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RELATIONSHIPS AMONG PRESCHOOL ATTENDANCE, TYPE, AND QUALITY

AND EARLY MATHEMATICAL LITERACY

by

Jennifer E. Throndsen

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Education
(Mathematics Education and Leadership)

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UTAH STATE UNIVERSITY
Logan, Utah

2018

ABSTRACT

Relationships Among Preschool Attendance, Type, and Quality and

Early Mathematical Literacy

by

Jennifer E. Throndsen, Doctor of Philosophy

Utah State University, 2018

Major Professors: Patricia Moyer-Packenham, Ph.D., and Jessica Shumway, Ph.D.
Department: School of Teacher Education and Leadership

The purpose of this research study was to investigate the relationships among

preschool attendance, preschool type (i.e., public, private, Head Start, and home-based

educational technology providers), and preschool quality and early mathematical literacy

for diverse students. By using statewide kindergarten early mathematical literacy

assessment scores, the researcher evaluated the impact of preschool attendance for

diverse groups, the influence of different types of preschool programs, and the

differences in student outcomes for students who attended programs deemed high-

quality. Data were obtained from the Utah State Board of Education (USBE) in relation

to preschool enrollment records and kindergarten entry scores on the state mandated

Kindergarten Entry and Exit Profile (KEEP) assessment for all kindergarten students

enrolled in the 2017-18 school year. The researcher conducted a 2x2 Factor ANOVA,

independent group means t tests, and multiple regression analyses to determine

relationships among preschool attendance, type, and quality and early mathematical literacy. In general, the independent variables of preschool attendance and preschool quality did not have a positive influence on early mathematical literacy as a whole (which was expected). However, an examination of specific demographic covariates, revealed some positive influences. The analysis of preschool type showed that students who participated in online preschool programming, on average, experienced the highest early mathematical literacy scores. Overall, the results suggested that students from diverse backgrounds experience improved early mathematical literacy when they attended preschool. Therefore, with the limited funding available for preschool, policymakers should consider which students might most benefit from preschool experience and target limited resources to such populations.

(133 pages)

PUBLIC ABSTRACT

Relationships Among Preschool Attendance, Type, and Quality and

Early Mathematical Literacy

Jennifer E. Throndsen

As students enter kindergarten, some students are more academically prepared than others. This study looked at the relationships among preschool attendance, preschool type (i.e., public, private, Head Start, and home-based technology providers) and preschool quality and early mathematical literacy skills for diverse students. The study sought to answer three research questions: What is the relationship between preschool attendance and early mathematical literacy? What is the relationship between preschool type and early mathematical literacy? What is the relationship between preschool quality and early mathematical literacy? Within each research question, there was also an investigation to see if there were differing effects for diverse student demographics. Data was obtained from the USBE in relation to preschool enrollment records and kindergarten entry scores on the state mandated Kindergarten Entry and Exit Profile (KEEP) assessment for all kindergarten students enrolled in the 2017-18 school year. The researcher conducted a 2x2 Factor ANOVA, independent group means t-tests, and multiple regression analysis to determine relationships among preschool attendance, type, and quality and early mathematical literacy. In general, the independent variables of attending preschool and the quality of the preschool did not seem to have the positive influence expected on early mathematical literacy as a whole, but when looking more

specifically at the demographic covariates, there were some positive influences. Students who participated in online preschool programming on average experienced the highest early mathematical literacy scores. Overall, the results suggested that students from diverse backgrounds experience improved early mathematical literacy when they attended preschool. Therefore, with the limited funding available for preschool, policymakers should consider which students might most benefit from preschool experience and target limited resources to such populations.

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CHAPTER I

INTRODUCTION

Background of the Problem

Being mathematically literate in today's society is indisputably a critical skill set for success. Mathematical literacy is an individual's ability to use, interpret, and apply mathematical knowledge (Jablonka, 2003). Unfortunately, a majority of students in the U.S. demonstrate a significant lack of proficiency in mathematical literacy. For example, national longitudinal data from the National Assessment of Educational Progress (NAEP) demonstrates that 4th-. 8th-, and 12th-grade students are not achieving proficiency in mathematics. In fact, the 2015 data showed that between 60% and 75% of students of these ages are not proficient in mathematics (National Center for Educational Statistics [NAEP], 2016).

Similarly, the Trends in International Mathematics and Science Study (TIMSS), an international mathematics and science assessment comparing the performance of 4th-. 8th-, and 12th-grade students from different countries, indicates that students in the United States are showing small improvements in mathematics, but are still underperforming 10 other countries worldwide (Provasnik et al., 2016). The TIMSS report provides additional evidence that the mathematical literacy of students in the U.S. is insufficient when compared with international peers.

The performance of students, as displayed in the NAEP and TIMSS data, may be in fact due to a lack of early childhood experiences to engage in rich learning in

mathematics. Kindergarten entry assessment data already represent an achievement deficit in school readiness, particularly in early mathematical literacy, as students enter the traditional school system (Chard et al., 2008; Duncan et al., 2007; Yoshikawa, Weiland, & Brooks-Gunn, 2016). This is especially evident for students from diverse family backgrounds, with such variables as minority status, low socioeconomic status (SES), and limited English proficiency. These early entry differences are often drastic and discouraging as they are highly predictive of future academic achievement. In fact, a meta-analysis of six studies found that early mathematical literacy not only predicts later success in mathematics, but also predicts later reading achievement even more so than early literacy skills (Duncan et al., 2007).

Purpose of the Study

The purpose of this research study was to investigate the impact of preschool attendance, preschool type (i.e., public, private, Head Start, and home-based educational technology providers), and preschool quality on early mathematical literacy via kindergarten entry assessment outcomes. The independent variables considered were preschool attendance, preschool type, preschool quality, and demographic covariates such as English learner, ethnic minority, SES, sex, students with disabilities, and student age (in months). The dependent variables were the results on early mathematical literacy test items from a state mandated assessment given at kindergarten entry called the Kindergarten Entry and Exit Profile (KEEP).

Statement of the Problem

Considering the highly predictive nature of early mathematical literacy and the substantial portion of American students who lack mathematical proficiency, it is essential that early educational opportunities support further development of mathematical literacy so that a student's academic trajectory is one of success rather than failure. In response to a preponderance of educational research on early mathematics experiences, policymakers and local education agencies (LEAs) have increased their investment into early childhood education. Specifically, preschool programs, with the intent of providing early learning experiences in mathematics, as well as avenues for early intervention, have been used as a mechanism to equalize the playing field for students as they enter kindergarten. This elevated investment is evidenced by increases in enrollment in preschool over the past 14 years.

In 2003, on average, states increased their investment in preschool by over 200%. More recently, in 2014, over $1 billion of new state funding was invested nationally with some states increasing their investment by over 20% (U.S. Department of Education, 2015). Due to the additional investment, the percentage of students enrolled in preschool has grown comparatively. In fact, since 1990, enrollment in preschool has increased by 12%. In 1990, 56% of 4-year-olds were enrolled in preschool; whereas, in 2013, 68% were enrolled (U.S. Department of Education, National Center for Education Statistics, 2015). Unfortunately, as the statistics show, the funding investments have been insufficient to permit all students to gain access to preschool programs.

To exacerbate the problem, the effects of preschool attendance, although well

researched, have yielded inconclusive findings. The general conclusion of the body of research related to preschool attendance consistently shows significant gains for students who attend preschool and their ability to outperform their peers who did not attend preschool in early mathematical literacy upon entry into kindergarten. These studies have focused on four main areas: improved school readiness, sustainability of effects, types of programs, and the quality of the programs.

Improved School Readiness

Numerous researchers have studied the impact of preschool attendance. They often do this from a vantage point of the impact of attendance on school readiness, including academic and social skill performance. A primary reliance on the Early Childhood Longitudinal Survey-Kindergarten (ECLS-K) data set, a nationally representative sample of the kindergarten cohort enrolled in U.S. schools in 1998, has dominated the research literature in this area. The ECLS-K data set provides a rich source for analysis and interpretation in an effort to understand the impact of preschool attendance on school readiness. The studies that use other sample populations have generally relied on much smaller samples to look at the effects. Unfortunately, due to the limitations of those studies, there is a lack of generalizability. As a result of the dominance of the ECLS-K data and the limitations of the other studies, further research is needed using a large sample that does not rely on the ECLS-K to expand the current body of research.

Sustainability of Effects

In general, the effects of preschool attendance have consistently demonstrated short-term impacts. Discouragingly, the effects largely dissipate after 1-2 years following their preschool attendance (Magnuson, Ruhm, & Waldfogel, 2007). This raises the question, is the investment in early education worth it if the achievement benefits are short-lived? The answer may be yes. Research indicates that preschool may be more beneficial for certain populations than others (Magnuson, Meyers, Ruhm, & Waldfogel, 2004). One particularly interesting finding is the impact of preschool attendance on students from diverse and at-risk families. Studies have found that such students experience more benefit in their early mathematical literacy, as well as school readiness in general. Best of all, those effects are lasting (Magnuson et al., 2007). Unfortunately, students from these backgrounds experience lower enrollment in preschool programs than their more advantaged peers.

The mixed evidence with respect to the short- and long-term benefits of preschool in relation to significant impact on school readiness skills, specifically in the area of early mathematical literacy, is inadequate. Such evidentiary inadequacies prevent state legislators from continuing to advance their investment in early childhood education. A study that confirms the potential of significant impacts on diverse and at-risk students in a population would provide further encouragement to policymakers in considering the appropriate target population for preschool enrollment.

Types of Programs

Across studies, there are generally three types of preschool programs that have

been studied: public, private, and federally funded Head Start programs. With the advancement of educational technology, there are now home-based technology providers providing preschool curriculum via intelligent educational software that adapt to student responses. At this time, the impact of such programming has yet to be explored, nor has it been compared to other types of programming. Considering that home-based technology providers can provide preschool programming at a much lower cost, understanding the potential impacts in comparison to more expensive brick and mortar type programs may inform the future use of early childhood investments. Understanding the potential impact of combining face-to-face preschool experiences with intelligent educational software may provide an even more robust understanding of the optimal type of preschool programming. Additionally, researchers who have studied the effects of different types of programming have called for more research on the effectiveness of each type of program.

Quality of Programs

Considering type of programming alone would be insufficient. The literature on this topic would suggest that attention to the quality of the program is also essential. A synthesis of the related research indicates that higher quality programs are associated with larger achievement effects. Only a few studies are available that have attended to the quality of preschool programming, and two of the studies did not analyze early mathematical literacy (Bryant et al., 2003; Swaminathan, Byrd, Humphrey, Heinsch, & Mitchell, 2014; Williams, Landry, Anthony, Swank, & Crawford, 2012). Further study is needed to understanding the relationship between the quality of the preschool program the student attended and the impact it has on the early mathematical literacy outcomes.

Summary

Overall, there is a substantial body of research on the effects of preschool. Such studies have made important contributions to the field and have helped lead initial increases in the investment in early educational programming. In order to more adequately understand the role of preschool programs in meeting the needs of American students and better prepare students for the mathematical skills and knowledge necessary, further study was warranted. Specifically, a larger sample, not reliant on the ECLS-K data set, that analyzes the relationship between preschool attendance, preschool type, preschool quality and the effects on students from diverse or at-risk families would provide necessary data to inform critical stakeholders on how to best invest limited early education funds in the future.

<div align="center">

Significance of the Problem

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Considering the large number of students lacking proficiency in mathematical literacy, identifying effective practices to change this trend is a valuable endeavor. Specifically considering the sizeable increases in the investment in preschool programming, identifying the types of preschool programs that have significant impact on student school readiness in mathematical literacy was worthy of additional study. The findings from this study are helpful for informing education stakeholders in investing their limited dollars in the most effective manner possible, thus, maximizing the effects of the substantial investments being made across the country. Additionally, the findings of this study inform parents on the influence of the type(s) of programming and the

quality of the programming on their students' early mathematical literacy outcomes allowing them to make more effective decisions as they choose preschool programming for their children.

With all of the recent attention paid to early childhood education and its influence of preschool attendance and improved school readiness, Utah's State legislature has increased their investment in quality preschool programs. A significant increase in investment, from zero dollars to $12 million through the use of federal and state dollars for preschool programs, has occurred since 2014.

Up until 2014, Utah invested no state funding into preschool programs. In the 2014 Utah legislative session, the legislature appropriated $1.04 million in state dollars to create the High Quality School Readiness Grant Program. The intent of the funds was directed at improving the quality of existing public and private preschool programs and to provide technical assistance for curriculum and teacher development. Two years later, in the 2016 Utah legislative session, an additional appropriation of $11 million of federal and state dollars, for the next 3 fiscal years, was allocated to support expansion of private, public, and home-based technology preschool programs deemed as high quality. These two appropriations catapulted interest and investment in early education in Utah.

Although there has been increased funding, the relationship between preschool attendance on school performance at kindergarten entry for Utah children has not been evaluated. In fact, until the fall of 2017, Utah did not have a common kindergarten assessment with which to analyze the impacts of preschool on student readiness at kindergarten entry. With the deployment of a state-created uniform kindergarten entry

assessment, titled the Kindergarten Entry and Exit Profile (KEEP; Utah State Board of Education [USBE], 2017a), an analysis of the benefits of such an increase in the investment in early education on a statewide scale is now possible. Establishing the potential academic benefits of preschool programs on school readiness and the impact of different levels of quality programming may further inform policymakers on how to support early education with such a substantial investment. Furthermore, parents will be better equipped to enroll their child in preschool programs that have greater impact on their child's early mathematical literacy skills, which ultimately will have lasting impacts on their child's future academic performance. The findings of this study inform funding decisions, parent preschool placement decisions, and provide evidence of the relationship between preschool and early mathematical literacy outcomes.

Research Design

With the constraints of limited educational funding, many state legislators are awaiting more conclusive evidence before making additional investments in preschool programming to more adequately serve the entire preschool population. Also, as more parents are enrolling their children in preschool there is a need for additional knowledge or evidence of the relationship between attending quality preschools and their child's future outcomes. To address the gap in knowledge in the area of preschool attendance, preschool type, and preschool quality and their relationship on early mathematical literacy, this study examined such influences on student performance with a standardized kindergarten entry assessment of a census population of approximately 45,000

kindergarten students enrolled in a preschool in the fall of 2017. The specific skills measured by the KEEP included an evaluation of students' number sense, numeral identification, and discrimination skills in number and geometry concepts. To understand the influence of preschool attendance, preschool type, and preschool quality on early mathematical literacy, this researched collected quantitative data from a statewide kindergarten entry assessment and preschool enrollment records. The research methods were quantitative and incorporated statistical analysis of preexisting state-level assessment data. The researcher used a multiple regression model to direct the analysis of Utah's entering kindergarten students and the influence of preschool attendance on their early mathematical literacy outcomes. The model included demographic covariates to identify specific populations that may have greater gains due to their participation in preschool.

Research Questions

In order to evaluate the influence of preschool attendance and the quality of the programs on school readiness, this research study answered the following research questions.

1. What is the relationship between preschool attendance and early mathematical literacy? Are there differing effects for diverse student demographics?

2. What is the relationship between preschool type and early mathematical literacy? Are there differing effects for diverse student demographics?

3. What is the relationship between preschool quality and early mathematical literacy? Are there differing effects for diverse student demographics?

Assumptions, Limitations, and Delimitations

Within this study, there were some basic assumptions and limitations that the researcher recognized and accepted as part of the research design. The assumption was the data provided by the USBE, with respect to preschool enrollment and kindergarten entry scores, were accurate. A limitation of the study was the focus on early mathematical literacy. Although mathematical literacy is not the only successful predictor, there were so few studies of which incorporated a mathematics achievement variable that the study would contribute to the knowledge of the field. Another limitation of the study was Utah's homogenous population. The limited variability in the demographic population lacked diversity when compared to other states and therefore may leave some of the findings to lack generalizability. Also, the data came from only one year of students during the 2017-18 school year; therefore, it is unlikely that identical results would appear in another cohort year. Finally, only certain aspects of preschool attendance and programming were addressed in this study. While other factors (e.g., teacher training, parent involvement) may have affected performance, these factors were beyond the scope of this study. This determination of quality was defined by the state of Utah and was a constraint on the study.

The researcher considered the delimitations, and limitations the researcher put into place to control for factors that might affect the results (Terrell, 2016), for what was included or excluded from the study. For this study, the researcher chose to study the entire population of kindergarten students rather than a random sample. The dependent variable was early mathematical literacy scores on the state KEEP assessment and *not*

other measurements of achievement. Also, the overall numeracy score from the KEEP was not intended to indicate the measure was the only measure of student outcomes. This measure was chosen as it is the only common data point for all entering kindergartners in the state of Utah and kindergarten entry scores have proven to be powerful predictors of future academic performance. The independent variables selected demonstrated connections to previously studied variables, such as preschool type and quality, while bringing additional unstudied layers such as online programming and quality differentials.

Definition of Terms

Preschool programs are educational services provided to students the year prior to their enrollment in kindergarten usually for children under 5 years of age.

School readiness includes the essential literacy, mathematics, and social skills needed for successful entry into kindergarten that have been found in research to be consistent predictors of future academic success.

High-quality programs defined by Utah's legislative code based on the following indicators: evidence-based curriculum, ongoing, focused, and intensive professional development, ongoing student assessment, one adult for every 10 students in the class, ongoing program evaluation, parent engagement, and a minimum standard of a child development associate certification for lead teacher.

Diverse and at-risk students are students who are designated as low-SES, English Language Learners (ELLs), minority status, sex, students with disabilities, and/or student

age (in months).

Sex describes two main categories students are designated into: male or female.

Short-term effects are cognitive or social gains found as the result of some type of treatment for up to one year after the treatment**.**

Long-term effects are cognitive or social gains found as a result of some type of treatment beyond one year after the treatment was received.

Preschool attendance describes students who did or did not attend preschool.

Preschool type describes whether the child attended face-to-face (public, private, Head Start setting), online (home-based technology provider), or a combination of face-to-face and online preschool.

Early mathematical literacy encompasses a student's ability "to count forward and backward, to associate written numeric symbols with quantities, and to categorize and differentiate objects based on particular attributes, facilitate the development of concepts, like equivalence and cardinality, and processes, like measuring and making simple calculations" (VanDerHeyden et al., 2011, p. 297). Such competencies develop for students with varying degrees of success. Some students' life experiences more adequately help with the development of such skills, while others may require more explicit opportunities for such skills to emerge. Early mathematical literacy is often assessed with measures to evaluate students' competency in recognizing, identifying, and/or reading numerals, oral counting, cardinality, enumerating sets, and discriminating quantities (Clarke, Baker, Smolkowski, & Chard, 2008; Geary & vanMarle, 2016; Jordan, Kaplan, Locuniak, & Ramineni, 2007; Neumann, Hood, Ford, & Nuemann, 2013;

Pinto, Bigozzi, Tarchi, Vezzani, Gamannossi, 2016; Purpura, Hume, Sims, & Lonigan,

2011; Clements & Sarama, 2016).

CHAPTER II

LITERATURE REVIEW

In order to begin to answer the research questions and to understand the variables associated with quality early learning with respect to developing early mathematical literacy and preschool programs, this chapter addresses the common themes found from conducting a review of the literature on school readiness and early mathematical literacy. More specifically, the themes discussed look at the effects of preschool attendance, types of preschool programs, quality of early learning, and the influence of early mathematical literacy competency.

Inclusion/Exclusion Criteria

To identify the relevant literature in school readiness and early mathematical literacy, the researcher conducted a comprehensive search of electronic databases. Using the search terms *school readiness* and *mathematical literacy*, the search produced several studies based on the Early Childhood Longitudinal Study-Kindergarten Cohort and a few using more traditional research models on the short-term and long-term effects of preschool attendance and school readiness. Upon reviewing the findings of these studies, a more extensive search was conducted to include some of the suggestions by the authors.

Using the initial studies identified as a starting point, the more extensive review of the literature included a search of electronic library engine searches focused on the relationship between preschool attendance and early mathematical literacy performance upon entry into kindergarten. The process involved searches in educational databases

such as EBSCOhost, PsycINFO, and Google Scholar. The search terms used included: *kindergarten, readiness, mathematical literacy, preschool, attendance*. Results were limited by publication year as only studies in the last 25 years, or between 1992 and 2017, were included and had to be peer reviewed.

Themes in the Literature

The more extensive search provided additional studies on the short-term and long-term effects of preschool attendance beyond those found in the initial search. Also, the refined scope produced studies on the influence of the type of preschool program attended by Taylor, Gibbs, and Slate (2000) and Magnuson et al. (2004), the quality of program being offered by Williams et al. (2012) and Bryant et al. (2003), and the predictive relationship between early mathematical literacy and future academic performance (Clements & Sarama, 2016; Duncan et al., 2007; Jablonka, 2003). These emerging themes directed the literature review that follows as well as the variables considered in this research study. The overlap found in the studies reviewed are previously studied factors, but as is noted in the review that follows, there are some gaps and limitations in the current body of literature on early mathematical literacy and preschool attendance.

Effects of Preschool Attendance on
Overall School Readiness

Researchers have investigated the impact of preschool attendance on school readiness and later outcomes (Connell & Prinz, 2002; Magnuson, Lahaei, & Waldfogel,

2006; Taylor et al., 2000; Votruba-Drzal, Coley, Collins, & Miller, 2015). To accomplish

this, researchers have generally used one of two approaches: The Early Childhood

Longitudinal Survey-Kindergarten (ECLS-K) data set or identifying their own set of

participants. Both approaches have yielded interesting findings.

   The ECLS-K is a data set from a nationally representative sample of

kindergarteners enrolled in the fall of 1998. The data set, which includes student

achievement data, parent interviews, and teacher and school questionnaires, was released

to the public and provides a rich information source for researchers to investigate the

short-term effects of various experiences on children's development. The longitudinal

data set also follows the sample population through eighth-grade and allows for long-

term effect analysis. Such a comprehensive data set permits researchers to consider the

variables that may affect children's cognitive, social-emotional, and physical

development.

   Not all researchers have relied on ECLS-K data to investigate preschool programs

and their effects of school readiness. The participant samples from these research designs

have varied in geographic location, size of sample, as well as the composition of the

kindergarten cohort examined.

   Although researchers have analyzed the effects with different population samples,

their research questions and findings have yielded similar results. Overall, researchers

have focused on three main concepts: (1) Does preschool attendance increase school

readiness at kindergarten entry? (2) Do the effects of preschool attendance persist or

dissipate over time? and (3) Do the results differ for at-risk families? The next section

summarizes the overall findings for each of these three questions.

Does preschool attendance increase school readiness at kindergarten entry?

The answer to this question has been a resounding yes. The body of literature on this topic has consistently demonstrated that for children who attend preschool, whether they are from at-risk families or not, there are significant gains and they outperform their peers who did not attend preschool (Hustedt, Kwanghee, Barnett, & Williams, 2015; Magnuson, et al., 2004, 2006, 2007; Nelson, 2005; Taylor et al., 2000; Winsler et al., 2008). More specifically, children who attended preschool demonstrated statistically significant higher scores for overall school readiness (Taylor et al., 2000) and they performed better on sub measures in reading, mathematics, vocabulary, print awareness, and English language proficiency (Herndon & Waggoner, 2015; Hustedt et al., 2015; Magnuson et al., 2006, 2007; Nelson, 2005). Magnuson et al. (2004) also found that they were less likely to repeat kindergarten.

