even though the relationships between student achievement and each of the ITJR were
not significant. Table 23 summarized the variance in student achievement, explained by the ITJR.

Table 23

*Summary of Explained Variance from the Final Individual-Factor, Level-2 Models for BAM and ACT*

<table>
<thead>
<tr>
<th>ITJR (Individual-Factor) Model</th>
<th>Grades 4-8</th>
<th>Grade 9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>between classes</td>
<td>between schools</td>
</tr>
<tr>
<td>CURR, PD, TIME, &amp; AUTON</td>
<td>20%</td>
<td>11%</td>
</tr>
<tr>
<td>AUTON alone</td>
<td>0%</td>
<td>5%</td>
</tr>
</tbody>
</table>

*Note.* ITJR refers to Instructional Teacher Job Resources. CURR refers to Curriculum, PD refers to Professional Development, TIME refers to Time to Collaborate, and AUTON refers to Instructional Autonomy.
CHAPTER 5
DISCUSSION

Introduction

This chapter contains five sections. The first contains a summary of the study including an overview of the problem, purpose statement and research question, review of methodology, and major findings. The second addresses how the major findings relate to the literature presented in Chapter 2. The third section discusses surprising or unexpected findings from the study. The fourth section discloses limitations of the study. Finally, the fifth section summarizes the findings, noting implications for action and finishing with concluding remarks.

Summary of the Study

Overview of the problem. Job demands for teachers are high (Hakanen et al., 2006) and yet teachers, especially teachers of mathematics (Gewertz, 2014), do not have the job resources needed to meet their students’ needs (e.g., Bidwell, 2013; Layton, 2015; Rentner & Kober, 2014a). Without this needed job support, teachers may become less engaged with their work (Klusmann et al., 2008), which may reduce their effectiveness as educators (Bakker & Bal, 2010; Kahn, 1990). Research on teacher job resources is especially important for mathematics teachers who are burnt-out and leaving the field of education (Sutcher, Darling-Hammond, & Carver-Thomas, 2016).

Purpose statement and research question. Teachers know these job resources matter and want support for instructional demands of the job (MET, 2010). For example,
on the Measures of Effective Teaching (MET) survey, teachers were asked what was most important to their students’ learning, and their most frequent reply (32% of teachers) was *Instructional Practice and Support*. MET (2010) outlined the following as examples of Instructional Practice and Support: providing instructional coaching, working in professional learning communities to develop and align instructional practices, feeling encouraged to try new things to improve instruction, and having autonomy to make decisions about instructional delivery (e.g. pacing, materials and pedagogy). Job resources for teachers have been identified as five broad categories: job control, supervisory support, access to information, social climate, and innovativeness (Hakanen et al., 2006). However, specifics as to how these job resources relate to teachers’ daily needs were not explicit. The goal of this research was not only to examine how job resources for teachers’ day-to-day instructional needs measure individual factors that create a model of ITJR but also to examine how these resources may relate to student achievement.

Although teachers self-report on the MET Study that job support and resources are the most important to student learning, thus far research has not explored nor defined specific job resources for instruction that might be related to student learning. In this study, my specific research question was “What is the relationship between instructional teacher job resources (ITJR) and student achievement in mathematics?” I specifically focused on job resources for mathematics teachers, as mathematics is an area with high attrition rates due to poor working conditions (Sutcher, Darling-Hammond, & Carver-Thomas, 2016).
After reviewing the MET survey questions and the research of Hakanen and colleagues (2006), the following five job resources for mathematics teachers’ instruction were theorized: curriculum materials of high quality being that they provided useful information regarding the mathematics content standards as well as information on pedagogy strategies and anticipated student misunderstandings, professional development (PD) intended to meet mathematics teachers’ needs, the ability to collaborate with their colleagues regarding their teaching practices, time during the work day for planning, and a sense of autonomy to make decisions regarding instruction for their students. As explained in Chapter 2, these ITJR were hypothetically split into Social and Physical job resources. I identified 16 survey questions from the MET study as potential indicators of these ITJR and examined their relationships in an Exploratory Factor Analysis (EFA) and a Confirmatory Factor Analysis (CFA) to develop and validate a model of job resources as factors.

**Review of methodology.** Data purchased from the MET Project were used to explore the research question posed. Both the EFA and CFA supported four factors: Curriculum, PD, Instructional Autonomy, and Time to Collaborate. Survey questions for both time to plan during the work day and for ability to collaborate with colleagues were indicators of Time to Collaborate. Factor scores, which report each factor as a weighted sum of each survey item, were created for the four job resource factors: CURR (Curriculum), PD, TIME (Time to Collaborate), and AUTON (Instructional Autonomy). Factor scores were also created for the higher-order factors: PHY for Physical ITJR (CURR and PD) and SOC for Social ITJR (TIME and AUTON). These ITJR variables were then used in Hierarchical Linear Modeling (HLM) to assess whether significant
relationships exist between mathematics teachers’ job resources for instruction and their students’ achievement.

