Linking Early Childhood Teachers' Characteristics to Their Perceptions of Students' Abilities and Responsiveness to Online Professional Development

---

A Dissertation

Presented to

The Faculty of the Curry School of Education

University of Virginia

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

---

by

Emily C. Furnari, B.S.

May 2016

Department of Curriculum Instruction and Special Education
Curry School of Education

DEDICATION

This work is dedicated to my mother and father, to my closest friends and colleagues at the University of Virginia, and to my partner in life, Tarik.

To Mom and Dad, thank you for teaching me the value of hard work and perseverance, and for supporting me in my decisions every step of the way.

To my dear friends and colleagues, thank you for engaging in countless discussions with me about teacher characteristics, for always believing in me, and for holding my hand through every page.

To Tarik, thank you for listening to me, loving me, and nurturing me with your unwavering support and passion for the pursuit of excellence.

ACKNOWLEDGEMENTS

I would like to give my sincerest gratitude to my co-advisors, Mable Kinzie and Jessica Whittaker. Over the past four years, you have helped me to become a stronger researcher, writer, and thinker through your mentorship, thoughtful feedback, and encouragement. Thank you for always pushing me to iterate continually, and for never accepting anything less than my best possible work.

Thank you to my dissertation committee, Bridget Hamre and Sara Dexter. I truly appreciate your support, thoughtful recommendations, and guidance. I would also like to thank Jamie DeCoster, for teaching me nearly everything I know about statistics, and for sharing his many tricks of the trade.

Thank you to the MyTeachingPartner-Math/Science Project for funding my time at the Curry School of Education. I am so grateful for this support and for the many valuable learning experiences I have had through contributing to this research and working with my wonderful colleagues.

Lastly, I would like to thank my best furry friend, Fitz. Thank you for always being there to put a smile on my face and bring warmth to my heart throughout this entire process.
Who rescued who?

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Linking Early Childhood Teachers' Characteristics: Conceptual Link Across the Three Manuscripts of this Dissertation

Emily C. Furnari

University of Virginia

The Three-Manuscript Dissertation: Overview

With this dissertation, I investigate the associations between early childhood teachers' characteristics (i.e., demographics, beliefs, and skills), and (1) their perception of students' abilities, (2) their engagement and learning in a Massively Open Online Course (MOOC), and (3) their use and perceptions of online curricular supports. I begin with the current document, in which I describe the rationale for this three-manuscript dissertation, and the conceptual links among the three manuscripts. In the first manuscript (pp. 26-67), I examine teacher characteristics (i.e., demographics, beliefs, and skills) and student characteristics that are related to pre-kindergarten (pre-k) teachers' perceptions of students' mathematics abilities. With the second manuscript (pp. 68-117), I examine the association between early childhood teacher characteristics (i.e., demographic and professional backgrounds, as well as psychological beliefs), and their engagement and learning in a MOOC focused on effective teacher-child interactions. Finally, in the third manuscript (pp. 118-161), I examine associations between pre-k teachers' characteristics (i.e., demographic backgrounds, readiness for professional development, teacher-child interaction quality, and technology comfort and habits), and their use, and perceptions, of online curricular supports provided as part of an intervention for early childhood mathematics and science education.

Procedural Notes

I have written this dissertation according to the guidelines in the 2010 Curry School of Education's Dissertation Manual, *Guidelines for Doctoral Dissertations*, manuscript-style dissertation option 1, which was in use when I began my doctoral research. According to these guidelines, the student must prepare three manuscripts, and

a document that demonstrates the conceptual links among these manuscripts. The student must have taken a lead role in completion of two of the three manuscripts.

In adherence to these guidelines, I am the first author on two of the three included manuscripts. Manuscript 1 is in press, at the *Journal of Psychoeducational Assessment*. Manuscript 2 is ready for submission to the journal of *Early Education and Development*. Manuscript 3 is ready for submission to the *Journal of Teaching and Teacher Education*.

Definitions

Child outcomes: Students' academic achievement and social emotional development.

Professional development: Teacher training, provided through workshops or professional meetings, which does not result in credits toward a higher education degree, but may be an in-service or pre-service requirement for licensing in child care.

Teachers' characteristics: Teachers' demographic backgrounds (e.g., age, primary language, years of education, teaching experience), teachers' psychological beliefs (e.g., readiness for professional development, self-efficacy, authoritarian beliefs), and teachers' skills (e.g., teacher-child interaction quality, and comfort with technology).

Teachers' practice or *classroom practices:* The practices, behaviors, and interactions that teachers exhibit in their classrooms and with their students.

Responsiveness: the extent to which participants (i.e., teachers) are involved in and satisfied with an intervention (i.e., professional development).

Rationale for this Three-Manuscript Dissertation

Teachers' characteristics (i.e., their demographic background, set of beliefs, and arsenal of skills) have been linked to their development of classroom practices in numerous studies (Buehl & Beck, 2015; Rimm-Kaufman & Hamre, 2010; Winton et al., 2016). Teacher characteristics were first of interest in the early 1960s, with researchers exploring the "dynamic organization of motives within the individual," including their demographic backgrounds, psychological beliefs, and set of skills (Getzels & Jackson, 1963, p. 507). These teacher characteristics were examined as predictors of student learning outcomes; however, this research left scholars with little understanding of how to use this information other than for the purposes of hiring teachers and selecting candidates for teacher prep programs (Ryans, 1960). For some time now, educational researchers have instead been focusing on teachers' classroom practices as the primary mechanism through which teachers support children's learning and development (Burchinal et al., 2008; Mashburn et al., 2008).

However, research on improving teachers' classroom practices and student outcomes has reached a bottleneck, where the small and outdated body of available research on teachers' characteristics is making it challenging for instructional designers to know how to appropriately tailor PD programs to teachers' individual backgrounds, beliefs, and skill sets (Winton, Snyder, & Goffin, 2016). It may be that teachers' characteristics are indeed important, but through a more proximal association with teachers' perceptions of students, and responsiveness to PD, both of which have been empirically linked to teachers' practice, and ultimately student outcomes.

For instance, some teacher characteristics are associated with perceptions of students' abilities (Mashburn & Henry, 2004), which can in-turn influence teacher practices and student achievement (Brophy, 1983). Teachers' individual characteristics have also been linked to their responsiveness (i.e., engagement and satisfaction) to PD (Downer, Locasale-Crouch, Hamre, & Pianta, 2009). However, little is known about the specific teacher characteristics that relate to teachers' perceptions of students, or the characteristics that make teachers are more or less likely to be responsive to PD. There is no available research about which teacher characteristics are associated with perceptions of pre-k students' mathematics abilities, and there are only a few studies (e.g., Downer et al., 2009; Roberts et al., 2014) examining which early childhood teachers are likely to be responsive to PD programs delivered online—a method that is increasing in popularity due to the high demand for large scale and affordable early childhood teacher training and professional development (Gill, 2011; NAYEC, 2014; Norris, 2010). With an understanding of the association between teachers' characteristics and their perceptions of students' abilities, targeted training can be developed to help teachers become more accurate reporters of students' abilities. Additionally, an understanding of teacher characteristics that are associated with responsiveness to PD will help providers of teacher training better individualize PD to support diverse groups of teachers (Winton et al., 2016).

Theoretical Background Linking Teachers' Characteristics and Classroom Practices

Some of the first research linking the characteristics of individuals to their behaviors came from Fishbein and Ajzen (1975), and Bandura (1986), who theorized that

an interplay between a person's beliefs and attitudes leads to his or her intentions and behaviors. Clark and Peterson (1984) based their work on these ideas about the origins of human behavior, and described teachers' thought processes (i.e., planning, decision-making, attributions, and implicit theories), as a way of explaining their classroom practices.

Synthesizing this research from the fields of both psychology and education, Pajeres (1992) suggested that "the beliefs teachers hold influence their perceptions and judgments, which in turn, affect their behavior in the classroom" (p. 307). This interpretation and application of the research on human behavior to teacher practice suggests that teacher characteristics may be linked to teacher practices through more proximal outcomes. For instance, teachers' perceptions of students, and responsiveness to professional development, are more proximal to teacher characteristics, and are known to be related to teachers' practices (Irwin & Supplee, 2012; Pohan, 1996). It may be that these proximal outcomes act as intermediary factors that influence teachers' classroom practices (Clark & Peterson, 1984; Pajares, 1992), and that understanding how teachers' characteristics relate to these outcomes will be beneficial to the ultimate goal of changing teachers' practice.

Conceptual Framework

In order to provide insight for future interventions focused on improving teachers' practices, I examine associations between teachers' characteristics and teachers' perceptions of students' abilities, as well as teachers' responsiveness to professional development. I begin with a logic model, where I situate these factors in the larger context of educational practice, and follow this with empirical research supporting the

links I describe. In this model, teachers' characteristics are associated with teachers' classroom practices both directly, and indirectly, through associations with: (1) perceptions of student abilities, and (2) responsiveness to professional development. For context and to demonstrate why these inquiries matter, child outcomes are illustrated as a distal goal, strongly influenced by teachers' classroom practices (I do not examine classroom practices or child outcomes in the present research). With the three manuscripts of this dissertation, I focus on providing empirical support for the relationships shown in the first half of this model (arrows labeled 1, 2, & 3).

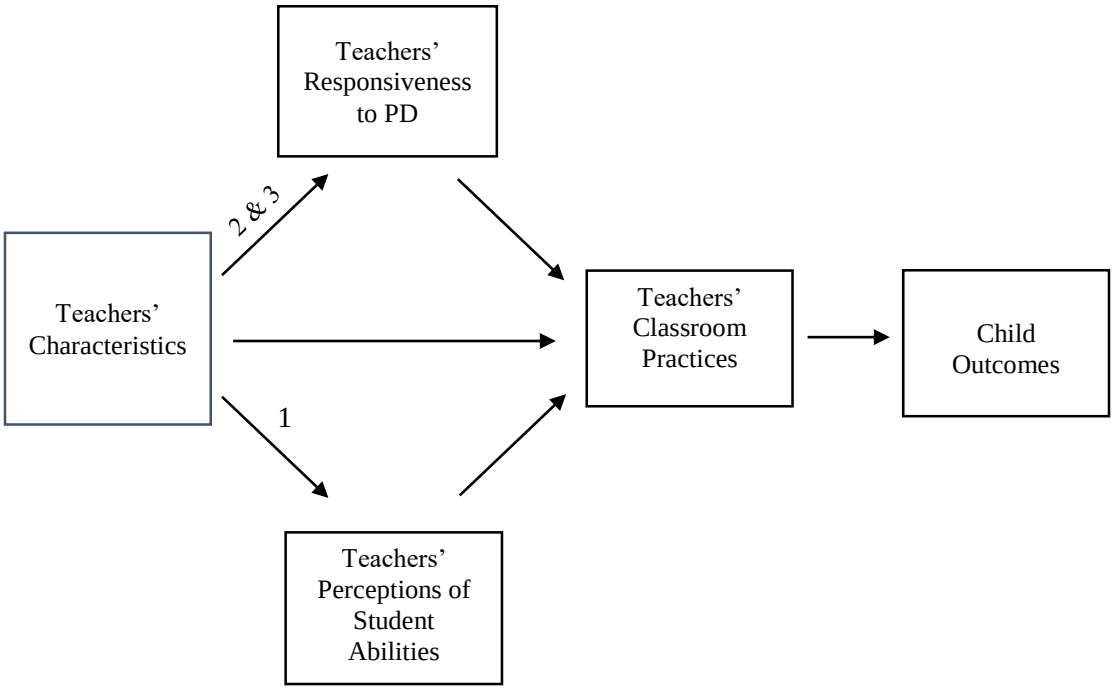

Figure 1. A model of the relationship between teachers' characteristics and child outcomes. The numbered arrows represent the relationships examined in each of the manuscripts (manuscripts 1, 2, and 3) of this dissertation.

Teacher Perceptions of Students and Responsiveness to PD: Links to Practice

Teacher perceptions of students and classroom practices. The importance of teachers' perceptions of students' abilities has been demonstrated in numerous studies.

For instance, teachers have been found to provide more praise, support, and persistence, to students whom they perceive to be more skilled and able (Brophy, 1983; Brophy & Good, 1970). Similarly, Pohan (1996) found that differential perceptions of students were empirically linked to differential treatment of students, and hypothesized that this finding could account for some of the variability seen in student outcomes. Evidence supporting the hypothesized effect of teachers' differential perceptions on student achievement was observed in first-and third-grade students whose teachers' perceptions of their abilities were predictive of these students' later achievement in mathematics and literacy in third- and fifth-grade (Hinnant, O'Brien, & Ghazarian, 2009). Further research supporting this finding also suggested that the effect of teachers' perceptions on students' gains becomes more pronounced as students get older (Jamil, 2013). However, despite knowledge of the problems associated with teachers' inaccurate perceptions of students' abilities, teacher ratings are being used to assess student achievement nation-wide (Kim, Lambert, & Burts, 2013), leaving questions about what factors influence teachers' perceptions of students, particularly in early childhood mathematics, where there is no available research in this area. Once research is available on the factors that influence teachers' perception of students, it may be possible to train teachers to become more objective assessors by engaging them in professional development (Begeny & Buchanan, 2010; Williford, Downer, Hamre, & Pianta, 2014).

Teacher responsiveness to PD and classroom practices. Teacher responsiveness to PD is defined as the extent to which teachers are engaged in, and satisfied with, a professional development intervention. Teachers' engagement in professional development has been shown to influence teachers' practices in a number of

studies (Zaslow et al., 2010); for instance, in one study, teachers' use of web-mediated professional development resources was associated with their incorporation of higher quality teacher-child interactions into their teaching practices (Pianta, Mashburn, Downer, Hamre, & Justice, 2008). However, despite knowledge of specific PD programs that are effective, the field is still lacking critical information about feasibility, acceptability, and utility of intervention[s], from the perspectives of end-users such as teachers (Hill, Beisiegel, & Jacob, 2013). Changes to the terrain of PD intervention research are thus being called for, with Winton and colleagues specifically recommending that "PD be planned and implemented in ways that effectively and efficiently address and capitalize on the diverse needs and characteristics of the ECE [Early Childhood Education] workforce" (p. 63) (Winton et al., 2016). There is existing evidence suggesting that not all teachers engage, and perceive value, in professional development to the same extent (e.g., Peterson, 2013; Roberts et al., 2014). And, the emergence of online platforms has presented teachers with new affordances and limitations to engaging in PD (e.g., increased flexibility, decreased face-to-face scaffolding). For these reasons, understanding teachers' responsiveness (Hill et al., 2013)—and the teacher characteristics related to responsiveness—have become critical to the evaluation of online professional development (OPD) interventions.

Describing Teacher Characteristics and their Importance

In order to capture the variety of unique aspects of teachers that may act as inputs to their classroom practices (Rimm-Kaufman & Hamre, 2010), I examine a broad make-up of teachers' characteristics. In the following paragraphs, I describe teachers' demographic and professional backgrounds, teachers' psychological attitudes and beliefs,

and teachers' skills and abilities (i.e., their teacher-child interaction quality, and comfort with technology), and demonstrate their importance in the context of teachers' perceptions of students, and responsiveness to professional development.

Demographic and professional backgrounds. Teachers' demographic and professional backgrounds have been examined as inputs to teachers' perceptions of students and responsiveness to PD. In terms of teachers' perceptions of students' abilities, Mashburn and Henry (2004) estimated that as much as 70% of the variability in pre-k teacher ratings of students' school readiness was due to factors unrelated to students' actual abilities; they demonstrated that teachers' highest levels of education and years of experience were among the construct irrelevant factors that were significantly related to teachers' perceptions of students' abilities. Teachers' highest level of education and years of experience have also been tied to teaching quality in some older studies (e.g., Howes, Whitebook, & Phillips, 1992; Phillipsen, Burchinal, Howes, & Cryer, 1997), though more recently some scholars (e.g., Early et al., 2007; Zaslow et al. 2010) have found these factors to be less influential to teaching practices than other factors, like engagement in professional development. In terms of teachers' engagement in PD, other demographic factors, such as teachers' age and experience, have been linked to engagement in online professional development, with older teachers, and those with less experience tending to engage more in online professional development resources and online coursework (Downer et al, 2009; McNamera, 2010).

Psychological attitudes and beliefs. Psychological characteristics of teachers have long been tied to teachers' classroom practices (Buehl & Beck, 2015). For instance, teachers with more self-efficacy (Ciani, Summers, & Easter, 2008; Thoonen, Sleegers,

Peetsma, & Oort, 2011), and less authoritarian beliefs (Driscoll & Pianta, 2010; Pianta et al., 2005), have been found to exhibit higher teaching quality, and more child-centered classroom practices. Teachers' self-efficacy is viewed as a motivational construct that influences or guides the goals teachers set for their students, and their effort toward meeting those goals (Fives & Buehl, 2012). Self-efficacy beliefs may thus be linked to teachers' perceptions of students as they pursue those goals. In addition, teachers' self-efficacy and authoritarian beliefs have been linked to teachers' responsiveness to PD, with more self-efficacious and less authoritarian teachers being more engaged in a school-based intervention (Rohrbach, Grana, Sussman, & Valente, 2006), and being more ready to change when involved in other interventions (Peterson, 2013; Roberts et al., 2014).

Skills and abilities. Teachers' skills such as their quality of teacher-child interactions, and abilities such as their comfort with technology, may also play a role in their responsiveness to OPD. Teachers' quality of teacher-child interactions may be a unique motivator for their responsiveness to PD that is focused on improving teacher-child interactions. In one study in particular, researchers found that teachers' exhibiting initial interactions that were more emotionally and instructionally supportive, in addition to those who had less organized classrooms, were more engaged with the online professional development resources that were provided as part of the intervention (Downer et al., 2009). Teachers' comfort with technology is also a unique ability that may motivate or dissuade teachers from responding positively to OPD. Evidence suggests that teachers' who report more comfort with technology (Arbaugh and Duray,

2002; Sun et al, 2008), and who use it more habitually (Sun, 2014), engage more with online learning, and report more satisfaction with their experience.

Overview of the Three Manuscripts of this Dissertation

In manuscript 1, I examined the extent to which teachers' characteristics influence teachers' perceptions of students' abilities. In manuscripts 2 and 3, I examine teachers' responsiveness to two different types of online professional development: a Massively Open Online Course (manuscript 2), and online curricular supports provided alongside a mathematics and science intervention (manuscript 3). These three studies provide insight into how teachers' characteristics influence their perceptions of students, and responsiveness to professional development. In the following paragraphs, I provide a brief rationale and description of each of the three manuscripts.

Manuscript 1: Teachers' Assessments of Student Abilities

Students' early mathematical skills are foundational for later skill development and are among the best predictors of later school success (Bowman, Donovan, & Burns, 2001; Duncan et al., 2007). Almost all states have recognized the importance of early mathematics by including it in their early learning standards, and 22 of those states also require school readiness assessments--in mathematics as well as other domains—for all students entering kindergarten (National Center for Education Statistics [NCES], 2013). With increases in preschool enrollment (NCES, 2013), it has become challenging for schools to meet assessment requirements (Le Floch et al., 2007). Assessments in preschool can either be direct (e.g., tests administered individually to the student), or indirect (e.g., teacher ratings of students' skills), with teacher ratings being used more commonly in recent years (Kim et al., 2013; Mashburn & Henry, 2004). However, there

is research suggesting that the correlation between teacher ratings and direct assessments in preschool mathematics is modest (.50). Additionally, there is evidence that as much as 70% of the variance in preschool teacher ratings may be unrelated to students' actual abilities (Kilday, Kinzie, Mashburn, & Whittaker, 2012; Mashburn & Henry, 2004). In the domain of mathematics, preschool teachers report low confidence in their abilities to teach the subject (Hart, 2002; Yesil-Dagli, Lake, & Jones, 2010), and may be especially prone to error in their assessments of student abilities. In this study, I examined the alignment between pre-k teachers' ratings and direct assessments, both of students' mathematical skills at the end of the school year, and how the characteristics of teachers, as well as of their students, are related to the measurement error in teachers' ratings.

Manuscript 2: Teachers' Engagement and Learning in Online Professional Development

The goal of expanding access to high quality early childhood education in the United States is widely supported by both private and public sectors, with increased funding from federal, state, and local governments (NAYEC, 2014). This increase in access must also be matched by increased efforts to prepare the early childhood workforce to provide high quality experiences for these children (Hamre, Hatfield, Pianta, & Jamil, 2014). One avenue for improving teaching quality in early childhood, is providing intentionally designed coursework to improve teachers' classroom interactions (Dickinson & Caswell, 2007; Hamre, Pianta, et al., 2012). Effective course designs for teachers have offered specific lecture-based instruction in evidence-based practice, as well as the extensive use of video examples to help teachers see these practices in action (Zaslow et al., 2010). Unfortunately, it is challenging to deliver this type of rigorous

educational experience to teachers (Hemmeter, Santos, & Ostrosky, 2008; Scott-Little et al., 2011). Additionally, it is hard for many early childhood teachers to attend traditional courses due to competing work/family responsibilities, and geographic limitations (Early & Winton, 2001). One potential way to provide teachers with access to this type of educational experience, is online coursework; in particular, Massively Open Online Courses (MOOCs) have the potential to reach thousands of teachers with a single instructor, and are flexible enough to allow for teachers to engage in them without having to take time out of the classroom. In addition, once created, MOOCs can be offered multiple times, to different teachers, with little to no cost of material reproduction. However, MOOCs are known to have low completion rates (Perna et al., 2014), and there is no available data on the degree to which early childhood teachers will actually engage in this type of learning experience. This study reports on learners' usage of one of the first MOOCs designed for early childhood teachers. We examine characteristics of learners, describe their engagement and performance in the course, examine the extent to which characteristics of learners were predictive of their engagement in the course components, and test the ways in which their engagement was related to their performance on assessments within the course.

Manuscript 3: Teachers' Perceptions and Use of Online Curricular Supports

Professional development (PD) in early childhood education is receiving national attention as a key strategy for strengthening the quality of teachers' classroom practices, and ultimately, students' achievement (NAYEC, 2014). However, teachers report challenges to participating in professional development due to time and geographic constraints, and PD providers struggle to provide high quality PD experiences at large

scales and affordable costs (Early & Winton, 2001). Online professional development (OPD) is one potential solution, as it can offer flexibility and convenience for teachers, as well as scalability and affordability for PD providers (Gill, 2011; Norris, 2010). However, despite nation-wide efforts to develop scalable and affordable professional development (NAYEC, 2014), there has been little research conducted in the area of online professional development (OPD).

Characteristics of teachers, and their use and perceptions of PD programs may explain some of the variability in efficacy of PD (Rimm-Kaufman & Hamre, 2010). Thus, gathering information about feasibility, acceptability, and utility of PD from the perspective of teachers, has been deemed necessary for creating a knowledge base that can guide researchers and practitioners in the best practices for understanding how to support teachers' engagement in PD (Hill et al., 2013). Concerning the utility OPD in particular, gathering the perspectives of teachers is especially relevant because OPD can often require teachers' voluntary, and independent engagement (Smith & Sivo, 2012). These qualities of OPD, suggest that teachers' characteristics may be instrumental to teachers' motivation, and ability to use OPD.

In this study, we examine pre-kindergarten (pre-k) teachers' use and perceptions of one type of OPD: online curricular supports that were provided to teachers in conjunction with an intervention in early childhood mathematics and science education. We provide descriptive information on teachers' use of the supports across the school year, and explore associations among the teacher characteristics and teachers' use and perceptions of the supports. We then examine how teacher characteristics (i.e., demographic characteristics, readiness for professional development, teacher-child

interaction quality, and technology comfort and habits) may predict teachers' use and perceptions of the online curricular supports.

Conclusion: The Three Study Design

Understanding how teachers' unique characteristics influence their responsiveness to professional development and their perceptions of students' abilities can provide useful entry points for intervention with teachers, and can provide information on how to maximize the effectiveness of those interventions (Buysse, Pianta, Barnett, Justice, & Sheridan, 2012; Hamre, Pianta, et al., 2012; Hamre, Downer, et al., 2012). For instance, if PD providers have an understanding of which teachers will likely be responsive to an online PD program, they can find ways to motivate and support those who are likely to be less responsive. Administrators who are choosing from a selection of PD programs, may be able to make informed decisions about the types of programs (e.g., a structured online course, or an open selection of online resources) that their teachers will likely use and perceive value in. Finally, instructional designers can be made aware of the teacher characteristics associated with different perceptions of student abilities, and responsiveness to PD programs, and can begin to build learning experiences that are seen as more valuable to teachers who are less motivated, and supports that will encourage greater engagement from those who struggle.

With the three papers in this dissertation, I examine teachers' characteristics (i.e., demographics, beliefs, and skills) as inputs into teachers' perceptions of students and responsiveness to PD. Together, these three studies contribute to a larger understanding of the unique and dynamic organization of motives within early childhood teachers. In particular, I interpret the findings of these three studies to inform the instructional design

of coursework, curricula, and professional development interventions for early childhood teachers.

References

Begeny, J. C., & Buchanan, H. (2010). Teachers' judgments of students' early literacy skills measured by the Early Literacy Skills Assessment: Comparisons of teachers with and without assessment administration experience. *Psychology in the Schools, 47*(8), 859–868. http://doi.org/10.1002/pits.20509

Brophy, J. E. (1983). Research on the self-fulfilling prophecy and teacher expectations. *Journal of Educational Psychology, 75*(5), 631.

Brophy, J. E., & Good, T. L. (1970). Teachers' communication of differential expectations for children's classroom performance: Some behavioral data. *Journal of Educational Psychology, 61*(5), 365.

Buehl, M. M., & Beck, J. S. (2015). The relationship between teachers' beliefs and teachers' practices. In *International Handbook of Research on Teachers' Beliefs* (pp. 66–84). New York, NY: Routledge.

Burchinal, M., Howes, C., Pianta, R., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (2008). Predicting Child Outcomes at the End of Kindergarten from the Quality of Pre-Kindergarten Teacher–Child Interactions and Instruction. *Applied Developmental Science, 12*(3), 140–153. http://doi.org/10.1080/10888690802199418

Buysse, V., Pianta, R., Barnett, W., Justice, L., & Sheridan, S. (2012). Access, participation, and supports: A framework for improving inclusive early education opportunities for children with disabilities. *Handbook of Early Childhood Education*, 480–506.

Clark, C. M., & Peterson, P. L. (1984). *Teachers' thought processes*. Institute for Research on Teaching, Michigan State University.

Curby, T. W., Rimm-Kaufman, S. E., & Cameron, C. (2009). Teacher–child interactions and children's achievement trajectories across kindergarten and first grade. *Journal of Educational Psychology*, *101*(4), 912.

Dickinson, D. K., & Caswell, L. (2007). Building support for language and early literacy in preschool classrooms through in-service professional development: Effects of the Literacy Environment Enrichment Program (LEEP). *Early Childhood Research Quarterly*, *22*(2), 243–260. http://doi.org/10.1016/j.ecresq.2007.03.001

Downer, J. T., Locasale-Crouch, J., Hamre, B., & Pianta, R. (2009). Teacher Characteristics Associated With Responsiveness and Exposure to Consultation and Online Professional Development Resources. *Early Education & Development*, *20*(3), 431–455. http://doi.org/10.1080/10409280802688626

Driscoll, K. C., & Pianta, R. C. (2010). Banking Time in Head Start: Early Efficacy of an Intervention Designed to Promote Supportive Teacher–Child Relationships. *Early Education and Development, 21*(1), 38–64. http://doi.org/10.1080/10409280802657449

Early, D. M., Maxwell, K. L., Burchinal, M., Alva, S., Bender, R. H., Bryant, D., … Griffin, J. A. (2007). Teachers' education, classroom quality, and young children's academic skills: Results from seven studies of preschool programs. *Child Development*, *78*(2), 558–580.

Early, D. M., & Winton, P. J. (2001). Preparing the workforce: early childhood teacher preparation at 2- and 4-year institutions of higher education. *Early Childhood*

Research Quarterly, 16(3), 285–306. http://doi.org/10.1016/S0885-2006(01)00106-5

Fives, H., & Buehl, M. M. (2012). Spring cleaning for the "messy" construct of teachers' beliefs: What are they? Which have been examined? What can they tell us? In K. R. Harris, S. Graham, T. Urdan, S. Graham, J. M. Royer, & M. Zeidner (Eds.), *APA educational psychology handbook, Vol 2: Individual differences and cultural and contextual factors.* (pp. 471–499). Washington: American Psychological Association. Retrieved from http://content.apa.org/books/13274-019

Getzels, J. W., & Jackson, P. W. (1963). The teacher's personality and characteristics. In *Handbook of research on teaching* (pp. 506–582).

Gill, W. E. (2011). *The Ready to Teach Program: A Federal Initiative in Support of Online Courses for Teachers*. Retrieved from http://eric.ed.gov/?id=ED530966

Hamre, B. K., Downer, J. T., Jamil, F., & Pianta, R. C. (2012). Enhancing teachers' intentional use of effective interactions with children: Designing and testing professional development interventions. *Handbook of Early Education*, 507–532.