One negative finding was found in Magnuson et al.'s (2007) study. They found that although attendance in preschool was associated with higher reading and mathematics achievement at kindergarten entry, there were also higher levels of behavior problems. This finding was not confirmed in any of the other studies reviewed.

Overall, these findings reconfirm support for the positive impact of early learning, but they also come with some caution to the field of early childhood. One caution is that a portion of the population is not benefitting from the positive impacts early learning has on school readiness. Many of these studies indicated lower enrollment of students from diverse and at-risk backgrounds, which could exacerbate the achievement gap (Magnuson

& Waldfogel, 2005). The field of early education may need to identify the barriers for such families to improve their engagement in preschool programs in order to prevent the achievement gap from being perpetuated.

Do the effects of preschool attendance persist or dissipate over time? As highlighted above, short-term impacts of preschool attendance are consistent across the body of research reviewed. Unfortunately, the impact for these outcomes to persist beyond entry is not as conclusive. In fact, the research studies that attended to student performance beyond kindergarten entry are mixed. In one study, conducted by Magnuson et al. (2004), their findings indicated that there were diminishing returns on achievement gains first experienced, but the effects remained statistically significant through the end of first grade.

Yet, another study conducted by Magnuson et al. (2007) found that the impact of preschool attendance dissipated or was completely lost as early as the end of first grade. To further support the diminished effects, a meta-analysis conducted by Leak et. al (2010) of 117 studies centered on the impact of preschool had similar findings. These researchers' analysis found that "impacts generally persisted at close to full strength for 1-2 years beyond the end of the preschool program, but at much less than full strength after that" (p. 1).

Overall, the short-term effects of preschool attendance are present upon kindergarten entry, but do not seem to persist beyond 1-2 years after attendance. This finding has led some to question if an investment in preschool is worth it if scores are likely to converge after a couple of years. In the section that follows, the research on the

long-term impacts for at-risk families had different results.

Do the results differ for at-risk families? Overwhelmingly, the research studies that examined the effects of preschool on at-risk families or groups resoundingly demonstrate significant positive outcomes on school readiness and overall academic success. For example, in the Votruba-Drzal et al. (2015) study, the researchers examined the impact of preschool attendance on children of immigrants. The results suggested such attendance was "associated with heightened math, reading, and expressive language skills and also with lower parent-rated externalizing behaviors for children of immigrants in comparison to children of native parents" (p. 549)**.** Similarly, Magnuson et al. (2006) found that preschool attendance raised reading and math scores equal to nonimmigrants, while also raising the child's English language proficiency.

Another example of the positive impact of preschool on at-risk children is demonstrated in Connell and Prinz's (2002) study. In this study, the researchers investigated the effects of preschool and parent-child relationships and their impact on student outcomes. The results of the study found that students from low socioeconomic families who attended preschool and had well-structured and responsive parent-child interactions had higher levels of social skills, receptive communication skills, and cognitive abilities.

These studies demonstrate consistent short-term effects for at-risk students and suggest that their enrollment in preschool has significant benefits both academically as well as socially. Unfortunately, children from mothers born outside the U.S. and families experiencing poverty are less likely to enroll their children in preschool programs than

other children (Magnuson et al., 2004, 2006).

In regards to long-term outcomes, one reassuring finding from the Magnuson et al. (2007) study was the impact of preschool on at-risk children. As discussed prior, this study did not find lasting impact of preschool beyond the end of first grade in general, but when specifically looking at at-risk children the findings are more beneficial and lasting. In fact, they found that the results for at-risk children who attended preschool experienced larger gains than their advantaged peers and the effects lasted longer.

Considering these findings, the evidence suggests that there is significant cause to continue providing preschool to students who come from at-risk families as the impact, both short- and long-term, persists and positively affects this population and their outcomes. Acknowledging that at-risk families are less likely to enroll in preschool, efforts need to be taken to engage with more at-risk families so that the inequality in school entry skills can be moderated.

Types of Preschool Programs

In the realm of early education, preschool programs are generally categorized into four types: public, private, Head Start, and home-based educational technology providers. In the following sections, I will describe the key elements of each type of program to allow for the programs to be distinguished. First, I will discuss more traditional brick and mortar models, such as public, private, and Head Start. Then, I will highlight a less traditional form that provides preschool programming through interactive, online software. Finally, following the descriptions of various types of preschool programs, I summarize the research about types of preschool programs and students' kindergarten

readiness.

Public preschool programs. The general description of a public preschool program is a program that is part of the public school system. These preschools are primarily funded by federal, state, and local funds and are frequently housed in elementary schools in school districts and charter schools. Often Title 1 and special education funding are combined with state and local funding. The preschool program offered is often a part-day experience, 2-3 hours for 3-5 days a week, and doesn't include wrap-around services such as health screenings, child care, etc. (Magnuson et al., 2004). Past data suggest that the quality of public preschools is "of notably higher quality" and generally have better paid, more educated teachers than other types of preschools (Winsler et al., 2008). The programs in this study were public preschool only programs as no child care programs were combined with the public programs.

Private provider preschool programs. A private preschool program, for the purpose of this study, includes community-based childcare programs that enroll children with and without childcare subsidies. They often serve students who qualify for subsidies due low SES, welfare assistance, or families currently receiving supports through Temporary Assistance for Needy Families (TANF). For children who attend who aren't subsidized, their families pay a fee to participate. The preschool program is often a part-day experience, similar to the public programs, but they often provide extended childcare for working parents so their children may stay the full workday.

Federally funded Head Start programs. Head Start preschool programs are federally funded programs that provide comprehensive services for children living in

poverty and children with significant developmental delays or disabilities. Head Start preschool programs focus on school readiness while providing individualized learning experiences that progress their social skills, emotional well-being, language and literacy skills, and concept development (U.S Department of Health and Human Services, 2014). Wrap-around services are an integral component and generally provide health and development screenings, meals, oral and mental health support, and parent-child relationship training. Families who participate in Head Start usually require more intensive services and are experiencing multiple risk factors. As such, Head Start is unique from other types of preschool programs as they provide each family with intensive case management to become economically stable and provide a healthy family environment. Their stakeholders receive access to extensive wrap-around services, such as childcare, based on the family's needs.

Home-based educational technology preschool provider. A home-based educational technology program provides preschool aged children with home access or wherever they may have internet to receive evidence-based, age appropriate, individualized instruction delivered through the software. The purpose of the educational technology is to develop school readiness skills. Current programs offer children access to reading, math and science instruction, multisensory reading tutoring, and includes an embedded computer adaptive reading test. Students who participate in the program are asked to spend at least 15 minutes 5 days a week on the software and encouraged to engage in the reading components of the software each day. Parent support is a required component of student participation. As such, the educational technology providers review

usage reports and reach out to parents when students are not meeting the recommended dosage for the software.

Does type of program matter? Considering the four general categories of preschool programs, only two studies in the last 25 years have compared different types of programs to see if one program has more impact than another. None of the studies have evaluated home-based educational technology programs. In Utah, over 10,000 students are engaged in a home-based educational technology program, but comparison to face-to-face preschools and no preschool has been limited in prior evaluations of the program. The first study, conducted by Taylor et al. (2000), found no relationship across school readiness scores when compared to type of preschool attended. The second study, investigated by Magnuson et al. (2007), found that children who attended preschool performed better than peers who remained home, received non-parental care, or attended Head Start. Both sets of researchers recommended more research "focused on evaluating the effectiveness of each form (e.g., public, private)" (Taylor et al., 2000, p. 194) of preschool programs should be conducted while considering the quality of the programs.

Quality Matters

Considering the type of preschool program solely may not be sufficient in evaluating the impact of preschool on school readiness. Yoshikawa et al. (2016) synthesized the research on preschool programs and found that higher quality programs were associated with larger effects. This finding, which is supported by other studies (Bryant et al., 2003; Williams et al., 2012), suggests that considering the quality of the preschool program being offered may provide valuable insights into the elements that

may have greater effects on student outcomes than program type alone.

In the following section, an overview of structural and process elements of preschool that are considered to impact the quality, a summary of the high quality indicators established by Utah's Legislature, and the linking of quality and improved school readiness outcomes will be discussed.

Quality elements. When discussing the quality of preschool, researchers generally categorize the elements of quality into two categories: structural and process (Magnuson et al., 2004Winsler et al., 2008; Yoshikawa et al., 2016). Structural quality includes higher trained/certified teachers, the use of standard curricula, class size, and staff-child ratio. Process quality consists of "classroom focus on literacy, language, and social skills through the implementation of a core curriculum" and "professional development for teachers specific to the area of school/cognitive readiness" (Williams et al., 2012, p. 23).

Drawing on the research base of the elements that indicate higher quality (U.S. Department of Education, 2016), Utah has put into statute specific high quality indicators used to evaluate preschool programs to determine their attainment or progress towards achieving high quality status. Utah's high-quality indicators are in tight alignment with the national conceptualization of quality except for the level of education desired for the lead teacher. In Utah, a minimum of a child development associate certification is expected, whereas, the national research expects a minimum of a bachelor's degree in early childhood education or similar field.

Utah's quality indicators. In Utah, during the 2014 legislative session, the

Legislature codified the elements of a high-quality school readiness (i.e., public, private, and Head Start). The elements were derived from the body of literature surrounding quality indicators in preschool programs. The defined elements include:

    a) an evidence-based curriculum that is aligned with all of the developmental domains and academic content areas defined in the Utah Early Childhood Standards adopted by the USBE, and incorporates intentional and differentiated instruction in whole group, small group, and child-directed learning, including the following academic content areas: oral language and listening comprehension; phonological awareness and prereading; alphabet and word knowledge; prewriting; book knowledge and print awareness; numeracy; creative arts; science and technology; and social studies health, and safety.

    b) ongoing, focused, and intensive professional development for staff of the school readiness program;

    c) ongoing assessment of a student's educational growth and developmental progress to inform instruction;

    d) a pre- and post-assessment of each student;

    e) a class size that does not exceed 20 students, with one adult for every 10 students in the class;

    f) ongoing program evaluation and data collection to monitor program goal achievement and implementation of required program components;

    g) family engagement, including ongoing communication between home and school and parent education opportunities based on each family's circumstances;

    h) each teacher having at least obtained: the minimum standard of a child development associate certification; or an associate or bachelor's degree in an early childhood education related field. (Elements of a High Quality School Readiness Program, 2016)

Given these elements, during the 2016 legislative session, the Utah legislator allocated funds to expand preschool programs that exemplified these high quality elements. State personnel at the USBE and the Department of Workforce Services were charged with

identifying high-quality preschool programs. To do so, the state agencies developed an

evaluation system to determine the eligibility of an applying preschool program. The

preschool programs submit grant applications with narratives to demonstrate their

incorporation of these elements in their programs. Their programs are observed and

program directors are interviewed to obtain further evidence of the high-quality

indicators. Programs that demonstrate achievement of all elements are then deemed high-

quality and become eligible for state funding to expand access to additional students.

Determining whether a home-based educational technology provider is quality

differs from the procedures described above from more traditional brick and mortar type

preschool programs. The home-based educational technology programs are intended to

be used in the home with the support of a caring adult. The high quality indicators

designated by the legislator for a home-based educational technology product must:

a) be an evidence-based and age appropriate individualized instruction
   assessment and feedback technology program that teaches eligible students
   early learning skills needed to be successful upon entry into kindergarten;

b) require regular parental engagement with the student in the students use of the
   home-based educational technology program; and,

c) be aligned with the Utah early childhood core standards (Elements of a High
   Quality School Readiness Program, 2016).

At this time, only one provider meets these indicators. Approximately 10,000 preschool

aged students in Utah are engaged in the interactive learning software UPSTART. Some

of these students are combining their use of the educational software with enrollment in

more traditional preschool programs, too.

With such a focus on providing high-quality preschool programming and the

research on the influence of quality elements, this leads to the question, "Is there an

impact on student outcomes when programs are of higher quality?" To address this question, the outcomes of three studies will be used as evidence.

Does higher quality preschool lead to stronger school readiness? In 2003, Bryant et al. conducted one study on the effects of children attending higher quality programs in comparison to children who attended lower quality programs. In their study, they found that children who attended higher quality programs scored significantly higher than their peers who attended lower quality programs on school readiness indicators. Specifically, the indicators that demonstrated positive relationships to quality were receptive language, print awareness, book knowledge, applied mathematics, and counting one-to-one.

Later in 2012, Williams et al. performed a similar investigation albeit with a different purpose. The primary purpose was to develop a quality rating system that could be used across the state of Texas that was scientifically based and empirically derived. To accomplish this, they sought to identify which quality preschool indicators linked to indicators of greater school readiness. They looked at both structural and process quality elements. The elements examined included "responsive teaching practice, classroom arrangement and organization, daily routines, lesson planning, monitoring progress of children's learning, use of small vs. large group activities, and classroom curriculum and materials" (Williams et al., 2012, p. 6). Out of these indicators, their analysis concluded that three of these had the ability to discriminate student outcomes: (1) teacher professional development, (2) intentional instructional approaches, and (3) literacy instruction, especially when writing activities were included. One limitation in this study

is that the school readiness measure used did not include a mathematics component. As such, the researchers were unable to determine the impact of math instruction on differences in student outcomes.

Swaminathan et al. (2014) identified similar high quality elements to Williams et al. (2012). Their research confirmed the influence of targeted teacher professional development, literacy focus, and evidence-based instructional strategies impact on achievement outcomes of students. In fact, the outcomes also indicated a reduction in the likelihood of requiring special education services. Even more impressive, the students continued to outperform their peers in reading and math assessments even into adulthood, were more likely to hold a skilled job, and attend a 4-year college than the control group.

These three studies help to build a body of evidence around the structural and process elements that impact improved student readiness outcomes. Unfortunately, only one of the studies was able to attend to mathematics outcomes due to insufficient metrics available. With such limited studies currently available, this calls for more investigation to be conducted into the quality of preschool programs and possible links to better school readiness, especially in the area of mathematics.

Early Mathematical Literacy Predictability

Across the U.S., many kindergarten students' early mathematical literacy is assessed upon entry. The results of such assessments are often used for placement decisions in full-day kindergarten, determining which students to target for early intervention supports, or providing instructional guidance for the student's kindergarten teacher (Clarke et al., 2008; Lembke & Foegen, 2009). Additionally, the Common Core

State Standards for Mathematics (CCSSM) have also placed an "emphasis on

kindergarten counting and cardinality skills" (Jacobi-Vessels,Brown, Molfese, & Do,

2016, p. 1). Such decisions have been further reinforced by research findings in relation

to their ability to predict future academic outcomes (Clements & Sarama, 2016). In fact, a

meta-analysis of six studies found that early mathematical literacy not only predicts later

success in mathematics, but also predicts later reading achievement even more so than

early literacy skills (Duncan et al., 2007). With such great predictive power, a child's

early educational opportunities may be an influential force in determining a student's

learning trajectory for many years to come.

Which early mathematical literacy skills are most predictive? A number of

researchers have spent time in the preschool and kindergarten space to investigate the

early mathematical literacy variables that are most accurate in predicting future academic

performance prior to entry into kindergarten (Clarke et al., 2008; Geary & vanMarle,

2016; Jordan et al., 2007; Neumann et al., 2013; Pinto et al., 2016; Purpura et al., 2011;

Sarama & Clements, 2016). As researchers have examined which measures are most

effective, there has been converging evidence based on their findings. For example, all of

the aforementioned researchers have found a student's ability to recognize, identify,

and/or read numerals is an essential early mathematical literacy skill (e.g., Geary &

vanMarle, 2016; Jordan et al., 2007; Neumann, et al., 2013). Similarly, most of the

researchers also found significant predictive power in oral counting and cardinality (e.g.,

Jordan et al., 2007; Pinto et al., 2016). A few have found a student's ability to enumerate

sets and to discriminate quantities to be predictive of later mathematics achievement

(e.g., Clarke et al., 2008; Pinto et al., 2016).

Considering the general consensus around the common early mathematical literacy competencies, it is evident that research has identified some of the most predictive factors that deserve instructional attention and focus in early childhood settings. These measures also make sense for assessing preschool and entering kindergarten students as they have yet to complete more formal mathematics problems. Therefore, early mathematical literacy can be defined as a student's ability "to count forward and backward, to associate written numeric symbols with quantities, and to categorize and differentiate objects based on particular attributes facilitate the development of concepts, like equivalence and cardinality, and processes, like measuring and making simple calculations" (VanDerHeyden et al., 2011, p. 297). Researchers and schools assess mathematical literacy in preschool and kindergarten through items such as oral counting, cardinality, numeral recognition, and quantity discrimination.

With this in mind, attention to the influence of preschool attendance and quality of the programming on early mathematical literacy outcomes could provide invaluable insights into the aspects of programs that are able to enrich the mathematical competency of young children. The evidence suggests that stronger early mathematical literacy outcomes yield better overall academic performance, which is one of the major goals of the K-12 education system. By being able to identify the types of programs and the impact of the quality of such programs on student development of early mathematical literacy, such information could guide future developments in preschool programming and lead to increased student performance in the area of mathematics.

Conceptual Framework

In light of the information found in the review of the literature presented in this chapter and lack of mathematical proficiency identified in Chapter I, the researcher developed a conceptual framework to evaluate the influence of preschool attendance and the quality of the programs on school readiness. Figure 1 shows a conceptual framework for understanding this relationship between preschool attendance and early mathematical literacy outcomes. The conceptual framework provides a structure for understanding this relationship and the interplay of variables such as attendance and program type (i.e. none, face-to-face, online), quality of the preschool program attended, and student variables
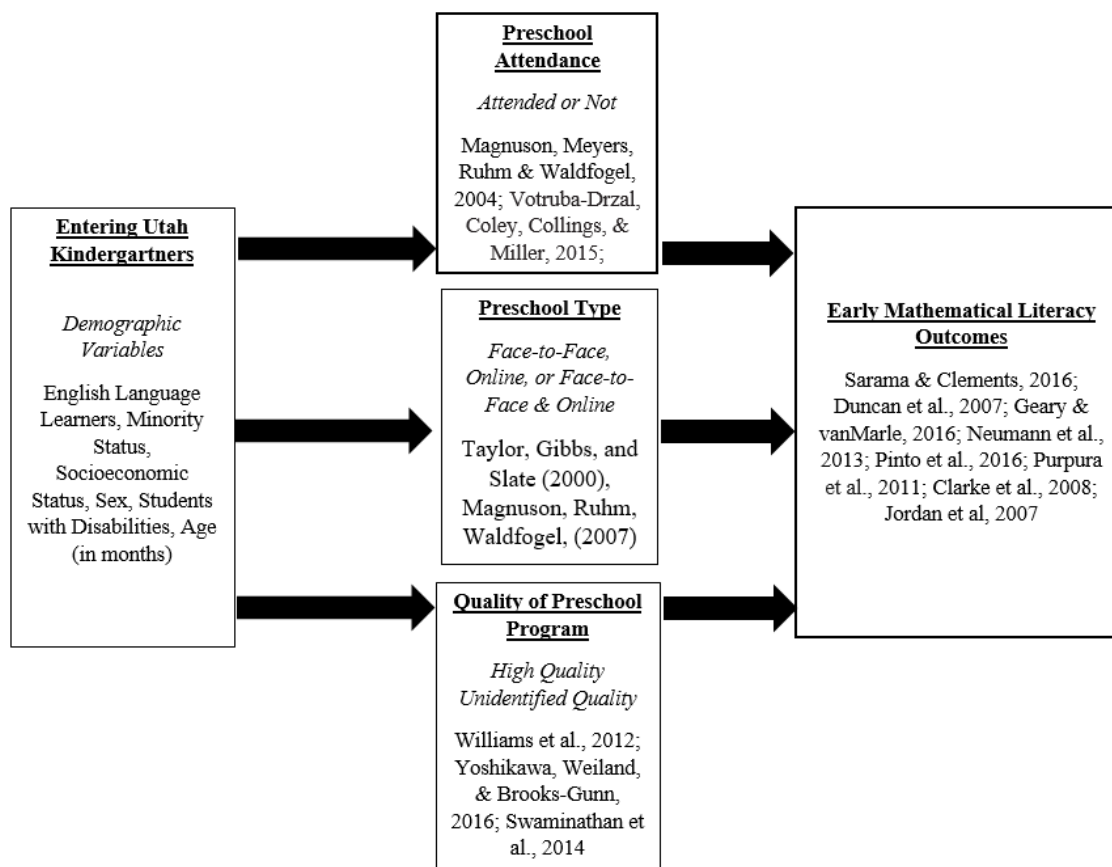
Figure 1. Conceptual framework.

(i.e., ELLs, minority status, SES, sex, students with disabilities, age (in months).

Analyzing how these conditions impact student achievement may provide critical insights

into the elements of preschool programming needed to maximize early mathematical

literacy outcomes.

Conclusion

Although a significant number of researchers have examined the effects of

preschool attendance on school readiness, there has been a lack of attention on the

influence of the type of programming a student enrolls in, along with the quality of such

programming. In fact, only two studies in the last 25 years have looked at the type of

programming attended and not a single study has looked at the differences between face-

to-face preschool programs to online preschool programming. Therefore, researchers

have recommended the need to study the relationship between early mathematical

literacy and the type of preschool attended (Taylor et al., 2000; Magnuson et al., 2007).

Additionally, with only three studies on the relationship between quality and school

readiness, and only one using mathematics as a metric (applied mathematics portion of

the Woodcock-Johnson), further study is needed to understand these relationships.

Considering the limited funding for early childhood programs, such as preschool,

it is critical to identify the factors that are having the greatest impact on student

achievement, especially early mathematical literacy due to its predictive qualities, as well

as the student populations that are most receptive to such learning experiences. This study

used one measure of student learning (i.e., a uniform kindergarten entry assessment:

KEEP), and examined its relationship to preschool attendance, preschool type, and preschool quality with a diverse student population while taking into consideration different demographic covariates.

CHAPTER III

METHODS

The purpose of this research study was to investigate the influence of preschool attendance, preschool type (i.e., public, private, Head Start, and home-based educational technology providers), and preschool quality on early mathematical literacy via kindergarten entry assessment outcomes for Utah kindergarten students. The independent variables considered included the type of program(s) attended, the influence of attendance in high-quality preschools, and demographic covariates such as English learner, ethnic minority, SES, sex, students with disabilities, and age (in months). The dependent variable was the results on early mathematical literacy test items from a state mandated assessment given at kindergarten entry called the Kindergarten Entry and Exit Profile (KEEP). This chapter provides a detailed description of the methods that were used to answer the following research questions.

1. What is the relationship between preschool attendance and early mathematical literacy? Are there differing effects for diverse student demographics?

2. What is the relationship between preschool type and early mathematical literacy? Are there differing effects for diverse student demographics?

3. What is the relationship between preschool quality and early mathematical literacy? Are there differing effects for diverse student demographics?

An empirical paradigm was used to interpret the data collected for this study in order to answer the research questions. With such an orientation, the researcher hypothesized that preschool attendance and the quality of the preschool program could explain differences in school readiness outcomes for entering kindergartners. As such, the researcher served as an objective observer and an independent interpreter of data. The researcher used

deductive reasoning, void of value judgements, but relied on the results to determine relationships between preschool attendance and the quality of preschool programs and their role in school readiness on all students, as well as considering differential effects for diverse students.

