Teacher Beliefs on Play and Academic Learning with a Kindergarten Coding Curriculum: A Mixed-Methods Study in the United States and Argentina

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Abstract

Around the world, kindergarten teachers face competing priorities of creating opportunities for play-centered learning and preparing students academically for formal school. There are two philosophies for approaching this tension. Some teachers believe academic learning and play are integrated (IB), while others believe academic learning and play are discrete phenomena to be balanced (DB). However, as playful computer science programs are introduced to kindergarten classrooms around the world, little is known on how teachers' individual beliefs about the integration of play and academic learning impact their use of these tools. This dissertation used a sequential mixed methods approach to conduct a secondary analysis of data from four states and provinces in the United States and Argentina teaching a play-based early childhood coding curriculum. We learned that teachers' beliefs about the integration of play and academic learning were aligned with existing frameworks in prior research. Using hierarchical linear regression, we found students of DB teachers had higher post-curriculum coding knowledge than students of IB teachers ($\beta = 1.81$, $p < 0.05$), but teacher beliefs did not affect post-curriculum computational thinking scores ($p > 0.1$). Finally, using content analysis, we found DB teachers generally finished the curriculum while many IB teachers did not, which may have led to differences in post-curriculum coding knowledge. Both teachers modified the curriculum while making space for open-ended play and creation, but DB teachers separated the formal lesson from coding free-play, while IB teachers were flexible with their lesson structure to create more open-ended project time. Both sets of teachers saw the curriculum as targeting key curriculum areas for kindergarten and saw success for their students who underperformed in other school settings and domains. In conclusion, this suggests that kindergarten teachers, regardless of their beliefs on play's relationship with learning, believe in

play and make space for play when teaching computer science. However, policy-makers should determine if learning goals for kindergarten computer science relate to academic content. Depending on kindergarten computer science learning goals, practitioners and curricula developers may need to not only integrate play and learning, but also find the balance between the two.

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CHAPTER 1: INTRODUCTION

There has been an increased prioritization in early childhood and elementary computer science and computational thinking education in the United States and around the world, both to increase economic opportunities for students and to improve equity in access to computer science fields. For example, in the United States, initiatives such as the Computer Science Teachers Association K-12 Computer Science Framework, #CSForAll, and #AccessCSForAll are working to create computer science standards and increase access to computer science programs across the country, including for kindergarten and elementary school (Barnes, 2017; K-12 Computer Science Framework Steering Committee, 2016; Santo et al., 2019; M. Smith, 2016). The United Nations Educational, Scientific and Cultural Organization (UNESCO) proposes that an expansion of computer science education, particularly in the early childhood years, can help nations reach UN Sustainable Development Goals of gender equity and education (UNESCO, 2017).

Alongside the initiatives, we have seen the development of tools and platforms to promote coding and computational thinking in early childhood and early elementary school students in developmentally appropriate ways. Examples of these tools include KIBO, a screen-free robot that is programmed using wooden blocks with barcodes; BeeBot, a screen-free robot that can be programmed to move using buttons on its back; and ScratchJr, a free programming language for tablets that uses a block-based coding language without words (Bers, 2018; Caballero-González et al., 2019; Elkin et al., 2016; Flannery et al., 2013; Papadakis & Kalogiannakis, 2020; Sullivan et al., 2015). To complement the tools and platforms, researchers and practitioners have created curricula to teach coding and computational thinking according to evidence-based practices and developmentally appropriate pedagogy in the early childhood classroom.