Hamre, B. K., Hatfield, B., Pianta, R., & Jamil, F. (2014). Evidence for General and Domain-Specific Elements of Teacher–Child Interactions: Associations With Preschool Children's Development. *Child Development, 85*(3), 1257–1274. http://doi.org/10.1111/cdev.12184

Hamre, B. K., Pianta, R. C., Burchinal, M., Field, S., LoCasale-Crouch, J., Downer, J. T., … Scott-Little, C. (2012). A Course on Effective Teacher-Child Interactions: Effects on Teacher Beliefs, Knowledge, and Observed Practice. *American*

Educational Research Journal, *49*(1), 88–123. http://doi.org/10.3102/0002831211434596

Hart, L. C. (2002). Preservice Teachers' Beliefs and Practice After Participating in an Integrated Content/Methods Course. *School Science and Mathematics*, *102*(1), 4–14. http://doi.org/10.1111/j.1949-8594.2002.tb18191.x

Hemmeter, M. L., Santos, R. M., & Ostrosky, M. M. (2008). Preparing Early Childhood Educators to Address Young Children's Social-Emotional Development and Challenging Behavior: A Survey of Higher Education Programs in Nine States. *Journal of Early Intervention*. http://doi.org/10.1177/1053815108320900

Hill, H. C., Beisiegel, M., & Jacob, R. (2013). Professional Development Research Consensus, Crossroads, and Challenges. *Educational Researcher*, *42*(9), 476–487. http://doi.org/10.3102/0013189X13512674

Hinnant, J. B., O'Brien, M., & Ghazarian, S. R. (2009). The longitudinal relations of teacher expectations to achievement in the early school years. *Journal of Educational Psychology*, *101*(3), 662–670. http://doi.org/10.1037/a0014306

Irwin, M., & Supplee, L. H. (2012). Directions in Implementation Research Methods for Behavioral and Social Science. *The Journal of Behavioral Health Services & Research*, *39*(4), 339–342. http://doi.org/10.1007/s11414-012-9293-z

Jamil, F. M. (2013). *Understanding Teacher Effectiveness: Theory and Measurement of Teacher Skills, Knowledge, and Beliefs* (Ph.D.). University of Virginia, United States -- Virginia. Retrieved from http://search.proquest.com.proxy.its.virginia.edu/pqdtglobal/docview/1445390422/B00C5C318BDF4004PQ/1?accountid=14678

Kilday, C. R., Kinzie, M. B., Mashburn, A. J., & Whittaker, J. V. (2012). Accuracy of Teacher Judgments of Preschoolers' Math Skills. *Journal of Psychoeducational Assessment*, *30*(2), 148–159. http://doi.org/10.1177/0734282911412722

Kim, D.-H., Lambert, R. G., & Burts, D. C. (2013). Evidence of the Validity of *Teaching Strategies GOLD*® Assessment Tool for English Language Learners and Children with Disabilities. *Early Education & Development*, *24*(4), 574–595. http://doi.org/10.1080/10409289.2012.701500

Mashburn, A. J., & Henry, G. T. (2004). Assessing school readiness: Validity and bias in preschool and kindergarten teachers' ratings. *Educational Measurement: Issues and Practice*, *23*(4), 16–30.

Norris, D. J. (2010). Raising the Educational Requirements for Teachers in Infant Toddler Classrooms: Implications for Institutions of Higher Education. *Journal of Early Childhood Teacher Education*, *31*(2), 146–158. http://doi.org/10.1080/10901021003781221

Pajares, M. F. (1992). Teachers' Beliefs and Educational Research: Cleaning up a Messy Construct. *Review of Educational Research*, *62*(3), 307–332. http://doi.org/10.2307/1170741

Perna, L. W., Ruby, A., Boruch, R. F., Wang, N., Scull, J., Ahmad, S., & Evans, C. (2014). Moving Through MOOCs Understanding the Progression of Users in Massive Open Online Courses. *Educational Researcher*, 0013189X14562423. http://doi.org/10.3102/0013189X14562423

Peterson, S. (2013). Readiness to change: Effective implementation processes for meeting people where they are. In T. Halle, A. Metz, & I. Martinez-Beck (Eds.),

Applying implementation science to early care and education programs and systems: Exploring a new frontier. Baltimore, MD: Brookes (pp. 43–64). Baltimore, MD, US: Paul H Brookes Publishing Co.

Pianta, R., Howes, C., Burchinal, M., Bryant, D., Clifford, R., Early, D., & Barbarin, O. (2005). Features of Pre-Kindergarten Programs, Classrooms, and Teachers: Do They Predict Observed Classroom Quality and Child-Teacher Interactions? *Applied Developmental Science*, *9*(3), 144–159. http://doi.org/10.1207/s1532480xads0903_2

Pohan, C. A. (1996). Preservice Teachers' Beliefs About Diversity: Uncovering Factors Leading to Multicultural Responsiveness. *Equity & Excellence in Education*, *29*(3), 62–69. http://doi.org/10.1080/1066568960290310

Rimm-Kaufman, S. E., & Hamre, B. K. (2010). The role of psychological and developmental science in efforts to improve teacher quality. *Teachers College Record*, *112*(12), 2988–3023.

Roberts, A. M., LoCasale-Crouch, J., DeCoster, J., Hamre, B. K., Downer, J. T., Williford, A. P., & Pianta, R. C. (2014). Individual and Contextual Factors Associated with Pre-Kindergarten Teachers' Responsiveness to the MyTeachingPartner Coaching Intervention. *Prevention Science*. http://doi.org/10.1007/s11121-014-0533-8

Rohrbach, L. A., Grana, R., Sussman, S., & Valente, T. W. (2006). Type II Translation Transporting Prevention Interventions From Research to Real-World Settings. *Evaluation & the Health Professions*, *29*(3), 302–333. http://doi.org/10.1177/0163278706290408

Ryans, D. G. (1960). *Characteristics of teachers: Their description, comparison, and appraisal* (Vol. xxiii). American Council on Education: American Council on Education.

Scott-Little, C., Paro, K. M. L., Thomason, A. C., Pianta, R. C., Hamre, B., Downer, J., … Howes, C. (2011). Implementation of a Course Focused on Language and Literacy Within Teacher–Child Interactions: Instructor and Student Perspectives Across Three Institutions of Higher Education. *Journal of Early Childhood Teacher Education*, *32*(3), 200–224. http://doi.org/10.1080/10901027.2011.594489

Smith, J. A. Jo.Smith@ucf.edu, & Sivo, S. A. . (2012). Predicting continued use of online teacher professional development and the influence of social presence and sociability. *British Journal of Educational Technology*, *43*(6), 871–882. http://doi.org/10.1111/j.1467-8535.2011.01223.x

Sun, S. Y. H. (2014). Learner perspectives on fully online language learning. *Distance Education*, *35*(1), 18–42. http://doi.org/10.1080/01587919.2014.891428

Williford, A. P., Downer, J. T., Hamre, B. K., & Pianta, R. C. (2014). The Virginia Kindergarten Readiness Project--Phase 2 Legislative Report. Research report prepared for Elevate Early Education (E3).

Winton, P. J., Snyder, P., & Goffin, S. G. (2016). Beyond the Status Quo: Rethinking Professional Development for Early Childhood Teachers. In L. J. Couse & S. L. Recchia (Eds.), *Handbook of Early Childhood Teacher Education* (pp. 54–68). Taylor & Francis.

Yesil-Dagli, U., Lake, V., & Jones, I. (2010). Preservice teachers‟ perceptions towards mathematics and science. *Journal of Research in Education, 20*(2), 32–48.

Zaslow, M., Tout, K., Halle, T., Whittaker, J. V., & Lavelle, B. (2010). Toward the Identification of Features of Effective Professional Development for Early Childhood Educators. Literature Review. *Office of Planning, Evaluation and Policy Development, US Department of Education*. Retrieved from http://eric.ed.gov/?id=ED527140

Running Head: FACTORS ASSOCIATED WITH ACCURACY IN TEACHER RATINGS

Factors Associated with Accuracy in Pre-Kindergarten Teacher Ratings of Students' Mathematics Skills

Emily C. Furnari, B.S.
Jessica Whittaker, Ph. D.
Mable Kinzie, Ph. D.
Jamie DeCoster, Ph.D.

University of Virginia

ABSTRACT

The No Child Left Behind Act requires that 95% of students in all public elementary and secondary schools are assessed in mathematics (Le Floch et al., 2007). Unfortunately, direct assessments of young students can be timely, costly, and challenging to administer. Therefore, policy makers have looked to indirect forms of assessment, such as teachers' ratings of student skills, as a substitute (Cabell, Justice, Zucker, & Kilday, 2009). However, pre-kindergarten teachers' ratings of students' mathematical knowledge and skills are only correlated with direct assessments at the .50 level (Kilday et al., 2012). Little is known about factors that influence accuracy in teacher ratings. In this study, we examine the influence of student and teacher characteristics on pre-kindergarten teachers' ratings of students' mathematical skills, controlling for direct assessment of these skills. Results indicate that students' race/ethnicity and social competency, as well as teachers' self-efficacy, are significantly related to pre-kindergarten teachers' ratings of students' mathematical skills.

Keywords: Teachers; Pre-Kindergarten; Validity; Mathematics

Students' early mathematical skills are foundational for later skill development and are among the best predictors of later school success (Bowman, Donovan, & Burns, 2001; Duncan et al., 2007). According to recent reports of national education progress, all states, with the exception of New Hampshire, have recognized the importance of early mathematics by including it in their early learning standards, with 22 of those states requiring school readiness assessments for all students entering kindergarten (NCES, 2013). These assessments can be direct (e.g., tests administered to the student), or indirect (e.g., teacher ratings of students' skills). With increases in preschool student enrollment in recent years (NCES, 2013) and the No Child Left Behind Act requiring the assessment of 95% of all students in public schools (Le Floch et al., 2007), it is becoming more common to use teacher ratings as a means of assessment of young students' knowledge, skills, and overall school readiness (Kim, Lambert, & Burts, 2013).

Research examining the concordance between teacher ratings and direct assessments of students' knowledge and skills, suggests that the correlations are modest (.50 to .63), and 70% of the variance in preschool teacher ratings may be unrelated to students' actual abilities (Kilday, Kinzie, Mashburn, & Whittaker, 2012; Mashburn & Henry, 2004; Südkamp, Kaiser, & Möller, 2012). These findings raise questions about the factors that may influence variability in teachers' ratings. While there is some research on this issue in elementary mathematics, and other research focusing on this issue in preschool literacy, there is still a gap in our understanding of factors that influence variability in teacher ratings in the domain of preschool mathematics. In this study, we examine the alignment between prekindergarten (pre-k) teachers' ratings and direct assessments of students' mathematical skills, and the construct-irrelevant variation,

or bias, in teachers' ratings, including student demographic characteristics, social-emotional competence, and teacher education, experience, and self-efficacy.

Assessment Approaches

Students' academic skills and abilities can be measured with direct or indirect assessments. In pre-k mathematics, direct assessments involve the student performing hands-on tasks and responding to questions to demonstrate knowledge and skills. For instance, to assess skills and knowledge related to the subdomain of number sense, students are asked to recognize and name numerals, and count and compare groups of objects (e.g., when given two sets of blocks, students are asked, "How many are there?" and "Which group has more?"). Since direct assessments are performed outside of the classroom, often by an objective assessor, and they involve a concrete set of tasks or questions with pre-defined criteria, there is less risk of measurement error attributable to the assessor or the classroom context (Braun, 1976). However, direct assessments can be costly to implement with young students, are sometimes lengthy, and require a trained assessor to administer (La Paro & Pianta, 2000). There is also risk of child-related measurement error, as some students can become fatigued, distracted, or uncomfortable with strangers (Vacc & Ritter, 1995).

In contrast, indirect assessments involve teachers rating students' proficiencies (typically on a likert-style scale from emerging-to-mastered) based on their observations of behavioral markers and indicators of student knowledge and skills. Indirect assessments require as little as five minutes per student, typically have low associated costs, and allow the students' performance on many occasions across time to be considered. However, teachers' ratings are prone to systematic errors, such as routinely

scoring some students more leniently than others, overusing of the central or average rating category, or failing to discriminate students' performance on distinct skills (Ferguson, 2003; Martínez, Stecher, & Borko, 2009; Martin & Shapiro, 2011; Ready & Wright, 2011).

The average correlation between teacher ratings and directly-assessed mathematical skills across grades 1-4 has been found to be .58 (Xiang & Schweinhart, 2002), which is slightly lower than the average correlation for K-12 general academic direct and indirect assessments (.63) (Südkamp et al., 2012). Specifically in pre-k math, and using the same set of teacher and student participants as in the current study, Kilday and colleagues found only a .50 correlation between teacher ratings and directly-assessed mathematical skills at the beginning of the school year, suggesting that other factors may be responsible for some of the variability in ratings (Kilday et al., 2012).

Variability in Teacher Ratings

In measuring students' skills and abilities there exists a true score and measurement error (Spearman, 1904). Despite the potential shortcoming of direct assessments, scholars who have examined validity and variance in teacher ratings have typically used direct assessments as the true score to which teacher ratings are compared (e.g., Ferguson, 2003; Mashburn & Henry, 2004; Ready & Wright, 2011; Südkamp et al., 2012). Teacher ratings that are not significantly different from directly-assessed scores are considered valid or accurate, while teacher ratings significantly above or below those directly-assessed scores represent measurement error (Ferguson, 2003). Measurement error can either be random or it can be systematic, following patterns based on the

characteristics of students, teachers, or classrooms. Systematic error represents trends in teacher beliefs that are expressed in their ratings of students' skills.

Concerning ratings of students' general kindergarten readiness, approximately 70% of the variance in pre-k teacher ratings –and 50% in kindergarten teacher ratings-- is determined by construct-irrelevant factors, such as student and teacher characteristics (Mashburn & Henry, 2004). It may be that students' characteristics influence teachers' ratings, independent of students' directly-assessed abilities. For instance, in two different studies, pre-k and kindergarten teachers rated literacy skills and school readiness of girls higher than boys, and older students higher than younger students; teachers also rated literacy skills higher for students from higher socioeconomic backgrounds. Compared with white students, teachers gave lower ratings to African American, Hispanic, and Asian students. Teachers also rated English Language Learners (ELLs) lower than their non-ELL peers (Mashburn & Henry, 2004; Ready & Wright, 2011).

There is some evidence that teachers also use students' social skills as a factor in rating their academic competencies. In studies with elementary aged students, teachers rated reading and mathematical skills higher for students they perceived to have higher social competence (Hinnant et al., 2009). We found no studies examining whether students' social emotional competence influences early childhood teachers' ratings of academic skills, but there is some evidence that the quality of teachers' perceived relationships with pre-k students (e.g., conflict, closeness) is associated with students' academic skills (Sabol & Pianta, 2012).

There is also evidence suggesting that teacher characteristics may influence their ratings of students (Kilday et al., 2012). Teachers with lower levels of education

(Mashburn & Henry, 2004) and teachers with less than three years of experience (Ready & Wright, 2011) have been found to give higher ratings of students' general academic and literacy skills. Teacher self-efficacy (i.e., teachers' judgments of their abilities to bring about desired outcomes of student engagement, and learning; Bandura, 1977) is another characteristic of teachers that has been linked to teachers' levels of education and experience. It has not yet been studied in association with accuracy in teachers' ratings, but has been positively linked to direct assessments of students' academic skills, such that students of teachers with higher self-efficacy perform better on direct assessments of academic skills (Anderson, Greene, & Loewen, 1988; Ashton & Webb, 1986; Ross, 1992); thus, it may also be associated with teachers' ratings of students' mathematical skills.

Present Study

The data for this study come from a field trial of *MyTeachingPartner-Math/Science*, which examined the impacts of pre-k mathematics curriculum and science curriculum and associated professional development on the quality of teacher-child interactions (Kinzie et al., in press) and children's mathematics and science knowledge and skills (Whitaker, Kinzie, Kraft-Sayre, Mashburn, & Pianta, 2007). In a previous study, using data from the larger intervention, we examined associations in the beginning of the school year between teacher ratings and direct assessments, and found a .50 correlation between teacher ratings of pre-k students' mathematical skills and direct assessments of those skills (Kilday et al., 2012). In this follow-up study, we examine the association between teacher ratings and direct assessments of pre-k students' mathematical skills at the end of the school year, and the student and teacher factors that

may contribute to construct-irrelevant variance in teachers' ratings of students' mathematical skills. Specifically, we explore the following research questions:

1. What is the association between direct assessments and teacher ratings of pre-k students' mathematical skills at the end of the school year?
2. To what extent are pre-k students' demographic characteristics, teachers' perceptions of students' social-emotional competence, and teachers' education, experience, and self-efficacy related to construct-irrelevant variance in teacher ratings of students' mathematical skills at the end of the school year?

Based on previous findings of the concordance between teacher ratings and direct assessments, we hypothesize that teacher ratings will be moderately related to direct assessments of students' mathematical skills. Regarding research question two, we hypothesize that students' sex and age, will be associated with construct-irrelevant variance in teacher ratings such that, controlling for direct assessments, we expect that teachers' ratings will be higher for girls as compared with boys, and older students as compared with younger students. We also hypothesize that students' socioeconomic status and race will be associated with construct irrelevant variance in teacher ratings such that, controlling for direct assessments, teacher ratings will be lower for students from low-income families and those of minority racial/ethnic status as compared with white students. We also hypothesize that, controlling for direct assessments, teachers with lower levels of education or less experience will rate students more highly than teachers with higher levels of education and more experience. Because teacher self-

efficacy has not been studied as it related to accuracy in teacher ratings, we do not have a hypothesis about the directionality of the association between self-efficacy and ratings.

Method

Participants

The sample for the current study includes 42 classrooms from a single school district near a small mid-Atlantic city. The sample included 435 students (51% female) who were all eligible for kindergarten in the subsequent academic year, with ages ranging from 2.92 to 5.71 (*M*=4.60, *SD*=0.32) years at the start of the study. The majority of students (66%) were African American, with 25% being Caucasian, and 8% from other racial/ethnic backgrounds (3.6% Hispanic, 1.4% Asian, .5% Native American, and 2.5% another race). The standardized income to needs ratio for each student's family ranged from 0.05 to 4.99 (*M*=1.34, *SD*=.98). Students' demographic characteristics, mean performance on direct mathematics assessments and mean teacher ratings of mathematical skills are presented in Table 1.

Participating teachers were predominantly female (97.60%); over half were Caucasian (53.80%), 43.60% were African American, and 2.60% were of another race/ethnicity. Their ages ranged from 24 to 65 years of age *(M*= 45.36 years, *SD*= 10.47*)*. The majority of teachers had a Master's degree (43.5%), with 41.9% having a bachelor's degree, and 14.6% having a bachelor's plus at least one additional year of coursework. Teachers reported having between 1 and 32 years of experience in teaching pre-k (*M*=7.27, *SD*=6.30). Descriptive information about teachers is presented in Table 1.

There was some teacher attrition throughout the course of the study. A total of 7 teachers dropped out of the study: four were pulled to participate in another study, one teacher left because of personal circumstances, and two because of workload; the total attrition rate was 17%. To estimate attrition bias, we compared the 35 classrooms who fully participated, to the 7 classrooms who left, and found no significant differences (all p's > .05) in mean family income-to-need ratio, teacher education, and teacher years of experience. Attrition of students also occurred. A total of 69 students could not be assessed in the spring due to teacher withdrawal from the study or student withdrawal from the preschool. To compensate for student attrition, we randomly selected an additional 28 students for spring assessment from the original pool of consented students. Students who had fall data of any kind were included in the study. We conducted comparative analyses to determine whether there were significant differences between students who had both fall and spring data (n =317) and students who had only fall or only spring data (n =127) with regard to race/ethnicity, age, sex, or family income-to-need ratio. We found that there was a significant difference in the number of African American students in the full sample and the sample with fall or spring only data, such that there was a higher proportion of African American students in the sample with fall or spring data only.

Procedures

At the start of the study, classrooms were randomly assigned to one of three groups: *MTP-M/S* curricula plus professional development supports (Plus), *MTP-M/S* curricula only (Basic), or a Control (Business-As-Usual) condition; we include all classrooms and use intervention group as a covariate in our analyses. At the beginning of

the school year, teachers completed a survey describing their demographic and professional backgrounds as well as their self-efficacy. Teachers also sent home a consent form and short family demographic survey to all student families. A total of 94% of parents or guardians consented to allow their students to participate in the direct assessment and teacher rating component of the study. From these 529 consented students, an average of 10 students per classroom were randomly selected for participation in both fall and spring assessments. Data collectors were reliably trained over two full days (see Kinzie et al., 2014, for training procedures), then visited classrooms and performed direct assessments. Additionally, teachers were asked to complete rating scales on students' mathematics and science knowledge and skills. Students who were reported by teachers as having Individualized Education Plans (6% of students) or limited English proficiency (3% of students) were excluded because there were no valid and reliable mathematics and science assessments for these populations at the time of assessment.

Data for this study were collected at two time points: fall and spring. Demographic information on students and teachers were collected only in the fall, while teacher self-efficacy, ratings of students, and direct assessments of students' mathematical skills were collected in both fall and spring. This study employs spring data on all measures, with exception of demographic information, which is based on fall data. We chose to analyze spring data, as opposed to fall data, in order to examine the concordance between ratings and direct assessments after teachers have had multiple opportunities --throughout the school year-- to observe students' skills and abilities.

Measures

Student and teacher backgrounds. Parents or caregivers completed a survey in the fall, providing information about their child's background including age, sex, race/ethnicity, and socioeconomic status (SES). As part of a fall survey, teachers reported their professional experience including their level of education (less than a bachelor's degree to graduate degree) and their years of experience in working professionally with pre-k children.

Direct assessments of students' mathematical skills

Number Sense & Operations. We used the *Test of Early Mathematical Ability-3rd Edition* (TEMA-3; Ginsburg & Baroody, 2003) to directly assess students' number sense and operations knowledge and skills. This standardized, norm-referenced measure is designed for use with students between 3 and 8 years of age, and uses pictures and counting chips to assess skills in counting, ordinality, cardinality, one-to-one correspondence, numeral recognition, and abilities in numerical operations. Ginsburg & Baroody (2003) report that the measure has high internal reliability with alphas exceeding .90 for all sub groups (i.e., different age, sex, ethnicity, and achievement-level groupings). *TEMA* developers have established concurrent validity with both the *KeyMath R Basic Concepts* subtest (r=.54) and the *Young Children's Achievement Test Math Quotient* (r=.91). We found excellent internal reliability in students' *TEMA-3* performance (.91 in the fall and .93 in the spring).

Geometry & Measurement. To assess students' knowledge of shapes, patterns, measurement, and positional words, we use the *Geometry and Measurement Assessment* (*GMA*), which is a derivative of the *Tools for Early Assessment of Mathematics* (*TEAM*;

Clements, Sarama, & Wolfe, 2011). The GMA includes six original *TEAM* items, seven extension questions, and seventeen new items. All of the extensions and new items were developed to address additional related curricular objectives not assessed in the *TEAM* and mirrored the format and style of the original *TEAM* items; for example, to extend a question requiring students to make a triangle and rectangle using coffee stirrers, a related question was added for making a square. The *TEAM* developers established construct validity (Clements, Sarama, & Liu, 2008) and we found an internal reliability of .82 in the fall and .86 in the spring.

In order to later compare students' direct assessment scores to teachers' ratings of their overall mathematical skills, we created a composite from the two direct assessments (*TEMA-3* and *GMA*). A correlational analysis showed they were moderately correlated and could be composited ($r=.66$). Giving each measure equal weight, we standardized students' scores on both measures and averaged the two, representing the overall direct assessment mathematics score for each student; the mean is 0 ($SD=1$) with a range of -2.57 to 2.53.

Teacher ratings of students' mathematical skills. The *Academic Rating Scale-Mathematics* (*ARS-M*) was developed by the Early Childhood Longitudinal Study-Kindergarten Cohort (2011). We added 5 items to the original seven items in order to address additional mathematical competencies covered in the *MTP-M/S* curricula and our direct assessments (Kinzie et al., 2014). For each item, the teacher rates the degree to which the student has exhibited a particular skill, on a scale of 1 to 5 (1- not yet, 2-beginning, 3- in progress, 4- intermediate, and 5- proficient in the skill). Teachers were also given the option to mark any skill as "Non-Applicable." Items reflected students'

knowledge and skills in the areas of number sense, operations, geometry, and measurement. We found excellent internal consistency, with a Cronbach's alpha of .97. We computed a mean ARS-M score for each student based on their teacher's spring ratings. The average teacher rating of students' mathematical skills in the spring was 'intermediate,' at 4.14 (SD=.78) with a range of 1.58 to 5.00 (see Table 1 for descriptive information on teacher ratings).

Students' Social-Emotional Competence. The *Teacher-Child Rating Scale* (*TCRS*; Hightower et al., 1986) is a 38-item teacher-report measure with subscales for problem behaviors, and social competence. The problem behaviors subscale measures students' acting-out, levels of shyness/anxiousness, and learning problems; it requires the teacher to rate the degree to which each item is a problem for the student (1= not a problem, 5=very serious problem). The social competence subscale measures students' reactions to limits/frustration tolerance, assertive social skills, and task orientation; teachers respond to each item by rating how well it describes the student (1= not at all, 5= very well). Excellent psychometric properties have been indicated for this measures when used with preschoolers (internal consistency and test-retest reliabilities range from .85 to .95; Hightower et al., 1986); concurrent validity has been established between the *TCRS* and other behavioral checklists (e.g., Trickett, McBride-Chang, & Putnam, 1994), and we found high internal consistency for the problem behaviors and social competence subscales (α's = .90 and .94, respectively).

Teachers' Self Efficacy. The *Teachers' Sense of Efficacy Scale- Short Form* (Tschannen-Moran & Woolfolk Hoy, 2001) is a 12 item likert-style questionnaire in which teachers report their perceived levels of effectiveness on student engagement,

instructional strategies, and classroom management. Internal reliability of this scale has been reported to be high, with alphas ranging from .81 to .86 on the subscales and .90 overall (Tschannen-Moran & Woolfolk Hoy, 2001); our analyses also showed high internal reliability in our sample (α = .90). Construct validity has also been confirmed with .16 and .64 correlations to subscales of the *Teacher Efficacy Scale* (Hoy & Woolfolk, 1993).

Analyses

The overall goal of our analysis was to examine (1) the association between teacher ratings of mathematical skills and students' directly-assessed mathematics abilities, and (2) which factors influence teachers' ratings of the students' mathematical skills, after controlling for the variation explained by students' directly-assessed mathematics abilities. We used ordinary least squares regression to predict teacher ratings of student mathematical skills first from the direct assessment of students' skills. The resulting coefficient represents the concordance between direct assessments and teacher ratings of students' mathematical skills.

Next, we added student demographic characteristics (sex, age, race/ethnicity, and SES), students' social-emotional competence (social competence and problem behaviors), and teacher education, experience, and self-efficacy, while controlling for students' directly-assessed mathematical skills. The resulting coefficients represent the degree to which each factor is associated with systematic differences in teacher ratings, after accounting for the variance explained by students' directly-assessed abilities. We use a cluster design to account for the nesting of students within classrooms. Analyses were run using full information maximum likelihood estimation so that data analyses

used all available data when estimating parameters, increasing the precision and accuracy of the estimated parameters (Enders & Bandalos, 2001). We include the intervention condition as a covariate, using two dummy coded variables representing each of the intervention groups with the control group as the reference category.

Results

When examining the relationship between direct assessments and ratings alone, the concordance is 0.50 (SE=0.06, p<.001). We observed that 25% of the variability in teacher ratings could be attributed to students' directly-assessed abilities, indicating that a substantial amount of variance remained to be potentially explained by student and/or teacher characteristics. After adding the other variables in our regression model, we observed that the predictive equation could explain 55% of the variability in teacher ratings. This 30% difference suggests that a larger proportion of the variability in teacher ratings is associated with construct-irrelevant factors than is associated with the direct assessment of student skill. The coefficients from the estimated model are presented in Table 2.

After controlling for students' directly-assessed skills, the results indicate that students' race/ethnicity and social competence, as well as teacher self-efficacy were significantly related to pre-k teacher ratings of students' mathematical skills, independent of students' directly-assessed abilities. Specifically, students in the 'other' race/ethnicity category (e.g., Hispanics and Asians) were rated as having significantly lower levels of mathematical competence than were Caucasians, and students with higher social competence were rated more highly in their mathematical skills. Teachers with greater self-efficacy also provided higher ratings of their students.

To further understand the relationship between the significant predictors of teacher ratings and direct assessments of student skills, we examined a regression model predicting students' direct assessment scores from all of the independent variables in the original predictive model. The resulting coefficients represented the degree to which each independent variable was related to students' directly-assessed mathematical skills. Results indicated that students' social competence was positively associated with their directly-assessed mathematical skills (b = 0.321, p <.001). However, despite being related to teacher ratings in the previous model, students' race and teachers' self-efficacy were not significantly associated with their directly-assessed mathematical skills.

Discussion

Our results suggest that pre-k teachers' ratings of students' mathematical skills at the end of the year are moderately aligned with concurrent direct assessments of those skills (b =0.50). This is consistent with our previous finding that the concordance was also .50 in the beginning of the year (Kilday et al., 2012), and is considerably lower than the average concordance for K-12 general academic direct and indirect assessments (b= .63) (Südkamp et al., 2012). Additionally, more of the variability in teacher ratings could be accounted for by construct-irrelevant student and teacher characteristics than by students' directly-assessed mathematical skills (30% and 25%, respectively).

Student Characteristics

Teachers in our study tended to rate students in the 'other' racial category (e.g., Hispanics and Asians) as having lower levels of mathematical knowledge and skills, as compared with Caucasian students. Similarly, Ready & Wright (2011) found that pre-k and kindergarten teachers rated Asian and Hispanic students as having lower literacy

skills. Additionally, there is evidence that ethnic match between teacher and student plays a role in teachers' relationships with students (Saft & Pianta, 2001; Zimmerman, Khoury, Vega, Gil, & Warheit, 1995). Since teachers in this sample are predominantly Caucasian and African American, it may be that an ethnic match between teacher and student is associated with teacher ratings, and perhaps teachers are better evaluators of student skills when a student's race/ethnicity matches their own. Future research should examine whether teachers are more accurate raters of students' knowledge and skills when there is a match between their race and the students' race.

Teachers rated mathematical skills more highly for students whom they perceived to be more socially competent. Our findings are supported by those of Hinnant and colleagues (2009) who found that elementary school teachers rated students with better social skills as being more competent in both reading and mathematics. Further explaining this finding, our post-hoc regression analyses (teacher perceptions of students' social competence were associated with students' directly-assessed mathematical skills) suggest that more socially competent students are, in fact, more proficient in mathematics, but that teachers may be oversensitive to this pattern.