Overview of Methods

Table 1 presents an overview of the research questions, data sources, variables, and data analysis methods. The main data source for this study was the KEEP, which provided an overall school readiness achievement score in early mathematical literacy. To answer the research questions, the study examined differences on KEEP scores in early mathematical literacy with respect to preschool attendance, type of preschool program attended, influence of program quality, and the influence of preschool programming for students from at-risk families. The body of literature on preschool attendance suggested that these variables had the potential to influence the gains students achieved.

The research methods were quantitative and incorporated statistical analysis of preexisting state-level assessment data. The researcher used three statistical methods (i.e., 2x2 Factor ANOVA, *t* test, and multiple regression) to direct the analysis of Utah's entering kindergarten students' KEEP scores and the influence of preschool attendance on their early mathematical literacy outcomes.

The rest of this chapter outlines the methods used to analyze the potential relationships between preschool attendance, type of programs attended, and quality and

Table 1

Methods Overview

Research question	Dependent variable	Independent variables	Inclusion criteria	Data analysis
1	Kindergarten Entry and Exit Profile (KEEP) (USBE, 2017)	• Preschool attendance	All enrolled kindergartners in Utah public schools in the fall of 2017	*t* test for independent group means Multiple regression to include other demographic covariates
2	Kindergarten Entry and Exit Profile (KEEP) (USBE, 2017)	• Face-to-face • Online	All enrolled kindergartners in Utah public schools in the fall of 2017	2x2 Factor ANOVA Multiple regression to include other demographic covariates
3	Kindergarten Entry and Exit Profile (KEEP) (USBE, 2017)	• High-quality • Undetermined quality	All enrolled kindergartners in Utah public schools in the fall of 2017 Preschool experience	*t* test for independent group means Multiple regression to include other demographic covariates

performance in early mathematical literacy upon entry into kindergarten. First, the

researcher provides a description of the research design followed by an overview of the

participants and setting for the study. Next, the researcher presents an explanation of the

main instrument and data sources used. To conclude, the researcher includes a discussion

of the data analysis processes and procedures.

Research Design

For this study, the researcher used a quantitative design to identify if there were

relationships among preschool attendance, preschool type (i.e., face-to-face programs,

online programs), and preschool quality (high quality or undetermined quality as designated by Utah's legislative code 53F-6-304)) and early mathematical literacy using student outcomes from a state created, standardized kindergarten entry assessment. To answer each of the research questions with different independent variables used to analyze relationships, the researcher used data from the KEEP (USBE, 2017a). A quantitative design was most appropriate for this study because the researcher was trying to identify if there was a relationship between early mathematical literacy performance and a student's preschool attendance, preschool type, and preschool quality.

Participants and Setting

The participants in this study included 45,895 public school and charter school kindergarteners enrolled at the beginning of the 2017-18 academic school year across the state of Utah. The researcher used participant data collected from all public school districts and most charter schools across the state of Utah (with the exception of Athenian eAcademy, Dual Immersion Academy, Timpanogos Academy, Treeside Charter, and Wasatch Waldorf who declined to participate). Table 2 provides an overview of Utah's 2017-18 public school kindergarten enrollment demographics.

Because of the size of the study population, a power analysis was not necessary as the design used the entire population rather than a representative or random sampling. By using a census, all students who enrolled in kindergarten in a public school at the beginning of the 2017-18 school year were included in the studied population. By using each individual student, the research outcomes allowed for the identification of more

Table 2

Utah's Public School Enrollment Demographics for Kindergarten

Demographic variable	# of students	%
American Indian	446	0.9
Asian	706	1.5
Black/African American	600	1.3
Hispanic/Latino	7,649	16.0
Multi-race	1,459	3.1
Pacific Islander	784	1.6
White	36,028	75.6
Male	24,601	52.0
Low SES	14,846	31.1
Students with disabilities	3,9455	8.3
English language learner	3,335	7.0

Note. Source: Utah's Data and Statistics Department (USBE, 2017b).

accurate generalizations in the study (Johnson & Christensen, 2014). A census approach

can be biased against certain groups, as some disaggregated groups *n* size, even in a

sample this size, may not be large enough to accurately generalize that population. In

order to limit this potential bias, the researcher worked to maintain as many students in

the data set as possible by coordinating with the KEEP data provider at the USBE, to fill

in any missing information as needed.

Instruments

The instrument used to collect data on kindergarten children's early mathematical

literacy achievement was the KEEP. The KEEP is an assessment designed by Utah

educators, higher education faculty members, and staff at the USBE with support by

personnel at the Center for Assessment. These stakeholders engaged in the development of the assessment from July of 2016 to April of 2017.

The entire assessment includes three scoring categories: literacy, numeracy and social emotional skills with a total of 14 questions and eight observational items. The assessment is untimed and anticipated to take less than 15 minutes to individually administer. The test is given paper-pencil and face-to-face. The numeracy portion of the assessment includes six questions with eight score-able items (visit the USBE website at https://schools.utah.gov/file/4b53e429-20f6-4a86-87e1-0faa27a0d505f for a copy KEEP Administrator's manual). The questions address rote counting, numeral recognition, one-to-one correspondence, cardinality, numeral association to quantity, shape creation, and quantity discrimination. These concepts have been used in previous research to assess early mathematical literacy (Clarke et al., 2008; Jordan et. al, 2007; Geary & vanMarle, 2016; Pinto et al., 2016).

Initially, the questions were written by a team of early childhood teachers and district personnel based on Utah's Early Childhood Standards. After the initial question development, USBE staff brought the questions to early childhood specialists at the university level. University experts were asked specifically what items would yield the most useful information and provide the best indicators for predicting future academic success. The work of Sarama and Clements (2009) was the primary guiding source for determining which numeracy questions to maintain, items to add, as well as which items needed revision. After revision, the questions were brought to about 100 stakeholders for review and guidance. The stakeholders included preschool and kindergarten teachers,

district personnel, early childhood specialists, and early childhood program providers. Their feedback was then used to further refine the questions, mostly with respect to the wording. The final draft was released to the public in April 2017.

The 2017-18 school year was the assessment's operational field test year. Upon collection of all administered tests, the USBE sought the counsel of the Center for Assessment to develop and analyze the psychometric indicators, such as reliability, validity, cut scores, and proficiency level descriptors. From the Center's work, in coordination with USBE staff, the assessment team developed validity evidence to support the design of the assessment, including cut scores, scoring rules, and reporting categories (see the Appendix for supporting documentation from the Center for Assessment).

With respect to reliability, the five reporting categories and the early mathematical literacy section overall proved reliable (see Table 3). Reliability coefficients ranged from 0.63 to 0.93. Table 3 breaks down the reliability of each category as well as the overall early mathematical literacy portion of the KEEP. It should

Table 3

Reliability Coefficients for KEEP Early Mathematical Literacy

Reporting category	Reliability
Quantity to numeral	$\alpha = 0.72$
Sense of quantity	$\alpha = 0.67$
Counting and cardinality	$\alpha = 0.82$
Shape creation	$\alpha = 0.63$
Numeral recognition	$\alpha = 0.93$
Overall	$\alpha = 0.92$

be noted that the KEEP battery as a whole performed highly reliable at 0.92.

As evidenced by the reliability coefficients and the validity documentation, it is reasonable to consider the KEEP's early mathematical literacy data as a valid and reliable measure for this study.

Data Sources

In order to collect the necessary data required to answer the research questions, the researcher coordinated with the USBE as they were the entity that held the data. The researcher collected two primary sources of data for this study: 2016-17 preschool enrollment data and the results of the fall 2017 administration of the KEEP. Public schools assessed kindergartners, enrolled during the 2017-18 academic school year. The KEEP data collected indicated students' school readiness in early mathematical literacy. Per the USBE's rule, any enrolled kindergartner was tested sometime during the six-week testing window (which consists of three weeks before or within three weeks of the start of school).

The USBE data contained information on the type of preschool program the student attended as well as the required demographic covariates needed for the analysis. The researcher requested data at the individual student level. The USBE data personnel scrambled students' identification numbers to protect student privacy. Elements collected in the spreadsheet from the students' kindergarten enrollment records included: scrambled student ID, district ID, Local Education Agency name, KEEP assessment score, EL status, sex, students with disability status, minority, age in months, and low-

income status. Information gathered from the students' preschool records included: enrollment in preschool, district or private provider attended, attended a high quality preschool, home-based technology student, and attended both a face-to-face preschool and online preschool. This information allowed the researcher to have the information needed to answer the three research questions for this study.

Dependent Variable

The KEEP assessment scores generated the dependent variable for this study. The KEEP had separate subscale scores for literacy, early mathematical literacy, and social emotional skills. The researcher was most interested in the early mathematical literacy outcomes for this study as early mathematical proficiency has been found to be the best indicator of future academic performance (Denton & West, 2002). As such, the researcher only analyzed the early mathematical literacy data. That portion of the assessment contained eight individually scored items and further divided into five dimensions based using vector pairs (see the Appendix). Student performance on those items were scored and combined to produce an overall early mathematics literacy score. The overall scores produced were continuous variables with a range from 0-36 points possible. For a student to be deemed proficient on the KEEP in early mathematical literacy, they had to achieve a score of 29 points or greater.

Independent Variables

Each of the three research questions focused on different independent variables. The three independent variables considered were preschool attendance, preschool type,

and preschool quality. Additionally, the researcher considered demographic covariates to look for differential effects on particular populations. The demographic covariates examined included: sex (male/female), low SES (yes/no), ethnic minority (yes/no), students with disabilities (yes/no), age (in months), and English language learner status (yes/no).

Procedures

Prior to data collection, the researcher submitted a request to obtain data and conduct the study to the Institutional Review Board (IRB) of Utah State University during the fall of 2017. Following IRB approval, the researcher submitted a data request for the preschool enrollment data and the KEEP assessment data to the USBE in the winter of 2017. The data request was reviewed by the Board and granted approval. As required, a copy of the IRB, the researcher's vitae, and a description of the proposed research study was included in the application submission to the USBE.

Data Analysis

The statistical analysis first identified which independent variables were statistically significant for the given population. The significance level of $p < 0.05$ was used throughout the analysis. Due to the large size of the population involved in this study, looking at whether there was statistical significance at the $p < 0.05$ level was not sufficient because the population sizes were so large that it is highly likely that significance would be found. Therefore, the researcher further analyzed the variables that

indicate the predetermined significance level by determining effect sizes. Calculating

effect sizes better demonstrated the size of the impact of the independent variables on the

population (J. Cohen, 1992).

Also, with respect to the large population sizes, it was expected that the data

would violate homogeneity of variance and normality as they were overpowered by the

N. To compensate for this, the researcher used histograms to visually inspect the data.

The Central Limit Theorem allowed the researcher to assume that the sampling

distribution of the mean would be nearly normal given the size of the samples from the

population (B. H. Cohen, 2013).

Prior to analyzing the data, the researcher first took time to prepare the data. The

researcher merged, cleaned, and organized the screening variables. Once the data were

prepared, the researcher analyzed the data.

To answer the first research question, the researcher compared preschool

attendance (the independent variable) to the KEEP assessment scores (the dependent

variable) using a *t*-test analysis for independent group means. This analysis included an

examination of the relationship between preschool attendance and early mathematical

literacy achievement for specific diverse and at-risk covariates such as sex (male/female),

low SES (yes/no based on free/reduced lunch status), ethnicity (yes/no, e.g., ethnic

minority/not ethnic minority), and English language learner status (yes/no). The

researcher analyzed the covariates with respect to the dependent variable data, KEEP

assessment numeracy scores, for students enrolled in kindergarten and attended preschool

to look for predictors. A multiple regression analysis was used in order to examine

multiple covariates and their relationship to early mathematical literacy outcomes.

The second statistical analysis investigated the influence of preschool type compared to the KEEP assessment numeracy scores using a 2x2 Factor ANOVA. The ANOVA was used to explain the values of early mathematical literacy achievement scores on the school readiness assessment based on the student's preschool type attended. The researcher again conducted a multiple regression analysis to investigate differential effects on diverse students.

The final analysis explored the influence of quality on differences in students' early mathematical literacy outcomes. Any kindergartner enrolled who contained a preschool enrollment record was included in the analysis. The researcher then divided the group into two groups: (1) students who enrolled in one of the high-quality preschool programs (identified by the state under Utah Code 53F-6-304), and (2) students who enrolled in a preschool in a program where the quality of the program was unidentified. A *t* test for independent group means was used to analyze the relationship between quality and student outcomes in early mathematical literacy. Additionally, a multiple regression analysis was used to explore the effects of various demographic covariates on student outcomes while still considering the quality of the program the students attended.

Assumptions

Using the types of data analyses described above, there were certain assumptions that the researcher was aware of and made efforts to compensate for threats to validity. Specifically, both the ANOVA and multiple regression analysis had challenges.

The use of an ANOVA for answering research question two has three main assumptions: random sample, homogeneity of variance, and assumption of normality. First, an ANOVA relies on the underlying assumption that a random sample was used. In this case, the entire population was being analyzed. To address this issue, the researcher calculated effect sizes on any variable that suggested statistical significance at or above the $p < .05$ level. Second, as mentioned earlier, the Central Limit Theorem was used to address the issues with homogeneity and normality due to the size of the samples.

With respect to the multiple regression analyses, the most basic assumption was that there was a linear relationship between the independent variables and the dependent variable in the population. Additionally, it was assumed that there was a normal distribution with the variables involved. As this was a large sample, there was little need for concern around normality as the size of the population should prevent extreme deviations (B. H. Cohen, 2013). Nevertheless, since a multiple regression model is based on the assumption of a normal distribution, the researcher analyzed the outcome of the residual variable and checked for distribution by performing a residual diagram on all covariates run to ensure the data met the assumptions for a multiple regression analysis.

Summary

In conclusion, this chapter outlined the methods used to analyze the potential relationships between preschool attendance, type of programs attended, and quality and early mathematical literacy performance upon entry into kindergarten. The researcher used an empirical paradigm to investigate the relationships between the independent

variables (attendance, type, and quality) and KEEP assessment scores (dependent variable) for the population of 2017 entering Utah kindergarten students. To answer the research questions, the analyses included t-tests for independent group means, a 2x2 Factor ANOVA, multiple regressions, and effect sizes. The next chapter presents the results of the study.

CHAPTER IV

RESULTS

Overview of Results

This chapter is organized around the three research questions: (1) What is the relationship between preschool attendance and early mathematical literacy? (2) What is the relationship between preschool type and early mathematical literacy? and (3) What is the relationship between preschool quality and early mathematical literacy? For each question, the researcher investigated differing effects for diverse student demographics.

The first part of this chapter describes the compilation and organization of data for the analyses using SPSS. The next part of the chapter is a report of the analyses. The tables throughout the chapter help to represent and interpret the data, identify trends in the data set, and provide a statistical summary of the data.

Data Compilation and Organization Techniques

In preparation for this study and prior to submitting the data request, the researcher met with a USBE data steward in February 2017 to describe the necessary variables that were included in the data pool. By having this meeting, the researcher was confident that the essential information provided by the data steward in the Excel spreadsheet contained the essential information upon approval of the data request. The researcher also spoke with the data steward about formatting the data to be in a format suitable for efficient importing into SPSS. The Excel template included the following

variables: school year (2018), scrambled student ID, district ID, LEA name, sex (0/1; male), low SES (0/1), age (in months; 60-83 months), English Learner status (0/1), ethnic minority (0/1), student with disability (0/1), attended PreK (0/1), PreK district attended (0/1), High Quality PreK (0/1), Online PreK participant (0/1), and KEEP score (continuous variable). A value of "0" represented "no" and a value of "1" represented "yes".

Upon IRB approval and Board approval, the data steward generated and shared the data with the researcher via a secure file transfer. The completed data file included 45,895 kindergarten students. Overall, the meeting held with the USBE data steward minimized the amount of cleaning and data organization required for this study.

As the researcher analyzed each research question, additional adjustments to the Excel spreadsheet were required due to some missing codes or unexplained data. First, there were ten students with age in months that would not have been eligible to attend kindergarten. The data ranged from 1 to 57 months of age. Additionally, 31 students had age in months that exceeded the typical age of a kindergartener from 84 to 236 months of age. To remedy this erroneous data, the researcher excluded these cases from the data set for the age variable.

For research question two, the data steward had only included a value of "1" to denote attendance/participating in the "attended PreK" and "Online PreK participant" columns. In order to conduct the analysis successfully within SPSS, the researcher add a value of "0" to denote non-attendance/participation. It should also be noted that the online programming data were incomplete. The provider of the online system provided

data that required many iterations to adequately match student enrollment records to their participation in the online preschool program.

To answer research question 3, the researcher obtained a list of the Local Education Agencies (LEAs) preschool programs currently designated as high quality from the USBE's Preschool Specialist. The list represented 15 Utah LEAs with high-quality preschool programs: Cache, Davis, Duchesne, Granite, Iron, Jordan, Logan, Murray, Nebo, Provo, Salt Lake, Sevier, South Sanpete, Washington, and Weber. The student list was then cross-referenced with which students attended preschool in one of those 15 LEAs. As the researcher reviewed the data in that column, she found that a number of students were not marked with either value of 0 or 1, with 1 representing participation in a high quality preschool. As such, the researcher sorted the data by LEA and marked all of the students who attended PreK in one of the high quality LEAs with a value of "1". The remaining students in non-high quality preK programs were then marked with a value of "0" to denote they had attended PreK, but had not attended in a high quality program LEA. Finally, the students who did not attend PreK were removed from the data set in order to answer research question three. With this adjustment, the data was imported into SPSS for analysis. This left 10,018, of the 45,895, or 21.8%, of the students in the original data set, who attended a public preschool.

Results for the Relationship Between Preschool Attendance and Early Mathematical Literacy

To answer research question 1, on the relationship between preschool attendance

and early mathematical literacy, the researcher ran an independent samples *t*-test to determine if there were differences in early mathematical literacy performance between students who attended preschool and students who did not attend. As expected, the early mathematical literacy scores for the population studied violated homogeneity of variance and normality, but visual inspection of the histogram showed a very similar distribution between the two groups (see Figure 2).

The independent group *t*-test results showed that students who attended preschool during the year prior to their enrollment in kindergarten ($M = 28.44$, $SD = 8.264$, $N = 10,018$), on average, underperformed compared to their peers who did not attend
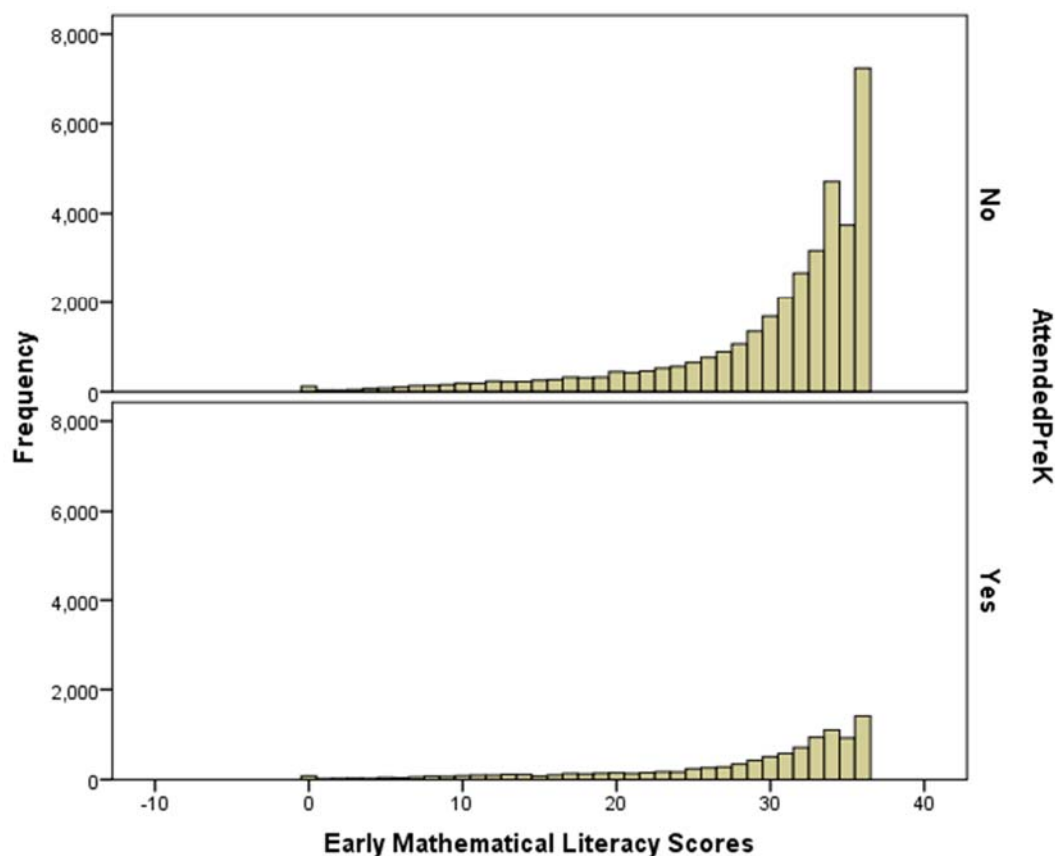
Figure 2. Histograms of early mathematical literacy scores by preschool attendance.

preschool (M = 30.18, SD = 7.10, N = 35,877), t (45,893) = 19.217, p < .001 with a difference of 1.742 and a Cohen's d of 0.22. This was a small effect size.

To further investigate research question 1, the researcher conducted a multiple regression analysis to determine if diverse student demographics predicted early mathematical literacy scores. Specifically, the demographic covariates considered were: sex (0/1; male), low SES (0/1), ethnic minority (0/1), students with disabilities (0/1), age (in months; 60-83 months), and ELL status (0/1). An exploratory analysis, using scatterplots and histograms, showed that the assumptions for a multiple regression were met. The researcher conducted a multiple regression analysis with mathematical literacy score as the dependent variable. The predictors for the model were preschool attendance, the demographic covariates, and the two-way interactions between preschool attendance and each demographic covariate such as prekxswd, prekxlowses, prekxethnicminority, and prekxELL. The main effects of the demographic covariates are reported in Table 4, and the interaction effects are reported in Table 5. The results of the regression analysis indicated that the main effects of the five predictors explained 19.2% of the variance, F (12, 45840) = 955.921, p < .001.

Table 4 shows the relationship between each covariate and early mathematical literacy performance, along with the level of significance, without consideration for their attending preschool.

Table 4 shows that for the students with the demographic covariates of low SES, ethnic minority, disabilities, and ELLs were likely to perform lower than their peers who did not have those demographic markers. The age covariate indicated that age

Table 4

Demographic Covariates as Predictors of Early Mathematical Literacy Scores Based on Attendance

Covariates	*B*	*SE B*	β	*t*	*p*
Intercept	13.588	0.490		27.746	<.001
Age in months	.274	.007	.159	37.618	<.001
Male	.137	.070	.009	1.944	.052
Students with disabilities	-3.691	.355	-.134	-10.407	<.001
Low SES	-3.501	.084	-.218	-41.588	<.001
Ethnic minority	-2.601	.096	-.150	-27.116	<.001
English language learner	-5.166	.167	-.178	-30.859	<.001

Codes: Age in months (60-83 months); male (0 = male, 1 = female); students with disabilities (0 = yes, 1 = no); low SES (0 = yes, 1 = no); ethnic minority (0 = yes; 1 = no); and English Language Learner (0 = yes, 1 = no).

N = 45,895.