One such curriculum is the Coding as Another Language (CAL) curriculum for ScratchJr, which, at the time of writing this dissertation, has been taught in at least seventeen countries (Ben Ari et al., 2023; Bers, Blake-West, et al., 2023; Bers, Levinson, et al., 2023; DevTech Research Group, 2023b). Although the curriculum has been translated and localized for cross-cultural use; the CAL program uses a single structure of its play-focused curriculum across countries, states, and contexts. That said, a single curriculum can be implemented in multiple ways, not only between countries and across cultures, but also within the same country, province, city, or school. Teachers might hold different beliefs about a single curriculum, potentially leading to variation in student outcomes (Govind, 2022). For example, research has shown that teachers' beliefs about pedagogy related to their teaching practices and to student outcomes with an early childhood coding program (Strawhacker et al., 2018). Although the curriculum is play-based, teachers' understandings of play in the academic space, might impact how the curriculum is taught or the physical environment in which the curriculum is taught in. Similarly, conceptions on school-readiness might impact teachers' priorities and practices in the classroom, which could also impact curriculum implementation. For example, a teacher who is focused on ELA standards related to reading and writing may emphasize the written activities in the curriculum more highly than a teacher who is focused on social and emotional standards and therefore emphasizes collaboration and peer-sharing activities. This dissertation used data from two states in the United States and two provinces in Argentina and a sequential mixed-methods approach to examine if kindergarten teachers' beliefs of the relationship between academic learning and play converge with student outcomes while teaching a coding curriculum.

CHAPTER 2: LITERATURE REVIEW

In this literature review, we first provide context on kindergarten as a historic and modern practice, including in both the United States and Argentina. Then, we describe the primary philosophies and pedagogies of kindergarten that exist around the world, as well as competing priorities that exist in kindergarten curricula. We linked these competing priorities to competing pedagogies that promote the integration or lack thereof of play and academic learning. Finally, we discuss early childhood computer science education, including its pedagogies and practices.

Kindergarten

The idea of kindergarten was introduced by Froebel in the early 1800s in Germany as an alternative educational option to the existing daycare systems (Allen, 1986). Both the Kindergarten and daycare systems were rooted in Christian ideas of providing a moral and spiritual education for children. However, the two educational systems could not be more different. The daycare system was developed to provide moral education to primarily the poor of the city and was rooted in philosophies of Original Sin. These programs focused on correcting young children's sinful tendencies with punishment and interventionist education.

In contrast, the kindergarten system offered a new educational approach, directed at all children, including the middle class. Kindergarten programs were seen as places for the promotion of children's civic, intellectual, and moral development, on the assumption that children would develop into positive young citizens if given the space and nurturing to do so (Allen, 1986). Froebel developed a curriculum and pedagogy drawing from play, nature and the natural world, language, song, and music, and he developed specific materials including a ball and box that served as central toys and collections of songs and nursery rhymes (Allen, 1986; Corcoran, 1926). The original kindergarten programs were half-day programs and intended to merge with and complement the family and home environment – the songs and games played at school could also be played at home, and Froebel's toys were designed for both home and school use. As such, the role of the teacher in leading and managing these classrooms was complex – somehow actively working, observing, and yet not interfering in the children's play (Corcoran, 1926).

In the modern day, the term "kindergarten" is often used to refer to the preprimary year or years of education, rather than to the specific kindergarten program and philosophy of education developed in 1800s Germany. As such, in the modern day, there is wide variety in kindergarten programs and their policies between and within countries. The classrooms may use different pedagogies, contain varied age groups, may or may not be mandatory, and may have different relationships with their related primary systems of education.

Like in Froebel's original kindergartens, play today is still understood to be developmentally essential for kindergarten children's learning, but there is wide variation in the extent to which play exists and how play is defined within the kindergarten curriculum. Broadly, play is understood as an enjoyable activity that is more focused on process than outcome (Ashiabi, 2007; Pyle & Danniels, 2017; Sturgess, 2003). There are three primary types of play that can occur in in the kindergarten setting – teacher-directed play, child-directed play, and a less common mutually-led play (Pyle et al., 2017). Play-based learning can encompass any of these mechanisms of play, although teachers' individual beliefs may lead them to value or prioritize one type of play over another (Lynch, 2015; Pyle et al., 2018). Play-based learning itself can also be implemented at various levels in the curriculum, with some programs including play-based learning for all domains and others including play-based learning for only a few. As a most common practice, play-based learning may prioritized for children's holistic development (such as social-emotional learning and approaches to learning skills), while more traditional forms of learning are prioritized for children's academic learning (Pyle et al., 2017).