Our hypotheses that girls would be rated higher than boys, older students would be rated higher than younger students, and that students from higher socioeconomic backgrounds would be rated higher, were not supported by our results. This is inconsistent with previous research suggesting that students' sex, age, and socioecomic backgrounds are associated with pre-k and kindergarten teacher ratings of general academic performance, literacy skills, and communication skills (Mashburn & Henry, 2004; Ready & Wright, 2011). It may be that teacher ratings of students' mathematical

skills are influenced by different factors than teacher ratings of students' general academics, literacy, and communication skills. For instance, teacher ratings of preschool mathematics abilities may be influenced by cultural biases (Lubienski, 2008) that favor males over females in mathematics; this could lead to a neutralizing effect whereby girls and boys are actually rated the same at an aggregate level.

Teacher Characteristics

Teachers reporting higher levels of self-efficacy also rated students' higher on their mathematical skills, independent of students' directly-assessed mathematical skills. There is evidence that academic achievement is higher among students whose teachers report higher levels of self-efficacy (Anderson et al., 1988; Ashton & Webb, 1986; Ross, 1992); however teachers may overestimate their effect on students' development. Our post-hoc analyses revealed that teacher self-efficacy in our study was not tied to students' performance on direct assessments. This suggests that pre-k teachers may be inaccurately attributing their students' end-of-year mathematical skills to their beliefs about their own abilities to promote desired outcomes in students. Further research in this area is needed to disentangle the ways in which self-efficacy influences teachers' ratings of their students' skills.

Teachers' education and experience were not related to systematic patterns in their ratings. This is contrary to previous research suggesting that teachers with lower levels of education and less experience rate students' higher (Mashburn & Henry, 2004; Ready & Wright, 2011). Our results may be different because all of the teachers in our sample had at least a Bachelor's degree, and the majority had a Master's, while the significant findings from Mashburn & Henry's (2004) study were for a group of teachers

who had less than a Bachelor's degree. Additionally, our findings with regard to both teacher education and experience, may have been impacted by our relatively small sample (42 teachers) as compared to that of Ready and Wright (2011), who found significant associations around teacher experience with a much larger sample of teachers.

Implications

Knowing the factors that influence teacher ratings, can help ensure appropriate interpretations by researchers who rely on teacher ratings as assessments of student performance. For instance, if these trends were uniformly found, researchers could potentially control for the sources of systematic variation in teacher ratings of student skills, to produce a result that more closely replicates a direct assessment of student skills. It may also be possible to train teachers to become more objective assessors; scholars have found that training teachers in giving direct assessments of student skills improves their accuracy when estimating their students' performance (Begeny & Buchanan, 2010), and their ability to administer a battery of direct and indirect assessments as intended by measure developers (Williford, Downer, Hamre, & Pianta, 2014).

Limitations

One limitation to this study is that our teacher rating scale and direct assessments quantify students' skills on different scales, and therefore cannot be directly compared without concealing a great deal of variance in each of the independent measures. In order to avoid directly comparing the measures, we use a predictive model, thereby allowing us to keep the scales of the separate measures intact. However, the limitation of this analysis is that the coefficients are only able to tell us whether teacher ratings tend to be higher or lower than direct assessments, rather than whether teachers overrate or

underrate relative to the direct assessments. To determine whether teacher ratings are over or under estimating students' abilities, a discrepancy score is required and thus measures employing the same scales (same items and same scoring/rating) are necessary. Another limitation is the problem of measurement error, which is a challenge to both direct and indirect assessments. While this study focuses on the potential biases in teacher ratings, it is important to remain cognizant of the error that is also present in direct assessments, which are subject to child-related error (e.g., fatigue, distractibility, discomfort) (Vacc & Ritter, 1995).

Conclusion

Assessment is required for 95% of all students in public schools (Le Floch et al., 2007), and at the beginning of kindergarten in 22 states. Several of these states (e.g., Connecticut, Louisiana, Wyoming) (Daily, Burkhauser, & Halle, 2010), and a nation-wide assessment program (Kim et al., 2013) rely on teacher ratings of student skills for either all or part of their assessments. The findings of the current study suggest that teachers are able to draw on their rich experiences interacting with students to rate student proficiencies; however, teacher biases pose potential complications for use of their ratings as measures of students' academic skills. Research triangulating students' actual abilities with various modes of assessment will inform researchers and policy makers so that they can better measure students' school readiness, guide instruction, and make decisions.

References

Anderson, R. N., Greene, M. L., & Loewen, P. S. (1988). Relationships among teachers' and students' thinking skills, sense of efficacy, and student achievement. *Alberta Journal of Educational Research, 34*(2), 148–165.

Ashton, P. T., & Webb, R. B. (1986). Making a difference: Teachers' sense of efficacy and student achievement.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215. http://doi.org/10.1037/0033-295X.84.2.191

Barnett, M. (2006). Using a Web-Based Professional Development System to Support Preservice Teachers in Examining Authentic Classroom Practice. *Journal of Technology & Teacher Education, 14*(4), 701 – 729.

Bates, A. T. (2005). *Technology, e-learning and distance education*. Routledge.

Beaudoin, M. F., Kurtz, G., & Eden, S. (2009). Experiences and Opinions of E-learners: What Works, What Doesn't, and What Competencies Ensure Successful Learning. *Interdisciplinary Journal of E-Learning & Learning Objects, 5*, 275.

Begeny, J. C., & Buchanan, H. (2010). Teachers' judgments of students' early literacy skills measured by the Early Literacy Skills Assessment: Comparisons of teachers with and without assessment administration experience. *Psychology in the Schools, 47*(8), 859–868. http://doi.org/10.1002/pits.20509

Bowman, B., Donovan, M. S., & Burns, M. S. (2001). Eager to learn. *National Research Council (US). Committee on Early*.

Braun, C. (1976). Teacher expectation: Sociopsychological dynamics. *Review of Educational Research*, *46*(2), 185–213. http://doi.org/10.3102/00346543046002185

Brophy, J. E. (1983). Research on the self-fulfilling prophecy and teacher expectations. *Journal of Educational Psychology*, *75*(5), 631.

Brophy, J. E., & Good, T. L. (1970). Teachers' communication of differential expectations for children's classroom performance: Some behavioral data. *Journal of Educational Psychology*, *61*(5), 365.

Buehl, M. M., & Beck, J. S. (2015). The relationship between teachers' beliefs and teachers' practices. In *International Handbook of Research on Teachers' Beliefs* (pp. 66–84). New York, NY: Routledge.

Burchinal, M., Howes, C., Pianta, R., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (2008). Predicting Child Outcomes at the End of Kindergarten from the Quality of Pre-Kindergarten Teacher–Child Interactions and Instruction. *Applied Developmental Science*, *12*(3), 140–153. http://doi.org/10.1080/10888690802199418

Buysse, V., Pianta, R., Barnett, W., Justice, L., & Sheridan, S. (2012). Access, participation, and supports: A framework for improving inclusive early education opportunities for children with disabilities. *Handbook of Early Childhood Education*, 480–506.

Cabell, S. Q., Justice, L. M., Zucker, T. A., & Kilday, C. R. (2009). Validity of teacher report for assessing the emergent literacy skills of at-risk preschoolers. *Language, Speech, and Hearing Services in Schools*, *40*(2), 161–173.

Cavanagh, S. (2013). Rapid rise seen in use of digital tools for PD. *Education Week*, *6*(3), 10.

Cho, M.-H., Demei, S., & Laffey, J. (2010). Relationships Between Self-Regulation and Social Experiences in Asynchronous Online Learning Environments. *Journal of Interactive Learning Research*, *21*(3), 297–316.

Cho, M.-H., & Jonassen, D. (2009). Development of the human interaction dimension of the Self-Regulated Learning Questionnaire in asynchronous online learning environments. *Educational Psychology*, *29*(1), 117–138. http://doi.org/10.1080/01443410802516934

Clark, C. M., & Peterson, P. L. (1984). *Teachers' thought processes*. Institute for Research on Teaching, Michigan State University.

Clements, D. H., Sarama, J. H., & Liu, X. H. (2008). Development of a measure of early mathematics achievement using the Rasch model: the Research-Based Early Maths Assessment. *Educational Psychology*, *28*(4), 457–482. http://doi.org/10.1080/01443410701777272

Clements, D. H., Sarama, J., & Wolfe, C. (2011). TEAM—Tools for early assessment in mathematics. *Columbus, OH: McGraw-Hill Education*.

Colvin, K. F., Champaign, J., Liu, A., Zhou, Q., Fredericks, C., & Pritchard, D. E. (2014). Learning in an introductory physics MOOC: All cohorts learn equally, including an on-campus class. *The International Review of Research in Open and Distributed Learning*, *15*(4). Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/1902

Curby, T. W., Rimm-Kaufman, S. E., & Cameron, C. (2009). Teacher–child interactions and children's achievement trajectories across kindergarten and first grade. *Journal of Educational Psychology*, *101*(4), 912.

Cusack, A. (2014). A handy cheatsheet on MOOCs. Retrieved July 28, 2015, from https://www.edsurge.com/n/2014-01-10-a-handy-cheatsheet-on-moocs

Daily, S., Burkhauser, M., & Halle, T. (2010). A Review of School Readiness Practices in the States: Early Learning Guidelines and Assessments. Early Childhood Highlights. Volume 1, Issue 3. *Child Trends*.

Deterding, S., Khaled, R., Nacke, L. E., & Dixon, D. (2011). Gamification: Toward a definition. In *CHI 2011 Gamification Workshop Proceedings* (pp. 12–15).

Dickinson, D. K., & Caswell, L. (2007). Building support for language and early literacy in preschool classrooms through in-service professional development: Effects of the Literacy Environment Enrichment Program (LEEP). *Early Childhood Research Quarterly*, *22*(2), 243–260. http://doi.org/10.1016/j.ecresq.2007.03.001

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J.-J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education*, *63*, 380–392. http://doi.org/10.1016/j.compedu.2012.12.020

Domínguez, X., Vitiello, V. E., Fuccillo, J. M., Greenfield, D. B., & Bulotsky-Shearer, R. J. (2011). The role of context in preschool learning: A multilevel examination of the contribution of context-specific problem behaviors and classroom process quality to low-income children's approaches to learning. *Journal of School Psychology*, *49*(2), 175–195. http://doi.org/10.1016/j.jsp.2010.11.002

Domitrovich, C. E., Bradshaw, C. P., Poduska, J. M., Hoagwood, K., Buckley, J. A., Olin, S., … Ialongo, N. S. (2008). Maximizing the Implementation Quality of Evidence-Based Preventive Interventions in Schools: A Conceptual Framework. *Advances in School Mental Health Promotion*, *1*(3), 6–28. http://doi.org/10.1080/1754730X.2008.9715730

Donohue, C., Fox, S., & Torrence, D. (2007). Early childhood educators as elearners. *Young Children*, *1*(6), 34–40.

Downer, J. T., Locasale-Crouch, J., Hamre, B., & Pianta, R. (2009). Teacher Characteristics Associated With Responsiveness and Exposure to Consultation and Online Professional Development Resources. *Early Education & Development*, *20*(3), 431–455. http://doi.org/10.1080/10409280802688626

Driscoll, A., Jicha, K., Hunt, A. N., Tichavsky, L., & Thompson, G. (2012). Can Online Courses Deliver In-class Results? A Comparison of Student Performance and Satisfaction in an Online versus a Face-to-face Introductory Sociology Course. *Teaching Sociology*, *40*(4), 312–331. http://doi.org/10.1177/0092055X12446624

Driscoll, K. C., & Pianta, R. C. (2010). Banking Time in Head Start: Early Efficacy of an Intervention Designed to Promote Supportive Teacher–Child Relationships. *Early Education and Development*, *21*(1), 38–64. http://doi.org/10.1080/10409280802657449

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology*, *92*(6), 1087–1101. http://doi.org/10.1037/0022-3514.92.6.1087

Duckworth, A. L., & Quinn, P. D. (2009). Development and Validation of the Short Grit Scale (Grit–S). *Journal of Personality Assessment*, *91*(2), 166–174. http://doi.org/10.1080/00223890802634290

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., … Brooks-Gunn, J. (2007). School readiness and later achievement. *Developmental Psychology*, *43*(6), 1428.

Duncan, G. J., & Magnuson, K. (2013). Investing in Preschool Programs. *The Journal of Economic Perspectives : A Journal of the American Economic Association*, *27*(2), 109–132. http://doi.org/10.1257/jep.27.2.109

Early, D. M., Maxwell, K. L., Burchinal, M., Alva, S., Bender, R. H., Bryant, D., … Griffin, J. A. (2007). Teachers' education, classroom quality, and young children's academic skills: Results from seven studies of preschool programs. *Child Development*, *78*(2), 558–580.

Early, D. M., & Winton, P. J. (2001). Preparing the workforce: early childhood teacher preparation at 2- and 4-year institutions of higher education. *Early Childhood Research Quarterly*, *16*(3), 285–306. http://doi.org/10.1016/S0885-2006(01)00106-5

Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling*, *8*(3), 430–457.

Ferguson, R. F. (2003). Teachers' Perceptions and Expectations and the Black-White Test Score Gap. *Urban Education*, *38*(4), 460–507. http://doi.org/10.1177/0042085903038004006

Festinger, L. (1962). Cognitive Dissonance. *Scientific American*, *207*(4), 93–106. http://doi.org/10.1038/scientificamerican1062-93

Fisher, W. W. (2014). *HLS1X: CopyrightX Course Report* (SSRN Scholarly Paper No. ID 2382332). Rochester, NY: Social Science Research Network. Retrieved from http://papers.ssrn.com/abstract=2382332

Fives, H., & Buehl, M. M. (2012). Spring cleaning for the "messy" construct of teachers' beliefs: What are they? Which have been examined? What can they tell us? In K. R. Harris, S. Graham, T. Urdan, S. Graham, J. M. Royer, & M. Zeidner (Eds.), *APA educational psychology handbook, Vol 2: Individual differences and cultural and contextual factors.* (pp. 471–499). Washington: American Psychological Association. Retrieved from http://content.apa.org/books/13274-019

Fuligni, A. S., Howes, C., Huang, Y., Hong, S. S., & Lara-Cinisomo, S. (2012). Activity settings and daily routines in preschool classrooms: Diverse experiences in early learning settings for low-income children. *Early Childhood Research Quarterly*, *27*(2), 198–209. http://doi.org/10.1016/j.ecresq.2011.10.001

Getzels, J. W., & Jackson, P. W. (1963). The teacher's personality and characteristics. In *Handbook of research on teaching* (pp. 506–582).

Gikandi, J. (2013). How can open online reflective journals enhance learning in teacher education? *Journal of Technology and Teacher Education*, *21*(1), 5–26.

Gill, W. E. (2011). *The Ready to Teach Program: A Federal Initiative in Support of Online Courses for Teachers*. Retrieved from http://eric.ed.gov/?id=ED530966

Ginsburg, A., Gray, T., & Levin, D. (2004). Online professional development for mathematics teachers: A strategic analysis. *American Institutes for Research*. Retrieved from http://eric.ed.gov/?id=ED492927

Ginsburg, H. P., & Baroody, A. J. (2003). *TEMA-3 Examiners Manual* (3rd ed.). Austin, Texas: PRO-ED.

Grays, M. (2013). Measuring motivation for coursework across the academic career: A longitudinal invariance study. *Unpublished Doctoral Dissertation). James Madison University, Harrisonburg, VA*.

Greene, J. A., Oswald, C. A., & Pomerantz, J. (2015). Predictors of Retention and Achievement in a Massive Open Online Course. *American Educational Research Journal*, 0002831215584621. http://doi.org/10.3102/0002831215584621

Hamre, B. K. (2014). Teachers' Daily Interactions With Children: An Essential Ingredient in Effective Early Childhood Programs. *Child Development Perspectives*, *8*(4), 223–230. http://doi.org/10.1111/cdep.12090

Hamre, B. K., Downer, J. T., Jamil, F., & Pianta, R. C. (2012). Enhancing teachers' intentional use of effective interactions with children: Designing and testing professional development interventions. *Handbook of Early Education*, 507–532.

Hamre, B. K., Hatfield, B., Pianta, R., & Jamil, F. (2014). Evidence for General and Domain-Specific Elements of Teacher–Child Interactions: Associations With Preschool Children's Development. *Child Development*, *85*(3), 1257–1274. http://doi.org/10.1111/cdev.12184

Hamre, B. K., & Pianta, R. C. (2007). Learning opportunities in preschool and early elementary classrooms. In R. C. Pianta, M. J. Cox, & K. L. Snow (Eds.), *School*

readiness and the transition to kindergarten in the era of accountability (pp. 49–83). Baltimore, MD, US: Paul H Brookes Publishing.

Hamre, B. K., Pianta, R. C., Burchinal, M., Field, S., LoCasale-Crouch, J., Downer, J. T., … Scott-Little, C. (2012). A Course on Effective Teacher-Child Interactions: Effects on Teacher Beliefs, Knowledge, and Observed Practice. *American Educational Research Journal*, *49*(1), 88–123. http://doi.org/10.3102/0002831211434596

Hart, L. C. (2002). Preservice Teachers' Beliefs and Practice After Participating in an Integrated Content/Methods Course. *School Science and Mathematics*, *102*(1), 4–14. http://doi.org/10.1111/j.1949-8594.2002.tb18191.x

Hatfield, B. E., Hestenes, L. L., Kintner-Duffy, V. L., & O'Brien, M. (2013). Classroom Emotional Support predicts differences in preschool children's cortisol and alpha-amylase levels. *Early Childhood Research Quarterly*, *28*(2), 347–356. http://doi.org/10.1016/j.ecresq.2012.08.001

Hemmeter, M. L., Santos, R. M., & Ostrosky, M. M. (2008). Preparing Early Childhood Educators to Address Young Children's Social-Emotional Development and Challenging Behavior: A Survey of Higher Education Programs in Nine States. *Journal of Early Intervention*. http://doi.org/10.1177/1053815108320900

Hightower, A. D., Work, W. C., Cowen, E. L., Lotyczewski, B., Spinell, A., Guare, J., & Rohrbeck, C. (1986). The Teacher-Child Rating Scale: A brief objective measure of elementary children's school problem behaviors and competencies. *School Psychology Review*, *15*(3), 393–409.

Hill, H. C., Beisiegel, M., & Jacob, R. (2013). Professional Development Research Consensus, Crossroads, and Challenges. *Educational Researcher*, *42*(9), 476–487. http://doi.org/10.3102/0013189X13512674

Hinnant, J. B., O'Brien, M., & Ghazarian, S. R. (2009). The longitudinal relations of teacher expectations to achievement in the early school years. *Journal of Educational Psychology*, *101*(3), 662–670. http://doi.org/10.1037/a0014306

Hoy, W. K., & Woolfolk, A. E. (1993). Teachers' Sense of Efficacy and the Organizational Health of Schools. *The Elementary School Journal*, *93*(4), pp. 355–372.

Institute of Medicine, & National Research Council. (2015). *Transforming the Workforce for Children Birth Through Age 8: A Unifying Foundation*. Washington, DC: The National Academies Press. Retrieved from http://www.nap.edu/catalog/19401/transforming-the-workforce-for-children-birth-through-age-8-a

Irwin, M., & Supplee, L. H. (2012). Directions in Implementation Research Methods for Behavioral and Social Science. *The Journal of Behavioral Health Services & Research*, *39*(4), 339–342. http://doi.org/10.1007/s11414-012-9293-z

Jamil, F. M. (2013). *Understanding Teacher Effectiveness: Theory and Measurement of Teacher Skills, Knowledge, and Beliefs* (Ph.D.). University of Virginia, United States -- Virginia. Retrieved from http://search.proquest.com.proxy.its.virginia.edu/pqdtglobal/docview/1445390422/B00C5C318BDF4004PQ/1?accountid=14678

Jang, J., Park, J. J. Y., & Yi, M. Y. (2015). Gamification of Online Learning. In C. Conati, N. Heffernan, A. Mitrovic, & M. F. Verdejo (Eds.), *Artificial Intelligence in Education* (pp. 646–649). Springer International Publishing. Retrieved from http://link.springer.com/chapter/10.1007/978-3-319-19773-9_82

Jobe, W., Östlund, C., & Svensson, L. (2014). MOOCs for Professional Teacher Development. In *Society for Information Technology & Teacher Education International Conference* (Vol. 2014, pp. 1580–1586). Retrieved from http://www.editlib.org/p/130997

Johnson, S. R., Seidenfeld, A. M., Izard, C. E., & Kobak, R. (2013). Can classroom emotional support enhance prosocial development among children with depressed caregivers? *Early Childhood Research Quarterly*, *28*(2), 282–290. http://doi.org/10.1016/j.ecresq.2012.07.003

Kilday, C. R., Kinzie, M. B., Mashburn, A. J., & Whittaker, J. V. (2012). Accuracy of Teacher Judgments of Preschoolers' Math Skills. *Journal of Psychoeducational Assessment*, *30*(2), 148–159. http://doi.org/10.1177/0734282911412722

Kim, D.-H., Lambert, R. G., & Burts, D. C. (2013). Evidence of the Validity of *Teaching Strategies GOLD*® Assessment Tool for English Language Learners and Children with Disabilities. *Early Education & Development*, *24*(4), 574–595. http://doi.org/10.1080/10409289.2012.701500

Kinzie, M. B., Whittaker, J. V., Williford, A. P., DeCoster, J., McGuire, P., Lee, Y., & Kilday, C. R. (2014). MyTeachingPartner-Math/Science pre-kindergarten curricula and teacher supports: Associations with children's mathematics and

science learning. *Early Childhood Research Quarterly*, *29*(4), 586–599. http://doi.org/10.1016/j.ecresq.2014.06.007

Kipnis, F., Whitebook, M., Austin, L., & Sakai, L. (2013). *The state of early childhood higher education in New Jersey: The New Jersey early childhood higher education inventory*. Berkeley, CA: Berkeley, CA: Center for the Study of Child Care Employment, University of California at Berkeley. Retrieved from http://www.irle.berkeley.edu/cscce/wp-content/uploads/2013/08/NJ-HEI-REPORT-FINAL.pdf

Koller, D., Ng, A., Chuong, D., & Zhenghao, C. (2013). Retention and Intention in Massive Open Online Courses: In Depth. Retrieved July 28, 2015, from

Kosovich, J. J., Hulleman, C. S., Barron, K. E., & Getty, S. (2014). A Practical Measure of Student Motivation Establishing Validity Evidence for the Expectancy-Value-Cost Scale in Middle School. *The Journal of Early Adolescence*, 0272431614556890. http://doi.org/10.1177/0272431614556890

La Paro, K. M., & Pianta, R. C. (2000). Predicting children's competence in the early school years: A meta-analytic review. *Review of Educational Research*, *70*(4), 443–484.

LaParo, K., Scott-Little, C., Ejimofor, A., Sumrall, T., Kintner-Duffy, V. L., Pianta, R. C., … Howes, C. (2014). Student Teaching Feedback and Evaluation: Results From a Seven-State Survey. *Journal of Early Childhood Teacher Education*, *35*(4), 318–336. http://doi.org/10.1080/10901027.2014.968297

Le Floch, K. C., Martinez, F., O'Day, J., Stecher, B., Taylor, J., & Cook, A. (2007). State and Local Implementation of the" No Child Left Behind Act." Volume III–Accountability under" NCLB" Interim Report. *US Department of Education*.

Lubienski, S. T. (2008). On "Gap Gazing" in Mathematics Education: The Need for Gaps Analyses. *Journal for Research in Mathematics Education*, *39*(4), 350–356.

Martínez, J. F., Stecher, B., & Borko, H. (2009). Classroom Assessment Practices, Teacher Judgments, and Student Achievement in Mathematics: Evidence from the ECLS. *Educational Assessment*, *14*(2), 78–102. http://doi.org/10.1080/10627190903039429

Martin, S. D., & Shapiro, E. S. (2011). Examining the accuracy of teachers' judgments of DIBELS performance. *Psychology in the Schools*, *48*(4), 343–356. http://doi.org/10.1002/pits.20558

Mashburn, A. J., & Henry, G. T. (2004). Assessing school readiness: Validity and bias in preschool and kindergarten teachers' ratings. *Educational Measurement: Issues and Practice*, *23*(4), 16–30.

Masters, J., Magidin de Kramer, R., O'Dwyer, L., Dash, S., & Russell, M. (2012). The effects of online teacher professional development on fourth grade students' knowledge and practices in English language arts. *Journal of Technology and Teacher Education*, *20*(1), 21–46.

Means, B., Bakia, M., & Murphy, R. (2014). *Learning online: What research tells us about whether, when and how*. Routledge.

Norris, D. J. (2010). Raising the Educational Requirements for Teachers in Infant Toddler Classrooms: Implications for Institutions of Higher Education. *Journal of*

Early Childhood Teacher Education, *31*(2), 146–158. http://doi.org/10.1080/10901021003781221

Olsen, H., Donaldson, A. J., & Hudson, S. D. (2010). Online professional development: Choices for early childhood educators. *Dimensions of Early Childhood*, *38*(1), 12–18.

Pajares, M. F. (1992). Teachers' Beliefs and Educational Research: Cleaning up a Messy Construct. *Review of Educational Research*, *62*(3), 307–332. http://doi.org/10.2307/1170741

Perna, L. W., Ruby, A., Boruch, R. F., Wang, N., Scull, J., Ahmad, S., & Evans, C. (2014). Moving Through MOOCs Understanding the Progression of Users in Massive Open Online Courses. *Educational Researcher*, 0013189X14562423. http://doi.org/10.3102/0013189X14562423

Peterson, S. (2013). Readiness to change: Effective implementation processes for meeting people where they are. In T. Halle, A. Metz, & I. Martinez-Beck (Eds.), *Applying implementation science to early care and education programs and systems: Exploring a new frontier. Baltimore, MD: Brookes* (pp. 43–64). Baltimore, MD, US: Paul H Brookes Publishing Co.

Pianta, R. C. (1999). *Enhancing relationships between children and teachers* (1st ed.). Washington, DC : American Psychological Association,. Retrieved from http://search.lib.virginia.edu/catalog/u2883269

Pianta, R. C., LaParo, K., & Hamre, B. K. (2008). Classroom Assessment Scoring System Manual: Pre-K. Baltimore: Brookes.

Pianta, R., Howes, C., Burchinal, M., Bryant, D., Clifford, R., Early, D., & Barbarin, O. (2005). Features of Pre-Kindergarten Programs, Classrooms, and Teachers: Do They Predict Observed Classroom Quality and Child-Teacher Interactions? *Applied Developmental Science*, *9*(3), 144–159. http://doi.org/10.1207/s1532480xads0903_2

Piech, C., Huang, J., Chen, Z., Do, C., Ng, A., & Koller, D. (2013). Tuned Models of Peer Assessment in MOOCs. *arXiv:1307.2579 [cs, Stat]*. Retrieved from http://arxiv.org/abs/1307.2579

Pohan, C. A. (1996). Preservice Teachers' Beliefs About Diversity: Uncovering Factors Leading to Multicultural Responsiveness. *Equity & Excellence in Education*, *29*(3), 62–69. http://doi.org/10.1080/1066568960290310

Raver, C. C., Jones, S. M., Li-Grining, C. P., Metzger, M., Champion, K. M., & Sardin, L. (2008). Improving preschool classroom processes: Preliminary findings from a randomized trial implemented in Head Start settings. *Early Childhood Research Quarterly*, *23*(1), 10–26. http://doi.org/10.1016/j.ecresq.2007.09.001

Ready, D. D., & Wright, D. L. (2011). Accuracy and Inaccuracy in Teachers' Perceptions of Young Children's Cognitive Abilities: The Role of Child Background and Classroom Context. *American Educational Research Journal*, *48*(2), 335–360. http://doi.org/10.3102/0002831210374874

Reich, J. (2015). Rebooting MOOC research. *Science Magazine*, *347*(6217), 34–35.

Rimm-Kaufman, S. E., & Hamre, B. K. (2010). The role of psychological and developmental science in efforts to improve teacher quality. *Teachers College Record*, *112*(12), 2988–3023.

Roberts, A. M., LoCasale-Crouch, J., DeCoster, J., Hamre, B. K., Downer, J. T., Williford, A. P., & Pianta, R. C. (2014). Individual and Contextual Factors Associated with Pre-Kindergarten Teachers' Responsiveness to the MyTeachingPartner Coaching Intervention. *Prevention Science*. http://doi.org/10.1007/s11121-014-0533-8

Robertson-Kraft, C., & Duckworth, A. L. (2014). True Grit: Trait-level Perseverance and Passion for Long-term Goals Predicts Effectiveness and Retention among Novice Teachers. *Teachers College Record (1970)*, *116*(3). Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4211426/

Rohrbach, L. A., Grana, R., Sussman, S., & Valente, T. W. (2006). Type II Translation Transporting Prevention Interventions From Research to Real-World Settings. *Evaluation & the Health Professions*, *29*(3), 302–333. http://doi.org/10.1177/0163278706290408

Ross, J. A. (1992). Teacher Efficacy and the Effects of Coaching on Student Achievement. *Canadian Journal of Education / Revue Canadienne de L'éducation*, *17*(1), pp. 51–65.

Russell, M., Kleiman, G., Carey, R., & Douglas, J. (2009). Comparing self-paced and cohort-based online courses for teachers. *Journal of Research on Technology in Education*, *41*(4), 443–466.

Ryans, D. G. (1960). *Characteristics of teachers: Their description, comparison, and appraisal* (Vol. xxiii). American Council on Education: American Council on Education.

Sabol, T. J., & Pianta, R. C. (2012). Recent trends in research on teacher–child relationships. *Attachment & Human Development*, *14*(3), 213–231. http://doi.org/10.1080/14616734.2012.672262

Saft, E. W., & Pianta, R. C. (2001). Teachers' perceptions of their relationships with students: Effects of child age, gender, and ethnicity of teachers and children. *School Psychology Quarterly*, *16*(2), 125.

Schaefer, E. S., & Edgerton, M. (1985). Parent and child correlates of parental modernity. *Parental Belief Systems: The Psychological Consequences for Children*, 287–318.