Table 5

Preschool Attendance and Demographic Covariate Predictors

Covariates	*B*	*SE B*	β	*t*	*p*
Students with disabilities	-1.394	0.383	-0.048	-3.638	<.001
Low SES	1.055	0.163	0.043	6.458	<.001
Ethnic minority	0.433	0.193	0.015	2.246	.025
English language learner	2.795	0.293	0.059	9.551	<.001

Codes: Students with disabilities (0 = yes, 1 = no); low SES (0 = yes, 1 = no); ethnic minority (0 = yes; 1 = no); and English Language Learner (0 = yes, 1 = no).

N = 10,018.

significantly predicted mathematical literacy scores (β = 0.159), *p* < .001, indicating that students who were older performed better than their younger aged peers. Sex did not significantly predict a student's early mathematical literacy performance (β = 0.009), *p* = .052. This means that, on average, students with low socioeconomic backgrounds, of an ethnic minority, with a disability, and/or learning English predicted lower outcomes on

the participants' early mathematical literacy scores, but not sex.

Table 5 presents the interaction effects of preschool attendance on early mathematical literacy performance for students who were categorized as low SES, ethnic minority, students with disabilities, and ELLs who attended preschool. In the multiple regression model, these categories included preKxlowSES, preKxethnicminority, preKxswd, and preKxEL in order to investigate the two-way interactions between preschool attendance and demographic covariates.

Table 5 shows a positive relationship between preschool attendance and all four covariates. In fact, students in the four-covariate groups demonstrated statistically significantly better performance than their demographic alike peers if they had attended preschool, with the greatest benefits for students from low SES families and ELLs. This means that students from diverse backgrounds and/or at-risk families experience improved early mathematical literacy performance when they attended preschool.

Results for Relationship Between Preschool Type and
Early Mathematical Literacy

To answer research question 2, on the relationship between preschool type and early mathematical literacy, the researcher conducted a 2x2 Factorial ANOVA. The ANOVA compared the main effects of the type of preschool attended and the interaction effect between preschool type and early mathematical literacy upon kindergarten entry. Preschool type included four categories (face-to-face, online, face-to-face and online, and neither). Again, as expected, the data violated homogeneity of variance and normality

due to the large sample, but visual inspection of the histograms showed a similar distribution across the groups (see Figure 3).

As shown in Table 6, the results of the ANOVA analysis showed a statistically significant interaction between the effects of face-to-face preschool and online preschool on early mathematical literacy, $F(1, 45{,}891) = 24.114$, $p < .001$ with an adjusted R^2 of 0.219, a medium effect size based on Pearson's Correlation Coefficient (B. H. Cohen, 2013).
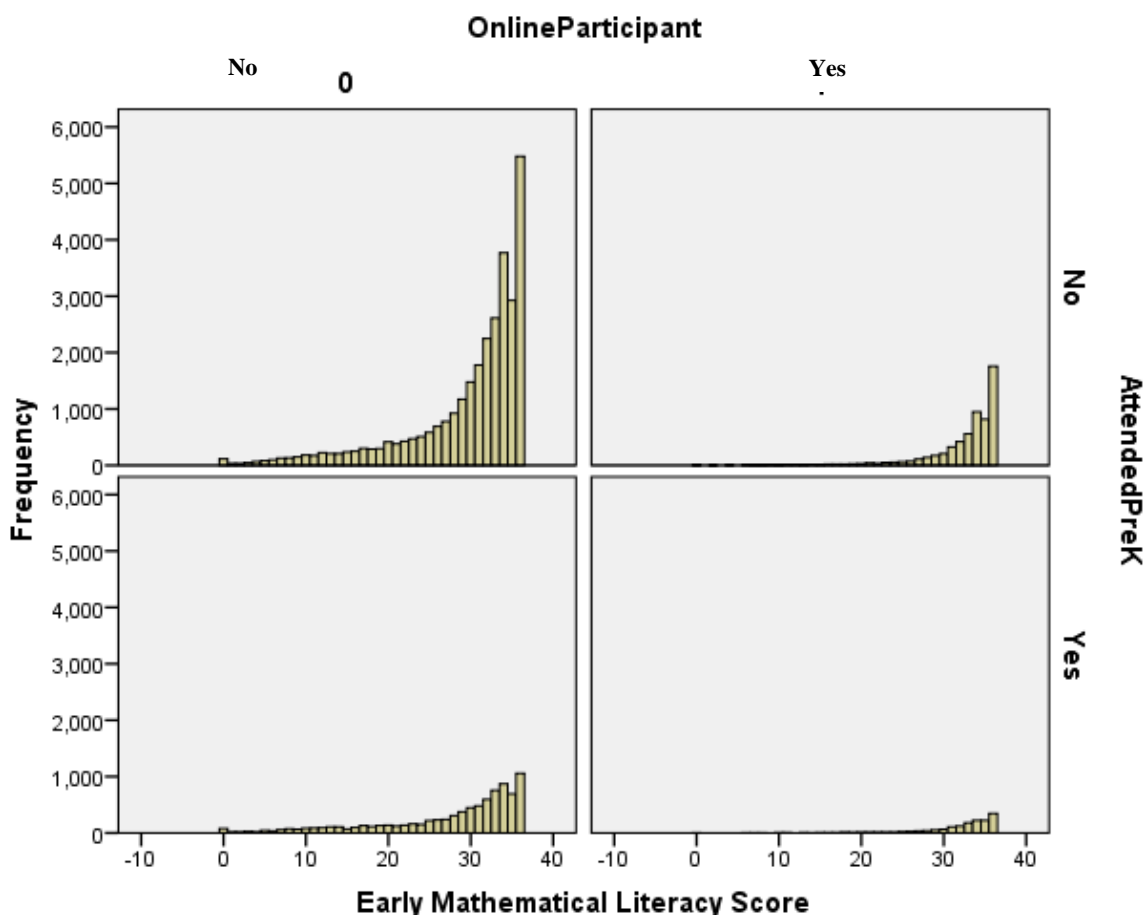
Figure 3. Histograms of the four categories of preschool type.

Table 6

2x2 ANOVA and Effect Size for Face-to-Face and Online Preschool

Source	df	SS	MS	F	p	η^2
Face-to-face preschool only	1	7632.98	7632.98	144.04	<.001	0.019
Online preschool only	1	48197.68	48197.68	909.54	<.001	0.003
Both face-to-face and online preschool	1	1277.85	1277.85	24.11	<.001	0.001
Total	45,895	43270395.00				

Table 6 summarized the ANOVA analysis indicating a significant interaction between the effects of preschool type and mathematical literacy scores. Hence, an analysis of main effects was needed to understand the interaction between preschool type and mathematical literacy scores. A simple main effects analysis showed that students who attended online preschool had significantly higher mathematical literacy scores than other groups, $p < .001$. Figure 4 graphically shows the main effects.

The left side of Figure 4 shows that students who participated in online preschool only, on average, outperformed all other groups, while the combination of face-to-face and online preschool reduced the gap between no preschool or only face-to-face preschool. The right side of Figure 4 data shows that participating in online preschool only or online preschool with face-to-face preschool had better results than the other conditions. This means that the online preschool only type more drastically influenced students' early mathematical literacy scores than any of the other types examined.

Next, the researcher further analyzed the data for research question 2 using a multiple regression analysis to determine if various demographic covariates predicted early mathematical literacy outcomes based on different types of preschool. The

Source	*M*	*SD*
Face-to-face preschool only	27.813	0.079
Online preschool only	32.536	0.094
Both face-to-face and online preschool	31.741	0.182
Neither face-to-face nor online preschool	29.707	0.042
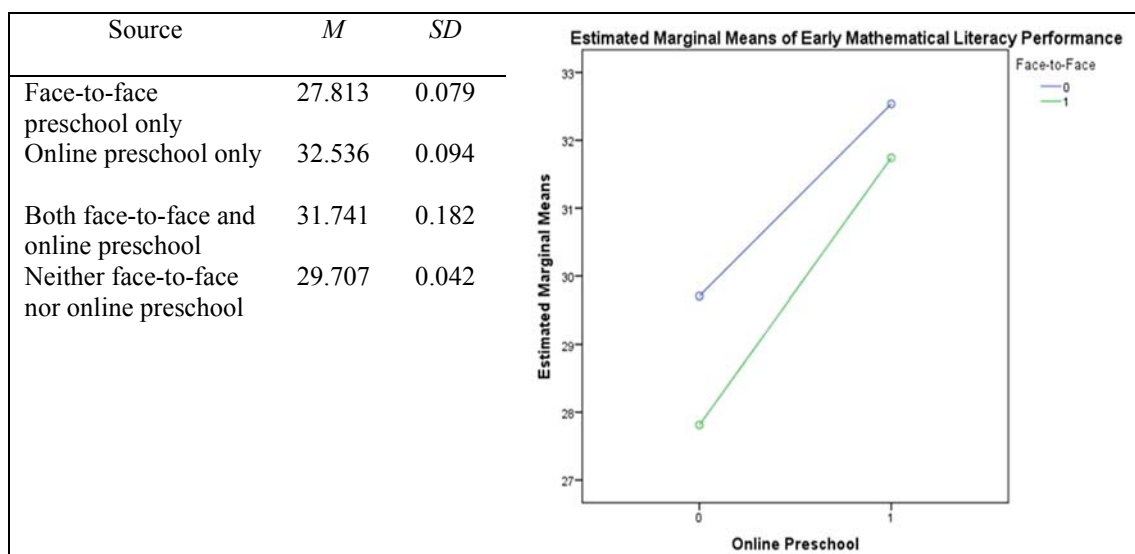
N = 45,895.

Figure 4. Mean performance on early mathematical literacy by preschool type.

researcher calculated a multiple regression to predict mathematical literacy outcomes based on age, sex, disability, low SES, ethnic minority, and ELL and disaggregated by preschool type (see Table 7).

As Table 7 shows, for students who did not attend preschool (i.e., face-to-face preschool or participate in online programming), all demographic covariates (except sex and age) predicted lower early mathematical literacy performance in statistically significant ways. For students who only attended face-to-face preschool, age was not a significant predictor for early mathematical literacy outcomes. However, students with disabilities scored lower, but to a lesser degree, than those with no preschool. Students designated as low SES, ELL, or ethnic minority actually scored higher with face-to-face preschool. For students who participated in the online preschool programming only, the covariates of low SES families, ELL, ethnic minorities, and students with disabilities also

Table 7

Betas for Four Preschool Type Categories and Demographic Covariate Predictors

Covariate	No face-to-face & no online (N = 29,877)		Yes, face-to-face & no online (N = 8,426)		No, face-to-face & yes online (N = 5,990)		Yes, face-to-face and yes online (N = 1,592)	
	Unstandardized β	Coefficients Std. Error	Unstandardized β	Coefficients Std. Error	Unstandardized β	Coefficients Std. Error	Unstandardized β	Coefficients Std. Error
Intercept	6.722	0.665						
Age in months	0.373**	0.010	0.023	0.022	-0.138**	0.025	-0.023*	0.057
Male	0.058	0.076	0.068	0.165	0.256	0.186	-0.407	0.408
Students with disabilities	-3.599**	0.362	-1.842**	0.394	0.004**	1.512	2.646*	1.561
Low SES	-3.712**	0.090	1.128**	0.176	2.266**	0.237	-0.295	0.450
Ethnic minority	-2.603**	0.102	0.588*	0.204	1.182**	0.278	-0.727	0.564
English language learner	-5.093**	0.172	2.753**	0.302	1.291*	0.604	-0.171	1.019

Note. Cells contain nonstandardized beta coefficients and standard error from separate subset multiple regression.

Codes: Age in months (60-83 months); male (0 = male, 1 = female); students with disabilities (0 = yes, 1 = no); low SES (0 = yes, 1 = no); ethnic minority (0 = yes; 1 = no); and English Language Learner (0 = yes, 1 = no).

$N = 45,895$

* $p < .05$.
** $p < .001$.

significantly predicted higher early mathematical literacy outcomes. Unlike face-to-face preschool, students who attended online preschool only seemed to have lower levels of performance when younger age was considered ($\beta = -0.138$), $p < .001$. Finally, for students who both attended face-to-face preschool and participated in the online preschool programming, only the covariates of age and disability significantly predicted early mathematical literacy outcomes. As with only online, younger age again had a negative influence on early mathematical literacy scores ($\beta = -0.23$), $p < .05$. It is important to note that low SES, ELLs, and minority status experienced neutral effects in the type with the face-to-face and online preschool combination.

Overall, sex was not a distinguishing variable across the four types of preschools analyzed. In contrast, early mathematical literacy results were positively affected for students from low SES families, ELLs, ethnic minorities, and students with disabilities who participated in face-to-face, online, and/or both types of programming over peers who did not attend/participate. This means that there was benefit for students of low SES, ethnic minority, and disability who attended preschool either face-to-face or online.

When comparing face-to-face with online preschool, there were positive and significant correlations with the demographic covariates, though in differing ways. For ELLs, face-to-face programming had a stronger correlation with early mathematical literacy outcomes ($\beta = 2.753$), $p < .001$. Students with the covariates of low SES, ethnic minority, and disability who attended online preschool had a significant positive beta weight, indicating they benefited in the online learning environment ($\beta = 2.266$), $p < .001$; ($\beta = 1.182$), $p < .001$; ($\beta = 0.004$), $p < .001$.

Results for the Relationship Between Preschool Quality and

Early Mathematical Literacy

To answer research question three, on the relationship between preschool quality and early mathematical literacy, the researcher conducted an independent samples *t* test. The independent samples *t* test compared students' early mathematical literacy performance between those who attended a high quality preschool deemed by the state and those who attended a preschool program not currently deemed high quality by the state. Due to the large sample sizes, the homogeneity of variance (*p* significant) and normality assumptions were violated, but a visual inspection of the associated histograms showed a similarly distributed data set between the two groups (Figure 5).
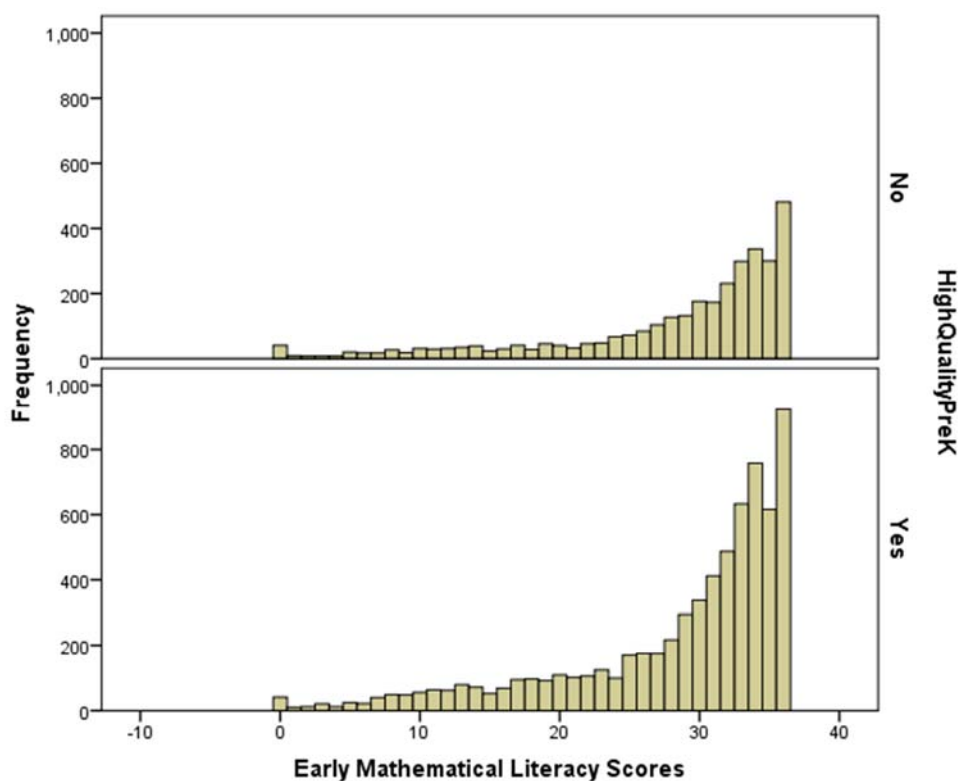
Figure 5. Histograms of early mathematical literacy scores and high-quality PreK.

The independent samples *t*-test results showed no significant differences between students who attended a high quality preschool program ($M = 28.49$, $SD = 8.11$, $N = 6762$) and those that did not ($M = 28.33$, $SD = 8.57$, $N = 3256$), $t(10,016) = -0.893$, $p = .372$ with an small effect size of $d = .02$.

Next, the researcher conducted a multiple regression analysis with mathematical literacy score. The predictors were preschool quality, the demographic covariates, and the two-way interactions between preschool quality and each demographic covariate such as HQxswd, HQxlowses, HQxethnicminority, and HQxELL. The main effects of the demographic covariates are reported in Table 8, and the interaction effects are reported in Table 9. Table 8 contains the results of the model for all students attending preschool. The covariates combined to account for 16.7% of the variance in mathematical literacy scores, although sex was not statistically significant, $F(13, 10,004) = 154.270$, $p < .001$.

Table 8 shows that the covariates low SES, ethnic minority, students with disabilities, and ELLs who attended preschool predicted lower early mathematical literacy scores than their peers without those variables. The lowest predicted scores were from students with disabilities ($\beta = -0.320$), $p < .001$. These results show that these demographic covariates contribute negatively to a student's early mathematical literacy performance upon entering kindergarten.

Table 9 presents the results of the regression model for the two-way interactions between high-quality preschool and the demographic covariates (e.g., HQxethnicminority).

As Table 9 shows, student participation in a high-quality preschool predicts

Table 8

Demographic Covariate Predictors on Early Mathematical Literacy for Students Who Attended Preschool

Covariates	*B*	*SE B*	β	*t*	*p*
Intercept	12.437	2.361		5.267	< .001
Age in months	0.294	0.035	0.130	8.331	< .001
Male	0.358	0.272	0.021	1.315	.189
Students with disabilities	-5.661	0.281	-0.320	-20.172	< .001
Low SES	-2.929	0.282	-0.176	-10.393	< .001
Ethnic minority	-1.882	0.349	-0.106	-5.395	< .001
English language learner	-2.912	0.517	-0.112	-5.629	< .001

Codes: Age in months (60-83 months); male (0 = male, 1 = female); students with disabilities (0 = yes, 1 = no); low SES (0 = yes, 1 = no); ethnic minority (0 = yes; 1 = no); and English Language Learner (0 = yes, 1 = no).

N = 10,018

Table 9

Demographic Covariate Predictors on Student Performance for Students Who Attended High-Quality Preschool

Covariates	*B*	*SE B*	β	*t*	*p*
Intercept	12.437	2.361		5.267	< .001
Age in months	0.116	0.043	0.438	2.660	.008
Male	-0.410	0.330	-0.024	-1.241	.215
Students with disabilities	0.938	0.347	0.046	2.702	.007
Low SES	0.728	0.343	0.041	2.123	.034
Ethnic minority	-0.422	0.416	-0.022	-1.013	.311
English language learner	0.758	0.608	0.025	1.245	.213

Codes: Age in months (60-83 months); male (0 = male, 1 = female); students with disabilities (0 = yes, 1 = no); low SES (0 = yes, 1 = no); ethnic minority (0 = yes; 1 = no); and English Language Learner (0 = yes, 1 = no).

N = 10,018

students' early mathematical literacy performance for three of the covariates analyzed. Notably, students from low socioeconomic families ($\beta = 0.728$), $p = .034$ and students with disabilities ($\beta = 0.938$), $p = .007$ were significantly predicted to have better outcomes when they attended a high-quality preschool program, whereas, ethnic minorities ($\beta = -0.422$), $p = .311$ and ELLs ($\beta = 0.758$) $p = .213$ do not appear to experience a statistically significant prediction. Age is a statistically significant predictor ($\beta = -0.116$, $p = .008$, but sex does not seem to be a predictor variable ($\beta = -0.410$), $p = .215$. Therefore, although high quality preschool as a variable did not yield better outcomes than an undetermined quality preschool, there are some statistically significant positive differences for specific student sub-groups.

During the analysis, the researcher noted a large discrepancy between the percent of children classified as students with disabilities. The incoming kindergarten population was comprised of 8.3% of students designated as having a disability, but the percentage of students in the study who attended public preschool classified as students with disabilities was 32% (3,234 of the 10,018 participants). These data suggested a disproportionate percentage of students with disabilities enrolled in the preschool programs analyzed. As such, the researcher wondered if the results of attending preschool might be skewed due to the large percentage of special education students in the sample.

To investigate this discrepancy, the researcher removed the students with disabilities from the data set and conducted another independent samples t test. The results of this additional analysis showed that students who did not attend preschool ($M = 30.18$, $SD = 7.1$, $N = 35,877$) outperformed their peers that did ($M = 29.90$, $SD = 6.97$, N

= 6,784), $t(42,659) = 3.032$, $p < .05$. While this was a significant result, the effect size results indicate a decline in the relationship between preschool attendance and early mathematical literacy. Initially, the effect size with the students with disabilities included in the data was $d = .22$, but with this population removed the effect size declined to $d = .03$. These results indicated that with the removal of students with disabilities from the data set there was essentially no difference between the performance levels of those that attended preschool and those that did not.

Summary

In conclusion, the results of this study indicated that preschool attendance and preschool quality did not have a significant relationship with improvements in early mathematical literacy. In fact, students who did not attend preschool demonstrated higher early mathematical literacy scores. A further analysis of preschool types revealed statistically significant relationships showing higher performance for students who participated in the online preschool programming type. Students who participated in the online preschool programming type outperformed all other types of preschool participation (i.e., face-to-face, face-to-face and online, no preschool participation). In addition, while the results for preschool quality showed no statistically significant differences between the students who attended high quality preschools and those that did not, further analyses showed that students with diverse and/or at-risk backgrounds who participated in preschool had improved early mathematical literacy outcomes when compared with their demographically alike peers who did not participate in preschool.

CHAPTER V

DISCUSSION

The purpose of this study was to investigate the relationships among preschool attendance, preschool type (i.e., public, private, Head Start, and home-based educational technology providers), and preschool quality and early mathematical literacy using a kindergarten entry assessment for Utah kindergarten students. This chapter summarizes the study, provides a discussion of the results, limitations, recommendations, and study conclusions.

Overview

The research questions in this study were: (1) What is the relationship between preschool attendance and early mathematical literacy? (2) What is the relationship between preschool type and early mathematical literacy? and (3) What is the relationship between preschool quality and early mathematical literacy? Each question examined differing effects for diverse student demographics. The researcher collected data from the USBE, from 74 LEAs, and included kindergarten entry scores for 45,895 of Utah's entering kindergarten students. The statistical methods used to analyze the data were *t* tests for independent group means, multiple regression, and a 2x2 Factor ANOVA. The researcher used SPSS software to conduct the data analyses. The findings from this study inform policymakers and educators on the factors that may influence early mathematical literacy for preschool-aged Utah children as they enter kindergarten.

Discussion of Results

Overall, the results demonstrated the relationships between attending preschool, the type of preschool attended, and the quality of the preschool with early mathematical literacy outcomes. In general, the independent variables of preschool attendance and preschool quality did not have a positive influence on early mathematical literacy as a whole (which was expected based on the literature). However, an investigation into specific demographic covariates yielded a more fine-grained explanation for early mathematical literacy outcomes. For example, students who attended online preschool had higher average early mathematical literacy scores than their peers who attended face-to-face preschool. However, when considering demographic covariates, student sub-groups were predicted to experience greater performance outcomes when attending face-to-face preschool in comparison to online preschool. The following sections will highlight the relationships among the independent variables and students' early mathematical literacy outcomes and correlational outcomes for particular demographic covariates.