HLM accounted for the clustering effect that occurs when students are nested in classrooms (Raudenbush & Bryk, 2002) and was used to analyze a three-level model of students (level-1) who are nested in classrooms (level-2) that are nested in schools (level-3). Level-1 control variables consisted of student gender, student minority status, and student free or reduced lunch status. Level-2 control variables consisted of teacher gender, teacher minority status, and years of experience. Student achievement was the outcome variable and two models were created, one for grades 4-8 using the Balanced Assessment in Mathematics (BAM) test as the outcome and one for grade 9 using the ACT QualityCore® test as the outcome. Variables of interest were all level-2 variables for ITJR: CURR, PD, TIME, and AUTON for the individual-factor models and PHY and SOC for the higher-order models.

Major Findings. As previously stated, prior to this model, research for big-picture job resources occurred but research for specific job resources for teachers’ instruction had not yet been identified (Bakker, Demerouti, & Verbeke, 2004; Hakanen, Bakker, & Schaufeli, 2006). The EFA and CFA provided validity evidence for a four-factor model that fit the data well. The main difference between the hypothesized five-factor model (i.e., the model including Curriculum, PD, Instructional Autonomy, Collaborating with Colleagues, and Planning Time) and the confirmed four-factor model was that variables for Time to Plan and Collaborating with Colleagues were merged to become Time to Collaborate. The hypothesized higher-order ITJR Model where Physical ITJR, comprised of Curriculum and PD, and Social ITJR, comprised of Time to
Collaborate and Instructional Autonomy was additionally supported using CFA. This is the first study to examine empirically how job resources that specifically support teachers’ instruction are measured.

Accounting for the cluster effect of students nested in classrooms nested in schools using an HLM model, I found a statistically significant positive relationship between teacher instructional autonomy and student achievement for grades 4-8 after controlling for student and teacher characteristics, \( \gamma_{040} = 0.225, p = .024 \). For each unit increase in teacher instructional autonomy, there was an expected increase in student achievement on the BAM assessment z-score by 0.22 points for grades 4-8, \( p < .05 \). However, the other ITJR were not statistically significantly related to achievement in grades 4-8. Above and beyond the student and teacher characteristics, the four ITJR of CURR, PD, TIME, and AUTON collectively accounted for 20% of the variance explained in student achievement between classrooms and almost 11% of the variance explained between schools for grades 4-8. Autonomy alone accounted for about 0% of the variance explained in student achievement between classrooms but about 5% of the variance explained between schools for grades 4-8, above and beyond the other ITJR and student and teacher characteristics.

Again, accounting for the cluster effect of students nested in classrooms nested in schools using an HLM model, I found that none of the ITJR were statistically significantly related to achievement in grade 9. Furthermore, for both grades 4-8 and grade 9, including the higher-order ITJR Model factors of Physical and Social teacher job resources did not yield statistically significant relationships with student achievement.
Findings Related to the Literature

Using the ITJR model supported by the CFA in this study to build on the Job Demands-Resources Model (JD-R; Fig. 1, Chapter 2; Bakker, Demerouti, & Verbeke, 2004) as well as the Job Demands-Resources (JD-R) Model for Education (Fig. 2, Chapter 2; Hakanen, Bakker, & Schaufeli, 2006), I propose a new JD-R Model for education with day-to-day resources for instructional support. The CFA provided validity evidence that the four resources of Instructional Autonomy, quality PD, quality Curriculum, and Time to Collaborate fit the data well for the ITJR hypothesized in this study. Figure 11 illustrates how these four ITJR may fit within the existing JD-R Model. The reader will recall from Figure 1 in Chapter 2 that the Job Resources listed were not specific for day-to-day support and included Autonomy, Possibilities Development, and Social Support. The reader also will recall from Figure 2 in Chapter 2 that the JD-R Model for Education did not list any specifics for Job Resources. The model presented here in Figure 11 provides administrators with specific ways they can support teachers, thereby equipping administrators to understand better how to reduce the risk of teacher burnout and increasing the potential for teachers to be engaged with their work of teaching students.

The reader will recall from Chapter 2 that teaching has various job demands. Chapter 2 also addresses that professionals who are supported with job resources will remain in their profession and remain engaged with their work, even when job demands are high; stress falls out of the model when employees are supported. Therefore, additional job resources were included, such as support for student counseling and student conduct, to emphasize the point that there may be many job resources for
supporting teachers. Future research is needed to examine if those job resources would also fit into the measurement of ITJR. Support for instructional job resources, as examined in this study, is just one area in which teachers need support.