Scott-Little, C., Paro, K. M. L., Thomason, A. C., Pianta, R. C., Hamre, B., Downer, J., … Howes, C. (2011). Implementation of a Course Focused on Language and Literacy Within Teacher–Child Interactions: Instructor and Student Perspectives Across Three Institutions of Higher Education. *Journal of Early Childhood Teacher Education*, *32*(3), 200–224. http://doi.org/10.1080/10901027.2011.594489

Smith, J. A. Jo.Smith@ucf.edu, & Sivo, S. A. . (2012). Predicting continued use of online teacher professional development and the influence of social presence and sociability. *British Journal of Educational Technology*, *43*(6), 871–882. http://doi.org/10.1111/j.1467-8535.2011.01223.x

Südkamp, A., Kaiser, J., & Möller, J. (2012). Accuracy of teachers' judgments of students' academic achievement: A meta-analysis. *Journal of Educational Psychology*, *104*(3), 743–762. http://doi.org/10.1037/a0027627

Sun, S. Y. H. (2014a). Learner perspectives on fully online language learning. *Distance Education*, *35*(1), 18–42. http://doi.org/10.1080/01587919.2014.891428

Sun, S. Y. H. (2014b). Learner perspectives on fully online language learning. *Distance Education*, *35*(1), 18–42. http://doi.org/10.1080/01587919.2014.891428

Trickett, P. K., McBride-Chang, C., & Putnam, F. W. (1994). The classroom performance and behavior of sexually abused females. *Development and Psychopathology*, *6*(01), 183–194. http://doi.org/10.1017/S0954579400005940

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, *17*(7), 783–805.

Vacc, N. A., & Ritter, S. H. (1995). Assessment of Preschool Children. ERIC Digest.

Vu, P., Cao, V., Vu, L., & Cepero, J. (2014). Factors Driving Learner Success in Online Professional Development. *The International Review of Research in Open and Distance Learning*, *15*(3), 120–139.

Whitebook, M., Phillips, D., & Howes, C. (2014). *Worthy work, STILL unlivable wages: The early childhood workforce 25 years after the National Child Care Staffing Study*. Berkeley, CA: Center for the Study of Childcare Employment, University of California, Berkeley. Retrieved from http://ffyf.org/wp-content/uploads/2014/11/Child-Care-Employment-Report-11.18.14.pdf

Williford, A. P., Downer, J. T., Hamre, B. K., & Pianta, R. C. (2014). The Virginia Kindergarten Readiness Project--Phase 2 Legislative Report. Research report prepared for Elevate Early Education (E3).

Williford, A. P., Whittaker, J. E. V., Vitiello, V. E., & Downer, J. T. (2013). Children's Engagement Within the Preschool Classroom and Their Development of Self-Regulation. *Early Education and Development*, *24*(2), 162–187. http://doi.org/10.1080/10409289.2011.628270

Winton, P. J., Snyder, P., & Goffin, S. G. (2016). Beyond the Status Quo: Rethinking Professional Development for Early Childhood Teachers. In L. J. Couse & S. L. Recchia (Eds.), *Handbook of Early Childhood Teacher Education* (pp. 54–68). Taylor & Francis.

Xiang, Z., & Schweinhart, L. J. (2002). *Effects five years later: The Michigan School Readiness Program evaluation through age 10*. High/Scope Educational Research Foundation.

Yesil-Dagli, U., Lake, V., & Jones, I. (2010). Preservice teachers‟ perceptions towards mathematics and science. *Journal of Research in Education*, *20*(2), 32–48.

Zaslow, M., Tout, K., Halle, T., Whittaker, J. V., & Lavelle, B. (2010). Toward the Identification of Features of Effective Professional Development for Early Childhood Educators. Literature Review. *Office of Planning, Evaluation and Policy Development, US Department of Education*. Retrieved from http://eric.ed.gov/?id=ED527140

Zimmerman, R. S., Khoury, E. L., Vega, W. A., Gil, A. G., & Warheit, G. J. (1995). Teacher and parent perceptions of behavior problems among a sample of African American, Hispanic, and non-Hispanic white students. *American Journal of Community Psychology*, *23*(2), 181–197.

Tables

Table 1
Descriptive Statistics of Student and Teacher-Level Variables

Student-level Variables	(%) M(SD)	N	Missing
Gender		435	9
Male	48.40%		
Female	49.50%		
Age	4.60 (.32)	410	34
Race/Ethnicity		437	7
Caucasian	25.86%		
African American	66.00%		
Other	8.01%		
Hispanic	3.6%		
Asian	1.4%		
Native American	.5%		
Other	2.5%		
Income to Need Ratio	1.34 (.98)	383	61
Social Competence	3.75 (.74)	330	114
Problem Behaviors	1.30 (.40)	332	112
TR- Math raw score[a]	4.14 (.78)	337	107
DA-TEMA raw score[b]	17.72 (8.84)	339	105
DA-GMA raw score	16.37 (5.17)	339	105
Teacher-level Variables	**(%) M(SD)**	**N**	**Missing**
Education		39	3
Bachelor's	41.9%		
Bachelor's plus one year coursework	14.6%		
Master's	43.5%		
Years of Experience	7.27(6.30)	36	6
Self-Efficacy	8.01(.64)	35	7

Notes. [a]TR is used to indicate Teacher Rating. [b]DA is used to indicate Direct Assessments.

Table 2
Standardized Regression Coefficients for predicting Pre-K Teachers' Ratings of Math Skills

Predictor	Estimate	S.E.	*p*-value
DA-Math[a]	0.306	0.059	< 0.001
St Age	0.028	0.041	0.50
St Female	0.051	0.033	0.12
St Race Afr. American	-0.037	0.059	0.53
St Race Other	-0.083	0.040	0.04
St Income-Need Ratio	0.023	0.045	0.62
St Social Competence	0.410	0.082	< 0.001
St Problem Behaviors	-0.017	0.065	0.79
Teach Education	-0.046	0.089	0.61
Teach Experience	0.077	0.078	0.32
Teach Self-Efficacy	0.234	0.084	0.005
Plus dummy code	-0.059	0.089	0.51
Basic dummy code	0.063	0.074	0.39

Notes. [a]DA-Math indicates the composite mathematics direct assessment score.

Running Head: EARLY CHILDHOOD MOOC

Engagement and Learning in a Massive Open Online Course (MOOC) in Effective Teacher-Child Interactions for Early Childhood Teachers

Bridget K. Hamre[1], Ph.D.
Emily Furnari[1], B.S.
Jennifer LoCasale-Crouch[1], Ph.D.
Kathy Neesen[1], Ph.D.
Amy Roberts[1], M.Ed.
Manuela Jimenez[2], Ph.D.
Hunger Gehlbach[3], Ph.D.

[1] University of Virginia
[2] Arizona State University
[3] Harvard University

Expanding access to early childhood education (ECE) in the United States is receiving broad support from public and private sectors, as well as increased funding from federal, state, and local governments. There is also broad consensus that investments in ECE will not succeed if these expansion efforts attend only to creating more slots for children without attending to the quality of children's daily experiences in those classrooms (Hamre, 2014). While preparing the workforce to provide young children with these experiences is of paramount importance (Institute of Medicine & National Research Council, 2015; Whitebook, Phillips, & Howes, 2014), our current system of higher education is not prepared to meet this need. By some estimates at least 100,000 preschool teachers with bachelor's degrees will be needed in the United States by the end of the decade (Whitebook et al., 2014).

Although teachers' educational experiences are not consistently linked to their classroom practices (e.g., Early et al., 2007), studies have demonstrated that intentionally designed coursework can improve teachers' classroom practice (Dickinson & Caswell, 2007; Hamre et al., 2012). These courses share several features, including a heavy and explicit focus on instructing teachers in specific evidence-based practices and the extensive use of video examples that help teachers see what these practices look like in real classrooms.

However, there are significant challenges inherent in getting this type of coursework to the early childhood teachers who need it most. Many states' higher education systems lack the personnel or processes that can help ensure that students are being exposed to rigorous educational and practice-based experiences during their coursework (Hemmeter, Santos, & Ostrosky, 2008; Scott-Little et al., 2011). Too few

colleges offer field placement assignments (Kipnis, Whitebook, Austin, & Sakai, 2013) or use evidence-based observational systems to provide feedback to teachers about their ability to enact effective teaching (LaParo et al., 2014). And attempts to scale up the use of evidence-based higher education courses suggest that faculty are resistant to teaching courses designed by others (Scott-Little et al., 2011). Even when colleges are offering solid educational experiences for current and future teachers, access is a huge issue for much of the workforce. Many early childhood teachers report that attending traditional institutes of higher education is a challenge due to due to competing work/family responsibilities and geographic limitations (Early & Winton, 2001).

One potential way to circumnavigate some of these barriers is through providing access to online coursework. The rise of Massive Open Online Courses (MOOCs) offer the possibility of providing high quality coursework to tens of thousands of ECE teachers. The current paper reports on one of the first MOOCs specifically for ECE teachers, offered through a partnership between the University of Virginia and Coursera. The 4-session course, entitled *Effective Classroom Interactions (ECI): Supporting Young Children's Development*, was four weeks in length, designed to elicit approximately 1-2 hours of engagement from learners each week. This paper examines engagement and learning outcomes in the ECI MOOC. More specifically the paper: 1) reports on characteristics of ECI MOOC learners; 2) provides descriptive information on engagement and learning in the course; 3) examines the extent to which characteristics of learners were predictive of engagement; and 4) tests the ways in which engagement was related to learning outcomes. Findings from this study have important implications for

the field as it moves to explore MOOCs as one option for enhancing the skills of early childhood educators.

The Need for Coursework on Emotionally Supportive Teacher-Child Interactions

Supporting young children's learning is a challenging task that requires a deep understanding of development and knowledge of the specific types of classroom experiences that can support children's development. Recent research documents the many types of classroom experiences that promote young children's social, emotional, behavioral, cognitive, and language development (Diamond, Justice, Siegler, Snyder, 2013). And, although there is strong evidence that teachers need to use curricula to support students' learning (Duncan & Magnuson, 2013), curricula must be coupled with teachers' interactions with students to support development these skills throughout the day.

The *Teaching through Interactions* framework (Hamre, Hatfield, Pianta, & Jamil, 2014; Hamre & Pianta, 2007) describes several types of teacher-child interactions that support young children's development. The initial framework (Hamre & Pianta, 2007) described three broad domains of teacher-child interactions: Emotional Support, Classroom Organization, and Instructional Support. More recent work suggests there may be an overarching element to effective teacher-child interactions characterized by responsivity to children's social, behavioral, and cognitive development (Hamre et al., 2014). Across these versions of the framework there is a clear focus on the need for teachers to be emotionally supportive in interactions with young children, and that was the focus of the ECI MOOC.

In emotionally supportive classrooms, teachers develop strong relationships with students, foster positive peer connections, are sensitive to the individual needs of children, and work to support young children's growing desires to demonstrate leadership and autonomy. Children in classrooms offering these kinds of support demonstrate stronger prosocial and self-regulatory skills (Johnson, Seidenfeld, Izard, & Kobak, 2013; Williford, Whittaker, Vitiello, & Downer, 2013). And, for children with behavior problems, these types of supports also help children learn more in the classroom (Domínguez, Vitiello, Fuccillo, Greenfield, & Bulotsky-Shearer, 2011). Children in emotionally supportive classrooms are also less likely to experience the increased levels of stress that are typically associated with attendance in out-of-home care settings (Hatfield, Hestenes, Kintner-Duffy, & O'Brien, 2013).

However, there are still large numbers of classrooms in which children are not given access to emotionally supportive adults (e.g., Fuligni, Howes, Huang, Hong, & Lara-Cinisomo, 2012). And children coming from economically disadvantaged backgrounds are less likely to receive emotionally supportive interactions than are their more advantaged peers (Bassok & Galdo, 2016). Thus there is a clear need for teachers to receive training and support on how to be emotionally supportive in the classroom.

A variety of approaches have proven effective in enhancing teachers' emotional support. Coaching interventions have demonstrated particularly strong impacts on these elements of teachers' practice (Domitrovich et al., 2008; Raver et al., 2008). However, coaching is expensive and can be challenging to implement at large scale. Thus recent efforts have focused on developing and testing coursework targeting supportive teacher-child interactions. The National Center for Research on Early Childhood Education

(NCRECE) demonstrated that providing teachers with a course that described these interactions in detail and helped them "see" what these interactions looked like in the classroom led to marked improvements in their interactions with young children (Hamre et al., 2012).

Online Courses for ECE teachers

Online coursework is an increasingly common method of delivery for teacher education (Cavanagh, 2013; Gill, 2011). Online courses have several advantages in terms of scalability, cost-efficiency, and implementation fidelity. In terms of scale there is no other medium through which interventions can be scaled as easily as the Internet. MOOCs, in particular, have demonstrated a clear ability to reach tens and even hundreds of thousands of participants from around the world (Bates, 2005). And, MOOCs can also be designed to utilize automated scoring systems and peer grading to provide institutions cost-effective and accurate reproducibility of their courses. This is something that is a challenge to do when offering coursework through more traditional channels that rely on a large cadre of faculty that have varying levels of knowledge of the latest science of early education and varying degrees of proficiency in effective teaching for adults. Many well-designed MOOCs capitalize on large groups of learners by incorporating connectivist learning theories to offer individuals the opportunity to share and build on one another's knowledge (Milligan, Littlejohn, & Margaryan, 2013; Saadatmand & Kumpulainen, 2014).

There have been several meta-analyses conducted to examine the results of studies comparing learner performance in online courses exhibit similar performance to learners in face-to-face settings (e.g., Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer,

2004; Sitzmann, Kraiger, Stewart, & Wisher, 2006). One recent meta-analysis included 50 studies and found no significant difference overall between learners receiving online and face-to-face instruction (Means, Bakia, & Murphy, 2014). For instance, in one study, 368 students enrolled in online (i.e., weekly PowerPoint lectures and discussion boards) or in-person (i.e., professor-delivered lectures and in-person discussions) sections of a college course performed similarly on mid-term and final exams regardless of the delivery method they received (Driscoll, Jicha, Hunt, Tichavsky, & Thompson, 2012). With regard to the education field, online coursework and professional development can impact teachers' knowledge and practice (Barnett, 2006; Ginsburg, Gray, & Levin, 2004; Masters, Magidin de Kramer, O'Dwyer, Dash, & Russell, 2012; Russell, Kleiman, Carey, & Douglas, 2009). Barnett (2006) found that pre-services teachers reported that watching videos of target practices in action and having asynchronous discussions about them online were integral to helping them understand inquiry-based classroom practices. Incorporating more object assessments of teachers, Russell and colleagues (2009) found an online professional development course for middle school algebra teachers improved teachers' pedagogical beliefs, knowledge of teaching mathematics, and observed instructional practices. And at least one study has documented that these improvements in teacher practice have positive consequences for students. Masters et al. (2012) conducted a randomized controlled trial to test the efficacy of a series of three online professional development workshops in English Language Arts instruction for fourth grade teachers; they found significant gains on grammar, comprehension, and vocabulary test performance for students of teachers who received the online professional development.

The growing body of research on online coursework for teachers is still fairly new with most studies employing relatively small sample sizes and qualitative approaches, (e.g., Gikandi, 2013; Ginsburg et al., 2004; Russell et al., 2009). Only a handful of studies have specifically looked into early childhood teachers' participation in online learning. Several papers have focused on the ways in which technology may be a barrier to participation for ECE teachers (i.e., Donohue, Fox, & Torrence, 2007; Olsen, Donaldson, & Hudson, 2010). One other recent paper reported on participation in a longer, more intensive form of the same course that was a focus of the current study (i.e., the longer course was offered for credit and directly through a university as opposed to Coursera) (Locasale-Crouch et al., in press). The 60 teachers in that study were highly engaged and satisfied with their online learning experience as demonstrated by measures of their activity in the online course and survey responses regarding their satisfaction. The present study seeks to expand on those findings with a much larger sample of 10,006 teachers, to ask questions about the potential of using online coursework with early childhood teachers at scale.

Massive Open Online Course Research

Research on MOOCs for teacher education is very limited, with the few studies available being more theoretical than empirical (Jobe, Östlund, & Svensson, 2014; Addo 2014). However, early research on MOOCs in other content areas does give rise to concerns regarding their true value. In particular, several recent studies document that most MOOCs have very low completion rates. Although definitions of "completion" vary, most MOOC's report that between 5% and 12% of those who register for the course actually complete it (Cusack, 2014; Koller, Ng, Chuong, & Zhenghao, 2013; Perna et al.,

2014). Most MOOC research is limited to measuring course engagement and completion, with little evidence regarding the degree to which MOOCs produce learning outcomes. This is because most MOOCs do not have robust assessment structures (i.e., ongoing, procedural and conceptual, and validated assessments), and MOOC researchers rarely employ rigorous study designs (i.e., experimental, or quasi-experimental) to make inferences about learning (Reich, 2015). Two notable exceptions (i.e., Colvin et al., 2014; Fisher, 2014) employed rigorous assessment to enable researches to infer that there were equal academic gains associated with engagement in online and face-to-face versions of a course. For example, Colvin and colleagues (2014) tested an online version of a mechanics course by providing students with online materials such as an e-textbook, along with weekly quizzes and problem sets; they utilized pre-and-post-tests, along with these weekly assessments and practice problems to assess learning in the online course and compare it with learning in a similar face-to-face version of the course. No studies have documented engagement rates or learning outcomes in MOOCs for early childhood teachers; while the present study does not overcome issues of assessment and design associated with current MOOC research, it can be taken as an early inquiry into the viability of MOOCs for early childhood educators.

If MOOCs are to be successful in supporting early childhood teachers, it is also important to understand characteristics of learners that are associated with engagement and learning outcomes. Previous research on online coursework has shown that learner success is affected not only by the characteristics of the learning environment but also by the characteristics of learners (Beaudoin, Kurtz, & Eden, 2009; Sun, 2014). Specific to the field of online professional development for teachers, Beaudoin and colleagues

(2009) found that learner characteristics such as self-motivation, time management, and capacity to learn with limited support, were the strongest predictors of learner success. Teachers in the age range of 25-34, as well as those with self-discipline, have also been found to be successful completers of online professional development modules (Vu, Cao, Vu, & Cepero, 2014). Learner self-efficacy has also been found to be critical for successful online learning, though it has not yet been studied in the context of teachers' online professional development (Cho, Demei, & Laffey, 2010; Cho & Jonassen, 2009).

Current Study

The current study reports on a MOOC offered by UVA through Coursera in the fall of 2013. Enrollment in the course began in May 2013 and continued through the end of the course in December 2013. The study first describes characteristics of enrollees and participants. We then use data from Coursera to provide a detailed summary of participants' engagement in course offerings. Next we look at the characteristics of participants that were associated with engagement. Finally we examine learning outcomes and the extent to which engagement in the course materials was associated with greater learning.

Method

Participants

The present study includes learners who enrolled in the Effective Classroom Interactions MOOC (ECI MOOC) through Coursera by the end of the course in December 2013. Data on engagement in course elements were automatically generated through the online system and thus we have complete engagement data on all learners. We categorize these learners in three categories, based on definitions presented in Perna

et al.'s (2014) review of learner engagement in 12 different Coursera MOOCs. We use *ECI enrollees* to refer to all learners who registered for the ECI MOOC. We use *ECI participants* for all learners who participated in the course in some way (i.e., accessing a lecture, posting on a discussion forum, or completing a quiz), and *ECI completers*, for all learners who accessed a lecture or completed a quiz at least once in all four sessions of the course. By the time the course closed, there were 26,812 ECI enrollees. Among those enrolled, there were 10,006 ECI participants (37% of enrollees) who engaged in the course in some way, and there were 4,681 ECI completers (18% of all enrollees, and 47% of all participants), who accessed a lecture or completed a quiz at least once in all four weeks of the course. The present study focuses on the engagement and learning of all learners who engaged in the course in some way (i.e., participants and completers).

We present demographic data obtained from ECI participants who responded to a voluntary pre-course survey (n=1,951; Table 1). The majority of survey responders were women (92%) and between the ages of 25 and 45 (54%). Most (53%) were from the United States, and a majority were native English speakers (59%). Most survey responders had at least a college degree (77%) and were or are currently teaching (82%); the majority of those with teaching experience, had worked specifically with young children.

Procedure

The ECI course was offered as a free MOOC on Coursera in the fall of 2013. Upon registering for the course, enrollees were asked to complete a pre-course survey including a consent for participation in the study. Following the pre-course survey, course content was made available to all enrollees for their free and open engagement.

Throughout the duration of the course, the Coursera website tracked learners' engagement with the various aspects of the course design.

ECI MOOC Design

The ECI MOOC was four weeks/sessions long and each session consisted of 8 to 11 video lectures available for download/streaming (typically between 5-8 minutes each), an open discussion forum area for posts and comments from anyone in the course, a "Test your Knowledge" quiz, and an optional homework assignment (see Table 2). Video lectures focused on providing teachers with definitions and scenarios of effective teacher-child interactions as described in the CLASS-Pre-K (Pianta, LaParo, & Hamre, 2008): Positive Climate, Teacher Sensitivity, and Regard for Child Perspectives. The course also included video lectures instructing teachers on the Banking Time approach for developing positive relationships with more challenging students (Pianta, 1999). In lectures focused on each of these areas, the instructor provided descriptive information about the given concepts (e.g., Positive Climate, Teacher Sensitivity, Regard for Student Perspectives), and video examples to help learners see these concepts embodied in real classrooms. The discussion forums in each session included prompts to help learners make meaning of the content in the lectures. For instance, learners were asked to "Share one way you plan to create a more Positive Climate in your classroom." ECI MOOC instructors moderated these discussion forums by asking follow up questions and providing responses to questions asked by participants. Additionally, there were general discussion forums open for the duration of the course that were available for students to voluntarily join and participate in, without the use of prompts; these included forums such as the "Head Start Teachers' Lounge," "International Teachers' Lounge," and

"Technical Issues." Each session also included a "Test your Knowledge" quiz. These quizzes included 10-14 multiple choice and true/false questions about the lecture content. Questions focused on the learner's ability to describe and identify the concepts in action; for instance, learners were asked to choose the definition that best fits a given dimension of teacher-child interaction, or a teacher-child interaction scenario was provided and learners were asked to identify the relevant dimension. Quizzes were scored based on the percentage of correct answers a learner provided. At the conclusion of the four-weeks of the course, learners received final grades which were calculated based on their performance on quizzes (80% of the final grade) and their completion of at least 10 discussion forum posts (20% of the final grade.

Measures

Pre-course questionnaire. In this study we used well-established measures with strong prior evidence of reliability and validity, as will be described below. However, several modifications were made. First some scales that are typically used only with teachers were modified for use with a broader set of MOOC learners (e.g., changing the word 'teacher' to 'adult'). Additionally, due to a desire to keep the survey short, many of the scales used in this study were shortened from their full versions. In these cases, we used data from other similar studies in which we had given the full survey to derive a subset of items that had both strong internal consistency and strong correlations with the full scale score. More details are provided below, and all reports of internal consistency are based on the subsample of participants who completed the pre-survey (n = 1,951).

Demographic and Professional Backgrounds. Participants' demographic characteristics, and professional backgrounds, were obtained through the pre-course

survey. Demographic characteristics included age, gender, and whether their primary language was English. Professional background characteristics included whether the learners were current students in an education program, their highest level of education attained, whether they have ever taught, and whether they were current preschool teachers at the time of the course. Participants also responded to a several scales regarding their psychological beliefs.

Psychological beliefs.

Adult-centered beliefs. Adult-centered beliefs about children were measured with a subset of 7 items from the 16-item Modernity Scale (Schaefer & Edgerton, 1985), This Likert-type questionnaire uses 5-point scale that discriminates between "traditional" or relatively adult-centered perspectives on interactions with children and more "modern or progressive" child-centered perspectives. Scores are derived by computing the mean of all items, with child-centered beliefs reversed-scored. Items used for this study included, "Children must be carefully trained early in life or their natural impulses will make them unmanageable"; "In order to be fair, a teacher must treat all children alike"; and, "The most important thing to teach children is absolute obedience to whoever is in authority." The internal consistency of these 7 items within the current sample was .85.

Teaching efficacy. An abbreviated and slightly revised version of the *Teacher Sense of Efficacy Scale* (Tschannen-Moran & Woolfolk Hoy, 2001) was included to assess participants' views on how effectively they could support children's learning and development. The four items used in this study were: "How often can you motivate children who show low interest in activities?"; "How much can you do to help children in your classroom value learning?"; "How often can you get children to believe they can do

well on activities?"; and "How much can you assist families in helping their children do well in school?". The response scale ranged from "Nothing" (1) to "A great deal" (5). Longer versions of this scale have been used extensively in research on educators (cites). The internal consistency in this sample was .76.

Expectancy-Value-Cost. Based on motivational theory participants were asked about their perceived expectancy, value, and cost for taking the course using a shortened version of (Kosovich, Hulleman, Barron, & Getty, 2014). Expectancy was assessed with 3 items including "How confident are you that you can be successful in this class." Value was assessed with 3 items including "How important is this class to you". Cost was assessed with 3 items including "How stressed out do you think you will be from this class". Prior research with middle school, high school, and college students demonstrates the scale has acceptable internal consistency (alpha's from .7-.9), and predictive of student learning outcomes such as topic interest and grades (Grays, 2013; Hulleman et al., under review; Kosovich et al., 2014). Internal consistency for these three scales were .82, .83, .69, respectively.

Grit. Participants' grit was measured using the 8-item Grit scale (Duckworth & Quinn, 2009). Items included: "I am a hard worker"; "I finish whatever I begin"; and "Setbacks don't discourage me." Participants responded to a 5-point Likert scale ranging from "not at all true of me" (1) to "completely true of me" (5). This scale has been used in numerous contexts with consistent evidence that grit predicts perseverance and completion of activities in professional domains in general (Duckworth, Peterson, Matthews, & Kelly, 2007), and specifically in the teaching profession (Robertson-Kraft & Duckworth, 2014). The internal consistency in this sample was .75.

ECI Participant Engagement. Engagement in the online course was obtained through end-of-course web-log data provided by Coursera and consisted of four main components: lectures accessed (downloaded or streamed), discussion forum activity, quiz completion, and optional homework assignment completion.

***Lectures accessed*.** For each session of the course there were several pre-recorded instructor video lectures available to participants to either download or live-stream. The percent of lectures viewed represents the total number of lectures that a participant either live-streamed or downloaded, according to the web log data file from Coursera, divided by the total number of lectures offered for the duration of the course.

***Quiz completion*.** At the end of each session of the course, a "Test Your Knowledge" quiz with 10-14 multiple-choice questions, was offered. Learners were required to answer all questions on the quiz in order to submit it and receive credit for quiz completion that session. Quiz completion is a measure of engagement and does not represent learning.

***Discussion forum activity*.** Throughout the duration of the course, a discussion forum area of the Coursera site was available to participants. Participants were able to either write an initial post on a given forum or write a comment (a response to another participants' post). Learners were required to make a cumulative 10 posts or comments throughout the duration of the course to receive full credit for discussion participation, which composed 20% of the participants' final grades. A score represents the total number of posts or comments each participant made throughout the course.

Optional homework activity completion. Four times throughout the course, once each session, participants were given the option to enact the principles of the session in

their classrooms, video-record their teaching, and view and reflect on their interactions with children. Learners were able to earn extra credit for completing the homework activities by writing about their reflections in an online form on the course site. Assignments were presented as extra credit, alongside the lectures and quizzes provided each week of the course. The assignments were not graded, and thus it is possible that participants simply entered meaningless information into the form that tracked homework completion. An analysis of session 1 homework suggests this was rarely the case, with almost all answers containing meaningful and relevant information.

ECI Participant Learning. Evaluations of participants' learning was based upon two main components: quiz scores, and course grades.

Quiz Scores. Quiz scores for each session were computed by dividing the number of correct answers by the total number of questions on each quiz. The scores from the four quizzes were then averaged, with zeroes included for quizzes not taken; all quizzes were given equal weight.

Course Grades. Course grades were computed by combining learners' quiz scores and discussion forum participation. Learners' average quiz scores accounted for 80% of their final grades. Discussion forum participation of at least 10 posts or comments accounted for 20% of final grades, with partial credit given for those who had fewer than 10 posts or comments.

Analyses

Basic descriptive analyses are provided on course engagement among all ECI participants (n = 10,006). To test the amount of variability in engagement explained by teachers' demographics, professional backgrounds, and psychological beliefs, we

conducted a series of linear regressions. We examined a separate linear regression model for each of the participation outcomes: (1) percent of lectures viewed, (2) number of discussion forum posts and comments, (3) number of quizzes completed, and (4) number of optional homework assignments completed. Additionally, we conducted a logistic regression, where course completion (i.e., whether a person was classified as an ECI Completer), was examined as a binary outcome. We simultaneously included all predictors in the regression models, thereby controlling for the effects of each. Analyses were run in Mplus version 7, using full information maximum likelihood estimation (FIML), which employs all available data when estimating parameters, thus increasing the precision and accuracy of the estimated parameters (Enders & Bandalos, 2001). While an activity log in Coursera collected engagement data from all ECI participants (n = 10,006), there is a measurable amount of missing data on learners' characteristics, as these data are taken from the pre-course survey, which was voluntarily completed by 1,951 participants. As a result, we have engagement data on the full sample of ECI participants, but only have learner characteristic data on those who completed the pre-course survey (n = 1,951).