Influence of Preschool Attendance

In analyzing research question 1, the relationship between preschool attendance and early mathematical literacy, the results indicated that attending preschool did not yield greater performance or preparation in early mathematical literacy. In fact, incoming kindergartners who did not attend preschool scored higher on the KEEP assessment than their peers who did attend, with a small effect size. This finding is in contrast with current

research on preschool attendance. From Taylor et al. (2000) to Herndon and Waggoner (2015), the research has resoundingly showed that students who attend preschool outperform their peers that do not. For those who support preschool education, this may seem like a discouraging result.

The multiple regression analysis, using various demographic covariates (i.e., sex, SES, ethnic minority, students with disabilities, age, and ELLs), indicated that there were significant correlations with performance for students from low SES families and ELLs. This corroborates Magnuson et al.'s (2004) findings showing that students from diverse backgrounds generally experience greater benefits from participating in preschool when compared with their less diverse peers.

Considering these results and the limited funding currently available for preschool in Utah, it may be important to consider targeting specific demographic sub-groups of students (e.g., low SES, ELLs) to attend preschool, since the influence experienced by those groups may be more beneficial in comparison to the general population of preschool-aged children as a whole. Such a strategy may more effectively target and support students who are at greatest risk for academic success and be a valuable approach to yielding a better return on the state's investment into early childhood education.

Influence of the Type of Preschool

To evaluate the interaction effects of the type of preschool a child attends and its influence on their development of early mathematical literacy, the researcher conducted a 2x2 Factor ANOVA. The results of the ANOVA yielded some very intriguing findings that may be useful for considering how to best invest in early education.

First, of the four preschool types considered (i.e., face-to-face, online, face-to-face and online, none), online interactive software alone outperformed all other options. Research (Jones, 2016) has shown that online learning can be effective for preschool learners in literacy, so perhaps it can also be effective for numeracy. Interestingly, students who participated in the online type and attended face-to-face preschool did not outperform students who only participated in the online type. This is interesting, as research has shown that more instructional time yields greater outcomes (Cattaneo, Oggenfuss, & Wolter, 2017). However, in this study, the evidence does not support that conclusion.

Second, similar to the results of research question one, students who did not attend or participate in any preschool program performed at higher levels, on average, than their peers who attended face-to-face preschool. However, these students did not outperform their peers in the online preschool type. Research has shown that interactive, online learning has led to improved learning for participants (Brouwer et al., 2017; Clements, 2002) as was similarly demonstrated in this study. One explanation for this is students engaging with interactive, adaptive software that closely aligns with their learning needs are benefiting from the tailored instruction they receive from the online programming.

Finally, according to the multiple regression analysis with demographic covariates, there were significant and positive correlations for the covariates considered. No matter the type, face-to-face, online, or a combination of both, students from low SES families, ethnic minorities, students with disabilities, and ELLs experienced enhanced

performance in early mathematical literacy in comparison to their demographically alike peers who did not participate in some kind of preschool experience. More specifically, students from low SES families and ethnic minorities benefitted the most through their participation in online programming; whereas, ELLs experienced the greatest benefit from a face-to-face preschool setting. Students with disabilities experienced the greatest gains when they attended a combination of face-to-face preschool and participated in the online preschool programming. This research result aligns with the findings from Votruba-Drzal et al. (2015) and Magnuson et al. (2006) in that they also found improved school readiness outcomes for specific demographic groups.

Given these findings, there is additional evidence that specific demographic groups experience heightened benefits when engaging in some type of early childhood experience. For most groups, one preschool type worked better over another, with the exception of students with disabilities, who appeared to benefit most from participating in both. The research on students with disabilities shows that there is benefit to their school readiness performance for those that participate in preschool programs (Magnuson et al., 2004). As a result, focusing early childhood efforts to support such student populations may increase the potential benefits for these demographic populations.

Impact of the Quality of the Preschool

The findings from the independent samples *t* test to understand the relationship between students who attend high quality preschools and early mathematical literacy showed no statistically significant differences between students who attended high-quality preschool and students who attended preschool with an undetermined level of

quality. This means that it did not matter if the child attended a preschool that was deemed high quality or another public preschool, as their early mathematical literacy scores were similar. The research literature suggests that high-quality preschool programming generally yields higher student achievement (Bryant et al., 2003; Swaminathan et al., 2014; Williams et al., 2012). However, the results of this study showed that high quality preschool programs were not related to higher scores for students on the KEEP assessment.

The multiple regression analysis, using the demographic covariates of low SES and disability, revealed statistically significant correlations when students were compared to their like peers who attended preschool, but not a high-quality preschool. Other demographic covariates were not significantly correlated, except for age. One reason for this result may be that the high quality preschool programs are better adept at meeting the diverse learning needs of low socioeconomic students and students with disabilities.

Limitations, Recommendations, and Conclusions

The following sections describe the limitations, suggested recommendations for future research studies, and potential considerations based on the results of this study.

Limitations

One main unforeseen limitation was the limited state level data available related to preschool enrollment. In initial discussions with the USBE, staff indicated that preschool enrollment data would be available. Once the researcher obtained the data, she found that the data only included public school preschool program information. Upon

further clarification from USBE staff, the State confirmed that it does not currently

collect enrollment or attendance data from private or other providers of preschool. This

left the results to be solely reflective of public school preschool programs.

In addition, preschool enrollment data were limited to what the LEAs had entered

into the system. Because of this limitation, some students may have been classified as

having not attended preschool, when they may have attended a private preschool, but

their data were not reported to the state to denote their attendance. Also, it is unknown the

number of days a student designated as having attended preschool actually attended. The

LEAs do not submit attendance data to the state for preschool students so the number of

days of attendance is unknown. This may help to explain some the of the limited effects

of preschool found in this study.

Lastly, the expected timeline for significant changes may be too brief given the

restraints of this study. It takes time for change to occur. Evidence suggests that it can

take up to three years to see real change. This study only used data from one year. A

longitudinal study may provide a more complete understanding of the influence of

preschool attendance on early mathematical literacy.

Recommendations

Considering the analyses and findings of this study, a few recommendations

would elevate the usefulness of the information ascertained. USBE staff, further research,

and/or potential legislative changes would be best to attend to these recommendations.

The first recommendation is for the USBE to work to collect data on the

preschool program and type attended, and approximate duration of preschool programs

for all incoming kindergarten students. This would allow for a more complete analysis of the effects of preschool on early mathematical literacy outcomes. Such data are currently limited to only public preschool students. With the availability of a more complete data set, researchers could conduct a thorough and comprehensive analysis of the impact of preschool on early mathematical literacy outcomes. Relatedly, it is also important to improve the accuracy of online preschool programming records. An 80% match rate is not adequate. A collaborative effort between the USBE and the online vendor provider could lead to greater matching potential and improved accuracy of the data.

The next recommendation is to conduct additional research to understand the lack of enhanced student performance for those that attended preschool. Given the findings with respect to the impact of preschool attendance on early mathematical literacy, it appears that students who attended preschool did not outperform their non-attending peers. It is important to understand why this study produced this result which conflicts with the current research on the benefits of preschool participation. Perhaps more instructional time in Utah's preschools is being spent on developing literacy or social and emotional skills, and less instructional time is focused on developing mathematical literacy. Based on the results of other studies, one would expect to find children that attended preschool to be more mathematically ready than their peers who did not, but the results of this study do not confirm this assumption. Also, because early mathematical literacy is highly predictive of future academic outcomes, ensuring that Utah's preschools are focusing on developing mathematics with early learners is critical.

Finally, two legislative changes may be warranted. First, considering the minimal

performance difference between LEAs that have been deemed high quality and those that have not, it may be wise to reexamine the indicators defined in state legislation that determines preschool quality. As described in Chapter II, Utah has defined the indicators of what a high-quality preschool is comprised of in legislation. If those indicators are not connected to improved student outcomes, then it is important to further consider if those indicators matter or if they are the right combination of indicators. Additional analysis at the school level may yield greater understanding of which schools are experiencing significantly different results and evaluating those programs to understand what the potential factors may be that contribute to improved student performance. Such a study could help to refine current legislation and more accurately identify the indicators of quality that truly influence student performance.

Also, given the significant achievement benefits for students who were enrolled in the UPSTART online preschool program, the state of Utah may want to consider expanding the funding and continuing to build awareness of the program. The results demonstrate an ability to equalize the playing field for students with demographic covariates which have proven to contribute to student performance. The program also provides parents with activities they can use to engage their student in early mathematical literacy as part of their participation in the program. Levine, Suriyakham, Rowe, Huttenlocher, and Gunderson (2010) found that the amount of number talk a child hears before the age of four predicts early mathematical literacy achievement such as cardinality. So, perhaps the mathematical conversations parents are engaging in may explain some of the variation. With such positive results, serving more students would be

of great value.

Conclusions

The results of this study showed that the independent variables of preschool attendance and preschool quality did not have a positive impact on early mathematical literacy as a whole. However, there were important positive influences for preschool types when examined with respect to demographic covariates. Students who participated in the online preschool programming type, on average, experienced the highest early mathematical literacy scores.

These results have important implications, such as who may benefit most from participation in preschool and the type of setting in which they are engaged. For example, with the success of the early mathematical literacy performance for students who participated in the online preschool programming, the data warrants efforts to continue to seek expansion of such programming so that more students can benefit from participation in this preschool type.

The key takeaway from this study is that participation in preschool had a limited influence on early mathematical literacy for the population as a whole. However, when considering specific demographic groups in this study, there are benefits to participation in preschool that could be an advantage point for closing the achievement gap. Particularly, students with demographic covariates, like low SES, ELLs, ethnic minorities, and students with disabilities, all demonstrated correlations with improved performance when involved in some type of preschool programming, whether online or face-to-face, in comparison to those who did not attend preschool. Considering these

outcomes and the limited funding available for preschool in Utah, it may be warranted to

consider targeting preschool opportunities to student populations with specific

demographic covariates, as those results are encouraging.

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APPENDIX

CENTER FOR ASSESSMENT: VALIDITY SUPPORTING DOCUMENTATION

The Center for Assessment was charged with evaluating the dimensionality of the literacy and numeracy portions of the entry assessment component of the Utah State Board of Education's (USBE's) Kindergarten Entry and Exit Profile (KEEP).

Literacy and numeracy items were analyzed separately. All analyses were conducted in the statistical computing platform ℝ (R Core Team, 2017). The dimensionality assessment involved the following steps:

1. Exploratory factor analysis[1] of KEEP items using the ℝ package *mirt* to conduct full-information factor analyses of the data,[2]
2. An investigation of the number of dimensions in each subject area using an angle-based approach operating on factor loadings from step 1,[3] and
3. An investigation of potentially meaningful clusters of items in each subject area using an agglomerative hierarchical clustering approach operating on the loadings in step 1 and from step 2, the range of reasonable potential numbers of dimensions.[4]

KEEP Numeracy Results

KEEP numeracy data were analyzed using full-information factor analysis for polytomous data (Muraki & Carlson, 1995) for a level of dimensionality ranging from 2 dimensions to 13 dimensions. The correlation of each item pair's vectors of loadings was calculated, which was then transformed into the angle between the vectors of each item pair's loadings by taking the inverse cosine of the correlation (e.g., $acos(...)$). As the dimensionality of the analyses changes, the angles between item pairs also changes, with the degree of change in angles from one level of dimensionality to the next generally

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[1] I typically use exploratory factor analysis only for evaluation of the appropriate number of dimensions to model, because in my experience it performs poorly for identifying which items are associated with which dimension and what the dimensions mean. I suspect this is because of a lack of simple structure. However, the nature of the KEEP items suggests that simple structure is much more likely. Therefore, the exploratory analyses were used to support all phases of the investigation. Promax (oblique) rotation was used to allow the obviously-correlated dimensions to be correlated in the analyses.

[2] Analyses used the command *mirt(data, model = i, itemtype = item.types, method = "QMCEM")* for an *i*-dimensional solution where *data* is the raw item-score data matrix, *item.types* list the types of items included in the analyses (2-parameter logistic for dichotomous items, generalized partial credit model for polytomous items), and *method* specifies the estimation method.

[3] See Reckase, Martineau, & Kim (2000), Zeng & Martineau (2008), and Zeng (2010) for a chronological view of the development of this method. The implementation of the method was further refined in this study.

[4] In this analysis, the factor loadings for all pairs of items were first analyzed to create a distance matrix of simple Euclidean distances between each possible pair of items. An agglomerative hierarchical clustering method (see Hastie, Tibshirani, & Friedman (2009), pages 520-529) was conducted using the item-pair distance matrix, with the Ward agglomeration method (Ward, 1963). This was accomplished using the base ℝ command *hclust(data, method = "ward.D")*.

decreasing. This can be used to produce something akin to a scree plot (Catell, 1952), but with considerably more information. This "angle-change scree plot" is a variation on plots previously developed by Zeng and Martineau (2008), and is plotted for KEEP Numeracy in Figure 1.

Reading Figure 1 can be challenging as it is a new type of plot. One limitation of this type of plot is that it is only useful if there are three or more dimensions. If this type of plot does not show three of more dimensions, determining if there are two or one dimension in the data requires other methods. This can be seen in the columns for 1 and 2 dimensions, where angle changes are zero from the previous dimension by definition.

Vertical lanes of the plot are produced for each number of potential dimensions in the following manner:

- The change in angle between every item pair is calculated from the previous level of dimensionality.

- The dots in each lane are arranged in a specific manner, with each column of dots in the lane representing item pairs that include a specific item. That is, the first column of dots represents changes in the angles between the first item and every other item. Likewise, the second column of dots represent changes in the angles between the second item and every other item, and so on until the last column of dots which represents changes in angles between the last item and every other item.
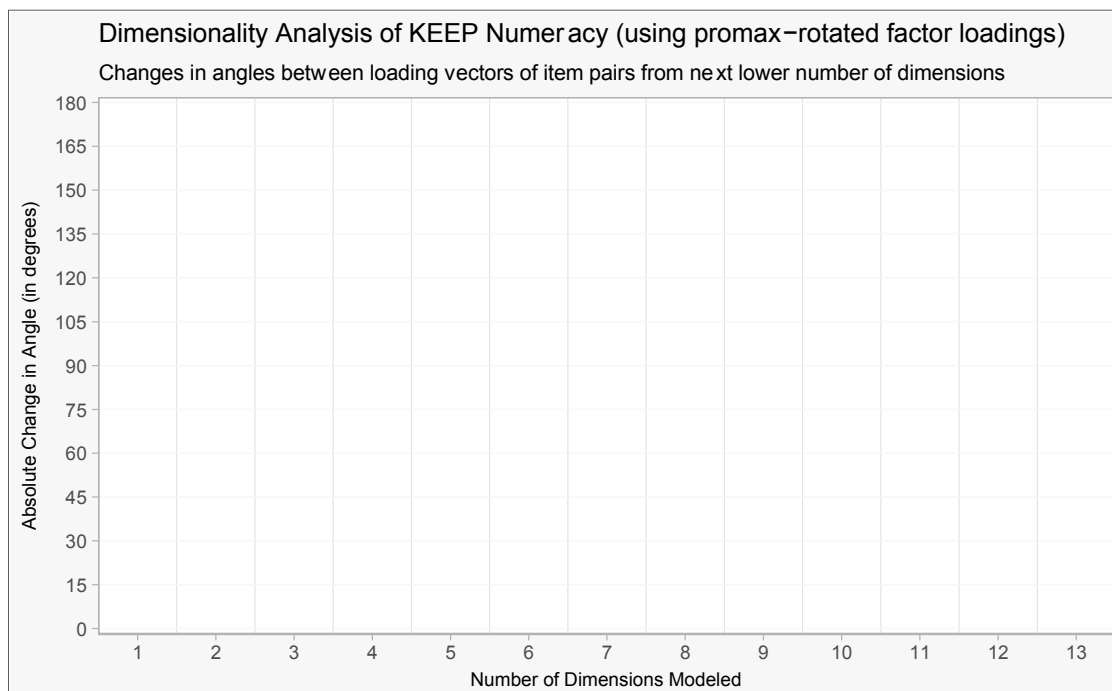

Figure 1. Angle-change scree plot for KEEP Numeracy.

With this understanding of how the figure is constructed, we can see that when moving from two dimensions to three, nearly all items have considerable changes in angles with other items. This suggests that the third dimension is capturing differences in items attributable to a real dimension. When moving from three dimensions to four, the changes are lesser in magnitude, but still considerable for nearly all items. When moving from four dimensions to five, the changes are smaller still and tend to affect only the second half of items. Moving to six dimensions does not appear to create meaningful changes between item pairs (e.g., the additional dimension may simply be modeling noise in the data). However, it is possible that this interpretation may be incorrect because when moving to seven dimensions, there appears to be a small set of items that experience considerable changes in their angles with other items. From then on, it seems clear that adding additional dimensions serves only be modeling noise in the data. Based on this result, potential clusters[5] of items were investigated for 5, 6, and 7 dimensions. The results are shown in Figures 2, 3, and 4, respectively.
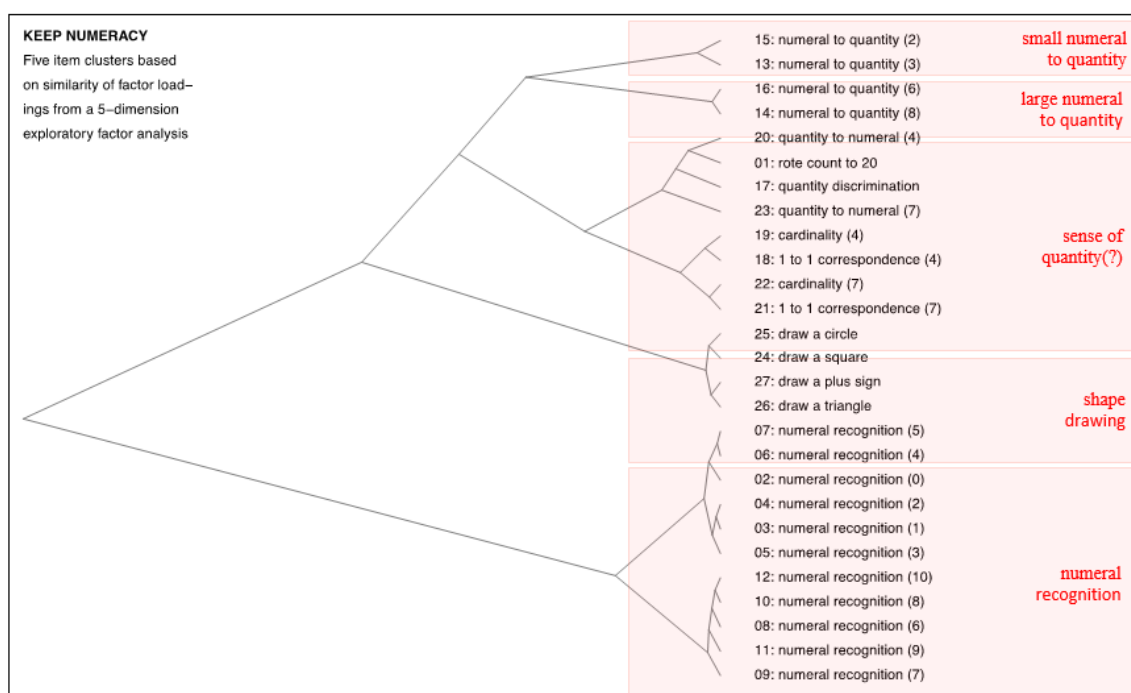
Figure 2. Hierarchical clustering results for a five-dimensional structure for KEEP Numeracy.

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[5] It is important to note that clustering algorithms work best for identifying dimensions when the data exhibit simple structure (meaning that items (primarily) load on a single dimension. Because the tasks in the KEEP are discrete and generally non-overlapping, this appears to be a reasonable assumption, so cluster analysis is used as the next step. The reason cluster analysis is not very useful with complex structures is that there may be more clusters in the data than there are dimensions when there is complex structure. For example, if a third-grade math test measures two dimensions (computation and problem solving) it is reasonable to suspect that a cluster analysis may mistake three clusters (e.g., items measuring only computation, items measuring only problem solving, and items measuring both) for 3 dimensions.

Figure 3. Hierarchical clustering results for a six-dimensional structure for KEEP Numeracy.

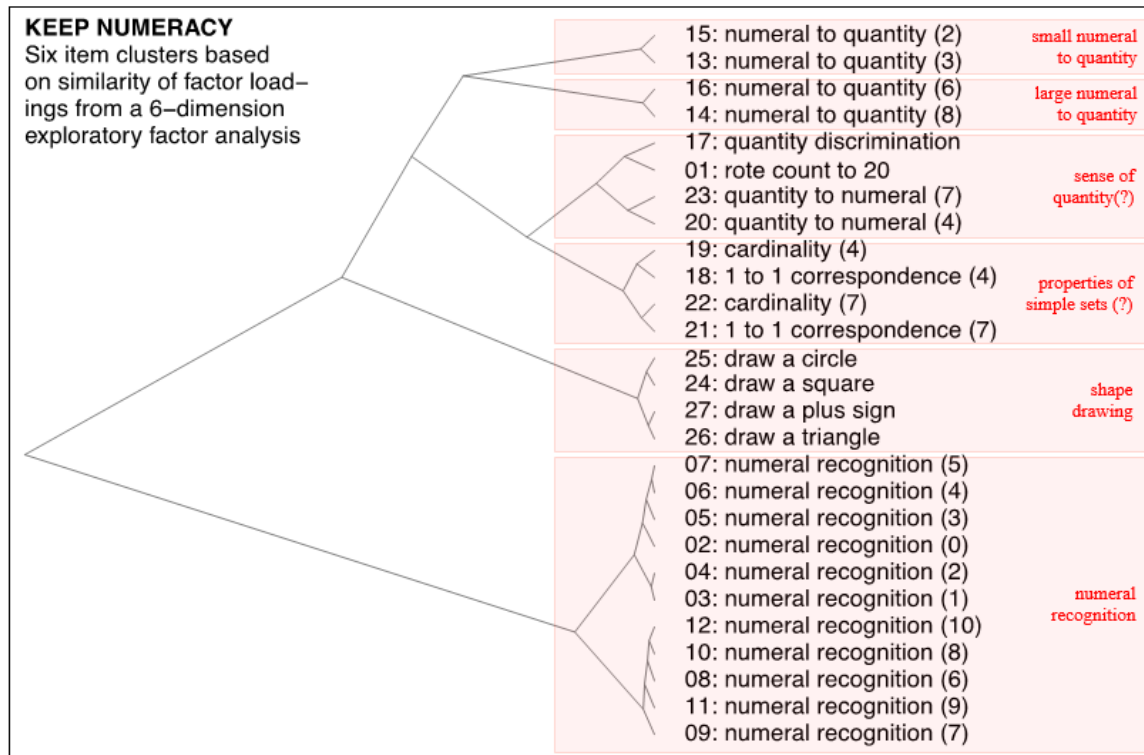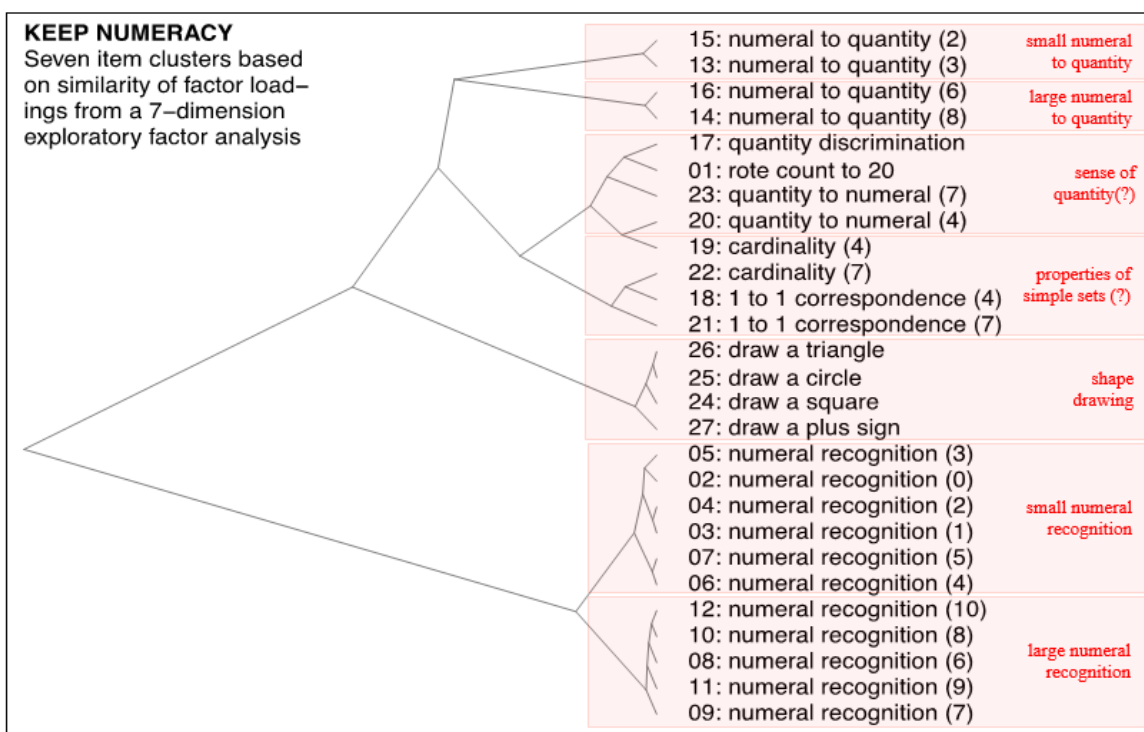*Figure 4*. Hierarchical clustering results for a seven-dimensional structure for KEEP Numeracy.