For this reason, play is often deprioritized in classrooms where academic learning is highly prioritized (Lynch, 2015). Academic learning in kindergarten prioritizes the learning of skills necessary for school-readiness, as kindergarten is the first year before traditional primary schooling begins (or increasingly in some countries, the first year of formal schooling). School readiness skills can include literacy and numeracy skills, in addition to other cognitive and social skills, and researchers and policy makers are focused on understanding early childhood and kindergarten school readiness in order to improve later school and career success (Pagani et al., 2010; Quirk et al., 2013). These skills are then prioritized in the classroom, often at the expense of play-based and holistic learning (Lynch, 2015; Pederson, 2007).

Kindergarten in the United States

German refugees brought the ideas of kindergarten to the United States in the mid-1800s (Allen, 1986). The first kindergarten programs in the United States were run by charitable organizations, but these programs were later absorbed by the public schools in a way that they would not be in Europe for many years. The first public kindergarten in the United States was open in St. Louis in 1878, and public kindergarten programs were available in most American cities by 1914. From the beginning, there were two factions of kindergarten philosophies, each with its own classroom practices – the more traditionally liberal kindergarten programs encouraging open-ended and collaborative free play with flexible use of materials and space, while the more conservative programs encouraged pragmatism in their use of pre-made, affordable, and bulk-produced play and learning materials (Prochner, 2011).

In the United States today, kindergarten is both the first year of formal school and part of the early childhood system (Kamerman & Gatenio-Gabel, 2007). Kindergarten programs are typically housed in an elementary school building, and most children are enrolled in public school programs, rather than in earlier early childhood years when the majority of children are enrolled in private programs, including programs that may emphasize “care” over “education” (Kamerman & Gatenio-Gabel, 2007). However, the differentiation between early childhood and elementary policies and practices in kindergarten is not always clear. For example, there is variation between states in whether kindergarten teachers are early childhood teachers, elementary school teachers, or both as determined by their licenses. In some states, such as New Hampshire, elementary school teaching licenses cover kindergarten, and in most states, an elementary special education license covers kindergarten as well (New Hampshire Department of Education, 2023). However, in many states, early childhood teachers are also qualified by their license to teach kindergarten, and in some states including Massachusetts, kindergarten can only be taught by early childhood licensed teachers, and elementary school licenses begin covering classrooms in first grade (Massachusetts Department of Elementary and Secondary Education, 2023).

Additionally, kindergarten classrooms in the United States are often set up in ways that may mimic or partially reflect a traditional early childhood room with a large carpet for circle time and learning centers for dramatic play, sensory centers, and art (Hamand, 2019). In the traditional early childhood classroom, these centers are used for center-based activities throughout the day, during which times children participate in both guided activities and free play. However, although these areas may be present in the American kindergarten classroom, teachers describe using less of these stations and their open-ended curriculum than in previous years (Brown et al., 2020; Goldstein, 2007).

In reflecting a traditional elementary classroom, the traditional American kindergarten classroom has a structured schedule including reading, writing, math, and enrichment sessions. Nap time, which is included in the early childhood schedule, is no longer part of the day in the kindergarten schedule (Goldstein, 2007). In addition to the early childhood classroom elements described above, kindergarten classrooms in the United States also begin to include material elements of traditional elementary school such as desks, and schools may introduce individual laptop programs at this time. National and state standards begin in kindergarten, such as the Common Core State Standards for literacy and math, the Next Generation Science Standards, and the CS K-12 standards for computer science (ISTE-S, 2016; National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010b, 2010a; National Research Council, 2015). Notably, each of these standards is referred to as "K-12," a familiar phrase in American schooling that identifying the kindergarten year as belonging with the numbered grades as part of formal school. Finally, national standardized assessments begin in kindergarten, a policy initially set by the No Child Left Behind act of 2001 (Bush, 2001; Pederson, 2007).

Most education policy in the United States is set at the state or district level, with funding determined at both the state and district level. Even national policies are primarily implemented at the state or district level – for example, although there are national assessment requirements, the assessments used are determined by the state or district (Bush, 2001; Pederson, 2007). Policies regarding kindergarten, such as whether kindergarten is mandatory, teacher license requirements, and the age cutoff for entering kindergarten, are typically set by the state or district, and funding varies by district as public schools are funded through local and property taxes (Fromberg, 2006). Kindergarten attendance is mandatory in 19 states and the District of Columbia, and districts are required to offer kindergarten in all but 9 states (Wood, 2022).