Figure 11. Job Demands-Resources Model for Education with resources for day-to-day Instructional Support. Job Resources with an * have not been explored or examined in this study.

Results from this study show that teachers who reported receiving higher levels of instructional autonomy from their administrators tended to have students with higher achievement. Supporting teachers with instructional autonomy also may decrease on-the-job stress and increase empowerment and professionalism (Pearson & Moomaw, 2005). Based on the theory proposed in the JD-R model (Bakker, Demerouti, & Verbeke, 2004; Hakanen, Bakker, and Schaufeli, 2006), mathematics teachers supported with instructional autonomy may be more likely to be engaged with their work (Klusmann et al., 2008) and may be less likely to leave the teaching profession (Klassen et al., 2012) than teachers who do not feel supported with instructional autonomy.

The finding from this study, that instructional autonomy is positively related to student achievement, is most similar to Pearson and Moomaw’s (2005) study, using a multivariate analysis of variance, where autonomy was statistically related to on-the-job
stress, empowerment, and professionalism. Pearson and Moomaw (2005) defined two types of autonomy that span this study’s definition of instructional autonomy: (a) curriculum autonomy in which teachers had control over instructional sequencing, materials, activities, and planning, and (b) general teaching autonomy which allowed on-the-job decision making. In that study, an increase in curriculum autonomy was found to be statistically significantly related to a decrease in on-the-job stress and an increase in general teaching autonomy was found to be statistically significantly related to increases in empowerment and professionalism (Pearson & Moomaw, 2005). In this current study, teacher autonomy for instructional planning was significantly and positively related to student achievement in mathematics for grades 4-8 after controlling for student and teacher characteristics. Instructional Autonomy was not a significant predictor for grade 9 achievement in this study. It is important to point out that, in some instances, the idea of working autonomously has been synonymous with working alone (Kelchtermans, 2006); however, this is not what is intended as an ITJR. As defined in Chapter 1, autonomy as an ITJR allows teachers to work alone or collaboratively to make instructional decisions to meet their students’ needs.

**Unexpected Findings**

Only one of the four factors had a statistically significant relationship with student achievement, Instructional Autonomy, and only for grades 4-8. This was unexpected due to previous findings from literature. However, considering the survey questions I used were not intended for this study, as addressed in the next section, the findings here are reasonable. Another unexpected finding was that the two variables Collaborating with Colleagues and Planning Time merged into one variable, Time to Collaborate. A
possible reason for this, as stated in Chapter 2, is that the complex tasks for teaching cannot be completed during planning time and as such, the survey questions may not be direct enough to represent Planning Time well. The need for survey questions to be more direct is addressed in the following section.

Limitations

A major limitation for this study was that the data used were not designed for ITJR as defined in Chapter 2. These data, purchased from the MET Project, included survey questions that were designed for the purpose of measuring effective teaching (MET, 2010). Although the survey questions used in this study were still relevant to concepts delineated in Chapter 2 for ITJR, the final variables may have benefited from (a) expanded questions (Stevens, 2009) and (b) more direct questions.

For instance, expanding the number of questions may have resulted in more survey items for each variable, which may have increased their reliability and validity. Five survey questions loaded onto the variable for PD where only three loaded on to AUTON and CURR each, and TIME only had two questions. With only two survey questions loading significantly, TIME needed more questions to increase its reliability (Stevens, 2009).

Questions could have been more direct as well by addressing issues of alignment. For instance, for CURR, survey questions addressed whether the materials provided “useful information about how to teach particular skills, strategies, texts, or other topics” or whether they “contain[ed] useful information for me about the content I am teaching,” but the questions could have gone farther. If the curriculum materials were helpful, a teacher may agree or strongly agree to both of those questions, saying that they contain
useful information about the content they are teaching. Yet that would not necessarily indicate whether the curriculum materials were aligned to the teacher’s content standards or if the materials were aligned to their students’ assessments. It may be possible that the curriculum materials used by teachers in the MET Project study were not aligned to either the instructional content standards or the assessments given; however, those specific questions were not asked of teachers on the surveys. If the alignment was weak between the measure of student achievement and teachers’ content standards, results should be interpreted with caution.

Aside from the intention of the survey questions, another limitation was issues with normality for both the survey questions and the factor scores for the ITRJ variables. Data from the survey questions were categorical and even bimodal in some instances, which resulted in issues with normality. Reviewing the Q-Q Plots, however, revealed generally linear behavior of the ITJR variables.