Although data are not available to suggest how well these survey responders represent the larger group of ECI participants, we do know that survey responders were more engaged in the course than ECI participants who did not complete the survey. All survey responders were part of the group of participants, with 61.30% of survey responders being completers. Survey responders finished more sessions (M =2.38, SD = 1.85) than those who did not respond to the survey (M = 1.61, SD = 1.84); they also made more discussion posts and comments (M = 9.91, SD = 7.80 compared to M = 8.72, SD =

7.59), and received higher grades (*M* =38.86, *SD* = 42.18 compared to *M* =10.94, *SD* = 27.43). These differences were statistically significant and practically meaningful (F(1, 9863) = 268.77, F(1, 9863) =22.3, F(1, 9863) = 2214.41, respectively). Thus, caution must be taken in inferring to the larger pool of ECI participants, knowing that the study sample for analyses that include survey data over-represent more engaged learners. We used FIML to estimate the parameters for the sample of 10,006 participants. We also ran identical analyses without using FIML, on the smaller sample of those who had pre-course survey data, and found highly consistent results; therefore, FIML results are reported. It is also important to note that due to the large sample size in the present study, we limit presentation and discussion of significant results to those with a *p*-value less than or equal to .01, with the exception of results regarding homework participation where we present significant results with a p-value less than or equal to .05 as the sample of participants who completed homework was much smaller (n=462). The tests of the standardized regression coefficients from these models are presented in Tables 5 and 6.

Results

Description of ECI MOOC Engagement

A total of 4,681 learners (17.5% of all enrollees, and 47% of all participants) completed the ECI MOOC, as defined by accessing at least one lecture or quiz in all four weeks.

Lectures accessed. Table 3 demonstrates that almost all ECI participants (98%), and all ECI completers (100%), accessed at least one lecture in the course. Thirty-seven percent of ECI participants, and 79% of ECI completers accessed all lectures in all four sessions (a total of 36 lectures). As Figure 1 displays, the number of lectures accessed by

ECI participants lessened over time, decreasing most significantly during the first session and decreasing less rapidly for the remainder of the course. Of the total 36 lectures, the average ECI participant accessed 25% (12 lectures, SD = 29.09). However, as displayed in Figure 2, there was significant variability with almost a third of ECI participants accessing 20% or fewer of lectures and over 40% accessing over 90% of lectures; many fewer participants fell in the middle of the distribution.

Quiz completion. Over half of ECI participants (52%), and all of ECI completers (100%), completed at least one end-of-session quiz. Over a third (38%) of ECI participants completed all four end-of-session quizzes. Quiz completion over time mirrored that of lectures, with significant declines each session: session 1 (n = 5087; 51% of participants); session 2 (n = 4375; 44% of participants); session 3 (n = 4047; 40% of participants); and session 4 (n = 3847; 38% of participants).

Discussion forum activity. Almost half of ECI participants (45%), and almost all ECI completers (97%) engaged in discussion forums. Among the 4,396 ECI participants who engaged in discussion forms, there were a total of 28,982 posts or comments. Almost half of ECI participants (45%) made 8 or fewer posts or comments. About a third (30%) made between 9-12 posts or comments, and a smaller proportion (10%) demonstrated very high engagement in this component, making 17 or more posts or comments.

Optional homework assignment completion. Optional homework assignments had low levels of engagement among all learners. These assignments, which required learners to enact what they were learning in the classroom, videotape it, and analyze their interactions with children, were completed by a very small number of learners. Ten

percent of ECI participants, and 22% of ECI completers, completed at least one homework assignment. Homework completion also declined over time, with 9.2% (n=922) of participants completing homework for session 1, to 5.6% (n=564) of participants for session 4.

Description of ECI MOOC Learning

Quiz scores. Quiz results suggest most ECI participants were engaged enough in course materials to answer knowledge questions about the content. Table 4 shows results from the "Test Your Knowledge" quizzes that were included at the end of each session. The average for each quiz, upon learners' first attempt, was over 80%, with quiz scores remaining fairly stable over time, and very few learners scoring below 50% on any quiz. Learners were able to take quizzes multiple times, for the purposes of increasing their mastery of the content, but we do not use this data in the present study.

Grades. Figure 3 shows a distribution of final grades based on the number of sessions or weeks learners participated in. This figure demonstrates that most participants who accessed at least one lecture or at least one quiz in all four sessions (ECI completers) did well in the course, with 53% scoring 81% or above.

Another important grade metric is receiving a statement of accomplishment, or a statement of accomplishment with distinction. Statements of accomplishment were given to learners with overall course grades of at least 75%, while statements of accomplishment with distinction were awarded for learners with overall course grades of 90% or higher. Twenty-eight percent of ECI participants received a statement of accomplishment, with a smaller number (17%) receiving statements of accomplishment

with distinction. Among ECI completers, 60% received statements of accomplishment, with 36% earning statements of accomplishment with distinction.

Predictors of Course Engagement and Learning

Table 5 presents results of linear regression models predicting ECI participant engagement as measured by percent of lectures accessed, number of discussion forum posts/comments, number of quizzes completed, and whether or not the course was completed.

***Percent of lectures accessed*.** Older ECI participants and those who were current preschool teachers accessed more lectures. In contrast, participants with higher self-reported teaching efficacy accessed fewer lectures. Reporting that one had a grittier personality was the strongest predictor of accessing lectures overall, with ECI participants of grittier personalities accessing a significantly higher percentage of lectures (b = .13). Other factors were not significantly related to lecture engagement.

***Quiz completion*.** Older participants, females, those whose primary language was English, and current preschool teachers completed more quizzes. As with the percent of lectures accessed, higher teaching efficacy was associated with completing fewer quizzes. ECI participants' grit emerged again as the strongest significant predictor of quiz completion (b = .20), with grittier personalities being associated with completion of more quizzes.

***Engagement in discussion forums*.** Participants whose primary language was English, current preschool teachers, those who value the subject area, and those who reported a grittier personality, all had more posts/comments in discussion forums throughout the course. Valuing the subject area was the strongest predictor for this outcome (b = .11), with grit being a strong predictor as well (b = .10).

Course completion. Course completion is a binary outcome, representing whether an ECI participant was an ECI completer (i.e., accessed at least one lecture or at least one quiz, in all four sessions of the course). Results showed that older participants, current preschool teachers, and those who reported lower levels of teaching efficacy were significantly more likely to be ECI completers. As with the other participation outcomes, grit was the strongest predictor of course completion, with grittier ECI participants being more likely to complete the course by almost a half of a standard deviation (b = .49).

Quiz scores and final grades. Participants' quiz scores and final grades represent a measure of their learning throughout the course. We conducted additional linear regression models to estimate the degree to which course engagement—in the form of accessing lectures, and posting or commenting on discussion forums—as well as the previously described learner characteristics, were related to learning outcomes. Results (Table 6) indicated that both engagement in lectures and discussion forums were significantly related to ECI participants' quiz scores and final grades, with greater engagement leading to higher quiz scores and higher final grades. Additionally, younger participants, those who had higher levels of education, and those with less authoritarian beliefs about children, performed better on quizzes. Grades were higher for participants whose first language was English, but other participant characteristics were not associated with grades. Interestingly, grit was not significantly related to performance on quizzes or final grades, despite being a significant predictor of all measures of engagement.

Discussion

The ECI MOOC, offered through a partnership between the University of Virginia and Coursera, demonstrated the feasibility of using MOOC's as one way to address the significant educational and professional development needs of the current early childhood workforce. The 10,006 participants in the ECI course were a very diverse group in terms of age, country of residence, and educational backgrounds. But data also suggest that the course reached its intended audience, with 82% of participants having teaching experience and the majority reporting that they were currently teaching young children. There was a course completion rate of 17.5% of all enrollees, which is a relatively high compared to other MOOCs, which have average completion rates of 10% by some estimates (Breslow et al., 2013), and 5% by some more stringent criteria (Koller et al., 2013). Importantly, most participants also seemed to learn from the course materials, as indicated by relatively high levels of performance on quizzes. Although we have much to learn about the potential of MOOC's to support the learning and development of early childhood workforce, this is clearly an avenue that should be further explored.

ECI MOOC Participation and Learning

Online coursework has great potential to support the learning and teaching skills of the early childhood workforce (Locasale-Crouch et al., 2016). But there are many questions about the extent to which early childhood educators will make use of these types of learning opportunities. In earlier research, a smaller sample of ECE teachers taking a longer 14-week version of the ECI course that was offered online through the University of Virginia, demonstrated high levels of engagement and learning (Hamre,

Locasale, Neesen, 2014; Locasale-Crouch et al., 2016). Particularly notable is that teachers who took that course, as compared to those who did not, made significant changes in their teaching practice as measured by video and live observations of teachers' practices (Hamre et al., 2014). The current study adds to this line of research by assessing the degree to which similar coursework, delivered as a MOOC, might engage a broad spectrum of early childhood teachers and whether they would demonstrate persistence in taking the course.

MOOC completion rates are defined in different ways, depending on the given course; in the ECI MOOC, 4,681 learners (17.5% of all those who enrolled) met our qualification for completing the course (i.e., accessing a lecture or completing a quiz at least once in all four weeks of the course). However, Koller et al. (2013) defined Coursera course completion as earning a credential signifying official completion of the course (i.e., receiving any statement of accomplishment), and reported that in total roughly five percent of students who enrolled in a Coursera MOOC earned this credential. In the ECI MOOC, a slightly higher percentage than the Coursera average earned a credential signifying official completion of the course (6.2% of all those enrolled).

One major limitation in the ECI MOOC was the lack of observational data on learners' classroom practices. Thus, we do not have information to determine whether online learning about interactions is translated into improvements in classroom practice. In the ECI MOOC, participants were encouraged to complete optional homework assignments that asked them to take what they learned about interactions each session and try it out in the classroom. They were asked to videotape their practice and then

watch and reflect on how well they were able to enact the practices they learned about online. Participants who completed these reflections received extra credit. However, we did not have them upload their video recordings because we did not have the resources to grade this homework or provide feedback in any way. Thus it isn't surprising that only a small minority of participants completed the homework.

Our prior work suggests that completing these elements of homework, and having "coaching" discussions about them with their instructor, are essential for most teachers to actually make improvements in their classroom teaching (Hamre, 2014). Future work on MOOCs should focus on finding ways to provide more robust feedback and support to students. With advances in technologies that allow for peer-scoring of homework in MOOCs (Piech et al., 2013) as well as a growth in online tools that allow for video upload and analysis, future versions of the ECI MOOC or similar courses are likely to have a great impact on actual teaching practice.

Characteristics of Learners Associated with ECI Participation and Learning

There are very few studies examining factors that contribute to participation and learning in MOOCs more generally (Greene, Oswald, & Pomerantz, 2015) and none that we know of within the ECE field. The few studies in this area have tended find that learners' level of commitment and alignment with goals are important predictors (e.g., Greene et al., 2015) and typically tend to find very few associations with demographic characteristics such as age. The findings reported here offer several new insights. Similar to findings from previous studies, there is evidence that learners who had jobs that were aligned to the content of the course, in this case being a preschool teacher, were more likely to watch lectures, join discussion forums, complete quizzes, and finish the

course. Interestingly, participants who were preschool teachers did not receive better scores on quizzes or grades than those who were not. Prior studies have had mixed findings related to the age of learners and course completion. In line with several other studies of online professional development in the early childhood field, older participants were more likely to complete more of the course than were those who were younger (Downer et al, 2009; McNamera, 2010; Vu et al., 2014). Finally, and not surprisingly, those who reported their primary language was English participated more in discussion forums and completed more quizzes.

Only a few prior studies have examined how psychological factors such as teaching self-efficacy and grit may contribute to course engagement (e.g., Cho et al., 2010). The strongest and most consistent predictor of engagement in the ECI MOOC was learners' self-reported grit. Grit is the tendency to sustain interest in and effort toward very long term goals (Duckworth et al., 2007). Self-reported grit is a strong predictor of a variety of educational and professional outcomes (Duckworth & Gross, 2014), thus it is not surprising to find this association here. This finding is consistent with prior work showing that students who reported being more self-regulated learners were more committed to online coursework (Cho et al., 2010). A future version of the ECI MOOC and other similar courses may promote more engagement by incorporating more ongoing assessment and instant feedback structures (e.g., quizzes after every lecture as opposed to once per session), which have been shown to support less self-regulated learners in online learning (A. Domínguez et al., 2013; Jang, Park, & Yi, 2015).

Interestingly, the results of this study also suggest that learners who reported feeling less self-efficacious as a teacher were more likely to engage more frequently in

the course materials. This finding runs counter to some prior work showing higher engagement in online professional development for teachers who reported greater self-efficacy (Downer et al., 2009). It seems likely that ECI MOOC participants with lower initial self-efficacy may have had greater motivation to take the course as a way of learning information that would help them feel more efficacious over time (Wheatley, 2002). It may also be that the sample in this study of MOOC participants is quite different from that in typical studies of professional development which include convenience samples of teachers who volunteer. To better understand these findings we need to understand more about why certain ECE teachers decided to sign up for MOOCs in the first place. This is an area in which a mixed-methods study could lend a great deal of knowledge by utilizing interviews to understand teachers' motivations and triangulate this information with quantitative data on their engagement in online coursework.

One other teacher characteristic assessed in this study was teachers' beliefs about children. Numerous studies show that teachers with more authoritarian beliefs about children are less likely to engage in the types of interactions that were a focus of the ECI MOOC (e.g., Pianta et al., 1995). Although authoritarian beliefs were not a significant predictor of engagement in the MOOC, they were negatively associated with quiz scores, suggesting that participants with more authoritarian beliefs did not perform as well as participants with less authoritarian beliefs. This inverse relationship may have been due to the psychological construct of cognitive dissonance, which suggests that learners may feel uncomfortable experiencing material that is incongruent with their personal beliefs (Festinger, 1962). This is another area in which a qualitative or mixed method study may

help us better understand the ways in which teacher beliefs influence their ability to benefit from course material.

Limitations and Future Research Directions

We expect that ECI MOOC participants were a highly motivated and self-starting group of learners. Thus it is hard to know how much the findings reported here would generalize to a more typical set of early childhood teachers. However, given the estimated need for at least 100,000 early childhood teachers with the knowledge and expertise to support young children's learning and development (Whitebook et al., 2014), we need to be thinking of new ways of reaching this workforce. One novel new approach to this work is EarlyEdU (http://www.earlyedualliance.org/). EarlyEdU is a collaborative among institutes of higher education in ten states that started in 2015, that offers in-person and online courses on numerous topics in early childhood – all drawing from the latest science. Two of the online courses focus on teacher-child interactions and draw directly from ECI. However, EarlyEdU is novel in that it is providing this content to other institutes of higher education so that ECE teachers in participating states can receive credit for these courses from a local institution. A pilot of these courses just began in January 2016 and so we will learn more about engagement and learning outcomes as these courses move forward.

Scholars in the field of online education are rapidly learning more about ways to effectively build and implement online courses in ways that are most likely to support learning. As this work moves forward, it is important that research on teacher education courses both integrate this knowledge as well as push on the ways in which online

learning must be developed to support the unique needs of teachers. In particular, finding ways to support the application of knowledge into daily practice is of central importance.

This study did not examine the extent to which participating teachers did actually change their practice, and our assessments of their learning were quite limited. Future research would benefit by including more rigorous examination of the practical impacts of this type of learning and begin to unpack for whom online courses may be a useful option. Given prior work (Hamre et al., 2014), we anticipate that producing changes in teaching practice may require fairly intensive support and guidance from an instructor. However, Joseph and Brennan (2012) demonstrated the value of peer collaborative groups in providing feedback around teaching practices. In that study, the researchers requested that teachers share video recordings of their attempts to engage in the interactions they were learning about with a small set of peers. Teachers' peers then provided feedback using detailed rubrics designed to ensure that the feedback was aligned with course materials. The researchers found that the peer feedback improved their ability to document change in teachers' interactions as well as teachers' abilities to reflect on their own growth. Given limited instructor resources, these peer networks may be a way to better provide the supports needed to change teachers' practice in a way that would scale to meet the needs of large numbers of MOOC participants.

Many states are actively considering changes to their certification and training of teachers. Within early childhood, the recommendations of the Institute of Medicine (Institute of Medicine & National Research Council, 2015) are pushing states to consider ways in which college coursework may be transformed to have a bigger impact on teachers' practice and students learning. This study suggests that MOOCs are one

possibility that should be considered for helping to meet the challenges inherent in these efforts. However, future research will need to explore the implications of course designs that can support a diverse set of learners, and examine a broader range of outcomes to ensure that these investments will pay off.

References:

Barnett, M. (2006). Using a Web-Based Professional Development System to Support Preservice Teachers in Examining Authentic Classroom Practice. *Journal of Technology & Teacher Education*, *14*(4), 701 – 729.

Bates, A. T. (2005). *Technology, e-learning and distance education*. Routledge.

Beaudoin, M. F., Kurtz, G., & Eden, S. (2009). Experiences and Opinions of E-learners: What Works, What Doesn't, and What Competencies Ensure Successful Learning. *Interdisciplinary Journal of E-Learning & Learning Objects*, *5*, 275.

Cavanagh, S. (2013). Rapid rise seen in use of digital tools for PD. *Education Week*, *6*(3), 10.

Cho, M.-H., Demei, S., & Laffey, J. (2010). Relationships Between Self-Regulation and Social Experiences in Asynchronous Online Learning Environments. *Journal of Interactive Learning Research*, *21*(3), 297–316.

Cho, M.-H., & Jonassen, D. (2009). Development of the human interaction dimension of the Self- Regulated Learning Questionnaire in asynchronous online learning environments. *Educational Psychology*, *29*(1), 117–138. http://doi.org/10.1080/01443410802516934

Colvin, K. F., Champaign, J., Liu, A., Zhou, Q., Fredericks, C., & Pritchard, D. E. (2014). Learning in an introductory physics MOOC: All cohorts learn equally, including an on-campus class. *The International Review of Research in Open and Distributed Learning*, *15*(4). Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/1902

Cusack, A. (2014). A handy cheatsheet on MOOCs. Retrieved July 28, 2015, from https://www.edsurge.com/n/2014-01-10-a-handy-cheatsheet-on-moocs

Deterding, S., Khaled, R., Nacke, L. E., & Dixon, D. (2011). Gamification: Toward a definition. In *CHI 2011 Gamification Workshop Proceedings* (pp. 12–15).

Dickinson, D. K., & Caswell, L. (2007). Building support for language and early literacy in preschool classrooms through in-service professional development: Effects of the Literacy Environment Enrichment Program (LEEP). *Early Childhood Research Quarterly*, *22*(2), 243–260. http://doi.org/10.1016/j.ecresq.2007.03.001

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J.-J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education*, *63*, 380–392. http://doi.org/10.1016/j.compedu.2012.12.020

Domínguez, X., Vitiello, V. E., Fuccillo, J. M., Greenfield, D. B., & Bulotsky-Shearer, R. J. (2011). The role of context in preschool learning: A multilevel examination of the contribution of context-specific problem behaviors and classroom process quality to low-income children's approaches to learning. *Journal of School Psychology*, *49*(2), 175–195. http://doi.org/10.1016/j.jsp.2010.11.002

Domitrovich, C. E., Bradshaw, C. P., Poduska, J. M., Hoagwood, K., Buckley, J. A., Olin, S., … Ialongo, N. S. (2008). Maximizing the Implementation Quality of Evidence-Based Preventive Interventions in Schools: A Conceptual Framework. *Advances in School Mental Health Promotion*, *1*(3), 6–28. http://doi.org/10.1080/1754730X.2008.9715730

Donohue, C., Fox, S., & Torrence, D. (2007). Early childhood educators as elearners. *Young Children*, *1*(6), 34–40.

Driscoll, A., Jicha, K., Hunt, A. N., Tichavsky, L., & Thompson, G. (2012). Can Online Courses Deliver In-class Results? A Comparison of Student Performance and Satisfaction in an Online versus a Face-to-face Introductory Sociology Course. *Teaching Sociology*, *40*(4), 312–331. http://doi.org/10.1177/0092055X12446624

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology*, *92*(6), 1087–1101. http://doi.org/10.1037/0022-3514.92.6.1087

Duckworth, A. L., & Quinn, P. D. (2009). Development and Validation of the Short Grit Scale (Grit–S). *Journal of Personality Assessment*, *91*(2), 166–174. http://doi.org/10.1080/00223890802634290

Duncan, G. J., & Magnuson, K. (2013). Investing in Preschool Programs. *The Journal of Economic Perspectives : A Journal of the American Economic Association*, *27*(2), 109–132. http://doi.org/10.1257/jep.27.2.109

Early, D. M., Maxwell, K. L., Burchinal, M., Alva, S., Bender, R. H., Bryant, D., … Griffin, J. A. (2007). Teachers' education, classroom quality, and young children's academic skills: Results from seven studies of preschool programs. *Child Development*, *78*(2), 558–580.

Early, D. M., & Winton, P. J. (2001). Preparing the workforce: early childhood teacher preparation at 2- and 4-year institutions of higher education. *Early Childhood Research Quarterly*, *16*(3), 285–306. http://doi.org/10.1016/S0885-2006(01)00106-5

Eccles, J. S., & Wigfield, A. (2002). Motivational Beliefs, Values, and Goals. *Annual Review of Psychology*, *53*(1), 109–132. http://doi.org/10.1146/annurev.psych.53.100901.135153

Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling*, *8*(3), 430–457.

Fisher, W. W. (2014). *HLS1X: CopyrightX Course Report* (SSRN Scholarly Paper No. ID 2382332). Rochester, NY: Social Science Research Network. Retrieved from http://papers.ssrn.com/abstract=2382332

Fuligni, A. S., Howes, C., Huang, Y., Hong, S. S., & Lara-Cinisomo, S. (2012). Activity settings and daily routines in preschool classrooms: Diverse experiences in early learning settings for low-income children. *Early Childhood Research Quarterly*, *27*(2), 198–209. http://doi.org/10.1016/j.ecresq.2011.10.001

Gikandi, J. (2013). How can open online reflective journals enhance learning in teacher education? *Journal of Technology and Teacher Education*, *21*(1), 5–26.

Gill, W. E. (2011). *The Ready to Teach Program: A Federal Initiative in Support of Online Courses for Teachers*. Retrieved from http://eric.ed.gov/?id=ED530966

Ginsburg, A., Gray, T., & Levin, D. (2004). Online professional development for mathematics teachers: A strategic analysis. *American Institutes for Research*. Retrieved from http://eric.ed.gov/?id=ED492927

Grays, M. (2013). Measuring motivation for coursework across the academic career: A longitudinal invariance study. *Unpublished Doctoral Dissertation). James Madison University, Harrisonburg, VA.*

Greene, J. A., Oswald, C. A., & Pomerantz, J. (2015). Predictors of Retention and Achievement in a Massive Open Online Course. *American Educational Research Journal*, 0002831215584621. http://doi.org/10.3102/0002831215584621

Hamre, B. K. (2014). Teachers' Daily Interactions With Children: An Essential Ingredient in Effective Early Childhood Programs. *Child Development Perspectives*, *8*(4), 223–230. http://doi.org/10.1111/cdep.12090

Hamre, B. K., Hatfield, B., Pianta, R., & Jamil, F. (2014). Evidence for General and Domain-Specific Elements of Teacher–Child Interactions: Associations With Preschool Children's Development. *Child Development*, *85*(3), 1257–1274. http://doi.org/10.1111/cdev.12184

Hamre, B. K., & Pianta, R. C. (2007). Learning opportunities in preschool and early elementary classrooms. In R. C. Pianta, M. J. Cox, & K. L. Snow (Eds.), *School readiness and the transition to kindergarten in the era of accountability* (pp. 49–83). Baltimore, MD, US: Paul H Brookes Publishing.

Hamre, B. K., Pianta, R. C., Burchinal, M., Field, S., LoCasale-Crouch, J., Downer, J. T., … Scott-Little, C. (2012). A Course on Effective Teacher-Child Interactions: Effects on Teacher Beliefs, Knowledge, and Observed Practice. *American Educational Research Journal*, *49*(1), 88–123. http://doi.org/10.3102/0002831211434596

Hatfield, B. E., Hestenes, L. L., Kintner-Duffy, V. L., & O'Brien, M. (2013). Classroom Emotional Support predicts differences in preschool children's cortisol and alpha-amylase levels. *Early Childhood Research Quarterly*, *28*(2), 347–356. http://doi.org/10.1016/j.ecresq.2012.08.001

Hemmeter, M. L., Santos, R. M., & Ostrosky, M. M. (2008). Preparing Early Childhood Educators to Address Young Children's Social-Emotional Development and Challenging Behavior: A Survey of Higher Education Programs in Nine States. *Journal of Early Intervention*. http://doi.org/10.1177/1053815108320900

Institute of Medicine, & National Research Council. (2015). *Transforming the Workforce for Children Birth Through Age 8: A Unifying Foundation*. Washington, DC: The National Academies Press. Retrieved from http://www.nap.edu/catalog/19401/transforming-the-workforce-for-children-birth-through-age-8-a

Jang, J., Park, J. J. Y., & Yi, M. Y. (2015). Gamification of Online Learning. In C. Conati, N. Heffernan, A. Mitrovic, & M. F. Verdejo (Eds.), *Artificial Intelligence in Education* (pp. 646–649). Springer International Publishing. Retrieved from http://link.springer.com/chapter/10.1007/978-3-319-19773-9_82

Jobe, W., Östlund, C., & Svensson, L. (2014). MOOCs for Professional Teacher Development. In *Society for Information Technology & Teacher Education International Conference* (Vol. 2014, pp. 1580–1586). Retrieved from http://www.editlib.org/p/130997

Johnson, S. R., Seidenfeld, A. M., Izard, C. E., & Kobak, R. (2013). Can classroom emotional support enhance prosocial development among children with depressed caregivers? *Early Childhood Research Quarterly*, *28*(2), 282–290. http://doi.org/10.1016/j.ecresq.2012.07.003

Joseph, G. E., & Brennan, C. (2013). Framing Quality: Annotated Video-Based Portfolios of Classroom Practice by Pre-service Teachers. *Early Childhood Education Journal*, *41*(6), 423–430. http://doi.org/10.1007/s10643-013-0576-7

Kipnis, F., Whitebook, M., Austin, L., & Sakai, L. (2013). *The state of early childhood higher education in New Jersey: The New Jersey early childhood higher education inventory*. Berkeley, CA: Berkeley, CA: Center for the Study of Child Care Employment, University of California at Berkeley. Retrieved from http://www.irle.berkeley.edu/cscce/wp-content/uploads/2013/08/NJ-HEI-REPORT-FINAL.pdf

Koller, D., Ng, A., Chuong, D., & Zhenghao, C. (2013). Retention and Intention in Massive Open Online Courses: In Depth. Retrieved July 28, 2015, from

Kosovich, J. J., Hulleman, C. S., Barron, K. E., & Getty, S. (2014). A Practical Measure of Student Motivation Establishing Validity Evidence for the Expectancy-Value-Cost Scale in Middle School. *The Journal of Early Adolescence*, 0272431614556890. http://doi.org/10.1177/0272431614556890

LaParo, K., Scott-Little, C., Ejimofor, A., Sumrall, T., Kintner-Duffy, V. L., Pianta, R. C., Howes, C. (2014). Student Teaching Feedback and Evaluation: Results From a Seven-State Survey. *Journal of Early Childhood Teacher Education*, *35*(4), 318–336. http://doi.org/10.1080/10901027.2014.968297

Masters, J., Magidin de Kramer, R., O'Dwyer, L., Dash, S., & Russell, M. (2012). The effects of online teacher professional development on fourth grade students' knowledge and practices in English language arts. *Journal of Technology and Teacher Education*, *20*(1), 21–46.

Means, B., Bakia, M., & Murphy, R. (2014). *Learning online: What research tells us about whether, when and how*. Routledge.

Olsen, H., Donaldson, A. J., & Hudson, S. D. (2010). Online professional development: Choices for early childhood educators. *Dimensions of Early Childhood*, *38*(1), 12–18.

Perna, L. W., Ruby, A., Boruch, R. F., Wang, N., Scull, J., Ahmad, S., & Evans, C. (2014). Moving Through MOOCs Understanding the Progression of Users in Massive Open Online Courses. *Educational Researcher*, 0013189X14562423. http://doi.org/10.3102/0013189X14562423

Pianta, R. C. (1999). *Enhancing relationships between children and teachers* (1st ed.). Washington, DC : American Psychological Association,. Retrieved from http://search.lib.virginia.edu/catalog/u2883269

Pianta, R. C., LaParo, K., & Hamre, B. K. (2008). Classroom Assessment Scoring System Manual: Pre-K. Baltimore: Brookes.

Piech, C., Huang, J., Chen, Z., Do, C., Ng, A., & Koller, D. (2013). Tuned Models of Peer Assessment in MOOCs. *arXiv:1307.2579 [cs, Stat]*. Retrieved from http://arxiv.org/abs/1307.2579

Raver, C. C., Jones, S. M., Li-Grining, C. P., Metzger, M., Champion, K. M., & Sardin, L. (2008). Improving preschool classroom processes: Preliminary findings from a randomized trial implemented in Head Start settings. *Early Childhood Research Quarterly*, *23*(1), 10–26. http://doi.org/10.1016/j.ecresq.2007.09.001

Reich, J. (2015). Rebooting MOOC research. *Science Magazine*, *347*(6217), 34–35.

Robertson-Kraft, C., & Duckworth, A. L. (2014). True Grit: Trait-level Perseverance and Passion for Long-term Goals Predicts Effectiveness and Retention among Novice Teachers. *Teachers College Record (1970)*, *116*(3). Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4211426/

Russell, M., Kleiman, G., Carey, R., & Douglas, J. (2009). Comparing self-paced and cohort-based online courses for teachers. *Journal of Research on Technology in Education*, *41*(4), 443–466.

Schaefer, E. S., & Edgerton, M. (1985). Parent and child correlates of parental modernity. *Parental Belief Systems: The Psychological Consequences for Children*, 287–318.

Scott-Little, C., Paro, K. M. L., Thomason, A. C., Pianta, R. C., Hamre, B., Downer, J., … Howes, C. (2011). Implementation of a Course Focused on Language and Literacy Within Teacher–Child Interactions: Instructor and Student Perspectives Across Three Institutions of Higher Education. *Journal of Early Childhood Teacher Education*, *32*(3), 200–224. http://doi.org/10.1080/10901027.2011.594489

Sun, S. Y. H. (2014). Learner perspectives on fully online language learning. *Distance Education*, *35*(1), 18–42. http://doi.org/10.1080/01587919.2014.891428

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, *17*(7), 783–805.