Private kindergartens exist in the United States and are entirely independent from the public school system. These kindergartens can be administered by religious organizations, nonprofit organizations, or as entirely independent nonprofits (Fromberg, 2006; Kamerman & Gatenio-Gabel, 2007). These kindergartens may be incorporated either in preschools or elementary schools depending on the kindergarten classroom and school. Private kindergarten classrooms in the United States, like all private schools, do not require teachers to hold licenses or degrees in education, and do not have government oversight, whether that be on teacher certification, curricula, or assessments (Fromberg, 2006).

Kindergarten in Argentina

Kindergarten programs emerged in Argentina in the 1800s alongside those in Germany and the United States, supported by a growing liberal community in the cities. These communities, as in the United States, saw kindergarten programs in the model of Froebel as a means of providing a moral education to low-income and immigrant residents of Buenos Aires and to residents of rural communities, as well as a means of modernizing Argentina and connecting the nation to a global world. Leaders of the Argentinian educational movement, such as Domingo Faustino Sarmiento, worked with American educational leaders such as Mary Peabody Mann, and curricular and training materials were often brought and translated from North America. Like in the United States and Europe, kindergarten programs were identified as spaces between the home and formal school and were considered part of the women’s domain.

Kindergarten became formally mandated in 1993 through a national educational reform, which among other changed mandated education between the ages of 5 and 14 (Dupre, 2000). The educational system also became divided into three levels: preprimary, primary, and secondary education, which were further established by the National Education Law in 2006. National objectives of kindergarten education focus on social, emotional, approaches to learning, and developmental goals including motor development, expression across multiple modalities, and developing a love of learning (Ley de Educación Nacional, 2006; Niveles Educativos, 2006). Formal academic subjects such as second language learning are optional, and although they may be encouraged, are not mandatory during kindergarten education (Tocalli-Beller, 2007).

Today, kindergarten remains housed in the preprimary programs, known as "inicial" programs (Cardini et al., 2020). Kindergarten programs therefore are often but not always physically located in separate buildings from primary schools. Primary schooling begins in the first grade, but inicial programming, including kindergarten programming, is mandatory beginning at age four (Cardini et al., 2020; Snaider, 2018). As such, school enrollment is very high. Over 85% of five years old children from the Corrientes province in the Northeast and over 90% of children in Mendoza were enrolled in a kindergarten classroom (Instituto Nacional de Estadística y Censos, n.d.-b). Enrollment in elementary school was even higher, with 100% enrollment across Argentina (OECD, n.d.).

Certifications and qualifications for kindergarten teachers in Argentina are set at the provincial and district level, although there are national standards for teacher education (GEM Report UNESCO, 2007). Kindergarten teachers can be educated either at universities or at non-university teacher training colleges. Early childhood educator training must cover general pedagogy, developmental knowledge relevant for young children, and any specialty disciplinary content (such as technology content for technology specialists).

Argentina has both national and provincial ministries of education. Broad policies such as the mandatory ages of schooling are set at the national level, but the educational system is primarily administered at the provincial level by the local ministries of education (Cardini et al., 2020). Some provinces have bills or laws regulating local education, but often educational directives are administered directly through the ministry, or through contracts with the teachers' unions. Formal of assessments begin at the third grade, although individual provinces including Mendoza may do greater tracking of students' performance.

In addition to the public schools administered by the provincial ministries of education, Argentina also has private schools which are often administered by NGOs or religious organizations (GEM Report UNESCO, 2007). Unlike in the United States, the private schools are also partially administered, overseen, and often subsidized by provincial ministries. Approximately 30% of students attend private schools for initial (preprimary) education (OECD, 2023).

Competing Kindergarten Priorities

School Readiness

As mentioned above, kindergarten is the year before primary school begins. As such, kindergarten pedagogies and programming have historically and globally focused on preparing children for school. This "readiness for school" does not have a singular meaning, and there are differing definitions and priorities between countries, within countries, and within school communities regarding which domains of children's development are most important in the preparation for school. Two primary domains exist as focuses of school readiness: academic readiness and social emotional readiness (Bierman et al., 2008; Brown & Lan, 2015; Shemesh & Golden, 2022, 2022).