To include as many students as possible in each model, I chose to listwise delete cases with missing data separately for each HLM model. Therefore, calculations of each proportion of variance explained may be biased as the models did not necessarily include all the same participants, depending on missing data for the variables in the models.

An additional limitation includes a procedural error during the EFA. The survey item for Individual Planning Time had a low communality score from the EFA and should have been removed. Because the item did not load on to any factors it most likely did not change the outcome of the EFA but removing it may have resulted in a more succinct path to the four-factor model. After realizing the error, I reran the EFA without
the survey question on Individual Planning Time and got the same results, suggesting three different models, a four-factor, a three-factor, and a one-factor model for the CFA.

**Conclusions**

**Implications for action.** In this first study on instructional job resources and student achievement, validity support for a four-factor model for day-to-day teacher support based on variables available in a large-scale teacher effectiveness dataset was provided. The validated four-factor model for ITJR may help administrators be more knowledgeable about how to support their teachers. With this operationalized understanding, administrators may be more likely to offer support to teachers so that they may receive job resources such as: (a) availability to quality curriculum, (b) PD sessions that develop teacher knowledge, (c) appropriate time provided to collaborate with other math teachers, and (d) autonomy from their administrators to create or modify their instructional plans to meet their students’ needs.

In particular, administrators should look for ways to offer, communicate, and encourage instructional autonomy for their teachers. Again, in this study, instructional autonomy included the following three survey questions: (a) Teachers have the autonomy to make decisions about instructional delivery (i.e., pacing, materials and pedagogy), (b) Teachers are assigned classes that maximize their likelihood of success with students, and (c) Teachers are encouraged to try new things to improve instruction. Results from this study show that teachers who reported receiving higher levels of those three items from their administrators, also had students with higher achievement. Supporting teachers with instructional autonomy also may decrease on-the-job stress and increase empowerment, professionalism (Pearson & Moomaw, 2005). Based on the theory
proposed in the JD-R model, mathematics teachers supported with instructional autonomy may make them more likely to be engaged with their work (Klusmann et al., 2008) and may make them less likely to leave the teaching profession (Klassen et al., 2012) than teachers who do not feel supported with instructional autonomy.

Although not widely accepted at this point, linking teacher pay to student achievement has been debated (Goldhaber, 2015). Merit pay attempts to quantify teachers’ efforts and effectiveness through their students’ end-of-course achievements. I would argue, based on the four-factor ITJR model validated in this study and the statistically significant relationship between one of the four factors and student achievement, that if a model for teacher merit pay is being considered, teacher job resources such as ITJR, or at least instructional autonomy, need to be included in the model. For instance, consider that two teachers are judged on their students’ achievement and they receive students of similar background, race, gender, ability, and so on, yet the teachers have vastly different ITJRs with which to work. According to the results of this study, teachers with higher levels of support, in particular instructional autonomy, will have higher results, yet these resources are often beyond their control.

**Recommendations for further research.** Continuing to examine the relationship between ITJRs and student achievement may offer additional or refined understandings of ways in which teachers may be supported with job resources. As only one of the four factors in the validated model was statistically related to student achievement, the findings in this study indicate that specific resources that support teachers’ instruction is an area for further research.
Additionally, finding a relationship between ITJR and teacher work engagement may further highlight the relationship as a potential mediator for reducing teacher burnout and attrition (Klusmann et al., 2008). By identifying, acknowledging, and addressing teachers’ professional needs, teachers may be more inclined to remain in their profession (Klassen et al., 2012). Moreover, doing so may allow teachers to feel as though they are treated as professionals (Pearson & Moomaw, 2005). As stated in Chapter 2, other professional fields have benefited from the Job Demands-Job Resources Model (e.g., Harter et al. 2002; Kahn, 1992; Leiter & Maslach, 2004; Schaufeli, Salanova, González-Romá, & Bakker, 2002); teachers may as well.

A next step for continuing to understand Instructional Teacher Job Resources would be to develop an ITJR Survey. As previously discussed, the ITJR Survey should include specific questions regarding alignment of content teaching standards, curriculum, and student assessment. A future study could replicate the statistical methods used in this study using the new ITJR Survey and student assessments that are aligned to instructional content standards. Although this study focused on mathematics teachers because of issues with attrition, future studies could include teachers of other content areas. Additionally, future studies could investigate whether there is a contextual difference for which ITJR are needed based on the grade level they teach.