Vu, P., Cao, V., Vu, L., & Cepero, J. (2014). Factors Driving Learner Success in Online Professional Development. *The International Review of Research in Open and Distance Learning*, *15*(3), 120–139.

Whitebook, M., Phillips, D., & Howes, C. (2014). *Worthy work, STILL unlivable wages: The early childhood workforce 25 years after the National Child Care Staffing Study*. Berkeley, CA: Center for the Study of Childcare Employment, University of California, Berkeley. Retrieved from http://ffyf.org/wp-content/uploads/2014/11/Child-Care-Employment-Report-11.18.14.pdf

Williford, A. P., Whittaker, J. E. V., Vitiello, V. E., & Downer, J. T. (2013). Children's Engagement Within the Preschool Classroom and Their Development of Self-Regulation. *Early Education and Development*, *24*(2), 162–187. http://doi.org/10.1080/10409289.2011.628270

Table 1. Demographic data on ECI MOOC Learners

	N	Percent
Female		92
Age	1904	
18-24	187	9.6
25-34	605	31.2
35-44	451	23.2
45-54	372	19.2
55-64	253	13.0
65+	36	1.9
Native English Speaker	1126	58.7
Highest Education	1919	
HS of less	128	6.7
Some college	317	16.5
College Degree	554	28.9
Some grad school	145	7.6
Graduate degree	775	40.4
Teaching Degree Major	932	
ECE	274	29.4
Elementary Education	153	16.4
Secondary Education	58	6.2
Special Education	63	6.8
ESL	116	12.4
Child Development	64	6.9
Other	204	21.9
Ever a Teacher of Children or Adolescents	1587	81.9
Current teacher level	1925	
Infants	133	6.9
Toddlers	260	13.5
Preschool	712	37.0
Kindergarten	340	17.7
1st to 3rd grade	291	15.1
4th to 6th grade	237	12.3
7th to 8th grade	143	7.4
9th to 12th grade	151	7.8
Head Start teacher	122	6.4

Table 2. *Course Content for Effective Classroom Interactions (ECI): Supporting Young Children's Development*

	Title	Learning Objectives	Number of Lessons	Expected length of session
Session 1	Creating Emotionally Supportive Classrooms	• Know how important teacher-child interactions are for supporting children's learning and development. • Know the Teaching through Interactions Framework – that provides a way of organizing and understanding the specific types of interactions that research shows are important. • See examples of effective teaching in each of the broad areas of the Teaching Through Interactions Framework – Emotional Support, Classroom Organization, Instructional Support • Reflect on your own classroom interactions – your areas of strength as well as areas in which you could improve.	9	3 hours
Session 2	Building Positive Relationships with Children – The dimension of Positive Climate	• Know about Positive Climate, what it looks like in preschool classrooms, and how it impacts young children. • See examples of Positive Climate. • Enact and reflect upon these practices in your own classroom.	9	3 hours
Session 3	Providing Individualized Support to Young Children – The dimension of Teacher Sensitivity	• Know about Teacher Sensitivity, what it looks like in preschool classrooms, and how it impacts young children. • See examples of Teacher Sensitivity. • Enact and reflect upon these practices in your own classroom.	8	2 hours
Session 4	Supporting Children's Independence and Sense of Self – The dimension of Regard for Child Perspectives	• Know about Regard for Child Perspectives, what it looks like in preschool classrooms, and how it impacts young children. • See examples of Regard for Child Perspectives. • Enact and reflect upon these practices in your own classroom.	8	2 hours

Table 3. *Global participation and completion data for all enrollees and participants.*

	Total Number	Percent of All ECI Participants (n=10006)	Percent of All ECI Completers (n=4681)
	N	%	%
Downloaded or streamed at least one lecture	9845	98.4%	100%
Downloaded or streamed all lectures	3705	37.0%	79.1%
Completed at least one Quiz	5173	51.7%	100%
Completed all Quizzes	3800	38.0%	81.2%
Participated in Discussion Forums	4542	45.4%	97.0%
Completed at least 1 homework assignment	1019	10.2%	21.8%
Completed all homework assignments	462	4.6%	9.9%
Received any Statement of Accomplishment	2835	28.3%	60.6%
Received Statement of Accomplishment with distinction	1695	16.9%	36.2%

Note: ECI Participants defined as people who accessed at least one lecture, completed at least one quiz, or made at least one post in the discussion forum. ECI Completer defined as people who accessed a lecture or completed a quiz at least once in all four weeks of the course.

Table 4. *Descriptive Statistics on Quiz Scores*

	Total Submissions	Average Score on First Attempt	Percent Scoring 50% or lower
Session 1	5087	85.0% (13.7)	1.9
Session 2	4375	88.5% (14.2)	3.1
Session 3	4047	81.4% (13.5)	3.0
Session 4	3847	81.2% (16.3)	5.7
Average for all Quizzes Completed	5173	84.0% (12.1)	1.7

Table 5
Standardized Coefficients from Models Predicting Participant Engagement in Course Components

Predictor:	Lectures (%)	Discussion Forums	Quizzes Completed	Homework Completion	Course Completion (Binary)
Demographic backgrounds:					
Age	0.098***	0.054*	0.08**	0.037	0.02**
Gender-Female	0.044	0.049*	0.07**	-0.015	0.28
Primary Lang-English	0.035	0.074***	0.09**	-0.013	0.12
Professional backgrounds:					
EdProgram Student	0.042	0.045*	0.04	0.002	0.13
Highest Education	-0.003	0.009	-0.01	-0.037	0.026
Have Taught	0.051*	0.022	0.05*	0.000	0.051
Preschool Teacher	0.084***	0.063**	0.07**	0.041*	0.44**
Psychological Beliefs:					
Teaching Efficacy	-0.117**	-0.033	-0.10**	0.037	-0.44**
Ideas about Children	0.018	-0.016	0.03	0.037	0.13
Value Subject Area	0.060	0.111***	0.08*	0.019	0.10
Career Satisfaction	0.028	-0.032	0.003	0.015	-0.035
Expectancy for Success	-0.004	0.008	0.004	-0.004	0.083
Anticipated Costs	-0.022	0.016	-0.02	0.014	0.006
Grit	0.128***	0.100***	0.20***	0.051*	0.49***

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

Table 6
Standardized Coefficients from Models Predicting Quiz Scores and Final Grades

Predictor:	Quiz Scores (%)	Final Grades (%)
Lectures Viewed	0.19***	0.56***
Posts/Comments	0.10***	0.43***
Age	-0.09**	-0.02
Gender-Female	-0.01	0.02
Primary Lang-English	0.07	0.07***
EdProgram Student	0.04	0.00
Highest Education	0.17***	0.01
Have Taught	0.02	0.01
Preschool Teacher	-0.01	0.00
Teaching Efficacy	-0.03	0.00
Ideas Children	-0.37***	-0.03
Value Subject Area	-0.10	0.01
Career Satisfaction	0.05	-0.01
Expect Success	-0.01	0.01
Anticipated Costs	-0.02	-0.01
Grit	-0.07	0.03

Note. ** = $p < .01$; *** = $p \leq .001$

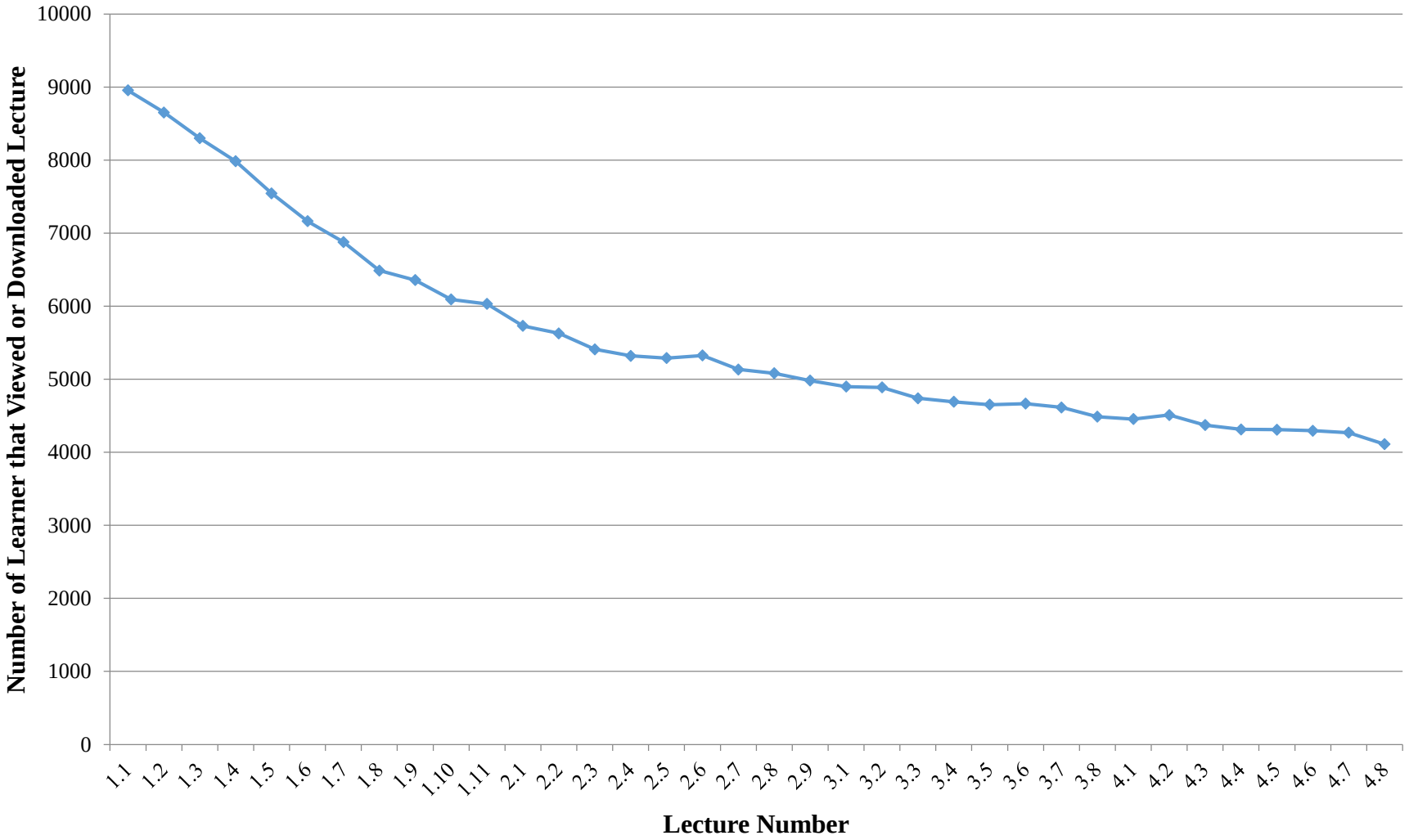

Figure 1. Number of Learners that Viewed or Downloaded Lectures across Sessions

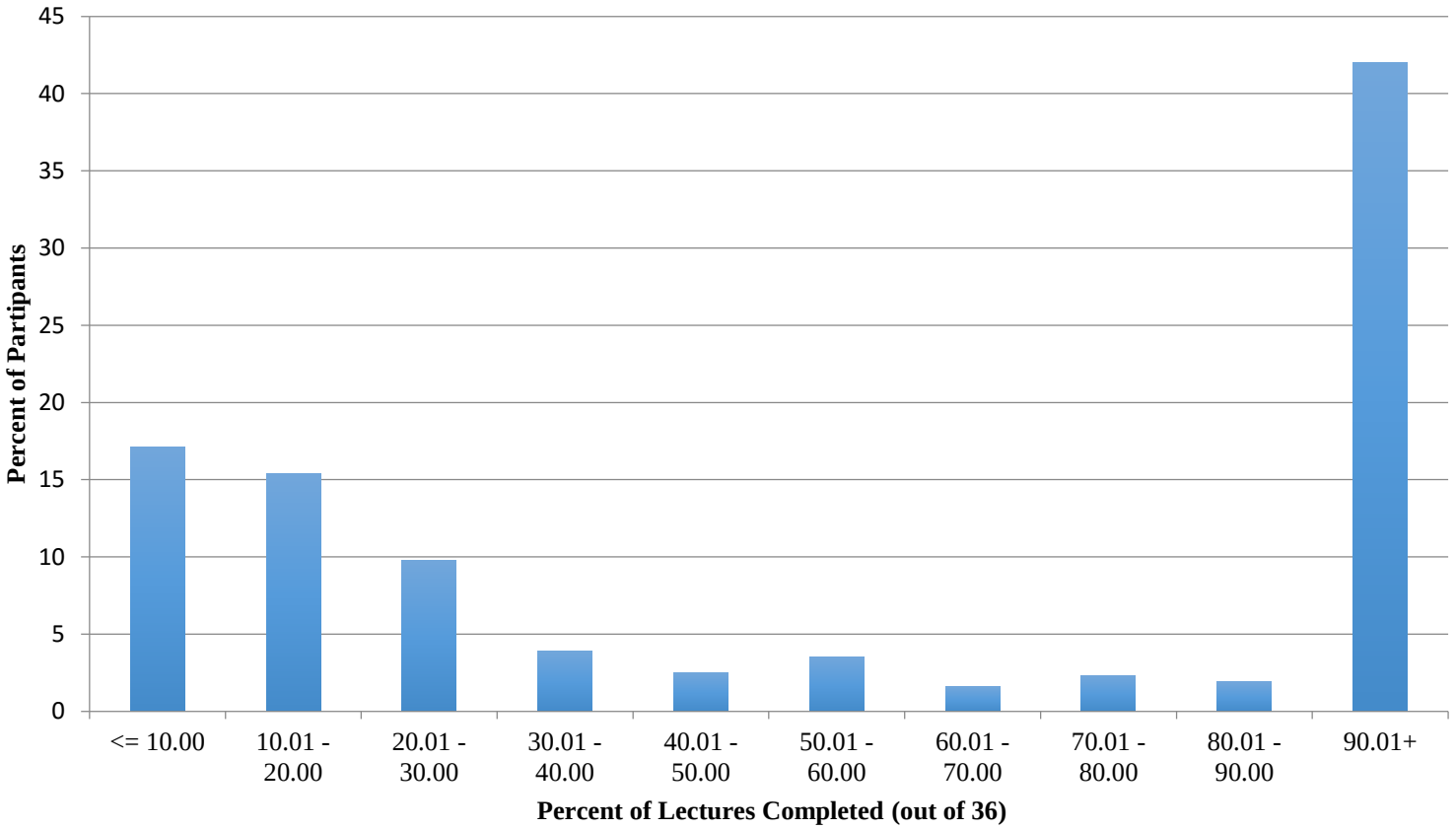

Figure 2. Percent of Participants Completing Lectures

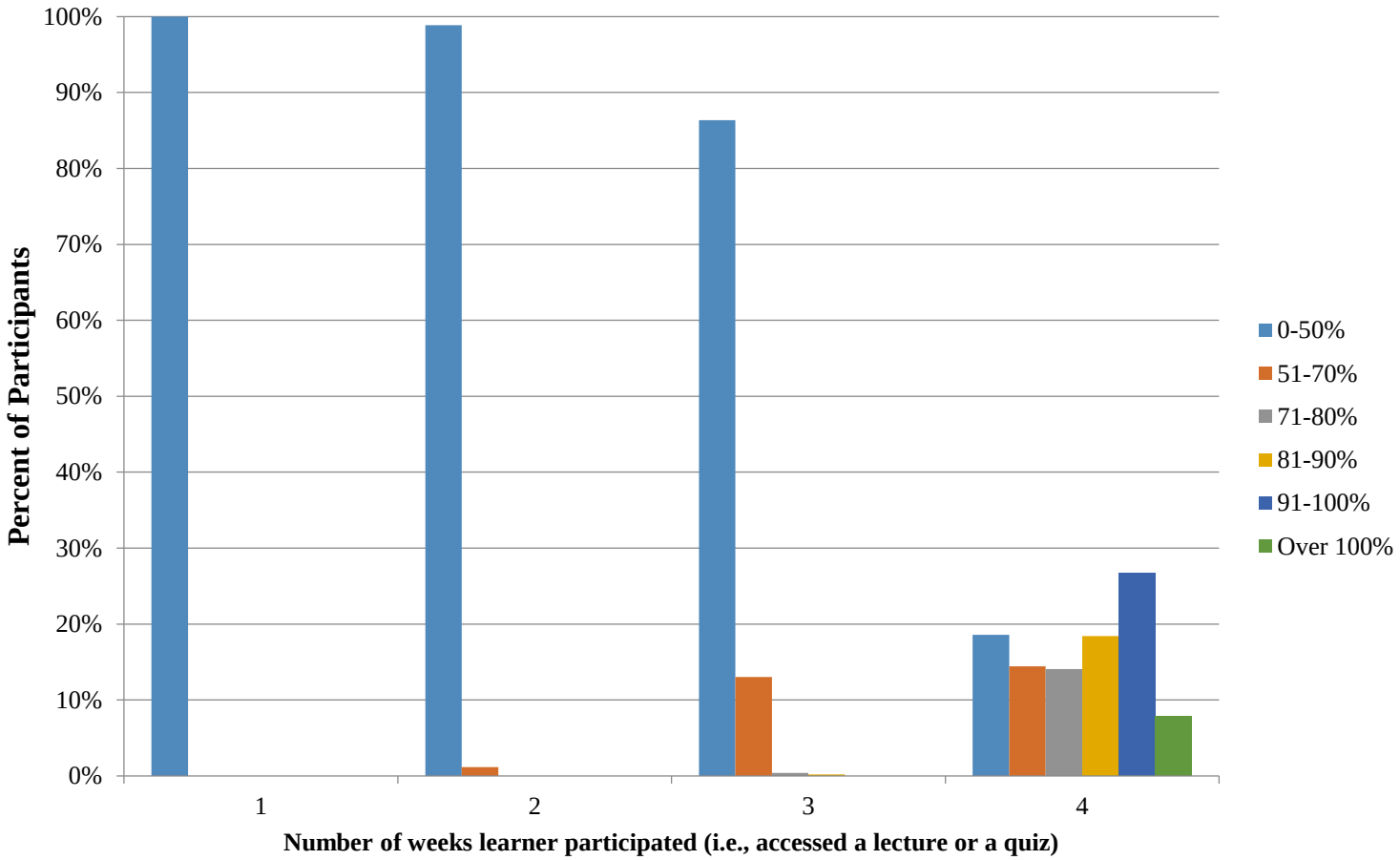

Figure 3. Distribution of Grades by Number of Weeks Learner Participated

Running Head: USE AND PERCEPTIONS OF ONLINE CURRICULAR SUPPORTS

Predictors of Pre-Kindergarten Teachers' Use and Perceptions of Online Curricular Supports

Emily Furnari, B.S.
Jessica Whittaker, Ph.D.
Mable Kinzie, Ph.D.
Emily Barton, B.S.

University of Virginia

Professional development (PD) in early childhood education is receiving national attention as a key strategy for strengthening the quality of teachers' classroom practices, and ultimately, students' achievement (National Association for the Education of Young Children [NAYEC], 2014). However, teachers report challenges to participating in professional development due to time and geographic constraints, and PD providers struggle to provide high quality PD experiences at large scale and affordable costs (Early & Winton, 2001). Online professional development (OPD) is one potential solution, as it can offer flexibility and convenience for teachers, as well as scalability and affordability for PD providers (Gill, 2011; Norris, 2010).

Despite national efforts to develop scalable and affordable online professional development (NAYEC, 2014), there has been little research conducted on teachers' use and perceptions of OPD. Concerning face-to-face PD, researchers have focused on conducting randomized controlled trials to evaluate effects of specific PD programs on student and teacher outcomes (Clements, Sarama, Wolfe, & Spitler, 2013; Ginsburg, Gray, & Levin, 2004; Goldenberg, Culp, Clements, Anderson, & Pasquale, 2014). However, the results of these studies are variable, and have not delivered information about the factors that could account for modest results (Winton, Snyder, & Goffin, 2016), nor have they provided insight into the ways designers can tailor PD programs to meet teachers' specific needs (Hill, Beisiegel, & Jacob, 2013). The relationship between teachers' characteristics, and their use and perceptions of PD programs may explain some of the variability in efficacy of PD (Rimm-Kaufman & Hamre, 2010), and can provide additional insight for the design of future programs. Thus, gathering information about both teacher characteristics and engagement in PD or use of OPD, and utility of PD from

the perspective of teachers, is necessary for creating a knowledge base that can guide researchers and practitioners in the best practices for understanding how to support teachers' participation and engagement in PD (Hill et al., 2013).

Teachers' perceptions of the utility of OPD are particularly important because OPD often requires teachers' *voluntary* and *independent* engagement (Smith & Sivo, 2012), as compared with face-to-face PD, where mandatory attendance is sometimes required by schools or districts (National Association for the Education of Young Children [NAYEC], 2014), and engagement is structured by an instructor. Characteristics of individual teachers may influence their use of or engagement with OPD, and their perceptions of the OPD program.

There are a variety of teacher characteristics that may support or hinder teachers' use of OPD. In particular, teachers' demographic characteristics (i.e., age, education, and experience) (Dusenberry et al., 2003), readiness for professional development (i.e., openness to change, work stress, and attitudes towards PD) (Roberts et al., 2014), technology comfort and habits (Sun, 2014), and quality of teacher-child interactions (Downer, Locasale-Crouch, Hamre, & Pianta, 2009), may be associated with their use and perceptions of OPD.

In the present study, we examined pre-kindergarten (pre-k) teachers' use and perceptions of one type of OPD: online curricular supports that were provided in conjunction with written curricula in mathematics and science. We explore associations between teachers' characteristics (i.e., demographic characteristics, readiness for professional development, teacher-child interaction quality, and technology comfort and habits), and their use and perceptions of the online supports. Understanding how

teachers' unique characteristics relate to their use and perceptions of OPD can inform a new knowledge base for the best practices aimed at supporting a diverse population of teachers in their engagement in online professional development.

Online Professional Development for teachers

Current understandings of PD for teachers suggest that professional development should be ongoing, focused explicitly on practices, and include demonstrations of these practices, in order to be effective at producing teacher and student outcomes (Winton et al., 2016). However, providing access to these kinds of experiences for a growing population of early childhood teachers (NAYEC, 2014) can be challenging due to logistical (i.e., time and geographic), and monetary constraints (Early & Winton, 2001). OPD offers one scalable approach to meeting the need for large scale professional development focused on classroom practices, and provides convenience and flexibility for teachers (Norris, 2010). Additionally, there is evidence that OPD can help pre-k teachers improve the quality of their classroom interactions (Pianta et al., 2008), and produce gains for children (Mashburn et al, 2010). In order to provide context for the online curricular supports that are central to the present study and situate them in the larger body of PD research (both OPD and face-to-face), we describe PD in terms of structure (degree of formality), and delivery format (online, face-to-face, or hybrid).

Concerning structure of PD, Jones and Dexter (2014) define all teacher professional development as being one of three different structural types (i.e., formal, informal, and independent), based on the level of support or encouragement teachers receive from their environment (e.g., school leadership, other teachers, or themselves). Formal PD is initiated and structured by leadership, such as a school principal, other

entities partnering with the school leadership. In contrast, informal and independent PD are initiated by teachers, such as when teachers engage with colleagues within their own school networks (informal), or with available digital learning materials or professional learning networks (independent). The online curricular supports in the current study are unique in that they are both formal and independent, because they are provided by a university partnering with school leadership, but at the same time teachers' use of the online supports is independently-initiated, rather than directly guided or structured by leadership.

Across delivery channels (i.e., online, hybrid, or face-to-face), OPD can take on a variety of different forms (e.g., online courses, online learning modules, online coaching, or online supports) (Vu, Cao, Vu, & Cepero, 2014). One of the most common forms of OPD is content-based online support; for instance links to content-based websites providing a combination of activity plans, planning resources, and informational documents (McNamera, 2010). These supports can typically be found on commercial websites (e.g., scholastic.com, teachingchannel.org), and state departments of education, or early care and education training and technical assistance websites (e.g., NAEYC, Head Start National Center for Quality Teaching and Learning) (Bishop, 2006). A novel form of content-based online support, is demonstration (demo) video, presenting real teachers implementing target practices as they interact with students in the classroom. Provision of demo videos has contributed to teachers' satisfaction with PD and improvement in their teaching practices (Barnett, 2006; Pianta et al., 2008; Whitaker, Kinzie, Kraft-Sayre, Mashburn, & Pianta, 2007). The delivery format of the OPD in the

current study can be considered hybrid, because the online curricular supports are supplementary to a printed curricula, and accompanied by five face-to-face workshops.

MTP-M/S Online Curricular Supports

This study focuses on teachers' use of and perceptions about the *MyTeachingPartner-Math/Science* (*MTP-M/S*) online curricular supports, which include a collection of resources provided as a companion to a mathematics and science curricular package. The curricular package includes printed copies of Activity Detail pages containing step-by-step written descriptions of how to implement each activity in the math and science curricula. These descriptions include a series of scaffolds for teachers, such as open-ended questions and probes to help teachers engage students in meaningful instructional interactions, multiple extension options to encourage integration of related knowledge and skills across the classroom day, and adaptations to enable teachers to differentiate the learning experience for children at varying skill and knowledge levels (Kinzie, Vick Whittaker, McGuire, Lee, & Kilday, 2013). The printed curricular notebook also includes two year-long "Trajectory" displays, one for mathematics and one for science, illustrating the ways in which the curricular designs develop children's concept knowledge and skills with curricular activities across the year, and with increasing complexity and depth of inquiry as the year progresses. Teachers can make use of these trajectories for year-long planning purposes, easily reviewing all activities that contribute to the developmental progression in each of the key mathematics and science domains, and learning about children's developmental trajectories in the process. The *MTP-M/S* website is composed of online versions of the Activity Detail pages, and year-long "Trajectory" pages. Exclusive to the *MTP-M/S* website, there are

also Demo Videos provided alongside each Activity Detail Page. Demo videos support teachers by providing real-life exemplars of classroom teachers implementing each of the steps described in the corresponding activity detail plan, with high fidelity and high quality teacher-child interactions. The online curricular supports were designed for independent (i.e., teacher-initiated) use, though they were provided by a formal entity (i.e., the *MTP-M/S* research team who partnered with early care and education center directors/principals). However, simply providing these online supports does not ensure that teachers' will use them, or perceive them as important to their classroom practice.

Teacher Characteristics Associated with Use and Perceptions of OPD

Research on user characteristics and information systems suggests that online learning success is influenced by the characteristics of the learner, in addition to the characteristics of the learning environment (Beaudoin, Kurtz, & Eden, 2009; Sun, 2014). However, in the field of education, there is a dearth of research on the specific characteristics of teachers that predict use and perceptions of OPD, a concern raised by scholars evaluating teacher professional development (Stes, De Maeyer, Gijbels, & Van Petegem, 2012). In our exploration of possible theoretical predictors of teachers' use and perceptions of OPD, we found extant research supporting the examination of teachers' demographic characteristics, readiness for professional development, teacher reported technology comfort and habits, and observed teacher-child interaction quality, as potential predictors of teachers' use and perceptions of the online curricular supports.

We demonstrate these four types of teacher characteristics and their theoretical relations to teachers' use and perceived value of online curricular supports in Figure 1. In addition, a double arrow represents the theorized reciprocal relationship. We discuss the

literature linking these teacher characteristics to their use and perceptions of the supports below.

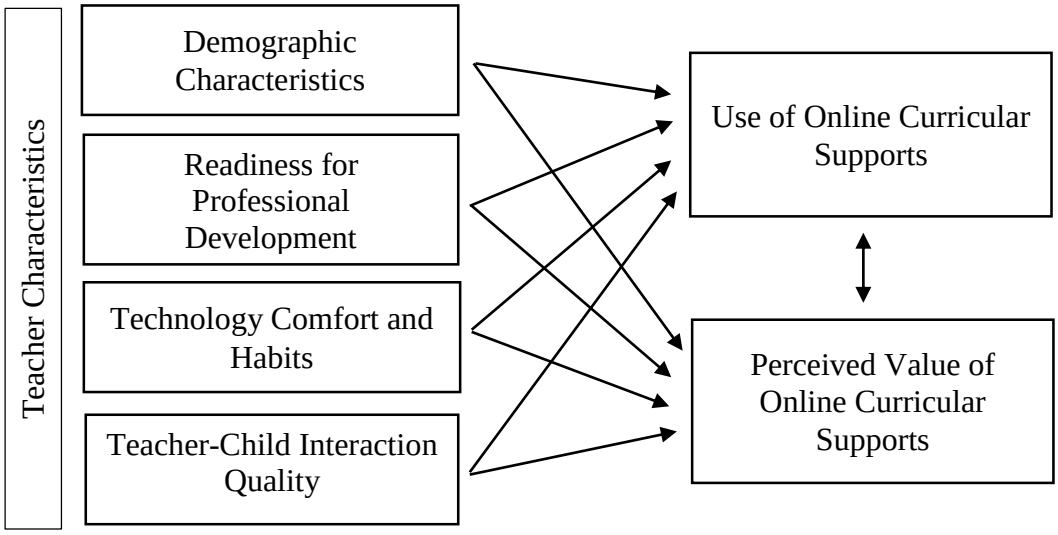

Figure 1. Model demonstrating the theoretical links among teachers' characteristics, teachers' use of online curricular supports, and teachers' perceived value of online curricular supports.