These figures are also likely unfamiliar. Based on the distance between items calculated as described above, a tree diagram can be developed showing which items are most closely related to each other, and as one goes to the left, which clusters of items are most closely related to each other, and so on up the line. The further to the left the two items and/or clusters join together, the more distantly they are related to each other.

In Figure 2, for example, because the factor analysis was conducted for five dimensions, and because we assume simple structure, we are looking for five clusters. We can find these five clusters at the point where a vertical line drawn across the plot intersects exactly five lines in the diagram. This vertical line is represented by the edges of the light red boxes. What is included in each of the boxes constitutes a cluster (and potentially a dimension).

Suggestions for Revising the Scoring Rules for Utah's

Kindergarten Entry and Exit Portfolio (KEEP) Entry Assessment

Center for Assessment

November 6, 2017

We had the opportunity to examine the test administration manuals during the recent KEEP standard setting workshop. This also enabled us to take a closer look at the scoring rules associated with each item in the KEEP entry assessment; that is, the items administered to entering kindergarten students. We, along with many of the workshop participants, expressed concerns about the differential weighting implied by the current scoring rules associated with the different items. We recognize that "nominal weighting" is likely different than the "effective weighting," but we still suspect that the items will be differentially weighted when it is not clear that is what is intended. Examining Question 1 (Oral Language) can help explain the difference between nominal and effective weighting. There are 32 potential points according to the scoring rules for this question, so the nominal weight in the overall score is 32 (or 24%) out of the 135 total possible points. However, many of the teachers who have administered this question noted that in the first part (Point and Name), very few students count more than 12-13 objects before giving up, so that tells us the real nominal weight is considerably less than 32 points (or 24%). Now, if there is very little variability in the scores (e.g., let's say that most kids count at least 10 objects and no more than 14), the effective weight of this question might be the same as many of the other items. That said, we recommend trying to adjust the nominal weights to help build credibility with the program and to hopefully help even out the effective weights.

In the table below, we propose two options for revising the scoring rules on the KEEP entry assessment. We found that almost all questions lend themselves nicely to a 5-point scale (0 to 4 points). Thus, in the first option, we went through and drafted an initial 5-

point rubric for each question in which the range or interval of the number objects/letters/numbers expected is roughly equal, except for possibly the lowest and the highest score categories. The appeal of this option is it simplicity – it should be easy for most kindergarten educators to understand and explain how students obtained the score points on each question. The first option yields a total of 34 possible points for the Literacy section and a total of 24 possible points for the Numeracy section.

For the second option, we proposed rescoring only the naming objects question (#1) for Literacy, and the rote counting question (#9) for Numeracy. To create the proposed rescoring categories for these two questions we conducted an empirical analysis of actual student performance on KEEP and adjusted the ranges or intervals so that there is a more uniform distribution of students across the score categories for each question. The benefit of this is that in using IRT to scale the test, we are unlikely to encounter the problem of reversals in step parameters, which would result in needing to make additional collapses between categories. This option treats items with large number of possible score points as essentially multiple test questions (e.g., a testlet). It does this because there is considerable data available in those test questions, and our analyses show that it is possible to produce highly reliable subscores based on those questions.

As an example, we have provided a KEEP literacy mockup score report in the figure at the end of this document, starting on page 6. In the Option-2 paradigm, students would get an overall score and performance level for each subject and 1 or more subscores (with, if desired, the +, =, - markers Utah uses with SAGE subscores, but with more reliable subscores). In Literacy, the way the dimensionality analysis shook out was with the following dimensions (names can be rethought by educators/experts in early literacy):

1. Foundations (oral language and concepts of print)
2. Letter recognition (both upper and lowercase)
3. Writing letters (both in own name and specific assigned letters)
4. Phonemic awareness (first word sounds)
5. Phonemic awareness (letter sounds)

Dimensions 4 and 5 could be collapsed to create a bigger overall phonemic awareness category, but there are some differences, enough that it would be reasonable to go either way.

In Numeracy, the analyses yielded the following dimensions (again, names are just placeholders for now):

1. Numeral to quantity
2. Sense of quantity (quantity to numeral, rote counting, quantity discrimination)
3. Properties of simple sets (cardinality, one to one correspondence)
4. Shape drawing
5. Numeral recognition

As with Literacy, there are some additional possibilities: 2 and 3 could be collapsed to create an overall "sense of quantity" category; and the data gives evidence that recognizing small numerals (0-5) is different at least for kindergartners than is recognizing large numerals (6-10)[6].

Question	Scoring Rules, Option 1	Scoring Rules, Option 2
Question 1a (Oral Language: Point and Name)	0 = no objects 1 = 1-5 objects 2 = 6-10 objects 3 = 11-15 objects 4 = 16+ objects	0 = no objects 1 = 1-2 objects 2 = 3 objects 3 = 4+ objects
Question 1b (Oral Language: Storytelling)	0 = no attempt, no story, disconnected 1 = tells a story using words and phrases only 2= tells a story using complete sentences	0 = no attempt, no story, disconnected 1 = tells a story using words and phrases only 2= tells a story using complete sentences Combine with storytelling and concepts of print to create a reliable *Foundations* subscore using all of the information from each item.
Question 2 (Uppercase Letter Recognition)	0 = no letters 1 = 1-5 letters 2 = 6-10 letters 3 = 11-20 letters 4 = 21+ letters	Score each letter separately as a single item scored 0, 1. Combine both sets (upper and lowercase) to create a reliable **letter recognition** subscore because available data has not been collapsed.
Question 3 (Lowercase Letter Recognition)	0 = no letters 1 = 1-5 letters 2 = 6-10 letters 3 = 11-20 letters 4 = 21+ letters	
Question 4 (Writing Name and Letters)	0 = Fewer than 2 letters 1 = 2 letters in name 2 = 2 letters in name plus a	Score as currently scored, treating *writing letters in first name* as a single item scored

[6] We can share the specific methods we used to come to these conclusions (i.e., items with many subparts can be treated as testlets (a cluster of individual items), and that these data show clear dimensions that can be used in deciding what (if any) subscores to report.

Question	Scoring Rules, Option 1	Scoring Rules, Option 2
	least 1 other letter 3 = 2 letters in name plus 2-4 other letters 4 = 2 letters in name plus 5 or more letters	0, 1, 2; and each of the 8 letters as its own item score 0 or 1. Combine into a reliable **writing letters** subscore because available data has not been collapsed.
Question 5 (First Sounds)	0 = no correct sounds 1 = 1-3 correct sounds 2 = 4-6 correct sounds 3 = 7-9 correct sounds 4 = 10 correct sounds	Score as currently scored, treating each first sound as a single item scored 0, 1, 2. Combine into a reliable **writing letters** subscore because available data has not been collapsed.
Question 6 (Letter Sounds)t	0 = no correct sounds 1 = 1-5 correct sounds 2 = 6-10 correct sounds 3 = 11-20 correct sounds 4 = 21+ correct sounds	Score as currently scored, treating each item as a single item scored 0, 1, 2. Combine into a reliable **writing letters** subscore because available data has not been collapsed.
Question 7 (Directionality)	0 = no correct signals 1 = 1 correct signal 2 = 2 correct signals 3 = 3 correct signals 4 = 4 correct signals	Score as currently scored, treating each concept as a single item scored 0, 1. Combine with oral language and concept of letter and concept of word to create a reliable "Foundations (?)" subscore, because available data has not been collapsed.
Question 8 (Concept of Letter/Word)	0 = none correct 2 = 1 correct 4 = 2 correct	
Question 9 (Rote Counting)	0 = No attempt, none 1 = counted 1 or more, up to 5 2 = counted more than 5 and up to 10 3 = counted more than 10 and up to 15 4 = counted more than 15 and up to 20	0 = No attempt, none 1 = counted 1 or more, up to 4 2 = counted more than 4 and up to 10 3 = counted more than 10 and up to 15 4 = counted more than 15 and up to 20 Combine with 1-1 correspondence, cardinality,

Question	Scoring Rules, Option 1	Scoring Rules, Option 2
		quantity to numeral, and quantity discrimination to create a reliable "Sense of Quantity" subscore by taking advantage of the greater amount of data.
Question 10 (Numeral Recognition)	Note: This question should have 20 possible numbers. Assuming this change is made: 0 = no numbers 1 = 1-5 numbers 2 = 6-10 numbers 3 = 11-15 numbers 4 = 16+ numbers	Score each as individual items scored 0/1. Combine to create a reliable *numeral recognition* subscore by taking advantage of the scored data for each number.
Question 11 (1-1 Correspondence, Cardinality, and Quantity to Numeral)	0 = counting up to 4 objects with errors or doesn't count any 1 = counting 4 objects correctly 2 = counting 4 objects correctly and telling how many they counted correctly 3 = counting 7 objects correctly and telling how many they counted and they can identify the number 4 when they counted 4 objects 4 = counting 7 objects correctly and telling how many they counted (7) and they can identify the number 7 when they counted 7 objects	Score as currently scored (separately for 4 and 7 manipulatives) with 1-1 correspondence, cardinality, and quantity to numeral as 2, 1, and 1 point items. Combine with rote counting and quantity discrimination to create a reliable "Sense of Quantity" subscore
Question 12 (Numeral to Quantity)	0 = none correct 1 = 1 correct 2 = 2 correct 3 = 3 correct 4 = 4 correct	Score as currently scored with each part (3, 8, 2, 6) scored as single 0/1 items. Possible create a subscore (may require another two prompts). If so, combine to create a numeral to quantity subscore.

Question	Scoring Rules, Option 1	Scoring Rules, Option 2
Question 13 (Quantity Discrimination)	0 = none correct 1 = 1 correct 2 = 2 correct 3 = 3 or 4 correct 4 = 5 correct	Score as currently scored (0, 1, 2, 3, 4, 5). Combine with rote counting and quantity discrimination to create a reliable "Sense of Quantity" subscore
Question 14 (Shape Creation)	0 = none correct 1 = 1 correct shape 2 = 2 correct shapes 3 = 3 correct shapes 4 = 4 correct shapes	Score as currently scored (0/1) for each shape. Combine to create a less reliable, but still useful, *shape creation* subscore
Total Points for Literacy (Questions 1 to 8)	34 points	108 points (If left as is, this creates an overall score weighted toward letter recognition and letter sounds. However, subscores can be combined in a weighted composite to get an overall score that treats items more equally, but doesn't discard the data from the items with many subparts).
Total Points for Numeracy (Questions 9 to 14)	24 points	36 points (If left as is, this creates an overall score weighted toward numeral recognition. However, subscores can be combined in a weighted composite to get an overall score that treats items more equally, but doesn't discard the data from the items with many subparts).

We recommend that you share this draft with the early childhood experts to have them fine-tune the specific rules for each item. Our intention with the suggested options is to give you a solid framework and good starting point.

Sample LITERACY Reports (zero score, perfect score, score at midway)

These reports are made possible by using all data to create reliable subscores. (This is a clunky mockup, however, made by a psychometrician, and the plus, equals, minus indicators on the left side do not track with the scores selected. They are there for illustrative purposes only). These can also be trimmed if there is too much. They allow for nice rollup (aggregate) reports because they can include scale score and PL aggregates, but can also dive as deep as percent of students able to recognize q, d, p, and b (which young kids often get mixed up)

KEEP Logo	Fall 2017 Entry Profile	Student ID Name		Group ID Name	

Overall KEEP Literacy Score

Scale Score	110	Scale Score + SEM + PL Graphic	Score and Margin of Error
Performance Level	2		

FOUNDATIONS — Oral Language and Concepts of Print

Achievement vs. Benchmark	+

Oral Language: Number of Objects Named in Drawing

None/no attempt	1 - 2 Objects	3 Objects	**4+ objects**

Oral Language: Storytelling

No Attempt/Disconnected	Word & Phrases	**Complete Sentences**

Achievement vs. Self	+

Concepts of Print

NONE	Where to Start	Scan Direction	Return Sweep	Letter	Word	ALL

LETTER RECOGNITION — Uppercase and Lowercase

Achievement vs. Benchmark	+

Uppercase Letters Recognized

NONE	1 - 5	6-10	11-15	16-20	21-25	ALL

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Achievement vs. Self	+

Lowercase Letters Recognized

NONE	1 - 5	6-10	11-15	16-20	21-25	ALL

a b c d e f g h i j k l m n o p q r s t u v w x y z

WRITING LETTERS — Letters in Own Name and Specific Letters on Demand

Achievement vs. Benchmark	+

Number of Letters in Own First Name Written Correctly

None/no attempt	One Letter Correct	**2+ Letters Correct**

Achievement vs. Self	+

Specific Letters Written Correctly

None	T	O	S	M	K	F	E	W	All

PHONEMIC AWARENESS — First Word Sounds

Achievement vs. Benchmark	+

Specific First Sounds of Words Repeated Correctly

NONE	top	not	chips	fog	shell	ALL
	lake	bat	sit	pan	cup	

Achievement vs. Self	+

PHONEMIC AWARENESS — Letter Sounds

Achievement vs. Benchmark	+

Letter Sounds Produced Correctly

NONE	1 - 5	6-10	11-15	16-20	21-25	ALL

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
a b c d e f g h i j k l m n o p q S s t u v w x y z

Achievement vs. Self	+

Overall KEEP Literacy Score

Scale Score	110
Performance Level	2

Scale Score + SEM + PL Graphic

Score and Margin of Error

FOUNDATIONS — Oral Language and Concepts of Print

Achievement vs. Benchmark	=

Oral Language: Number of Objects Named in Drawing

None/no attempt	1 - 2 Objects	3 Objects	4+ objects

Oral Language: Storytelling

No Attempt/Disconnected	Word & Phrases	**Complete Sentences**

Achievement vs. Self	=

Concepts of Print

NONE	Where to Start	Scan Direction	Return Sweep	Letter	Word	ALL

LETTER RECOGNITION — Uppercase and Lowercase

Achievement vs. Benchmark	+

Uppercase Letters Recognized

NONE	1 - 5	6-10	11-15	16-20	21-25	ALL

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |

Achievement vs. Self	+

Lowercase Letters Recognized

NONE	1 - 5	6-10	11-15	**16-20**	21-25	ALL

| a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z |

WRITING LETTERS — Letters in Own Name and Specific Letters on Demand

Achievement vs. Benchmark	+

Number of Letters in Own First Name Written Correctly

None/no attempt	One Letter Correct	**2+ Letters Correct**

Achievement vs. Self	+

Specific Letters Written Correctly

None	**T**	**O**	**S**	M	K	**F**	**E**	**W**	All

PHONEMIC AWARENESS — First Word Sounds

Achievement vs. Benchmark	+

Specific First Sounds of Words Repeated Correctly

NONE	top	not	chips	fog	shell	ALL
	lake	bat	sit	pan	cup	

Achievement vs. Self	+

PHONEMIC AWARENESS — Letter Sounds

Achievement vs. Benchmark	+

Letter Sounds Produced Correctly

NONE	1 - 5	6-10	11-15	16-20	**21-25**	ALL

| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | I | **J** | **K** | **L** | **M** | **N** | **O** | **P** | Q | **R** | **S** | **T** | U | **V** | **W** | X | Y | **Z** |
| **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | i | **j** | **k** | **l** | **m** | **n** | **o** | **p** | q | **S** | **s** | **t** | u | **v** | **w** | x | y | **z** |

Achievement vs. Self	+

Overall KEEP Literacy Score

Scale Score	110
Performance Level	2

Scale Score + SEM + PL Graphic

Score and Margin of Error

FOUNDATIONS — Oral Language and Concepts of Print

Achievement vs. Benchmark	—

Oral Language: Number of Objects Named in Drawing

None/no attempt	1 - 2 Objects	3 Objects	4+ objects

Oral Language: Storytelling

No Attempt/Disconnected	Word & Phrases	Complete Sentences

Achievement vs. Self	—

Concepts of Print

NONE	Where to Start	Scan Direction	Return Sweep	Letter	Word	ALL

LETTER RECOGNITION — Uppercase and Lowercase

Achievement vs. Benchmark	+

Uppercase Letters Recognized

NONE	1 - 5	6-10	11-15	16-20	21-25	ALL

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Achievement vs. Self	+

Lowercase Letters Recognized

NONE	1 - 5	6-10	11-15	16-20	21-25	ALL

a b c d e f g h i j k l m n o p q r s t u v w x y z

WRITING LETTERS — Letters in Own Name and Specific Letters on Demand

Achievement vs. Benchmark	+

Number of Letters in Own First Name Written Correctly

None/no attempt	One Letter Correct	2+ Letters Correct

Achievement vs. Self	+

Specific Letters Written Correctly

None	T	O	S	M	K	F	E	W	All

PHONEMIC AWARENESS — First Word Sounds

Achievement vs. Benchmark	+

Specific First Sounds of Words Repeated Correctly

NONE	top	not	chips	fog	shell	ALL
	lake	bat	sit	pan	cup	

Achievement vs. Self	+

PHONEMIC AWARENESS — Letter Sounds

Achievement vs. Benchmark	+

Letter Sounds Produced Correctly

NONE	1 - 5	6-10	11-15	16-20	21-25	ALL

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
a b c d e f g h i j k l m n o p q r s t u v w x y z

Achievement vs. Self	+

Memorandum

To: Cydnee Carter (Utah State Board of Education)
From: Leslie Keng, Joseph Martineau and Scott Marion (Center for Assessment)
Date: 12/1/2017
Re: Utah KEEP Standard Setting Process

The Utah State Board of Education (USBE) with support from the Center for Assessment has developed and implemented a standard setting process to establish cut scores that defined performance levels on Utah's Kindergarten Entry and Exit Profile (KEEP) for entering kindergarten students. Based on input from Utah educators, it was determined that three performance levels, which represent different levels of readiness to succeed in kindergarten, were appropriate for KEEP. This report provides an overview of the process used to set the cut scores that define the KEEP performance levels for entering kindergarten students and summarizes the outcomes for the process.

Background

Utah's Kindergarten Entry and Exit Profile (KEEP) is intended to inform various stakeholders, such as parents, teachers, and leadership, on the academic and social-emotional development of entering and exiting kindergarten students. USBE has developed KEEP to replace various local kindergarten assessments. KEEP is designed to be administered in individual testing sessions (kindergarten teacher with a single student). A certified teacher is expected to administer the profile. If needed, the profile may be administered by a certified educator who is not the student's classroom teacher, but it should always be administered in individual sessions. For entering kindergarten students, the KEEP testing window begins three weeks before the first day of school for the local education agency (LEA) and continues through the first two weeks of school. This provides LEAs a five-week testing window. The administration of KEEP is untimed, but is designed to take less than 20 minutes to administer.

The test questions (or items) on the KEEP for entering kindergarten students are based on Utah's Core Standards for preschool (https://www.schools.utah.gov/curr/preschool). The profile includes 14 questions with 8 observational items across three sections: literacy, numeracy and social-emotional development. The focus of the KEEP standard setting process is on the 14 questions in the literacy and numeracy sections. Table 1 is the original KEEP test blueprint for the literacy and numeracy sections, as described in Utah's KEEP Test Administration Manual.

Table 1. Original KEEP blueprint

Literacy	Numeracy
1. Oral language (32 points)	9. Oral counting (20 points)
2. Alphabet knowledge: uppercase (26 points)	10. Numeral identification (11 points)
3. Alphabet knowledge: lowercase (26 points)	11. Number sense: 1-1 correspondence, cardinality and quality to numeral (8 points)
4. Writing letters (10 points)	12. Number sense: numeral to quantity (4 points)
5. Phonological awareness (10 points)	13. Discrimination: quantity discrimination (5 points)
6. Alphabetic principle (26 points)	14. Discrimination: shape creation (4 points)
7. Concept of print: directionality (3 points)	
8. Concept of print: letter and word (2 points)	
Total = 8 items, 135 points	Total = 6 items, 52 points

To provide meaning to the KEEP test scores, USBE with support from the Center for Assessment developed and implemented a standard setting process to established KEEP performance levels for entering kindergarten students. The process involved kindergarten educators from across the state of Utah and is based on well-defined and legally-defensible approaches that have been used to set cut scores in other assessment programs. Overall, the process included two phases. In the first phase, a crowd-sourcing approach was used to determine cut score boundaries. These boundaries then informed a committee-based performance level setting process that yielded performance level descriptors (PLDs) and cut scores for KEEP.