As previously stated, analyzing possible interaction effects between each of the job resources such as Autonomy and PD would be helpful in future studies. For instance, does an increase in PD have a negative effect on teachers’ autonomy? By better understanding the relationships between ITJRs, administrators and district policy makers may be better equipped to support their teachers with a balanced set of resources.
Another step for continuing to understand how to support teachers is to investigate whether there is a statistical relationship between ITJR and Teacher Work Engagement. Previous studies have offered survey design suggestions for Work Engagement as may be considered in future research (Dalal, Baysinger, Brummel, & LeBreton, 2012; Klassen et al., 2012). If a link between these two constructs can be found, teachers should receive ITJR support regardless of the relationship between ITJR and student achievement. If ITJRs moderate Teacher Work Engagement and teachers are then provided ITJRs, teachers may feel supported as professionals (Pearson & Moomaw, 2005), and attrition may be reduced (Klassen et al., 2012).

To better understand how to support teachers’ complex job demands, future studies could extend the instructional category of teacher job resources to other areas. Disruptive pupil behavior, for example, is a job demand factor for teachers (Hakanen et al., 2006). What specific job resources for disruptive pupil behavior might help teachers feel supported to be engaged with their work? Likewise, might teachers be more engaged with their work if school counseling services were offered for their students who may benefit from mental health services? Pupil behavior and Counseling for Students are only two additional job resources that may help teachers feel supported as professionals so that they may be engaged with their work.

**Concluding remarks.** Dissatisfied with administrative support and working conditions, mathematics teacher attrition has reached alarming rates due, in large part, to lack of support (Sutcher, Darling-Hammond, & Carver-Thomas, 2016). To help administrators and researchers understand how to better support mathematics teachers, a specific set of day-to-day ITJR were researched, hypothesized, analyzed, and presented in
this study. A model was presented, illustrating how the following ITJR fit with existing research: Instructional Autonomy, Professional Development, Curriculum, and Time to Collaborate.

Instructional job resources are just one set of job resources with which teachers may be supported to meet the demands of their job. Benefits of supporting teachers with job resources may include a decrease in attrition rates, an increase in teacher work engagement, and an increase in student achievement. Only one of the ITJR, Instructional Autonomy, was found to have a statistically significant relationship with student achievement for grades 4-8. For each unit increase in teacher autonomy, there was an expected increase in student achievement on the BAM assessment z-score by 0.22 points for grades 4-8, \( p < .05 \). The four ITJR collectively accounted for 20% of the variance in student achievement between classrooms and almost 11% of the variance between schools for grades 4-8. Instructional Autonomy alone accounted for about 5% of the variance explained in student achievement between schools for grades 4-8, above and beyond the other ITJR and student and teacher characteristics.
CHAPTER 6

INSTRUCTIONAL TEACHER JOB RESOURCES: A CURRENT EXAMPLE

This study focused on the relationship between teacher job resources that support mathematics teachers’ instruction and student achievement. This chapter provides a current example of the importance of ITJR in the context of implementing new content standards; specifically, the Common Core State Standard for Mathematics (CCSS-M), which were released in 2010.

Teams of education specialists and mathematicians researched commonalities of the standards used in the most successful countries as a basis for CCSS-M. As of July 2013, the CCSS-M were voluntarily adopted by 45 states and the District of Columbia; however, curriculum resources that may have eased the transition to adopt the CCSS were not ready (Bidwell, 2013; Rentner & Kober, 2014a).

In the sections that follow, possible complications from the implementation of CCSS-M without appropriate ITJR are presented such as (a) resources for CCSS-M implementation, (b) student assessments aligned to the CCSS-M, and (c) mathematics teacher recruitment and retention.

Resources for CCSS-M Implementation

CCSS-M resources supporting teacher implementation, such as professional development (PD) and aligned curriculum materials, are still being refined (Layton, 2015; Rentner, 2013). The Center on Education Policy (CEP) reported that in 2014 only
one-third of teachers were prepared to teach the CCSS (Rentner & Kober, 2014a). The CEP surveyed nine of the 45 states that adopted CCSS and found that at least six of the nine states reported CCSS-related PD for English or Mathematics had been provided to less than half of their teachers (Bidwell, 2013). In addition, three other states had reduced or ceased PD altogether due to funding (Bidwell, 2013). A survey administered by the Education Week Research Center found that of the CCSS PD available, teachers rated the sessions as low quality with more PD sessions offered for English teachers than mathematics teachers (Gewertz, 2014). Although achievement scores for mathematics merit more focused PD, mathematics teachers may have gone without this support (Gewertz, 2014).