Demographic characteristics. Teacher demographics such as age, education, and years of experience working with children, have been found to be related to teacher engagement in professional development. Specific to OPD, older teachers have been found to participate in online learning more than their younger counter parts (McNamera, 2010; Vu et al., 2014). Older teachers have also been found to be more engaged with an online coaching intervention and its associated online resources (Downer et al., 2009). Teachers' education has been studied in existing literature on teachers' responsiveness to interventions (Domitrovich et al., 2015; Williford, Wolcott, Whittaker, & Locasale-Crouch, 2015), with researchers finding varied results. For instance, Roberts et al. (2014) found that teachers with more years of formal education participated in more coaching sessions, and reported greater satisfaction with an online coaching program. However,

Domitrovich and colleagues (2015) found that teachers' level of education was not related to their implementation of the intervention. Teachers' years of experience has been examined in a study of teachers' use of online coaching resources, where teachers with more experience made less use of the online resources (Downer et al., 2009). In the present study, we hypothesized that older teachers, and teachers' with fewer years of experience, as compared with younger, and more experienced teachers, would use the online curricular supports to a greater extent and would report finding them more useful. Given the finding by Roberts et al. (2014) was in relation to teachers' engagement in an online intervention, we hypothesized that teachers' education in our study, would similarly be positively linked with use and perceptions of the online supports.

Readiness for professional development. We use readiness for professional development to describe three separate factors: openness to change, work-related stress response, and attitudes about professional development, which have been linked to child outcomes in past research (Getzels & Jackson, 1963). More recently, scholars have suggested teachers' openness, stress response, and attitudes about PD, are linked to their development of classroom practices (Rimm-Kaufman & Hamre, 2010; Winton et al., 2016). Openness to change has been found to be influential in research on health behavior change and mental health counseling, and has recently emerged as an important factor in predicting teachers' engagement in interventions (Peterson, 2013). Roberts, et al. (2014), examined teachers' openness to change, and found that teachers who were more open to change attended more coaching sessions, were rated as more engaged by their coaches, and made greater voluntary use of the resources on the coaching website.

We hypothesized that teachers in our study who reported more openness would exhibit greater use of online supports and report greater perceived value in these supports.

Work-related stress, for example feeling that there is not adequate planning time may also contribute to teachers' readiness for professional development. Wagner and French (2010) found that teachers' work-related stress predicted their intrinsic interest in professional development; while Farber and Ascher (1991) discovered that teachers reporting more work-related stress also reported lower levels of job satisfaction and had higher rates of attrition from an intervention study. Given the relatively high implementation requirements of the intervention in the present study (i.e., two math and two science activities every week), we hypothesized that teachers with more work-related stress (e.g., feelings of time limitations) would have less time to prepare for activities and thus would be less likely to use and perceive value in the online curricular supports.

Teachers' attitudes about professional development, are influenced in part by their feelings about past PD experiences. These learner attitudes appear to be critical to their willingness to engage in online learning experiences, and their perceptions of value in these experiences. For instance, in studies of learner attrition from an online course, 42% of those who dropped out did so due to negative attitudes about the learning environment (Chuyung et al., 1998). Additionally, learner attitudes have been found to be a key predictor of course completion, after controlling for demographic characteristics (Levy, 2007). User attitudes towards information systems (i.e., affect, or liking, for using them) have also been found to be positively related to their use and perceptions of information systems (Sabherwal, Jeyaraj, & Chowa, 2006). In the current study, we hypothesized that

teacher-reported attitudes toward professional development would be positively associated with teachers' use and perceptions of the web supports.

Technology Comfort and Habits. Evidence suggests online learners' technology self-efficacy predicts their perceptions of online coursework (Lim, 2001), and is associated with online academic achievement (McGhee, 2010). Anxiety or discomfort with technology is linked to decreased satisfaction with online learning experiences (Arbaugh, 2002; Arbaugh and Duray, 2002; Hong, 2002; Piccoli et al, 2001; Sun et al, 2008). Conversely teachers' technology use habits have been linked to their engagement in online learning, with teachers who report more frequent use of internet technologies such as email and search engines, exhibiting greater engagement in an online professional development module (Sun, 2014). In the current study, we hypothesized that teachers who reported more frequent technology use would be more likely to use and perceive value in the online curricular supports.

Teacher-child interaction quality. In the school-based intervention literature, implementation of various teaching practices has been evaluated through observations of teaching skills (Ringwalt et al., 2003; Rohrbach, Graham, & Hansen, 1993), and quality of teacher-child interactions (Dusenberry et al., 2003). In one study, researchers found that teachers observed to exhibit more emotionally and instructionally supportive classroom interactions, and those with lower quality Classroom Organization, were more engaged in the coaching they received, and were more engaged with the online professional development resources that were provided as part of the intervention (Downer et al., 2009). However, because this is a relatively new area of research with few studies examining the association between initial teaching quality and use and

perceptions of OPD, we do not make a hypothesis regarding the direction of the association between teacher-child interaction quality and use and perceptions of OPD in this study.

The Relationship between Use and Perceptions of Technology

Use and perceptions of technology-based systems are recognized as key measures of system success (Davis, 1989; DeLone & McLean, 1992). In information systems research, user use and perceptions of technology-based information systems have been found to predict important outcomes such as continued use of the technology, realization of the technology's success, and improvement of user job performance (DeLone & McLean, 1992, 2003). More recently, teachers' use and perceptions have been examined as indicators of teachers' voluntary adoption of computer-based learning management systems (Holden & Rada, 2011), and online professional development (Smith & Sivo, 2012).

Numerous studies provide evidence of a positive relationship between use of technology-based information systems and user satisfaction with those systems (Baroudi et al., 1986; Doll & Torkzadeh, 1991; DeLone & McLean, 1992; Torkzadeh & Dwyer, 1994; Chiu, Chiu & Chang, 2007; DeLone and McLean's 2003, 2004). DeLone and McLean (2003) suggested that use and perceptions of a system are part of a bidirectional feedback loop, where initial perceptions of the system lead to use of the system, which in turn leads to post-use perceptions of the system. Thus, teachers' use and perceived value of the online supports may have a bidirectional relationship, where use of the online supports contributes to teachers' perceived value of them, and perceived value in turn, to greater use. In the current study, we were not able to examine longitudinal data on

teachers' use of the online supports, perceptions, and then future use. However, we examined the more preliminary question of whether a significant relationship exists between teachers' mean use of the online curricular supports across the school year, and their end-of-year perceptions of the value of these supports.

Present Study

In the present study, we examined pre-k teachers' use and perceptions of the *MyTeachingPartner-Math/Science* website, consisting of online curricular supports that were provided in conjunction with a printed curricular notebook, and five face-to-face workshops. We explored teacher characteristics that may be associated with teachers' use and perceptions of the supports. Specifically, we examine the following research questions.

1. What are the associations between teachers' characteristics (i.e., demographic characteristics, readiness for professional development, technology comfort and habits, and teacher-child interaction quality) and teachers' use of online curricular supports?
2. What are the associations between teachers' characteristics (i.e., demographic characteristics, readiness for professional development, technology comfort and habits, and teacher-child interaction quality) and teachers' perceived value of online curricular supports?
3. Is there a significant relationship between teachers' use and perceived value of online curricular supports?

Method

Participants

Data for this study were taken from teachers' first year of participation in a two-year randomized controlled trial of *MyTeachingPartner-Math/Science* (*MTP-M/S*; 2013-2015) that included 171 teachers across 2 cohorts. Teachers were randomly assigned to one of two conditions (*MTP-M/S intervention* [*n* = 87], or *Business as Usual* [*n*=84]). To better ensure there would be no differences between treatment groups, we stratified randomization based on preschool program type, and the number of participating classrooms within a building. There were no significant differences on any of the teacher characteristics between treatment conditions at baseline.

Because the focus of this study is on teachers' use and perceptions of the online professional development supports, we focused only on teachers assigned to the *MTP-M/S* intervention condition (i.e., those provided with printed curricula, five face-to-face workshops, and access to the online curricular supports), excluding those in the *Business-As-Usual* condition. The sample for the current study included two cohorts of teachers: Cohort 1, consisting of 65 teachers in classrooms located near a mid-sized mid-western city, and Cohort 2, consisting of 22 teachers in classrooms located near a mid-sized city on the east coast. Across both cohorts, teachers ranged in age from 21 to 73 years old (*M*=37.67, SD=11.78), and reported having 0 to 30 years of previous teaching experience with pre-k children (*M*=6.98, SD=7.58). Nearly a third of the teachers reported their highest level of education as completion of a Bachelor's degree (32%), and just more than one-fifth had obtained a master's degree (22%), while about one-fifth of teachers each reported a two-year associate degree (21%), and a high school diploma plus some

additional college coursework (20%), as their highest level of education. Table 1 includes descriptive statistics on teachers' demographics as well as the additional teacher characteristics that are of interest in the present study. Independent sample t-tests comparing the cohorts on these teacher characteristics indicated that teachers in Cohort 2, on average, had obtained a higher level of education (M = 6.50 in Cohort 2 compared to 5.09 in Cohort 1; $t(76) = 7.48$, $p < .001$). They also reported less positive attitudes about professional development (M = 3.13 compared to 3.45; $t(76) = -4.08$, $p < .001$), more work-related stress (M = 2.83 compared to 2.13; $t(76) = 3.77$, $p < .001$) , and more frequent use of technology (M = 4.47 compared to 3.57; $t(76) = 3.83$, $p < .001$). They were also observed to have lower quality Instructional Support at baseline (M = 2.54 compared to 2.84 in Cohort 1; $t(66) = -3.35$, $p < .001$).

Attrition. There was some teacher attrition throughout the course of the study. A total of 21 (24.13%) teachers dropped out of the study. Seventeen teachers left the study for reasons unrelated to the intervention (i.e., moved, quit, terminated, or absent due to pregnant/maternity leave, death in the family, or health issues), while four teachers left for reasons related to the intervention (i.e., three felt overwhelmed by curricula, and that the math and sciences activities were not developmentally appropriate for pre-k children, and one felt that the time spent on the curricula took away from time available for religious studies). In addition, nine teachers joined the study late, as replacements for teachers who had dropped from the study. To estimate attrition bias, we used an independent samples t-test to compare the 56 teachers who participated in the entire one-year study period, to the 30 teachers who participated in part of the study (i.e., teachers who either dropped from their participation in the study, or who joined the study as a

replacement). We found no significant differences (all *p*'s > .05) in mean values for almost all of teacher characteristics. However, there was a significant difference in the average highest level of education, and the average quality of Instructional Support at baseline, such that teachers who either dropped from the study, or served as late-joining replacements, were found to have lower levels of education (M = 5.04 compared to 5.63 for teachers in the whole study; $t(76) = -2.05$, $p = .04$), but higher quality Instructional Support (M = 3.05 compared to 2.67 for teachers in the whole study; $t(66) = 3.27$, $p = .002$).

Procedures

Recruitment procedures for teachers were slightly different between cohorts. For Cohort 1, we recruited classrooms by mailing fliers to the directors of potential preschool programs. After receiving interest from various programs, we determined the eligibility of their classrooms based on our recruitment guidelines; classrooms were required to have 75% of students in their classrooms meeting our eligibility guidelines (e.g., children were English speaking, kindergarten eligible the year following the study). Teachers were then informed of their classroom's eligibility and were recruited to voluntarily participate in the study. For Cohort 2, we recruited a single state-funded preschool program that included over 40 preschool classrooms, all of which met our eligibility criteria. The director of the preschool program enrolled all teachers and classrooms in the study. Teachers were then informed of the program's participation in the study, and were asked to consent to participation prior to assignment to research condition; all

teachers consented to participation and were subsequently assigned to treatment or control groups.

At the start of the school year, teachers assigned to the *MTP-M/S* intervention attended an orientation meeting, where they were informed of their assignment to the treatment condition, and provided with a printed *MTP-M/S* curricula notebook, as well as access to the *MTP-M/S* website. At the orientation meeting, teachers were given a brief orientation to the *MTP-M/S* curricular notebook and website, with a demonstration of how to log in to the website, and how to access the Activity Detail pages, Trajectory pages, and Demo Videos.

Measures

Teachers were asked to complete a fall survey containing questions about their demographic characteristics, backgrounds, readiness for professional development, and technology comfort and habits. In order to assess teacher-child interaction quality, teachers were asked to video record their teaching across the year, and we coded teacher-child interaction quality from these videos (see below for more detail). Data on teachers' use of the online curricular supports were collected automatically through the web log, from the time teachers were granted access to the website, to the end of the school year. At the end of the school year, teachers were asked to complete a spring survey to report on their perceptions of the online curricular supports.

Teacher Characteristics.

Demographic Characteristics. As part of a fall survey, teachers reported on their year of birth, highest level of education, and years of experience teaching. Teacher age was calculated by subtracting their date of birth from the date of survey completion.

Highest level of education was designated as high school, high school plus some additional coursework, associate's degree, bachelor's degree, or graduate degree. Teachers' years of experience teaching included years working professionally with children prior to kindergarten entry.

Readiness for professional development.

Attitudes about PD. The *Teacher Attitudes about Professional Development* scale (*TAP*) (Torff, Sessions, & Byrnes, 2005) is a five-item Likert-style questionnaire designed for assessing teachers' beliefs about professional-development. For example, teachers are asked to report their level of agreement with a series of statements about PD (e.g., If I did not have to attend in-service workshops, I would not; and, I have been enriched by the teacher training events I have attended). The *TAP* developers report that the scale has high internal consistency ($\alpha = .87$), a stable one-factor structure, and satisfactory discriminant validity relative to measures of social desirability, authoritarianism, and teacher self-efficacy (Torff et al., 2005). In the current sample, internal consistency was .84.

Openness to change. Teachers' *Openness to Change* is a subscale of a larger measure: *An Assessment of a* (*Pre)School's Readiness for Change* (Wanless, Groark & Hatfield, 2015). It is designed for use before a preschool is exposed to an intervention. The measure is broken into four domains (principal/director, preschool, community, and teacher). The openness to change subscale is part of the teacher domain, and contains two Likert-style statements (i.e., I seek out information about new teaching strategies that might benefit my children, and if someone told me that they had a new idea that might improve my teaching, I would ask them to tell me more about it). Teachers rate their

level of agreement with each statement on five-point scale (strongly disagree to strongly agree). The internal consistency reliability across the two items in the present study was $\alpha = .76$.

Work-related stress. Teachers' *work-related stress* is a subscale from the *Teacher Stress Inventory* (Fimian, 1988). The work-related stress subscale contains 6 items, assessing how intensely teachers experience work-related stresses (i.e., feeling there is little time to prepare, too much to do, the pace of the school day is too fast, their class size is too big, personal priorities are being shortchanged, and there is too much administrative paperwork). Items are rated on a response scale from 0-5 ('no stress' to 'highly stressful'). *Teacher Stress Inventory* developers reported satisfactory internal consistency of the *work-related stress* subscale ($\alpha = .80$) (Fiminian & Fastenau, 1990), and in the current study, we also found high internal consistency ($\alpha = .85$).

Technology comfort and habits.

Technology comfort. Teachers reported on their feelings about technology as part of the fall teacher survey. This eight-item Likert-style questionnaire was adapted from the comfort subscale of the *Teachers' Attitudes Toward Computers Questionnaire* (Christensen & Knezek, 2009), where we changed the word 'computer' to 'technology' throughout. The questionnaire requires teachers to state their level of agreement ('Strongly disagree' to 'Strongly agree'), with each feeling about technology. Statements included feelings of both comfort and anxiety, such as: "I think that working with technology is enjoyable", and "Working with technology makes me nervous." Items regarding anxiety were reverse-coded to match the comfort items such that higher responses would indicate greater comfort or lower anxiety around using technology.

Developers of the original questionnaire demonstrated that the comfort subscale has high internal consistency (α = .92), and with the adapted items in the present study, we also found high internal consistency (α = .92).

Technology habits. Teachers also reported on their technology habits as part of the fall teacher survey. This three-item scale required teachers to report on the frequency ('Never' to 'Almost Daily') with which they have: "Used technology to teach in their classrooms," "Provided students opportunities to learn with technology," and "Used the Internet to assist in their lesson planning." In the present study, we found internal consistency was satisfactory (α = .60).

Teacher-child interaction quality at baseline. Teachers were asked to implement all *MTP-M/S* activities, and to video record and submit them (approximately 16 per month) via U.S. mail, throughout the school year. All video equipment was provided, and there was a standard protocol for teachers to follow when recording their activity implementation. To measure baseline levels of teacher-child interaction quality for each teacher, we randomly selected two videos (one mathematics and one science) from the months of September, October, and November.

A team of coders was trained to reliability, and coded the quality of classroom interactions using the *Classroom Assessment Scoring System* (*CLASS*; Pianta, La Paro, et al., 2008). The *CLASS* is an observational measure made up of 10 dimensions scored on 7-point scales. These dimensions make up the three primary domains of interaction quality: *Emotional Support*, *Classroom Organization*, and *Instructional Support*. Reliability and validity of the *CLASS* have been established in multiple studies (e.g., La Paro, Pianta, & Stuhlman, 2004; Mashburn et al., 2008), including evidence of its

associations with child outcomes. Coder training consisted of two 8-hour days led by a certified *CLASS* trainer; coders were exposed to short video clips illustrating each *CLASS* dimension, and five master-coded videos of preschool classrooms to practice coding. Following training, each coder was required to pass a reliability test in which they needed to score within one point of the master code on 80% of scores, across five additional video segments. Reliably was maintained across coders via weekly calibration meetings.

After achieving reliability, coders were randomly assigned videos to code, from the pool of randomly selected videos for each teacher each month, with at least 20% of videos being assigned to two coders, for double coding. Following the *CLASS* coding, we created a composite *CLASS* score for teachers in each domain, based on the scores obtained for the six activities coded across the three months. In the current sample internal consistency for Emotional Support was $\alpha = .73$, Classroom Organization was $\alpha = 65$, and Instructional Support was $\alpha = .82$. Inter-rater reliability was calculated across the 20% of videos that were assigned for double coding and coder agreement within one point on the seven-point scale for each dimension ranged from 75.13% (Quality of Feedback)-98.36% (Negative Climate).

Outcome variables.

Use of online curricular supports. The *MTP-M/S* website includes three types of online curricular supports. There are digital copies of the 132 activity plans and two year-long "Trajectory" displays (one for mathematics and one for science), all of which are also located in the printed curricular notebook provided to teachers. In addition, the

website includes 132 video demonstrations (one for each activity) of real teachers implementing the activities with high fidelity.

Technology use is typically measured by frequency of visits, duration of visits, or pages visited (Delone & McClean, 2003). We measured teachers' use of the online curricular supports using an online server log of teachers' activity on the *MTP-M/S* website. We collected data on each teachers' total minutes spent visiting Activity Detail pages, Trajectory pages, and Demo Videos. To account for users who may have visited a page and then left their computers without logging off or closing out the web page, we re-coded any visits that were longer than 15 minutes to exactly 15 minutes.

Activity detail and Trajectory pages. The web log was used to calculate the amount of time teachers spent on Activity Detail and Trajectory pages by subtracting the time teachers landed on a page, from the time they left the page. We used this information to create a total number of minutes spent visiting Activity Detail pages and Trajectory pages in each month, and across the school year.

Demo videos. The web log captured all of teachers' interactions with the web video player, including: play, pause, and seeking throughout the video. We used the web log record of each of these actions to compute the total time teachers spent viewing each video, subtracting the appropriate amount of time when teachers skipped sections of the videos, and added the appropriate amount of time when teachers watched the same sections of the videos multiple times. We used these computations to create a total number of minutes each teacher spent viewing Demo Videos each month, as well as across the school year.

Perceived Value of Online Curricular Supports. In a spring survey, teachers responded to six items focused on their perceptions about the value of the online curricular supports to their teaching practice. The in-house-developed Likert-style items asked teachers to respond to each statement with 'strongly disagree' to 'strongly agree', with a neutral option in the middle. Statements focused on teachers' perceived value of the website for their implementation of the activities, and their teaching practices. For example: The *MTP-M/S* website "added value to my teaching practice," and "helped me to better implement the *MTP-M/S* activities." The alpha for this sample was .95.

Analyses

First we examined teachers' web use over the course of the year descriptively, in order better understand the trends in teachers' use of the online supports. Then, we explored the associations among teachers' characteristics and teachers' use and perceptions of the online supports. Finally, we examined the relationship between the two outcome measures: teachers' use of the online supports and teachers' perceived value of the online supports using a partial bivariate correlation that controlled for teachers' cohort.

Our central goal was to identify which factors were associated with teachers' use and perceptions of the online supports. We used ordinary least squares regression to examine the associations between teachers' demographic characteristics (i.e., age, years of teaching experience, highest level of education), readiness for professional development (i.e., attitudes about PD, openness to change, and work-related stress), technology comfort and habits, and quality of teacher-child interactions (i.e., Emotional Support, Classroom Organization, and Instructional Support), and the outcome variables: teachers' use of the online supports (i.e., Activity Detail Page use, Trajectory Page use,

Demo Video viewing), and teachers' perceived value of the online supports. These analyses allowed us to examine each teacher characteristic, while controlling for the variance associated with the other teacher characteristics included in the model. The resulting coefficients represent the degree to which each factor is associated with systematic differences in each of the outcomes, after accounting for the variance explained by the other variables in the model.

Due to the substantial attrition rate of 24.13%, we used multiple imputation and Full Information Maximum Likelihood estimation (FIML) to treat all missing data. Web use data were considered missing during the months of the study where teachers were not participating (e.g., months after teachers had left the study, or months before teachers had joined the study). We employed predictive mean matching (Rubin, 1986; Little, 1988) within *SPSS 23* to obtain estimates of the missing data. This method is considered appropriate for data that are not normally distributed (Allison, 2015), as in the case of the web use outcome data, which was skewed toward zero (the mean usage was skewed toward zero, compared to the median usage value). After performing the multiple imputation, the web use outcome data retained its positive skew (means continued to be skewed toward zero), so we conducted a log transformation on the web use outcome variables to create a more normal distribution. In order to account for variance associated with teachers' cohort or length of participation in the study, we included several auxiliary variables in each of the models (i.e., teachers' cohort, total months of participation in the study, whether he/she dropped from the study, joined late as a replacement, and whether the participant was part of the study in the fall season (months of September to December), spring season (months of January to May), or both). These auxiliary

variables were used to account for teachers' different levels of exposure to the online supports (e.g., teachers who were in the study only in the fall or the spring vs. those who were in the study all year). Analyses were run in *Mplus version 7.0* using full information maximum likelihood estimation, so that the data analyses used all available data when estimating parameters, increasing the precision and accuracy of the estimated parameters (Enders & Bandalos, 2001).

Results

First we present descriptive information about teachers' use of the online supports. Then we present the results of the regression models in which we examined associations between teachers' characteristics, and their use and perceptions of the online supports. Finally, we describe results of our partial correlation analyses, which allowed us to examine the relationships between measures of teachers' use of the online supports and their perceptions of the online supports.

Descriptive data on teachers' use of online curricular supports

Summary statistics on teachers' use of Activity Detail pages, Trajectory pages, and Demo Videos, are presented in Table 2. Overall, 63 teachers made use of the online supports at some point throughout the year. Teachers used Activity Detail pages for an average of 53.01 minutes (*SD* =102.66; range 0.03-376.37 minutes), while the average for Demo Videos use was similar but with a larger range of use times recorded (*M = 54.39; SD* = 90.65; range of 0.73 minutes to 7.4 hours). The two Trajectory pages were used for an average of 7.57 minutes (*SD* = 20.01; range of 0.27 to 116.72). Figure 2 depicts the use of these supports across the months of the school year; usage appears to

be highest at the beginning of the school and to decrease to more moderate levels for the remaining months of the year.

Associations between teachers' characteristics, and teachers' use and perceptions of online curricular supports

Demographic and professional backgrounds. Older teachers used all categories of the website (i.e., Activity Detail pages, Trajectory pages, and Demo Videos) more than did younger teachers, and perceived more value in the supports (all *p's* <.05). In contrast, teachers with more experience teaching were found to make significantly less use of Activity Detail pages ($p<.001$), and perceive less value in the supports overall ($p<.05$), than did teachers with less experience.

Readiness for professional development. Teachers with a more positive attitude about professional development exhibited significantly greater use of Demo Videos ($p<.05$), and perceived more value in the supports ($p<.001$). There were no observed associations between teachers' work-related stress or teachers' openness to change, and teachers' use or perceptions of the online supports.

Technology comfort and habits. Teachers who reported more habitual use of technology (e.g., checking email and using the Internet more often, etc.) spent more time viewing Demo Videos ($p<.05$). Additionally, teachers who reported greater comfort with technology tended to make greater use of the Trajectory pages, though this association only approached statistical significance ($p<.10$). There were no significant associations between teachers' technology and comfort habits and their perceptions of the online supports.

Teacher-child interaction quality. Teachers demonstrating higher quality Emotional Support at the beginning of the school year made greater use of the Activity Detail pages ($p<.001$). There were no significant associations between the other domains of teacher-child interaction quality and use or perceptions of the online supports.

Associations between teachers' use, and perceptions of online curricular supports

Partial correlations, controlling for teachers' cohort are presented in table 4. Results demonstrated that across the categories of web use, teachers' viewing of Demo Videos was a significant correlate of teachers' perceived value of the supports ($r=.49$, $p<.05$). There were no significant correlations between Activity Detail Page or Trajectory Page use and perceived value.

Discussion

Research on user characteristics and information systems suggests that online learning success is influenced by the characteristics of the learner, in addition to the characteristics of the learning environment (Beaudoin et al., 2009; Sun, 2014). However, the small and now-dated body of available research on teachers' characteristics has made it challenging to tailor PD programs to teachers' specific needs (Winton et al., 2016). In the present study, we found several different characteristics of teachers to be influential, including demographic factors (i.e., age and experience), aspects of teachers' readiness for professional development (i.e., attitudes about PD), their technology use habits, and the quality of their Emotional Support in their classroom. These factors were significantly related to teachers' use and perceptions of online curricular supports.

Teachers' use of Demo Videos was positively related to their perceptions of value of the supports.

Associations between teachers' characteristics and use and perceptions of online curricular supports

Demographic and professional backgrounds. Consistent with previous research (e.g., Downer et al., 2009), older teachers made more use of the online supports, while teachers with more experience made less use of the online supports. Older teachers also perceived more value in the supports while more experienced teachers perceived less value. Teachers' highest level of education had no influence on their use or perceptions of the supports. The finding that older teachers made greater use of the online supports is somewhat surprising given that older adults tend to make less of use of the Internet than younger adults; however, in terms of engaging in OPD, older teachers have been found to participate in online learning more than their younger counter parts (McNamera, 2010; Vu et al., 2014). Research on the implications of teachers' psychological development on their teaching practices has suggested that people become more conscientious and agreeable as they move from college age to middle adulthood (Rimm-Kaufman & Hamre, 2010). It may be that older teachers are more conscientious and agreeable to the suggestions made by leaders of this intervention, and thus make greater use of the online supports that the leaders encouraged them to use.

Teachers with more experience made less use of the Activity Detail pages and perceived less value in the online supports. This was consistent with findings by Downer and colleagues (2009), who reported that teachers with more years of experience made less use of online resources that were offered as supplementary to an online coaching

intervention. In a similar vein, teachers who are experienced (mid-career) have reported more confidence in their teaching abilities than their early-career and late-career counter parts (Klassen & Chiu, 2010). We found it somewhat perplexing that despite the correlation between age and years of experience, the two factors demonstrated contrasting relations with teachers' use of the online supports. To further examine this finding, we graphically examined teachers' age and years of experience in the present study and found for early-and-mid-career teachers (i.e., those with fewer than 15 years of experience), being older was associated with increased use of the supports; however, for late-career teachers the relationship between age and use of the Activity Detail pages appeared to be less prominent. There may be an interaction between teachers' age and years of experience, such that the relationship between age and use of the online supports is stronger for teachers who have less experience. Teachers' with less experience may find themselves in greater need of help implementing the intervention, with older teachers being more conscientious and therefore being more likely to turn to the online curricular supports for that guidance.

Readiness for professional development. Teachers who had more positive attitudes about PD (e.g., reported that they believe PD is worth the time it takes, or that they have been positively impacted by teacher training events), made greater use of the Demo Videos, and perceived more value in the online supports overall. This finding is consistent with findings regarding user attitudes towards information systems (i.e., affect, or liking, for using them), which have been found to be related to user's use and perceptions of information systems (Sabherwal, Jeyaraj, & Chowa, 2006). Teachers who report more positive affect or liking of professional development in general may be more

open to exploring the online supports (Roberts et al., 2014). Positive feelings about PD in general may also carry over to feelings about the *MTP-M/S* website, encouraging these teachers to find more value in online supports.

Teachers' openness to change and reports of work-related stress were not significantly related to use or perceptions of the online supports. On average, teachers' reports of their openness to change was fairly high (4.7 on a scale of 1 to 5) and limited in variability (*SD* = .40). Teachers may have responded in a way they believed to be most favorable, thereby skewing the response pattern and limiting our ability to find significant differences in teachers' use and perceptions based on their reported openness to change. Consistent with Roberts et al. (2014), we did not find a significant relationship between teachers' work related stress and their use or perceptions of the web supports; this may have been due to teachers' relatively low levels of reported stress (average of 2.3 on a scale of 1 to 5), with these reports also somewhat limited in terms of variability across teachers (*SD* = .77).

Technology comfort and habits. Teachers who reported more frequent habits of internet and computer use spent more time viewing Demo Videos. This is consistent with prior research that showed that teachers who reported more frequent use of internet technologies such as email and search engines, exhibited greater engagement in an online professional development module (Sun, 2014). Demo videos were more demanding of high levels of internet bandwidth than other supports on the website due to the requirements of delivering video materials, and some teachers reported challenges with streaming these videos. The finding that more frequent technology users made greater use of the Demo Videos may be due to the confound of stable internet connectivity. The

challenge of streaming video on low-bandwidth internet is frustrating, requiring the patience of waiting for buffer time, and sometimes failing to view video at all.

Though comfort with technology has been linked to use and perceptions of online coursework in other studies (e.g., Lim, 2001; McGhee, 2010; Sun et al., 2008), it was not significantly related to use or perceptions of the online supports in the present study. This may be because the online supports in the present study were not particularly challenging to use—they typically required teachers to have the ability to log-in to a website, navigate to different pages, and click the play button on the video player—as compared to the technology utilized in the online learning experiences associated with coursework, such as learning modules, discussion boards, and online quizzes.