Phase 1: Crowdsourcing to Determine KEEP Cut Score Boundaries

Over the spring and summer of 2017, USBE leveraged existing KEEP training session to recruit Utah kindergarten teachers to participate in an initial crowdsourcing standard setting activity. Participants were given a web address to work from after the training had been completed. For each item on the KEEP, participants were asked to enter the expected score of an incoming kindergarten student who is just ready for her or his classroom. These judgments were entered individually for every item. A total of 252 participants entered complete data for both literacy and numeracy sections. The frequency of recommended cut score, which is a sum of the individual expected item score provided by each participant, are shown for literacy in Figure 1 (maximum total score = 135) and numeracy in Figure 2 (maximum total score = 52). At the top of each figure, various z-scores and percentiles are summarized using blue and red dots, respectively.
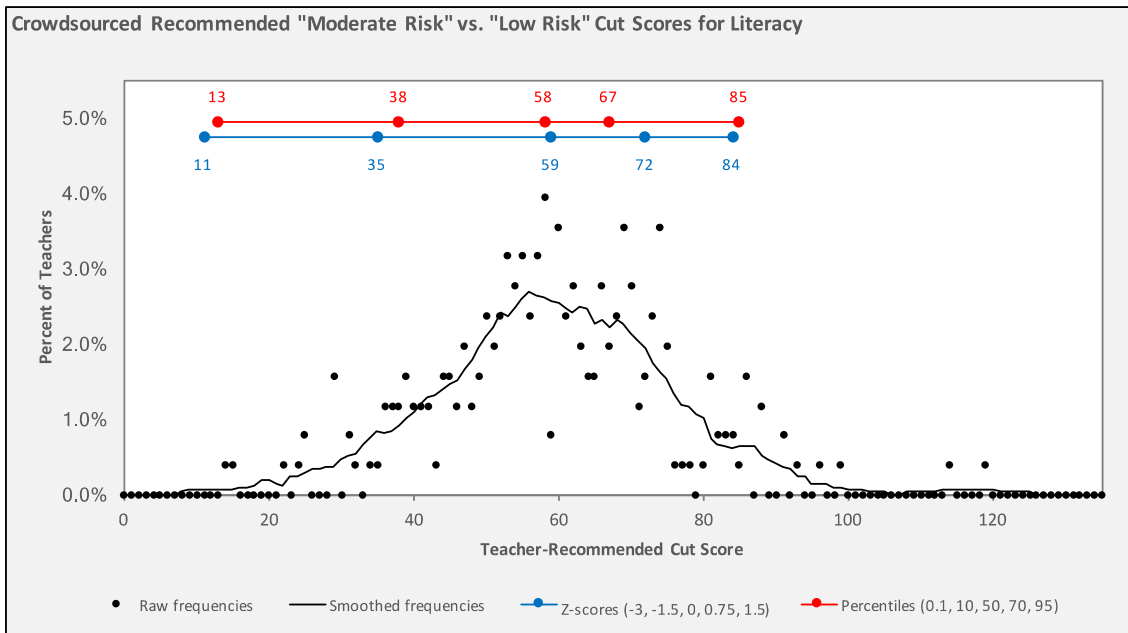
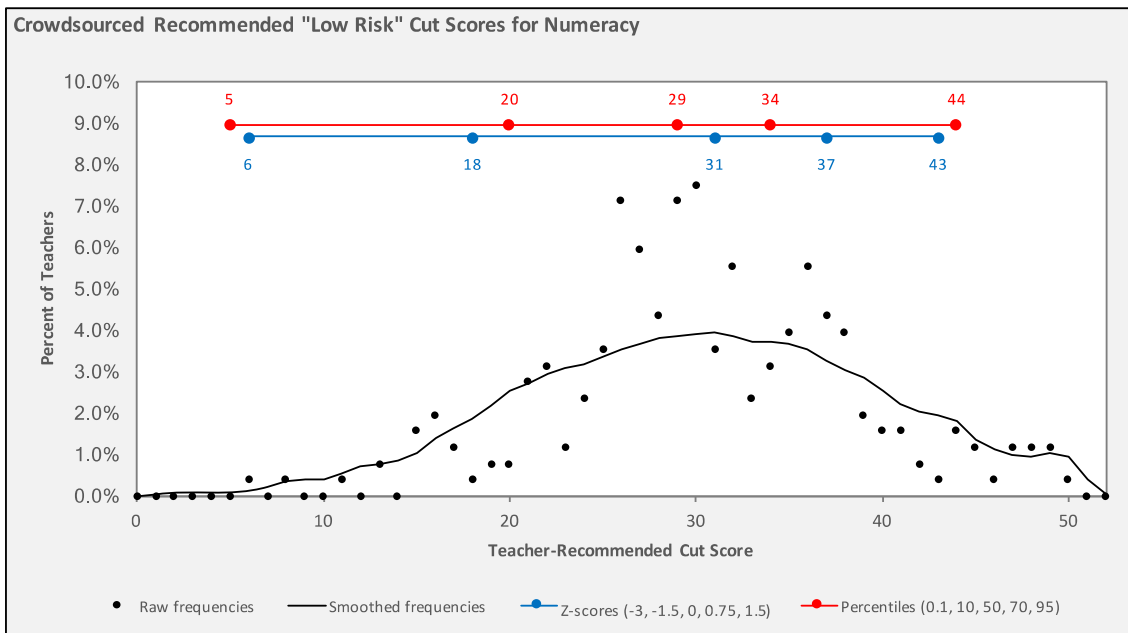*Figure 1. Summary of crowdsourced cut scores for the KEEP literacy section*

Figure 2. Summary of crowdsourced cut scores for the KEEP numeracy section

Phase 2: Committees to Establish KEEP Cut Scores

During the months of October and November 2017, USBE convened committees to participate in the process of establishing cut scores for KEEP. This committees were comprised of Utah kindergarten educators and USBE staff who helped design the KEEP. A total of three committees were convened. The first committee met in mid-October to draft performance level descriptors (PLDs) for KEEP. A second committee participated in a standard setting workshop in early November to recommend preliminary KEEP cut scores. The third committee joined a webinar at the end of November to validate and finalize the KEEP cut scores.

PLD DEVELOPMENT MEETING

PLDs are statements that describe the expected knowledge, skills and abilities of students in each performance level for an assessment. PLDs are a fundamental component to any standard setting process. The cut scores recommended through the standard setting process should operationalize the PLDs, by defining the score or threshold that must be achieved to move from one performance level to the next. It is therefore vital that Utah kindergarten educators, who are familiar with the expectation in Utah's Core Standards for preschool and have experience working with kindergarten students, are involved in developing the PLD for KEEP.

On October 12, 2017, USBE held the PLD development meeting to draft an initial version of the KEEP PLDs. The kindergarten teachers who participated in the meeting were first trained by the Center for Assessment on the purpose and characteristics of PLDs. They were then provided preliminary PLDs as starting points for the development activity. In developing the PLDs, the participants first provided recommendations for the labels of the three KEEP performance levels. They then drafted policy descriptors, which are high-level statements that describes students in the performance levels. Finally, the participants drafted the more detailed PLDs for both the literacy and numeracy sections. Table 2 shows the template used during the PLD development meeting to guide the committee's activities.

Table 2: Template for PLD development

Performance Level Label	
Policy Descriptor: A high-level statement that describes students in the performance level.	
Literacy PLDs	Numeracy PLDs
Descriptions of what students in this performance level are expected to know or do in: • Oral language • Alphabet knowledge • Writing letters • Phonological awareness • Alphabetic principle • Concept of print	Descriptions of what students in this performance level are expected to know or do in: • Oral counting • Numeral identification • Number sense • Discrimination

STANDARD SETTING WORKSHOP

On November 1, 2017, USBE convened an in-person standard setting workshop in Salt Lake City, Utah. The workshop had 15 participants, including kindergarten teachers, some of whom helped develop the draft PLDs, along with USBE staff. The main charge for the participants was to recommend two cut scores that establish three performance levels for each of the KEEP sections – literacy and numeracy. The participants were given the opportunity to experience the KEEP and review the draft PLDs. They were then trained on the standard setting approach known as the *modified Body of Work* (or *card sorting*) procedure, and were given the opportunity to practice the procedure, before participating in three rounds of judgment. Because of the limited amount of time allotted for the workshop (about 5.5 hours in total), the committee was split into two groups – one for literacy and the other for numeracy – starting with the PLD review and for the rounds of judgment. Table 3 shows the annotated agenda for the standard setting workshop.

Table 3. Annotated Agenda for KEEP Standard Setting Workshop

Time	Activity
8:30 a.m.	Welcome, Introductions and Overview (15 minutes) • Welcome standard setting committee (USBE) • Quick introduction of all participants (All) • Overview of KEEP (USBE) • Overview of standard setting process (Center)

8:45 a.m.	Experience the KEEP (15 minutes)
	• Committee members experience the KEEP by reviewing the all of items in the literacy and numeracy sections
	    o A description of how KEEP is scores should be provided. (USBE?)
	    o Per the TAC's advice, this committee will not recommend cut scores for the social-emotional section
	• Because not all committee members have experience administering the KEEP, we will give a few minutes to

9:00 a.m.	Review and Discussion of Performance Level Descriptors (PLDs) (20 minutes) • Introduction to PLDs and how the initial KEEP PLDs were drafted (Center) • Committee members independently review KEEP PLDs (All) o They are encouraged to take notes for the discussion to follow. • Committee discuss as at their tables their thoughts on the KEEP PLDs and how the PLDs relate to their expectations (Center facilitates)
9:20 a.m.	Standard Setting Training (25 minutes, Center facilitates) • Committee members are trained on the modified body of work ("card sorting") methodology • Committee members participate in a short practice exercise.
9:45 a.m.	Round 1: Range-finding (45 minutes) • Designate committee members to either literacy or numeracy section • Committee members independently provide their initial judgments for their assigned section.
10:30 a.m.	Break (20 minutes) • The processing of Round 1 judgments and the selection of Round 2 profiles should occur during this break.
10:50 a.m.	Round 1 Feedback and Discussion (30 minutes, Center facilitates) • Committees are provided with a summary of their Round 1 judgments. • The feedback data will include descriptive statistics (mean, median, minimum, and maximum) for each cut score, along with panelist agreement statistics. • At their tables, committee members discuss the rationale for their judgments and the feedback data for their particular section.
11:20 a.m.	Round 2: Pinpointing (40 minutes) • Committee members independently provide their initial judgments for their assigned section. • The profiles in this round will be more focused around each cut score.

Time	Activity
12:00 p.m.	Lunch (45 minutes) • Processing of Round 2 judgments will occur during the lunch break
12:45 p.m.	Round 2 Feedback and Discussion (30 minutes, Center facilitates) • Committees are provided with a summary of the Round 2 judgments. • The feedback data will include descriptive statistics (mean, median, minimum, and maximum) for each cut score, panelist agreement statistics, and impact data. • At their tables, committee members discuss their judgments and thoughts on the impact data for both the literacy and numeracy sections. o Each table should select a spokesperson for the group sharing • The spokesperson for each table shared a summary of the table discussion
1:15 p.m.	Round 3: Articulation (30 minutes, Center facilitates) • As a committee, the participants can make adjustments to the Round 2 (median) cut scores for both literacy and numeracy. • Any adjustments to the cut scores require consensus and rationale based on the PLDs and profiles. • The cut score at the end of Round 3 will be the final recommended cut scores for KEEP.
1:45 p.m.	Meeting Wrap-up and Next Steps (15 minutes) • If committee members have any recommend edits to the PLDs, they could provide it at this point. • Committee members take the workshop evaluation survey • Describe next steps and thank the committee for their participation. (USBE)
2:00 p.m.	Meeting Adjourned

One of the key tools provided to the workshop participants for each round of judgment were *examinee profile cards*, which were populated with actual student performance on KEEP. Figures 4 and 5 on the following page show example examinee profile cards for literacy and numeracy, respectively. Packets of examinee profile cards were distributed to the participants in the first two rounds of judgment. The primary task for the participant in these rounds was to review the overall performance (or body of work) represented in each examinee profile card. Based on the KEEP PLDs, the participant would sort (or rate) each profile card into one of the three KEEP performance levels. Figure 3 provides a visual illustration of the "card sorting" procedure that the participants followed in the first two rounds of judgment.

Figure 3. The "card sorting" procedure
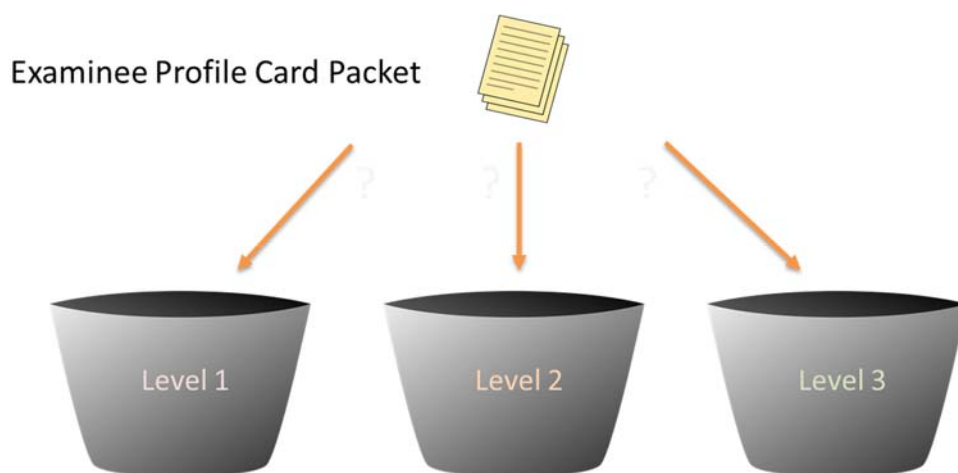The examinee profile card packets given to participants in the first two rounds differed in the range of the scores represented. Because the goal of the first round of judgment was *range-finding*. The packets included profile cards from a broader score range. The score ranges were informed by the cut score boundaries from the phase-1 crowdsourcing approach (see Figures 1 and 2).

Profile ID
1523

KEEP Literacy Achievement Data

Number of Objects Named from Drawing

none	**1**	**2**	**3**	**4**	**5**	6	7	8	9	10	11	12	13	14	15
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

Storytelling

- No attempt, does not tell a story, or uses disconnected statements.
- Tells a story using only words and phrases.
- **Tells a story using complete sentences.**

Uppercase Letter Recognition

none	**A**	**B**	**C**	**D**	E	**F**	G	H	I	J	K	**L**	M	**N**	**O**	P	Q	**R**	**S**	**T**	U	V	**W**	**X**	**Y**	**Z**

Uppercase Letter Recognition

none	**a**	b	**c**	d	**e**	f	g	h	i	j	k	l	m	n	**o**	**p**	q	r	**s**	**t**	u	v	**w**	**x**	**y**	**z**

Writing Letters in First Name

- No attempt or no letters written correctly
- One letter written correctly
- **Two or more letters written correctly**

Writing Specific Letters

none	T	**O**	**S**	M	K	**F**	**E**	W

Reproducing First Sounds

none	top	not	chips	fog	shell	lake	bat	sit	pan	cup

Producing Letter Sounds

none	Aa	**Bb**	Cc	Dd	Ee	Ff	Gg	Hh	Ii	Jj	Kk	Ll	Mm	Nn	Oo	Pp	Qq	Rr	**Ss**	**Tt**	Uu	Vv	Ww	Xx	Yy	Zz

Directionality of print

none	**where to start**	**direction to scan**	**return sweep**

Units of Print

none	**letter**	**word**

Figure 4. A KEEP literacy examinee profile card

Profile ID

422

KEEP Numeracy Achievement Data

Rote Counting																				
none	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	16	17	18	19	20

Numeral Recognition										
none	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	9	**10**

Matching Numeral to Quantity			
none	**3**	8	**2**	6

Quantity Discrimination

5 | Number of correct comparisons (out of 5)

One-to-one Correspondence (with 4 manipulatives)
- Does not use one-to-one correspondence
- Uses one-to-one correspondence with some errors
- **Uses one-to-one correspondence without errors**

Cardinality (with 4 manipulatives)
- Incorrect
- **Correct**

Quantity to Numeral (with 4 manipulatives)
- Incorrect
- **Correct**

One-to-one Correspondence (with 7 manipulatives)
- Does not use one-to-one correspondence
- Uses one-to-one correspondence with some errors
- **Uses one-to-one correspondence without errors**

Cardinality (with 7 manipulatives)
- Incorrect
- **Correct**

Quantity to Numeral (with 7 manipulatives)
- Incorrect
- **Correct**

Drawing Shapes				
none	**square**	**circle**	**triangle**	**plus sign**

Figure 5. A KEEP numeracy examinee profile card

The goal of the second round of judgment was *pinpointing*. Accordingly, the participants were presented with two packets of profile cards: a pinpointing set for the higher (Level 2 vs. Level 3) cut score and another pinpointing set for the lower (Level 1 vs. Level 2) cut score. The score ranges represented in each of the round-2 packets were much narrower and included multiple examinee profile cards for a given score point. The score range for each pinpointing set were informed by the recommended (median) cut scores from all the participants in the first round.

After each round of judgment, the participants were provided with empirical data that summarized the ratings provided by their groups (i.e., literacy or numeracy) in the preceding round of judgment. The participants were asked to share the thought process and rationale for their ratings. The feedback data also highlighted specific profile cards with greater degrees of disagreements among the participants to help guide the group discussions. *Impact data*, defined as the percentage of students in each performance level based on the committee-recommended cut scores, were also shared with the participants as part of the round-2 feedback data. The impact data were provided as a reality check, not to manipulate the proficiency rates. Participants were instructed to use the impact data to evaluate the reasonableness of the round-2 cut scores. However, their judgments should still be based on the PLDs and the examinee profile cards.

The goal of the final (third) round of judgment was *articulation*, or finetuning. As a group, the participants could adjust the round-2 recommended cut scores for their section (literacy or numeracy). There were constraints on how much adjustment each group could make. The constraints were based on the variance of the round-2 cut scores given across all panelists. Any adjustments also required group consensus and a rationale based on the PLDs and examinee profile cards. Table 4 shows the cut scores and associated impact data for each KEEP section after three rounds of judgment.

Table 4. KEEP cut scores and impact data after the standard setting workshop (11/1/2017)

Literacy (Total Score = 135)			Numeracy (Total Score = 52)		
Level	Cut Score	Impact	Level	Cut Score	Impact
Level 3	46	64.7%	Level 3	41	67.3%
Level 2	28	12.6%	Level 2	27	21.9%
Level 1	n/a	22.6%	Level 1	n/a	10.8%

During the workshop, participants were asked to provide feedback on the draft KEEP PLDs. One overarching concern voiced by the participants were about the labels of the performance level in the draft PLDs (i.e., "high risk", "moderate risk", and "low risk"). The concern was around associating the work "risk" with entering kindergarten students. The committee recommended the alternative labels: "Level 1", "Level 2", and "Level 3."

STANDARDS VALIDATION WEBINAR

During the standard setting workshop, participants expressed concerns about the differential weighting implied by the scoring rules in the original KEEP blueprint (see Table 1). Specifically, certain items seemed to be weighted substantially different in the total score than intended by the blueprint. For example, the first item (oral language) accounts for 32 points out of the 135 total points (or 24%) in the literacy section. However, many of the teachers who have administered this question noted that in the first part of the item (point and name), very few students could count more than 12-13 objects before giving up. This implies that the actual (or effective) weight of this item is considerably less than 32 points (or 24%). Given this disparity between in the intended and actual weights (or nominal vs. effective weights), the participants agreed that it was advisable to adjust the original KEEP scoring rules to help build credibility with the program. This implied, however, that the cut scores recommended during the standard setting workshop should be validated based on any changes made to the KEEP scoring rules.

On November 28, 2017, participants from the standard setting workshop were invited to join the KEEP standards validation webinar. The goal of the webinar was the validate and finalize the KEEP cut scores. Prior to the webinar, the kindergarten educators were presented with re-scoring options for KEEP and agreed on adjusting the original scoring rule for two KEEP items – one in literacy and the other in numeracy. The two items along with the associated new scoring rules are shown in Table 5. The new scoring rules were recommended based on analyses of empirical data from the KEEP administration. The updated KEEP blueprint under the new scoring rules (with changes shown in red) are provided in Table 6.

Table 5. New scoring rules for KEEP items

Question #1 (Oral Language) – Literacy	Question #9 (Rote Counting) – Numeracy
Point and Name (out of 3 points) • 0 = no objects • 1 = 1-2 objects • 2 = 3 objects • 3 = 4+ objects Storytelling (out of 2 points) • 0 = no attempt, no story, disconnected • 1 = tells a story using words and phrases only • 2= tells a story using complete sentences	Out of 4 points: • 0 = No attempt, none • 1 = counted 1 or more, up to 4 • 2 = counted more than 4 and up to 10 • 3 = counted more than 10 and up to 15 • 4 = counted more than 15 and up to 20

Table 6. Updated KEEP blueprint

Literacy	Numeracy
1. Oral language (5 points) 2. Alphabet knowledge: uppercase (26 points) 3. Alphabet knowledge: lowercase (26 points) 4. Writing letters (10 points) 5. Phonological awareness (10 points) 6. Alphabetic principle (26 points) 7. Concept of print: directionality (3 points) 8. Concept of print: letter and word (2 points)	9. Oral counting (4 points) 10. Numeral identification (11 points) 11. Number sense: 1-1 correspondence, cardinality and quality to numeral (8 points) 12. Number sense: numeral to quantity (4 points) 13. Discrimination: quantity discrimination (5 points) 14. Discrimination: shape creation (4 points)
Total = 8 items, 108 points	Total = 6 items, 36 points

During the KEEP standards validation webinar, participants were given a recap of the standard setting workshop, followed by a summary of the new scoring rules and updated blueprint. The participants were then shown updated cut scores and associated impact data based on the new scoring rules. Their task was to consider whether the updated cut scores and impact data seemed reasonable and, if not, the committee could adjust the cut scores based on the PLDs and examinee profile cards, which were available to the participants for review. In other words, the participants were asked to redo the round-3 articulation process from the standard setting workshop with the updated information. The rationale for only re-visiting round 3, and not the entire performance level setting process from the workshop, was because the scoring rules and impact data were not provided and therefore not part of what the workshop participants considered prior to receiving round-2 feedback data. Accordingly, the updated cut scores and impact data shared with the participants were those *after the round-2 judgments*. The adjustments made to the cut scores (along with the associated impact data) during the original round-3 articulation were presented to the participants as a point of reference. After evaluating and discussing the new information, the participants decided that the cut scores and impact data from their original round-2 judgments were reasonable under the new scoring rules and made no further adjustments. The final recommended KEEP cut scores and impact data are summarized in Table 7.

Table 7. KEEP cut scores and impact data after the standards validation webinar (11/28/2017)

Literacy (Total Score = 108)			Numeracy (Total Score = 36)		
Level	Cut Score	Impact	Level	Cut Score	Impact
Level 3	47	61.4%	Level 3	29	72.5%
Level 2	26	14.6%	Level 2	18	18.7%
Level 1	n/a	24.0%	Level 1	n/a	8.8%

As part of the standards validation webinar, participants were presented with the updated KEEP PLDs and were given the opportunity to provide additional feedback.

Next Steps

The standard setting process described in this report is for the KEEP administered to students as they *enter kindergarten*. USBE will be working with the Center for Assessment to develop and implement standard setting processes for the KEEP given the students as they *exit kindergarten*, as well as for the Alternate KEEP.