Curriculum support for mathematics teachers may be even worse. In addition to less opportunities for PD support, current curriculum resources for the CCSS-M are characterized as misaligned (Layton, 2015; Rentner & Kober, 2014a). The CEP reports approximately 90% of districts struggled to identify or develop CCSS-M aligned curriculum materials. This is due in part to publishing companies that presented existing materials to districts claiming alignment with CCSS-M when they were not (Layton, 2015; Rentner & Kober, 2014a). Groups such as the CCSS Mathematics Curriculum Materials Analysis Project are working to sort out the issue to determine which materials are actually aligned but in the meantime, teachers may be left without accurate guiding resources (McShane, 2013). Inadequate ITJR such as PD and curriculum materials, coupled with pressure to provide effective instruction, may heighten teachers’ job demands such as requiring them to develop their own materials for new content standards which they may not fully understand as discussed in Chapter 2.
Student assessments aligned to the CCSS-M

Each state using CCSS-M is not required to use an end-of-course (EOC) exam for mathematics that is aligned to the CCSS-M (Gewertz, 2015; Rentner & Kober, 2014b). Two federally-funded test consortia exist, PARCC (Partnership for Assessment of Readiness for College and Careers) and SBAC (Smarter Balanced Assessment Consortium), but not all states who have adopted CCSS have purchased them (Rentner & Kober, 2014b). Out of the 45 states, currently nine states have adopted PARRC (www.parcconline.org/about/states), and 15 states have adopted SBAC (www.smarterbalanced.org/about/members). The remaining 21 states are left to design or purchase their own test.

One of the first states to begin testing for CCSS-M, Kentucky, used their own exam (Rentner & Kober, 2014b). For instance, Kentucky uses an exam for its Algebra 2 EOC that was created by ACT, Incorporated’s “QualityCore”® prior to the creation of CCSS-M (education.ky.gov/AA/Assessments/Pages/EOC.aspx). On the QualityCore EOC exam for Algebra 2, matrix algebra was assessed even though it was not listed in the CCSS-M for teachers to cover in regular Algebra 2 classes (R. Davis, personal communication, April 23, 2016). Soon after CCSS-M was adopted, teachers in Kentucky had been told matrix test items would not be on the EOC and yet they were (R. Davis, personal communication, April 23, 2016). Teachers may then choose to cover matrix algebra for two reasons: in case it is actually counted in the assessment score or to support student moral while taking the EOC exam as seeing unfamiliar content may startle students. Doing so however, erodes instructional time for other content that needs to be taught for future course advancement. Schools in the 21 states like Kentucky that do not purchase CCSS-M-endorsed exam packages may be using misaligned exams, scoring students on old content material that teachers are not supposed to
cover according to CCSS-M. Inadequate job resources such as misaligned assessments, coupled with pressure to increase student achievement, may heighten teachers’ job demands.

**Mathematics teacher recruitment and retention**

Mathematics teacher recruitment and retention has been an issue for middle and secondary schools for some time in the U.S. (Sutcher, Darling-Hammond, & Carver-Thomas, 2016). The recent implementation of CCSS-M has the potential to increase stressful working conditions for mathematics teachers in the U.S. who may experience burnout or disengagement, which may lead to teachers leaving the field of education. Teachers certified in secondary mathematics are among the most difficult positions to fill (Ronfeldt, Loeb, & Wyckoff, 2013; Shaul & Ganson, 2005); yet, these teachers are critical because they are responsible for student performance in a high-stakes content area (Walker, 2014). In fact, the U.S. Government Accountability Office acknowledges problematic issues around the recruiting and retaining of mathematics teachers (Shaul & Ganson, 2005). Furthermore, researchers assert that the mathematics teacher shortage is not due to issues with recruitment but to issues with retention (Ingersoll, 2001; Schaffhauser, 2014).

This chapter provided a brief example of the importance of ITJR in the context of implementing the CCSS-M. Mathematics teachers do not have the ITJR needed to successfully implement the CCSS-M (Rentner & Kober, 2014a). In light of the current conditions described above it is likely that job demands may be high and job resources may be low for many mathematics educators in the U.S. The combination of the pressure on mathematics teachers to increase student achievement on high-stakes testing (job demands), the lack of resources needed to implement the CCSS-M (job resources), and the need to retain effective mathematics teachers, make factors of work engagement and
ITJR a needed area of research. Increasing student achievement in mathematics requires retaining quality teachers who are engaged in their work and are supported with instructional job resources.
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CURRICULUM VITA

AMY STOKES-LEVINE

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Louisville, KY 40206

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EDUCATION

University of Louisville, Louisville, KY 2013 – 2017
School of Education
Doctorate of Philosophy in Curriculum and Instruction
  **Dissertation:** Instructional Teacher Job Resources and Student Achievement in Mathematics
  **Dean’s Citation Award,** top 10% of degree program

Bellarmine University, Louisville, KY 2004 – 2006
School of Education
Master of Arts in Teaching, Secondary Mathematics
  **Kappa Delta Pi**

Southern Methodist University, Dallas, TX 1998 – 2002
School of Engineering and Applied Sciences
Bachelor of Science in Engineering Management Information Systems

CERTIFICATIONS

Professional Certificate for Teaching Mathematics, Grades 8 Through 12 Expires 2018
Mathematics Program Consultant 2012 – 2018
Public Education & Business Coalition; Planning for Thinking Institute January 2009
Cognitive Coaching Foundations Seminar April 2013
Grant Writing Academy May 2017

PROFESSIONAL EMPLOYMENT EXPERIENCE

University of Louisville, Louisville, KY August 2014 – May 2017
Graduate Teaching and Research Assistant.