Teacher-child interaction quality. Teachers who were observed at the beginning of the school year to show higher levels of Emotional Support were found to make greater use of the Activity Detail pages. As seen in the school-based intervention literature, teachers evidencing stronger interactions with students were more likely to implement an intervention (Dusenbury, Brannigan, Falco, & Hansen, 2003) and utilize online PD resources (Downer et al., 2009). In this study, teachers with higher baseline Emotional Support may have been more likely to implement the activities and to use the Activity Detail pages than their less emotionally supportive counterparts.

Relationship between teachers' use, and perceptions of online curricular supports

Despite the strong relationships shared between the amount of teachers' video viewing and the other categories of their web use, teachers' video viewing was the only category of web use that was correlated with their perceptions of value for the website (r=.49, p<.05). Extant research consistently supports a strong positive relationship

between usage levels and user perceptions of information systems (e.g., Baroudi et al., 1986; Doll & Torkzadeh, 1991; DeLone & McLean, 1992; Torkzadeh & Dwyer, 1994; Chiu, Chiu & Chang, 2007), so it might otherwise be surprising that use of Activity Detail pages and Trajectory pages were not correlated with perceptions of the website. However, this finding makes sense, given that Activity Detail pages and Trajectory pages were both available to teachers in print as well as on the website, while Demo Videos were only available on the website. It may be that video viewing was the only category of web use correlated with perceiving value in the supports, because it was the only feature that was exclusively available on the website.

Implications and Future Research Directions

A variety of teachers (i.e., younger, more experienced, those with less positive attitudes about PD, less technically inclined, and less emotionally supportive) were found to use the online supports less, and perceive less value in them. Future OPD programs could potentially increase their engagement over time and their emotional investment by selecting online supports with an eye for what is desired by teachers (e.g., video demonstrations), and for what would provide support beyond what can be made available to teachers in print form (e.g., interactivity, and real-time feedback). Younger adults have grown up in a technology rich era, and are likely to have had many more experiences with computers, smart phones, online resources, and social media (McFarlane, Triggs, & Yee, 2008). Future online resources can be made more interactive for younger teachers by allowing them to interact with and annotate Activity Detail pages, and by presenting them with real-time data regarding their involvement in the intervention (e.g., number of activities implemented, number of pages visited, videos

viewed, etc.). Interactivity and user data are utilized not only in online learning management systems (e.g., Coursera, Moodle), but also in technology-based information systems, such as exercise and nutritional trackers, and sales and job performance databases (e.g., Salesforce), to help sustain learner engagement over time and increase their emotional investment. Applying these innovations to design and development of OPD, may help draw a wider range of teachers (i.e., ages and levels of experience) and increase usage of online curricular supports over time (Sharple, Taylor, & Vavoula, 2010; Lonsdale, Baber, Sharples, & Arvantis, 2004).

However, increasing the amount of interactivity in supports can make them more complex and decrease their usability, especially for teachers who are less comfortable with technology. Future OPD research should remain cognizant of teachers' comfort with technology, as the frustration associated with technological issues could present a significant barrier to some teachers' engagement.

Future designers of OPD focused on teacher-child interactions can help encourage usage by teachers with lower Emotional Support by providing other side benefits to visiting the online supports or viewing demo videos. OPD websites can include other online features that appeal to all teachers. For instance, integrating the activity pages with an interactive planning calendar, or synchronizing the materials shopping lists to teachers' smartphones, may be useful features for teachers who like to have highly organized classrooms. These features may draw users to the Activity Detail pages, which will give them greater exposure to the supports than they might otherwise seek out.

Finally, teachers with more positive attitudes about professional development made more use of the Demo Videos and perceived more value in the supports than their

counterparts with less positive attitudes about PD. Attitudes about PD are likely to co-vary with teachers' use and perceptions of the current online supports, such that teachers with less positive attitudes are likely to make less use of the supports, have less positive perceptions about them, and continue to use them at low rates if at all (DeLone & McLean, 2003; Mei Lick Cheok & Su Luan Wong, 2015). OPD designers and providers can foster positive attitudes about PD through organizational support, and explicit expectations from leadership (Ross & Gray, 2006; Vu et al., 2014). Additionally, if the online supports are designed to be novel, useful, and engaging, then teachers will be more likely to have positive attitudes towards them (Vu et al., 2014).

Limitations

There are several limitations to the current study that should be acknowledged. One important limitation in the present study is the significant attrition rate. Because the web use variable was collected continuously across the school year, rather than at a single time point, like the fall survey or spring survey, it was subject to a considerable amount of missing data due to teacher attrition. Results of the present study should be generalized only with care, because the present sample and corresponding imputed data is more representative of teachers who were in the entire study than those who left the study early or who were joined late as replacements.

It should also be noted that results regarding the associations between teachers' readiness for professional development (i.e., attitudes about PD, openness to change, and work-related stress) and teachers' perceived value of the online supports are subject to same-rater bias (i.e., both readiness for professional development and perceived value of the online supports were reported by teachers). These results have an increased

likelihood of being related, such that teachers who may have more positive outlooks might be likely to answer questions regarding their attitudes and perceptions in similar ways.

A final limitation relates to our examination of the relationship between measures of teachers' use of the online supports and their perceptions of the online supports. We were not able to examine longitudinal data to confirm whether the relationship between use and perceptions is bidirectional, as suggested by previous research. Future studies should examine teachers' perceptions about online professional development prior to their use of the online program, and then again after their period of use. This type of longitudinal data will help researchers determine whether teachers' early perceptions of OPD predict their use of OPD and their perceived value after having used it.

Conclusion

With the high demand for large-scale and affordable early childhood teacher training and professional development, there has been growth in the number of professional development programs delivered online. However, there are only a few studies (e.g., Downer et al., 2009; Roberts et al., 2014) examining how teacher characteristics are associated with early childhood teachers' use and perceptions of OPD. Findings from the current study suggest that teachers' characteristics are associated with their use of online curricular supports, and their perceived value of those supports. In particular, teachers' demographics such as age and teaching experience, as well as teachers' attitudes about PD, quality of teacher-child interactions, and technology habits, were all significantly related to teachers' use and perceptions of the provided online supports. Future designers and providers of OPD may be able to better plan features for

the characteristics of the teachers in their audience. They may also be able to consider investments in various features as offering relative advantages and uses by their specific audience. By understanding the characteristics of teachers, OPD designers can thereby create novel experiences that motivate teachers to engage and invest in their professional development.

References

Allison, P. (2015, March 15). Imputation by Predictive Mean Matching: Promise & Peril | Statistical Horizons. Retrieved March 15, 2016, from http://statisticalhorizons.com/predictive-mean-matching

Arbaugh, J. B. (2000). Virtual classroom characteristics and student satisfaction with internet-based MBA courses. *Journal of Management Education*, 24(1), 32–54.

Arbaugh, J. B. (2002). Managing the on-line classroom: a study of technological and behavioral characteristics of web-based MBA courses. *Journal of High Technology Management Research*, 13, 203–223.

Baroudi, J. J., Margethe H., Olson and Blake Ives. (1986) "An Empirical Study of the Impact of User Involvement on System Usage and Information Satisfaction." *Communications of the ACM*, 29(3), 232-238.

Barnett, M. (2006). Using a Web-Based Professional Development System to Support Preservice Teachers in Examining Authentic Classroom Practice. *Journal of Technology & Teacher Education*, *14*(4), 701 – 729.

Beaudoin, M. F., Kurtz, G., & Eden, S. (2009). Experiences and Opinions of E-learners: What Works, What Doesn't, and What Competencies Ensure Successful Learning. *Interdisciplinary Journal of E-Learning & Learning Objects*, *5*, 275.

Bishop, A. (2006). Online professional development: Get the facts. Retrieved from http://www.techlearning.com/showArticle.php?articleID=193600873

Chiu, C.-M., Chiu, C.-S., & Chang, H.-C. (2007). Examining the integrated influence of fairness and quality on learners' satisfaction and Web-based learning continuance

intention. *Information Systems Journal*, *17*(3), 271–287. http://doi.org/10.1111/j.1365-2575.2007.00238.x

Christensen, R. W., & Knezek, G. A. (2009). Construct validity for the teachers' attitudes toward computers questionnaire. *Journal of Computing in Teacher Education*, *25*(4), 143–155.

Chyung, Y., Winiecki, D. J. & Fenner, J. A. (1998). A case study: Increase enrollment by reducing dropout rates in adult distance education. In *Proceedings of the Annual Conference on Distance Teaching & Learning*, Madison, WI: Publisher.

Clements, D. H., Sarama, J., Wolfe, C. B., & Spitler, M. E. (2013). Longitudinal Evaluation of a Scale-Up Model for Teaching Mathematics With Trajectories and Technologies Persistence of Effects in the Third Year. *American Educational Research Journal*, *50*(4), 812–850. http://doi.org/10.3102/0002831212469270

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319–340. http://doi.org/10.2307/249008

DeLone, W. H., & McLean, E. R. (1992). Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, *3*(1), 60–95.

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. *Journal of Management Information Systems*, *19*(4), 9–30.

Doll, W.J., and Torkzadeh, G. (1998). Developing a multidimensional measure of systems use in an organizational context. *Information & Management*, 33, 4, 171–185.

Domitrovich, C. E., Pas, E. T., Bradshaw, C. P., Becker, K. D., Keperling, J. P., Embry, D. D., & Ialongo, N. (2015). Individual and School Organizational Factors that Influence Implementation of the PAX Good Behavior Game Intervention. *Prevention Science*, *16*(8), 1064–1074. http://doi.org/10.1007/s11121-015-0557-8

Downer, J. T., Locasale-Crouch, J., Hamre, B., & Pianta, R. (2009). Teacher Characteristics Associated With Responsiveness and Exposure to Consultation and Online Professional Development Resources. *Early Education & Development*, *20*(3), 431–455. http://doi.org/10.1080/10409280802688626

Dusenbury, L., Brannigan, R., Falco, M., & Hansen, W. B. (2003). A review of research on fidelity of implementation: implications for drug abuse prevention in school settings. *Health Education Research*, *18*(2), 237–256. http://doi.org/10.1093/her/18.2.237

Early, D. M., & Winton, P. J. (2001). Preparing the workforce: early childhood teacher preparation at 2- and 4-year institutions of higher education. *Early Childhood Research Quarterly*, *16*(3), 285–306. http://doi.org/10.1016/S0885-2006(01)00106-5

Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling*, *8*(3), 430–457.

Farber, B., & Ascher, C. (1991). Urban School Restructuring and Teacher Burnout. ERIC/CUE Digest, Number 75. Retrieved from http://eric.ed.gov/?id=ED340812

Getzels, J. W., & Jackson, P. W. (1963). The teacher's personality and characteristics. In *Handbook of research on teaching* (pp. 506–582).

Gill, W. E. (2011). *The Ready to Teach Program: A Federal Initiative in Support of Online Courses for Teachers*. Retrieved from http://eric.ed.gov/?id=ED530966

Ginsburg, A., Gray, T., & Levin, D. (2004). Online professional development for mathematics teachers: A strategic analysis. *American Institutes for Research*. Retrieved from http://eric.ed.gov/?id=ED492927

Goldenberg, L., Culp, K., Clements, M., Anderson, A., & Pasquale, M. (2014). Online Professional Development for High-School Biology Teachers: Effects on Teachers' and Students' Knowledge. *Journal of Technology and Teacher Education*, *22*(3), 287–309.

Hill, H. C., Beisiegel, M., & Jacob, R. (2013). Professional Development Research Consensus, Crossroads, and Challenges. *Educational Researcher*, *42*(9), 476–487. http://doi.org/10.3102/0013189X13512674

Holden, H., & Rada, R. (2011). Understanding the influence of perceived usability and technology self-efficacy on teachers' technology acceptance. *Journal of Research on Technology in Education*, *43*(4), 343–367.

Hong, K. S. (2002). Relationships between students' and instructional variables with satisfaction and learning from a Web-based course. *Internet and Higher Education*, 5, 267–281.

Jones, W. M., & Dexter, S. (2014). How teachers learn: the roles of formal, informal, and independent learning. *Educational Technology Research and Development*, *62*(3), 367–384. http://doi.org/10.1007/s11423-014-9337-6

Kinzie, M. B., Vick Whittaker, J., McGuire, P., Lee, Y., & Kilday, C. R. (2013). *Research on Curricular Development for Pre-kindergarten Mathermatics & Science*.

Klassen, R. M., & Chiu, M. M. (2010). Effects on teachers' self-efficacy and job satisfaction: Teacher gender, years of experience, and job stress. *Journal of Educational Psychology*, *102*(3), 741–756. http://doi.org/10.1037/a0019237

La Paro, K. M., Pianta, R. C., & Stuhlman, M. (2004). The classroom assessment scoring system: Findings from the prekindergarten year. *The Elementary School Journal*, 409–426.

Levy, Y. (2007). Comparing dropouts and persistence in e-learning courses. *Education & Computers*, 48 (2), 185-204. doi: 10.1016/j.compedu.2004.12.004

Lim, C. K. (2001). Computer self-efficacy, academic self-concept, and other predictors of satisfaction and future participation of adult distance learners. *American Journal of Distance Education*, *15*(2), 41–51. http://doi.org/10.1080/08923640109527083

Little, R. J. A. (1988). Missing-Data Adjustments in Large Surveys. *Journal of Business & Economic Statistics*, *6*(3), 287–296. http://doi.org/10.1080/07350015.1988.10509663

Lonsdale, P., Baber, C., Sharples, M., & Arvanitis, T. N. (2004). A context awareness architecture for facilitating mobile learning. *Learning with Mobile Devices: Research and Development*, 79–85.

Mashburn, A. J., Downer, J. T., Hamre, B. K., Justice, L. M., & Pianta, R. C. (2010). Consultation for Teachers and Children's Language and Literacy Development

during Pre-Kindergarten. *Applied Developmental Science*, *14*(4), 179–196. http://doi.org/10.1080/10888691.2010.516187

Mashburn, A. J., Pianta, R. C., Hamre, B. K., Downer, J. T., Barbarin, O. A., Bryant, D., … Howes, C. (2008). Measures of classroom quality in prekindergarten and children's development of academic, language, and social skills. *Child Development*, *79*(3), 732–749.

McFarlane, A., Triggs, P., & Yee, W. (2008). Researching mobile learning-Interim report to Becta. UK: Becta. Retrieved from: http://dera.ioe.ac.uk/1471/1/becta_2008_mobilelearning_interim_report.pdf

McGhee, R. M. H. (2010). *Asynchronous Interaction, Online Technologies Self-Efficacy and Self-Regulated Learning as Predictors of Academic Achievement in an Online Class*. ProQuest LLC.

McNamara, C. L. (2010). K-12 teacher participation in online professional development. Retrieved from https://escholarship.org/uc/item/1zd9k8z6.pdf

Mei Lick Cheok, & Su Luan Wong. (2015). Predictors of E-Learning Satisfaction in Teaching and Learning for School Teachers: A Literature Review. *Les Prophètes de Satisfaction d'Apprentissage En Ligne Dans Enseignement et Apprentissage Pour Professeurs Scolaires : Une Revue de Littérature.*, *8*(1), 75–90.

National Association for the Education of Young Children (NAYEC). (2014). High-Quality Early Childhood Educators Are the Key to Qualiity Programs for Children. Retrieved from http://www.naeyc.org/files/naeyc/201NAEYC_Childhood%20Educators.pdf

Norris, D. J. (2010). Raising the Educational Requirements for Teachers in Infant Toddler Classrooms: Implications for Institutions of Higher Education. *Journal of Early Childhood Teacher Education*, *31*(2), 146–158. http://doi.org/10.1080/10901021003781221

Peterson, S. (2013). Readiness to change: Effective implementation processes for meeting people where they are. In T. Halle, A. Metz, & I. Martinez-Beck (Eds.), *Applying implementation science to early care and education programs and systems: Exploring a new frontier. Baltimore, MD: Brookes* (pp. 43–64). Baltimore, MD, US: Paul H Brookes Publishing Co.

Pianta, R. C., Mashburn, A. J., Downer, J. T., Hamre, B. K., & Justice, L. (2008). Effects of web-mediated professional development resources on teacher–child interactions in pre-kindergarten classrooms. *Early Childhood Research Quarterly*, *23*(4), 431–451. http://doi.org/10.1016/j.ecresq.2008.02.001

Piccoli, G., Ahmad, R., & Ives, B. (2001). Web-based virtual learning environments: a research framework and a preliminary assessment of effectiveness in basic IT skill training. *MIS Quarterly*, 25(4), 401–426

Rimm-Kaufman, S. E., & Hamre, B. K. (2010). The role of psychological and developmental science in efforts to improve teacher quality. *Teachers College Record*, *112*(12), 2988–3023.

Ringwalt, C. L., Ennett, S., Johnson, R., Rohrbach, L. A., Simons-Rudolph, A., Vincus, A., & Thorne, J. (2003). Factors associated with fidelity to substance use prevention curriculum guides in the nation's middle schools. *Health Education & Behavior*, 30, 375–391.

Roberts, A. M., LoCasale-Crouch, J., DeCoster, J., Hamre, B. K., Downer, J. T., Williford, A. P., & Pianta, R. C. (2014). Individual and Contextual Factors Associated with Pre-Kindergarten Teachers' Responsiveness to the MyTeachingPartner Coaching Intervention. *Prevention Science*. http://doi.org/10.1007/s11121-014-0533-8

Rohrbach, L. A., Graham, J. W., & Hansen, W. B. (1993). Diffusion of a school-based substance abuse prevention program: predictors of program implementation. *Preventive Medicine*, *22*(2), 237–260. http://doi.org/10.1006/pmed.1993.1020

Ross, J. A., & Gray, P. (2006). Transformational leadership and teacher commitment to organizational values: The mediating effects of collective teacher efficacy. *School Effectiveness and School Improvement*, *17*(2), 179–199. http://doi.org/10.1080/09243450600565795

Rubin, D. B. (1986). Statistical Matching Using File Concatenation With Adjusted Weights and Multiple Imputations. *Journal of Business & Economic Statistics*, *4*(1), 87–94. http://doi.org/10.1080/07350015.1986.10509497

Sabherwal, R., Jeyaraj, A., & Chowa, C. (2006). Information System Success: Individual and Organizational Determinants. *Management Science*, *52*(12), 1849–1864. http://doi.org/10.1287/mnsc.1060.0583

Sharples, P. D. M., Taylor, P. D. J., & Vavoula, D. G. (2010). A Theory of Learning for the Mobile Age. In P. D. B. Bachmair (Ed.), *Medienbildung in neuen Kulturräumen* (pp. 87–99). VS Verlag für Sozialwissenschaften. Retrieved from http://link.springer.com/chapter/10.1007/978-3-531-92133-4_6

Smith, J. A., & Sivo, S. A. . (2012). Predicting continued use of online teacher professional development and the influence of social presence and sociability. *British Journal of Educational Technology*, *43*(6), 871–882. http://doi.org/10.1111/j.1467-8535.2011.01223.x

Stes, A., De Maeyer, S., Gijbels, D., & Van Petegem, P. (2012). Instructional development for teachers in higher education: effects on students' learning outcomes. *Teaching in Higher Education*, *17*(3), 295–308. http://doi.org/10.1080/13562517.2011.611872

Sun, S. Y. H. (2014). Learner perspectives on fully online language learning. *Distance Education*, *35*(1), 18–42. http://doi.org/10.1080/01587919.2014.891428

Sun, P.-C., Tsai, R. J., Finger, G., Chen, Y.-Y., & Yeh, D. (2008). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education*, *50*(4), 1183–1202. http://doi.org/10.1016/j.compedu.2006.11.007

Torff, B., Sessions, D., & Byrnes, K. (2005). Assessment of Teachers' Attitudes about Professional Development. *Educational and Psychological Measurement*, *65*(5), 820–830. http://doi.org/10.1177/0013164405275664

Torkzadeh, G., & Dwyer, D. (1994). A path analytic study of determinants of information system usage. *Omega*, *22*(4), 339–348. http://doi.org/10.1016/0305-0483(94)90060-4

Vu, P., Cao, V., Vu, L., & Cepero, J. (2014). Factors Driving Learner Success in Online Professional Development. *The International Review of Research in Open and Distance Learning*, *15*(3), 120–139.

Wagner, B. D., & French, L. (2010). Motivation, Work Satisfaction, and Teacher Change Among Early Childhood Teachers. *Journal of Research in Childhood Education*, *24*(2), 152–171. http://doi.org/10.1080/02568541003635268

Wanless, S. B., Groark, C., & Hatfield, B. (2015). Assessing organizational readiness. *Handbook of social emotional learning*. New York, NY: Guilford Publications.

Williford, A. P., Wolcott, C. S., Whittaker, J. V., & Locasale-Crouch, J. (2015). Program and Teacher Characteristics Predicting the Implementation of Banking Time with Preschoolers Who Display Disruptive Behaviors. *Prevention Science*, *16*(8), 1054–1063. http://doi.org/10.1007/s11121-015-0544-0

Winton, P. J., Snyder, P., & Goffin, S. G. (2016). Beyond the Status Quo: Rethinking Professional Development for Early Childhood Teachers. In L. J. Couse & S. L. Recchia (Eds.), *Handbook of Early Childhood Teacher Education* (pp. 54–68). Taylor & Francis.

Table 1
Descriptive Statistics

Predictor Variables	(%) M(SD)	N	Missing
Demographic/Professional Backgrounds			
Age	37.67 (11.78)	76	11
Years of Teaching Experience	6.98 (7.58)	77	10
Highest level of Education		78	9
High School Diploma	4.8%		
H.S. plus some coursework	20.2%		
Two-year degree	20.5%		
Bachelor's Degree	32.1%		
Master's Degree	21.8%		
Readiness for PD		77	10
Attitudes about PD	3.37 (.33)		
Openness to Change	4.70 (.40)		
Work-related Stress	2.32 (.77)		
Teacher-Child Interaction Quality		65	22
Emotional Support	5.13 (.39)		
Classroom Organization	5.50 (.43)		
Instructional Support	2.77 (.45)		
Technology Comfort & Habits		77	10
Technology Comfort	4.12 (.75)		
Technology Habits	3.8 (.98)		

Table 2
Descriptive Information about teachers' Use and Perceptions of Online Curricular Supports

	Activity Detail Page Minutes			Trajectory Page Minutes			Demo Video Viewing Minutes			Perceived Value	
	N	M(SD)	SUM	N	M(SD)	SUM	N	M(SD)	SUM	N	M(SD)
September	30	20.50 (24.11)	615.02	24	3.91 (4.62)	93.90	19	17.72 (17.41)	336.73		-
October	23	30.25 (50.89)	695.72	8	9.02 (12.44)	72.13	22	15.89 (15.44)	349.63		-
November	15	22.58 (40.73)	338.68	4	5.29 (9.44)	21.15	15	15.26 (19.03)	228.93		-
December	8	27.44 (27.96)	219.50	1	4.25 (-)	4.25	7	22.25 (17.73)	155.75		-
January	11	19.81 (14.66)	217.95	4	16.70 (32.01)	66.82	13	25.36 (29.31)	329.70		-
February	9	23.80 (21.41)	214.22	6	3.97 (5.97)	23.85	10	18.70 (20.76)	187.00		-
March	10	17.16 (23.27)	171.55	6	1.28 (1.34)	7.70	8	27.53 (19.55)	220.23		-
April	8	15.64 (34.70)	125.08	4	1.38 (1.03)	5.52	11	13.64 (14.80)	150.08		-
Total	49	53.01 (102.66)	2597.72	39	7.57 (20.01)	295.32	36	54.39 (90.65)	1958.07	56	3.59 (1.0)

Notes. Sum refers to the sum of use minutes for all teachers. Total refers to the use across all months in the school year.

Table 3
Standardized Coefficients from Models Predicting Use and Perceptions of Online Curricular Supports

Predictor:	Activity Detail Use Estimate (SE)	Trajectory Use Estimate (SE)	Demo Video Use Estimate (SE)	Perceived Value Estimate (SE)
Demographic and Professional Backgrounds:				
Age	0.380*** (.100)	0.279** (.107)	0.426*** (.101)	0.337** (.098)
Years of Experience	-0.305** (.102)	-0.026 (.110)	-0.139 (.105)	-0.209* (.100)
Highest Level of Ed	0.113 (.106)	0.183 (.113)	-0.080 (.108)	-0.186 (.105)
Readiness for Professional Development				
Attitudes about PD	-0.047 (.104)	0.172 (.110)	0.222* (.105)	0.460*** (.099)
Openness to Change	-0.070 (.100)	-0.169 (.106)	-0.088 (.102)	-0.001 (.098)
Work-related Stress	-0.021 (.111)	0.117 (.118)	0.009 (.113)	0.066 (.109)
Quality of Teacher-Child Interactions				
Emotional Support	0.505*** (.120)	0.191 (.130)	0.150 (.125)	0.174 (.122)
Classroom Organization	-0.240† (.126)	-0.215 (.134)	-0.088 (.128)	-0.070 (.123)
Instructional Support	-0.111 (.124)	-0.049 (.133)	-0.067 (.127)	-0.037 (.120)
Technology Comfort and Habits				
Technology Comfort	0.010 (.097)	0.153 (.103)	0.014 (.099)	0.033 (.095)
Technology Habits	0.113 (.092)	-0.021 (.098)	0.227* (.093)	-0.148 (.090)
Auxiliary Variables:				
Cohort 2	-0.023 (.124)	-0.226 (.131)	0.132 (.126)	-0.003 (.125)
Months in Study	0.060 (.341)	-0.030 (.364)	-0.112 (.348)	0.811* (.333)
Dropped	0.086 (.202)	0.058 (.215)	0.197 (.206)	0.408* (.198)
Replacement	0.098 (.131)	0.131 (.139)	0.195 (.133)	0.035 (.130)
Season	-0.350 (.286)	-0.125 (.306)	-0.098 (.293)	-0.416 (.282)

Note. † = p<.10 * = p<.05; ** = p < .01; *** = p ≤ .001

Table 4
Partial Correlations among Teachers' Characteristics, Use, and Perceptions of Online Curricular Supports, Controlling for Cohort

	Activity Detail Mins	Trajectory Mins	Video Viewing Mins	Perceived Value
Activity Detail Mins	-	-	-	0.28
Trajectory Mins	0.20	-	-	0.33
Video Viewing Mins	0.48*	0.85***	-	0.49*

Notes. † = p<.10 * = p<.05; ** = p < .01; *** = p ≤ .001

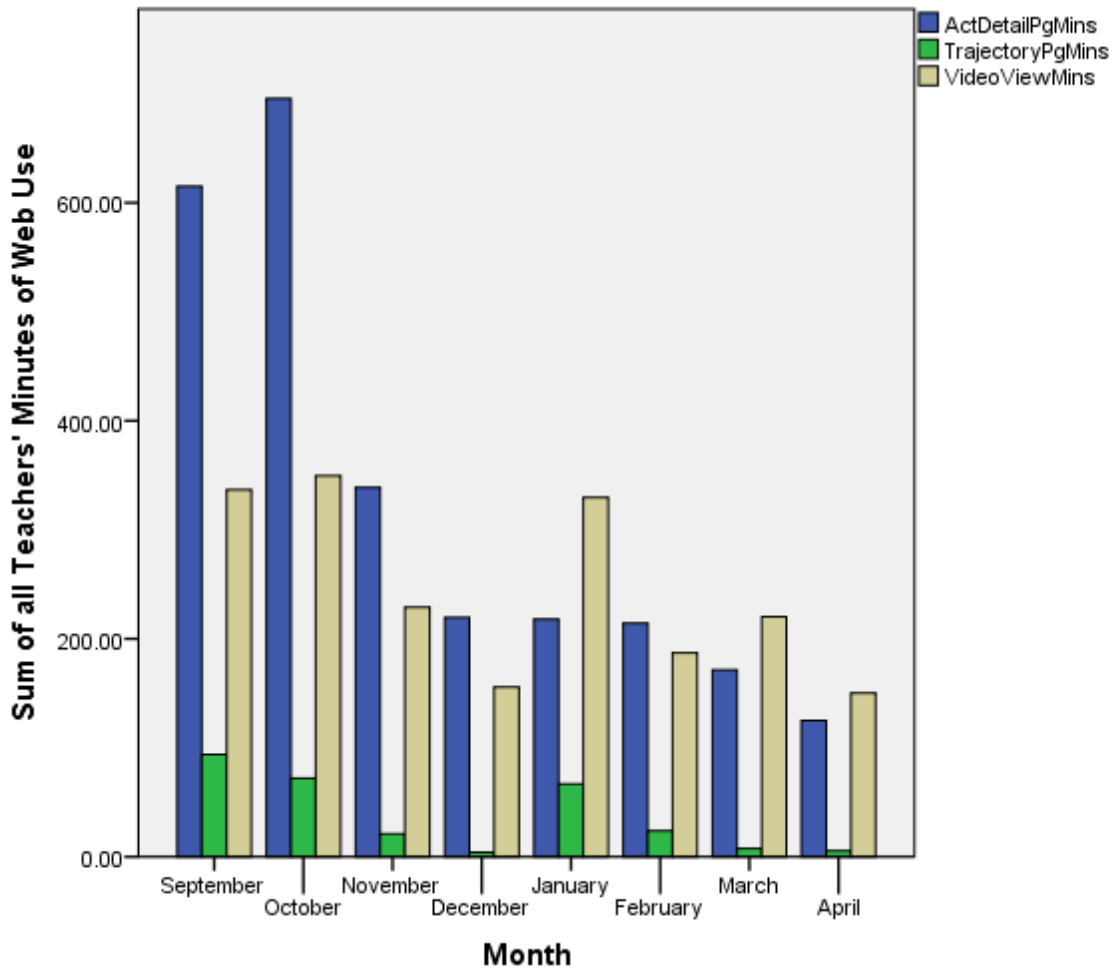

Figure 2. Total minutes of use for all teachers by month.