CURRICULUM VITA

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EDUCATION

Ph.D.   May 2018
Mathematics Educational Leadership, Utah State University

Admin   May 2010
Administrative Certificate K-12, University of Alaska Anchorage

M.Ed.   December 2006
Master of Education, Southern Utah University

B.A.   December 2003
Elementary Education, Westminster College, Summa Cum Laude
Utah Professional Teaching License Level 2, Grades 1-8

ADDITIONAL ENDORSEMENTS

May 2014
Level 1 Reading Endorsement, Southern Utah University

May 2008
Gifted and Talented Endorsement, Utah State University

May 2008
English as a Second Language Endorsement, Weber State University

December 2006
Elementary Mathematics Endorsement, Southern Utah University

EMPLOYMENT HISTORY

UTAH STATE OFFICE OF EDUCATION

Coordinator, PreK-12 Literacy and Library Media (2014-present)

Responsibilities include directing the English Language Arts and Library Media curricular supports, professional learning, and administration and compliance of State laws and Board rules. Supervisor of 11 specialists and assistants for the Dual Immersion, World Languages, K-3 Literacy, Secondary ELA, Concurrent Enrollment, Advanced Placement, International Baccalaureate, Gifted and Talented, STAR and preschool programs.

CANYONS SCHOOL DISTRICT

Evidence-Based Learning Specialist, Elementary Language Arts (2013-2014)
Evidence-Based Learning Department
Sandy, Utah
Responsibilities included leading the Elementary English Language Arts providing curricular, programmatic, and professional learning supports for paraprofessionals and teachers districtwide in grades K-5. Served on the Dual Language Immersion team as the Chinese Specialist and supported the Elementary Mathematics team.

Achievement Coach (2012-2013)
Oak Hollow Elementary
Draper, Utah
Responsibilities included providing instructional coaching in classroom management, student engagement, lesson preparation and planning, and lesson delivery as a vehicle to improve student achievement outcomes. Organized Tier II reading and math intervention programs and support personnel to provide students with targeted skill interventions.

MATANUSKA-SUSITNA BOROUGH SCHOOL DISTRICT

4th Grade Classroom Teacher (2011-12)
Tanaina Elementary
Wasilla, Alaska
Responsibilities included planning, implementing and adjusting instruction to meet the needs of 32 fourth-graders in a Title 1 school. Additional duties included serving as the mathletes coach, gifted and talented specialist, and a member of the schoolwide Response to Intervention (RtI) team.

District Coordinator, English Language Learner Program (2008-2011)
Federal Programs Department
Palmer, Alaska
Responsibilities included supervising and supporting 20 ESL teachers and paraprofessionals in providing language acquisition instruction to the district's English Learner population. Selected instructional curriculum, attended to Title III compliance and documentation, offered events to engage the community, as well as provided professional learning for staff and teachers districtwide.

GRANITE SCHOOL DISTRICT

1st Grade Classroom Teacher (2004-2008)
Twin Peaks Elementary
Murray, Utah
Responsibilities included planning, implementing and adjusting instruction to meet the diverse needs of students. Additional duties included serving as the gifted and talented specialist, school webmaster, YPP/Acuity specialist, and testing coordinator.

RESEARCH

Research Interests:
- mathematics achievement and instruction
- mathematics and writing

PUBLICATIONS

Journal Articles (Refereed)

Throndsen, J., MacDonald, B., & Hunt, J. (2017). Developing a kindergartener's concept of cardinality. *Australian Primary Mathematics Classroom*, *22*(2), 21-25.

Nadelson, L. S., Throndsen, J., Campbell, J. E., Arp, M., Durfee, M., Dupree, K., & Schoepf, S. (2016). Are They Using the Data? Teacher Perceptions of, Practices with, and Preparation to Use Assessment Data. *International Journal of Education*, *8*(3), 50-69.

Throndsen, J. & Brown, L. (Fall/Winter 2015-16). Using Writing in the Mathematics Classroom. *Utah Mathematics Teacher*, *8,* 11-16.

Throndsen, J. (2014). Knock'em Down. *Teaching Children Mathematics*, *20*(9), 584.

GRANTS FUNDED

Program Director (1.2 million). Read. Graduate. Succeed. 2016-2019. National & Community Service Grant for the Governor and Mayor Initiative. Project goal: To provide one-on-one tutoring and mentoring experiences through AmeriCorps members and volunteers to students statewide in grades 1-12 to enhance their reading competency and post-secondary opportunities.

Grant Writer (1.7 million). Project LEAP (Language, Equity and Academic Performance). 2012-2017. National Professional Development Project Grant. Project goal: Provide English as a Second Language endorsement courses through a distance learning project in three regions: Anchorage, Juneau, and Matanuska-Susitna Borough.

Project Director (1 million). *Preparing Utah Teachers for the Elementary Mathematics Endorsement.* 2010-2013. U.S. Department of Education, Math and Science Partnership Grant. Project goal: Provide elementary mathematics endorsement courses through a mix of on-site and distance learning between two districts, one suburban and one rural.

PRESENTATIONS
State & Regional Presentations

Alaska Math Consortium (AMC)

Throndsen, J. (2011, October). *Math and Science Partnership: MatSu, BSSD, and UAS.* Alaska Math and Science Annual State Conference, Fairbanks, Alaska.

Throndsen, J. (2011, October*). Using Math Literature to Support Mathematics Learning.* Alaska Math and Science Annual State Conference, Fairbanks, Alaska.

Utah Council for the International Reading Association (UCIRA)

Throndsen, J., (2015, October). *Integration of Knowledge and Ideas.* Annual Conference for the Utah
Council for the International Reading Association (UCIRA), Salt Lake City, Utah.

Utah Council of Teachers of Mathematics (UCTM)

Throndsen, J. (2015, November). *Using Writing in the Mathematics Classroom.* Annual Conference of the
Utah Council of Teachers of Mathematics (UCTM), Lehi, Utah.

Throndsen, J. (2013, November). *Creating Students with a Growth-Mindset.* Annual Conference of the
Utah Council of Teachers of Mathematics (UCTM), Salt Lake City, Utah.

Throndsen. J. (2013, November). *Using Math Literature to Meet the Demands of the Core.* Annual
Conference for the Utah Council of Teachers of Mathematics (UCTM), Salt Lake City, Utah.

Utah Council of Exceptional Children (Utah CEC)

Throndsen, J. (2015, February). *Scaffolding Students in Writing from Sources.* Annual Conference of the
Utah Council of Exceptional Children, Murray, Utah.

Utah Educational Library Media Association (UELMA)

Throndsen, J. (2015, March). *Introducing the Elementary Library Media Standards 2015.* Annual
Conference of the Utah Educational Library Media Association, Sandy, Utah)

Utah Middle Level Association

Throndsen, J, & Rose, G. (2016, March). *Motivating Reluctant Readers.* Annual Conference of the Utah
Middle Level Association, Murray, Utah.

Utah Multi-Tiered System of Supports (UMTSS)

Throndsen, J. (2013, June). *Using Skill-Based Instruction to Support Struggling Readers.* Annual
Conference of the Utah Multi-Tiered System of Supports, Layton, Utah.

Utah State Board of Education (USBE)

Throndsen, J., Wiebke, S., Williams, L., Gross, H., Barlow, W. (2018, March*). Kindergarten Exit
Training.* Utah State Board of Education, Salt Lake City, UT.

Throndsen, J. (2017, November). *Integration of Knowledge and Ideas.* Washington County School
District, St. George, UT.

Throndsen, J., Wiebke, S., Williams, L. (2017, October). *Launching Reading.* Utah State Board of
Education, Ogden, UT.

Throndsen, J., Wiebke, S., Randazzo, M. (2017, July). *Kindergarten Entry Training for KEEP.* Utah State
Board of Education, Salt Lake City, UT.

Throndsen, J. (2017, March). *Principals' Literacy Institute.* Utah State Office of Education, Layton, UT.

Throndsen, J. & Wiebke, S. (2017, February). *Launching Writing with the Write Tools.* Utah State Board of Education, Salt Lake City, UT.

Throndsen, J. (2016, December). *Preschool to Kindergarten Transition Summit.* Utah State Board of Education, Salt Lake City, UT.

Throndsen, J. (2016, December). *Read Alouds and Oral Language for Preschool*. Utah State Board of Education, Salt Lake City, UT.

Throndsen, J. & Wiebke, S. (2016, September). Launching Writing with the Write Tools. Utah State Board of Education, Salt Lake City, UT.

Throndsen, J. (2016, September). *Instructional Routines with Impact for Dual Language Immersion*. Utah State Board of Education, Layton, UT.

Okroy, S., Bowe, M., Sutherland, B., Wiebke, S. & Throndsen, J. (2016, September). Early Childhood Literacy Conference. Utah State Board of Education, Murray, UT.

Throndsen, J., Wiebke, S., Benson, J., & Carter, C. (2016, August). Strengthening Your Core Institute, Utah State Board of Education, Salt Lake City, UT.

Throndsen, J., Rose, G. & Gerrity, C. (2016, June). K-12 Library Media Collaborative Workshop. Utah State Board of Education, Salt Lake City, UT.

Throndsen, J. & Benson, J. (2016, June). Evidence-Based Instructional Strategies: Feedback. Assessment to Achievement, Utah State Board of Education, Salt Lake City, UT.

Throndsen, J. (2016, March). *Principals' Literacy Institute.* Utah State Board of Education, Layton, UT.

Throndsen, J., Benson, J., Wiebke, S., & Carter, C. (2016, February). *DIBELS Lead Instructor Institute*. Utah State Office of Education, Salt Lake City, Utah.

Throndsen, J. (2016, January). *Developing Academic Language and Literacy.* Dual Language Immersion-French, Layton, Utah.

Throndsen, J. (2015, December). *Using Writing in Mathematics Instruction*. University of Utah, Salt Lake City, Utah.

Throndsen, J. (2015, December). *The Big 5 of Reading Instruction.* Principals' Literacy Institute, Utah State Office of Education, Cedar City, Utah.

Throndsen, J. (2015, November). *Pressing Questions from Preservice Teachers*. Utah State University, Logan, Utah.

Throndsen, J. (2015, September). *Core Instruction: The Most Critical Component of Literacy.* Principals' Literacy Institute, Utah State Office of Education, Salt Lake City, Utah.

Throndsen, J & Benson, J. (2015, September). DIBELS Leadership Institute. Utah State Office of Education, Salt Lake City, Utah.

Throndsen, J. (2015, September). *K-3 Reading Improvement Program Changes and Updates*. Utah School Superintendents Association, Sandy, Utah.

Throndsen, J. (2015, June). *Designing Performance Tasks that Integrate ELA and the Content Areas*. Performance Task Workgroup, Utah State Office of Education, Juab, Utah.

Throndsen, J. (2015, June). *Using Your School Improvement Plan to Develop a Yearlong Literacy Professional Learning Plan*. Principals' Literacy Academy, Utah State Office of Education, Salt Lake City, Utah.

Throndsen, J. (2015, April). *Meeting the Needs of ELs in English Language Arts*. Federal Programs Directors' Meeting, Utah State Office of Education, West Jordan, Utah.

Throndsen, J. (2015, March). *Vella's Principles of Adult Learning Theory in on Online Environment*. Professional Learning Series, Utah State Office of Education, Salt Lake City, Utah.

Throndsen, J. (2015, January). *Instructional implications for Fluency, Vocabulary, Comprehension, Writing and Word Study*. Principals' Literacy Academy, Utah State Office of Education, Salt Lake City, Utah.

Throndsen, J. (2014, November). *Instructional Implications for Phonemic Awareness, Phonics and Progress Monitoring*. Principals' Literacy Academy, Utah State Office of Education, Provo, Utah.

Throndsen, J. (2014, September). *Multi-Tiered System of Supports and Tiered Instruction*. Principals' Literacy Academy, Utah State Office of Education, Park City, Utah.

Throndsen, J. (2013, Summer). *Comprehensive Mathematics Instruction: Grades 2-3*. Elementary Core Academy, Utah State Office of Education, Statewide, Utah.

Throndsen, J. (2008, Summer). *Whole Number Relations*. Elementary Core Academy, Utah State Office of Education, Statewide, Utah.

Utah State Legislator

Millner, A., & Throndsen, J. (February 2018). House Education Committee. Utah State Capitol, Salt Lake City, Utah.

Throndsen, J. (2016, September). *Education Interim Committee*. Utah State Capitol, Salt Lake City, Utah.

Throndsen, J. (2016, January). *Public Appropriations Committee*. Utah State Capitol, Salt Lake City, Utah.

Throndsen, J. (2015, November). *Education Interim Committee*. Utah State Capitol, Salt Lake City, Utah.

Throndsen, J. (2015, July). *Education Interim Committee*. Utah State Capitol, Salt Lake City, Utah.

Throndsen, J. (2015, May). *Governor's Education Commission*. Utah State Capitol, Salt Lake City, Utah.

Throndsen, J. (2015, January). *HB 69: English Language Arts Instructional Tool*. House Education Committee, Salt Lake City, Utah (with Representative Moss and Senator Stephenson).

District Presentations

Throndsen, J. (2018, March). *Tiered Interventions and Systems*. Discover Elementary, Vernal, UT.

Throndsen, J. & Brown, L. (2018, March). *Dyad Reading*. North Ogden Elementary, Ogden, UT.

Throndsen, J. (2018, March). *Informative Writing and Student Relationships*. Dixie Sun Elementary, St. George, UT.

Throndsen, J. (2018, January). *Small Group Instruction and Engagement in Reading*. Granite School District, Salt Lake City, UT.

Throndsen, J. (2018, January). *Learning Intentions and Success Criteria*. Sevier School District, Richfield, UT.

Throndsen, J. (2017, December). *Reading Engagement Strategies for All*. Dixie Sun Elementary, St. George, UT.

Throndsen, J. (2017, September). *Essential Practices for Literacy Instruction*. South Sanpete School District, UT.

Throndsen, J. (2017, August). *Using Assessment to Guide Instruction.* Piute School District, Piute, UT.

Throndsen, J. (2017, August). *Core Instruction and the Key Areas for Literacy Instruction.* Centennial Elementary, Roosevelt, UT.

Throndsen, J. (2017, January). *Aligning Best Practices in Reading Instruction*. Provo School District, Provo, UT.

Throndsen, J. (2016, October. *Using Lexiles to Enhance Student Performance*. Tooele School District, Stansbury, UT.

Throndsen, J. (2016, September). *Using the TOSREC for Students with Disabilities.* Canyons School District, Sandy, UT.

Throndsen, J. (2016, September). *Analyzing Student Writing to Adjust Instruction.* South Sanpete School District, Manti, UT.

Throndsen, J. (2016, August). *Reading and Writing Instruction and Intervention.* Altamont Elementary, Altamont, UT.

Throndsen, J. (2016, August). *Scaffolding Reading Instruction for Diverse Learners.* Provo School District, Provo, UT.

Throndsen, J. (2016, February). *Developing Students as Writers*. Uintah School District, Vernal, Utah.

Throndsen, J. (2016, January). *Developing Writers through Modeling.* Box Elder School District, Brigham City, Utah.

Throndsen, J. (2016, January). *Engagement Strategies in Phonemic Awareness and Phonics Instruction.* South Sanpete School District, Gunnison, Utah.

Throndsen, J. (2015, October). *Skill-Based Instructional Grouping*. South Sanpete School District, Manti, Utah.

Throndsen, J. (2015, September). *Building Academic Language for All Students*. Cache County School District, Logan, Utah.

Throndsen, J. (2015, September). *Close Reading and Reading Fluency*. Box Elder School District, Brigham City, Utah.

Throndsen, J. (2015, September). *Scaffolding Instruction for All Learners*. Jordan School District, West Jordan, Utah.

Throndsen, J. (2015, August). *Critical Components in Literacy Instruction*. Duchesne County School District, Roosevelt, Utah.

Throndsen, J. (2015, August). *Cognitive Rigor in Writing Instruction*. Thomas Edison Charter School, Logan, Utah.

Throndsen, J. (2015, August). *Components for Planning and Implementing Close Reading*. Early Light Academy, West Jordan, Utah.

Throndsen, J. (2015, July). *Improving Students' Reading Comprehension across the Content Areas*. Kane County School District, Kanab, Utah.

Throndsen, J. & Benson, J. (2015, May). *Using DIBELS as a Universal Screener in Grades K-3*. Alpine School District, Pleasant Grove, Utah.

Throndsen, J. (2015, April). *Integrating Reading, Speaking and Writing in the ELA Classroom*. Canyon Grove Academy, Pleasant Grove, Utah.

Throndsen, J. (2015, March). *Teaching Writing Using Multiple Sources*. Uintah School District, Vernal, Utah.

Throndsen, J. (2015, March). Scaffolding Writing Instruction. Elk Run Elementary, Magna, Utah.

Throndsen, J. (2015, March). *Close Reading in Grades K-5*. Early Light Academy, South Jordan, Utah.

Throndsen, J. (2015, March). *Writing Across the Curriculum*. McKinley Elementary, Tremonton, Utah.

Throndsen, J. (2015, January). *Addressing Cognitive Rigor through Writing*. Granite School District, Oakwood Elementary, Holladay, Utah.

Throndsen, J. (2015, January). *Achieving Cognitive Rigor in the K-9 Classroom*. Thomas Edison Charter School, North and South Campus, Logan, Utah.

Throndsen, J. (2014, October). *Using your Comprehensive Core Program: Reading Street.* South Sanpete School District, Manti, Utah.

Throndsen, J. (2014, August). *Designing Writing Instruction to Meet the Demands of the Core.* Beaver School District, Beaver, Utah.

Throndsen, J. (2014, August). *Writing from Sources*. Canyons School District, Sandy, Utah.

Throndsen, J. (2014, February). *Text Complexity and Close Reading*. High-Yielding Practice for Educators Workshop, Canyons School District, Sandy, Utah.

NATIONAL PRESENTATIONS

Throndsen, J. (2016, April). Developing a Growth-Mindset. NCTM Annual Conference, San Francisco, California.

Stephens-French, P. & Throndsen, J. (2016, April). Building a Whole School Foundation for Mathematical Rigor. NCTM Annual Conference, San Francisco, California.

Throndsen, J. (2015, September). Using Writing to Promote Mathematics Understanding. ASCD Four Corners Conference, Farmington, New Mexico.

Throndsen, J. (2015, February). Developing OER Performance Tasks for Grades K-5. CCSSO SCASS ELA Conference, Austin, Texas.

Throndsen, J. (2014, December). *Developing Lead Learners: Principals' Academy.* Learning Forward Annual Conference, Nashville, Tennessee.

INTERNATIONAL PRESENTATIONS

Throndsen, J. (2014, November). *Chinese Dual Immersion in Utah Schools.* China Bridge Delegation Conference, Beijing, China.

Guest Teaching Presentations

Throndsen, J. (2016, March). Measurement Mania. Dr. MacDonald's class, Utah State University, Logan, Utah.

Throndsen, J. (2015, December). Promoting Conceptual Understanding through Writing. University of Utah, Salt Lake City, Utah.

ADJUNCT POSITIONS

Utah State University, Logan, Utah (Fall 2015)

ELED 3100—Classroom Reading Instruction
Undergraduate Course.   Provides an introduction to classroom reading instruction. Focuses on the five essential elements of reading: phonemic awareness, phonics, fluency, vocabulary, and comprehension as identified by the National Reading Panel (2000).

Southern Utah University, Cedar City, Utah (2012-2014)
College of Education and Human Development

EDRG 5340—Foundations of Literacy
Graduate Course. Provides historical perspective on reading instruction, an introduction to theories and models of literacy acquisition, and discussions of research related to lifelong literacy and its instructional implications.

EDRG 5370 – Teaching Process Writing
Graduate Course. Examines theories, concepts, and methodologies that promote the development of strategic writers. Prepares teachers to provide research-based methods for teaching K-12 students to develop a range of writing skills and applications including how to compose opinion/argument, information/expository, and narrative writing.

EDRG 5320 – Advanced Content Literacy
Graduate Course. Provides an in-depth understanding of the research findings, issues, principles, and practices related to exemplary, research-based literacy instruction in the content areas. Emphasis in preparing teachers to provide every student with meaningful and engaging opportunities to learn high-level skills in reading, writing, and speaking while working with graphics and texts in the K-12 curriculum. Teachers also evaluate texts in various content areas to identify qualitative and quantitative features of a text and address reader and task considerations.

EDRG 5345 – Advanced Early Literacy and Language Acquisition
Graduate Course. Provides an overview of the research about the developmental stages of human growth and how language learning and print acquisition proceed. Emphasis on the instructional insights into what oral language and literacy supports are required by children in K-12 with varying linguistic, social, and cultural backgrounds.

EDRG 5350 – Reading Assessment and Instruction
Graduate Course. Attends to developing and using a variety of formal and informal assessments and instructional procedures to increase or accelerate students' reading outcomes. Instruction on how to screen for reading difficulties, diagnose reading deficits, and monitor progress to ensure optimal growth in reading is accomplished through teachers learning procedures for gathering, analyzing and interpreting data to inform instruction.

EDRG 5380 – Advanced Reading Comprehension
Graduate Course. Examines current theories and models that impact reading comprehension and application in instruction. Emphasis on understanding reading comprehension, increasing the range, quality and complexity of reading materials used by students, and support student responses to text as complex, critical thinkers.

EDRG 5330 – Teaching with Children's and Adolescent Literature
Graduate Course. Examines the use of literature and informational texts as an avenue for implementing evidence-based strategies to meet the demands of the standards through close reading, text-dependent questioning, cognitive rigor, and scaffolding techniques.

University of Alaska Southeast, Juneau, Alaska (2010-2014)
School of Education

COURSES TAUGHT – UNIVERSITY OF ALASKA SOUTHEAST

EDMA 614 – Numeration and Operations: Mathematics for K-8 Teachers
Graduate Course. Addresses the concept of number, how number is represented, and the relationship between and among numbers, number systems, and basic operations. Emphasizes standards and research-based practice for supporting K-8 students construct efficient computational skills with conceptual understanding.

EDMA 658 – Technology for Teaching and Learning Mathematics
Graduate Course. Provides the knowledge and skills to apply technology to help students understand mathematics content. Applications include virtual manipulatives, calculators, spreadsheets, software tutors, web applications, modeling software, and GPS.

COMMITTEES

Facilitator January 2015-present	Professional Learning Series Design Committee
Facilitator Dec 2014-Sept 2015	Elementary Library Media Standards Revision Committee
Facilitator January 2015-August 2015	Open Education Resources (OER) Performance Task Design Committee
Facilitator September 2014-May 2016	Reading Interventionist Endorsement Committee

NATIONAL LEADERSHIP & SERVICE

Reviewer (2013-present)	*Teaching Children Mathematics,* National Council of Teachers of Mathematics

STATE SERVICE – LEADERSHIP ACTIVITIES

Board Member (June 2017-present)	*School Readiness Board. Appointed by Governor's Office of Management and Budget. Work to support high quality school readiness programs.*
Board Member (January 2016-December 2017)	*Utah Council for Teachers of Mathematics. Appointed by UCTM Board to serve on the board. Work collaboratively to solicit, review, and compile articles for the UCTM bi-annual journal.*
Board Member (2014-2017)	*Utah State Library Board*. Appointed by the governor to represent the Utah State Office of Education on the board. Collaborate with library leadership and staff. Meet bimonthly to monitor program progress.
Committee Member (2013-2014)	*School Community Council.* Represent out-of-boundary parents in making educational decisions for students at Uintah Elementary in Salt Lake City School District.

PROFESSIONAL AFFILIATIONS

Member (2014-present)	*International Literacy Association (ILA)*
Member (2014-2016)	*Utah Council for the International Reading Association (UCIRA)*
Member (2014-present)	*American Educational Research Association (AERA)*
Member (2011-present)	*National Council of Teachers of Mathematics (NCTM)*
Member (2008-2016)	*Association for Supervision and Curriculum Development (ASCD)*