  **Research Assistant** August 2014 – December 2016
  Scored teacher participant entries for DTAMS research; assisted and facilitated summer professional development on statistics education for middle and secondary mathematics teachers with Dr. Susan Peters through the CAREER Grant; assisted and facilitated ongoing follow-up professional development sessions on statistics education for middle and secondary mathematics teachers through the CAREER Grant; transcribed video and audio files from the week-long summer professional development session as well as the ongoing follow-up sessions; coded and analyzed data from video, audio, and transcription files on teacher learning through Mezirow’s Learning Theory.

  **Spring Research Conference Lead Organizer** August 2015 – March 2015
  The Spring Research Conference unites three university institutions: University of Louisville, University of Kentucky, and the University of Cincinnati. Each year students conducting research at each of these institutions
gain presentation experience and feedback and are exposed to emerging research in the fields of education, nursing, and sciences. As the lead conference organizer, I collaborated with all three institutions to plan conference logistics such as location, set-up, and food, as well as the online application process. Planning the presentation schedule included: fielding and categorizing online submissions, creating a time schedule, securing session facilitators, volunteers, and guest speakers for the lunch panel. Additionally, conference attendees received free gifts such as a bag, conference t-shirt, and a research book of their choosing.

**Mathematics Methods Teacher, Middle/High.**
August 2014 – May 2015
Taught middle- and high-school teacher candidates methods for teaching mathematics for grades 6-12. Some of the broad major topics included were algebra, geometry, statistics, technology, navigating content and process standards, and lesson planning. Students were also enrolled in a parallel course which gave the teacher candidates to field exposure for the first time. Lesson plans were submitted to me 48 hours prior to teaching in their field placement so that I could provide feedback before and after each session they taught.

**Adolescent Literacy Project, Mathematics Specialist**
June, 2014
Led mathematics break-out sessions for middle and high school mathematics teachers during an ALP summer institute. ALP provides high caliber, intensive, literacy professional development for middle and high school educators and administrators. Topics covered in June 2014 included: What can we learn from our students by incorporating appropriate reading and writing in the mathematics classroom?, Sources of appropriate reading materials for the mathematics classroom, Methods for appropriate writing in the mathematics classroom (Math Journals and Graphic Novels), and Interpreting mathematical understanding from student writing.

**South Oldham High School, Crestwood, KY**
August 2012 – May 2014
**High School Math Teacher.** Taught Advanced Pre-Calculus, AP Calculus, and Intro to College Algebra. Provided after-school tutoring for mathematics.

**Academic Team Coach**
2012 – 2014
Recruited for and organized team practices and study sessions for the Academic Team. Arranged travel to and from weekly quick recall meets across various counties. Secured volunteers such as question readers, timers, judges, and drivers, for each meet. Scored, cataloged, and communicated results to each team member arranging additional study materials when necessary.

**Oldham County High School, Buckner, KY**
August 2007 – May 2012
**High School Math Teacher.** Taught Algebra 1, Advanced Algebra 2, Advanced Pre-Calculus, and AP Calculus to high school students. Administered after-school tutoring for mathematics. Served on the Curriculum Committee and as sponsor to the senior class. Assisted in district mapping and task drafting for Mathematics Curriculum 9-12.

**District Curriculum Team**
2011 – 2012
Worked with Assistant Superintendent, Anita Davis, and five other high school teachers to draft unit guides for new mathematics curriculum as well as transfer tasks and grading rubrics during the Common Core for State Standards rollout which provided teachers across the district with high quality unit plans helps to ensure all students receive superior instruction.

**Oldham County Learning Institute – Lab Host Teacher**
2010 – 2012
Attended workshops at the Learning Institute in Denver, Colorado, Oldham County Board, and with the OCHS OCLI team to extend personal teaching practices and translate those practiced in the Public Education and Business Coalition to the high school math classroom. Offered classroom observations to, on average, thirteen colleagues at a time to demonstrate techniques of teaching through the use of Thinking Strategies, Building Community, and Guided Release.

**Senior Class Sponsor**
2008 – 2012
Planned prom, field trips, a privilege program, t-shirt sales, and graduation for the senior class. The privilege program encourages seniors to have good grades and attendance in order to partake in the various incentives throughout the year.

**Extended School Services Coordinator**
2009 – 2010
Coordinated after school tutoring sessions for each subject and tracked student attendance. Communicated with high school teachers to maintain a smooth service for students in need of extra help.
**Eminence Independent School**, Eminence, KY  

**Extended School Services Coordinator**  
2004 – 2007  
Coordinated after school tutoring sessions for each subject and tracked student attendance. Communicated with high school teachers to maintain a smooth service for students in need of extra help. ESS is aided by core subject teachers as well as ESS aids.

**Master Schedule – Scheduling Coordinator**  
2004 – 2007  
Aligned master schedule according to students’ previous course enrollment with school expectations to create a balanced schedule for staff and students. Creating this new master schedule allowed teachers to create manageable caps for their classrooms to enhance the classroom experience for each student.

**Testing Schedule – Scheduling Coordinator**  
2004 – 2007  
Scheduled each student and teacher during CATS testing to a specified room. Coordinated testing room set-ups, head counts, and test administrator needs. Provided schedules for students and staff during CATS testing and review week.

**Freshmen Class Sponsor**  
2003 – 2007  
Assisted first year high school students as an advisory. Administered locker distribution, student fee collection, and homecoming activities, as well as class fundraisers.

**Beta Club Sponsor**  
2004 – 2006  
Reinstated high standards such as GPA and service hours to Eminence’s Sr. Beta Club. Members had to hold a 3.2 GPA and complete 30 hours of community service for the year. As a result, Beta Club Members raised over $3,000 for Cystic Fibrosis Research through a student lead benefit concert and a 5K run/walk. Other activities included directing a school play, after school tutoring, donating presents for Volunteers of America shelters, etc.

**Women's Discussion Group Leader**  
2004 - 2005  
Led a discussion group after school for high school girls interested in the effects of media and societal stereotypes. Provided an outlet for girls to discuss personal experiences and sensitive issues.

**Southern Methodist University**, Dallas, TX  
**Resident Assistant.** Liaison between the residents and administration. Responsible for providing support, leadership, information, communication, mediation, and guidance while enforcing Residence Hall policies for residents. Accountable for residents’ safety and contentment within reason. RAs stayed on call twenty-four hours a day, seven days a week.

**General Electric**, Louisville, KY  
**Engineering Intern.** In 2001, I worked with a Korean-interfaced washer unit to design and implement test protocol to create innovative delicate cycles for home use. In 2000, I helped design consumer based dispenser control panel, and completed competitive benchmark testing for capacity, local temperature readings, and ice production rate.

**AWARDS**

**Dean’s Citation Award.** top 10% of Ph.D. program at the University of Louisville  
May 2017

**Doctoral Dissertation Completion Award**  
January 2017 – May 2017  
Awarded to outstanding Ph.D. candidates in their final semester at the University of Louisville, this scholarship is granted to applicants who demonstrate strong evidence of scholarly ability and program progress. The award includes tuition, health care, and a stipend. Applicants must be nominated by their Department Chair.

**Mathematics Teacher of the Year, Oldham County High School**  
2009 – 2010

**Mathematics Teacher of the Year, Oldham County High School**  
2007 – 2008

**Kappa Delta Pi, Bellarmine University 4.0 GPA**  
2007
Teacher of the Year, Eminence Independent School 2005 – 2006
Teacher of the Year, Eminence Independent School 2004 – 2005
Who’s Who Among America’s Teachers, Nominated by students at Eminence Independent School 2006
Who’s Who Among America’s Teachers, Nominated by students at Eminence Independent School 2005
Rookie of the Year – SMU Residence Life and Student Housing May 2000
Recognition Chair on Executive Council for SMU’s Residence Life and Student Housing Fall 2000

PUBLICATIONS


PRESENTATIONS


PROFESSIONAL MEMBERSHIPS

National Council Teachers of Mathematics
Association of Mathematics Teacher Educators
Kentucky Council Teachers of Mathematics
Kappa Delta Pi

ACTIVITIES AND SERVICE

Doctoral Induction Panel September 2015 & August 2016
Graduate Student Council Advocacy Group; Frankfort, KY March 2016
Met with state senators to report on and answer questions regarding the School to Prison Pipeline 2015 – Present
Reviewer for Mathematics Teacher (NCTM) 2015 – Present
University of Louisville Science Symposium, Judge Spring 2014
Habitat for Humanity 1998 – Present
Society of Women Engineers; Women in Science Engineering 1998 – 2001