In many countries around the world, there are tensions between teachers' aspirations for kindergarten pedagogy and the demands for school readiness of policies, parents, and primary school curricula (Shemesh & Golden, 2022). These demands and associated expectations of school-readiness can exist on the national level, on the regional level, or at the individual school or community level. Comparisons between countries have suggested that some of this variation may relate to the relationship between early childhood and formal education systems. Unlike in traditional school, there is a broader acceptance of and directive for play-based and playful learning in preschool education, as seen through research on and policy directives initiatives for "playful learning" and guided play in preschool (Ilgaz et al., 2018; Zosh et al., 2022). However, kindergarten is not always seen as part of early childhood education, and in countries where preprimary education is part of the formal schooling system, there is a greater understanding that the purpose of early education is to serve that formal schooling system (Bingham & Whitebread, 2012).

In contrast, other countries have a history in which preprimary education is separate from formal education and serves a unique role in supporting holistic child development and families of young children (Bingham & Whitebread, 2012). This is famously seen in Scandinavian countries such as Finland, as well as in European countries such as Estonia or Italy with the Reggio Emilia program (Hewett, 2001; Niikko & Ugaste, 2012). Here, early childhood education is viewed as a partnership between the educators and the families, and attends to a child's physical, social, emotional, spiritual, cognitive, ethical, and future coping skills with the intention of supporting the development of the whole child. In Finland in particular, one of the goals of the education program is the child's immediate happiness and enjoyment, unlike the European programs where future emotional skills were the educational goal of the teachers. These programs highlight play as an adaptive and individualized program where children can explore their environment, relationships, and community.

School Readiness in the United States. Since No Child Left Behind was implemented in the United States in 2001, kindergarten has been schoolified and school-readiness goals have become more academic and literacy focused (Bassok et al., 2016; Brown et al., 2020; Brown & Lan, 2015; Fromberg, 2006). Teachers report that expectations and standards for exiting kindergarteners have transitioned from reading-readiness to reading (Brown et al., 2020; Repko-Erwin, 2017). Additionally, there has been an increased focus on literacy and math skills and a decreased focus in science, social studies, or other subjects utilizing a hands-on exploratory approach to learning (Bassok et al., 2016). Research with teachers suggests that NCLB-related policies, specifically testing policies and policies formalizing standards, have taken the fun, play, and child-centered learning out of kindergarten, with one teacher going so far as to say "Cute is dead" (Brown et al., 2020). Even where content has stayed the same, the teaching practices and pedagogies of the kindergarten classroom have changed in response to NCLB and associated policies. Teachers report the loss of dramatic play areas and integrated and thematic curricula, and research suggests that daily use of textbooks has more than doubled (Bassok et al., 2016; Brown et al., 2020).

As a result of NCLB, focus on academic school-readiness in the United States has also been pushed earlier. In response, kindergarten has become more like "school" and less like a year of preparation for school. In response, there has been a greater emphasis on preschool to prepare children for kindergarten, whereas previously and like in other countries, kindergarten served to prepare children for primary school (Repko-Erwin, 2017).

School Readiness in Argentina. Discussions of school-readiness in Argentina have emerged in discussions and debates of universal early childhood education programs (Snaider, 2018). Broadly in Argentina, childhood education is valued and prioritized for its economic potentials of addressing poverty and produce human capital, especially relevant as poverty in Argentina disproportionately impacts children (Lopreite & Macdonald, 2014; Redondo, 2020). However, a child's *readiness for formal school* is not understood as the primary purpose or goal of early childhood education. Officially, the educational objectives for kindergarten focus on holistic development, including expression, creativity, and social-emotional skills, with objectives of school content and school-readiness first appearing in the primary school objectives (Ley de Educación Nacional, 2006).

Publicly and in the media, discussions of school-readiness have featured policy-makers and parents, with parents in particular highlighted supporting children's' academic and cognitive development, rather than teaching specific academic content or skills, as the mechanism of preparing children for school through early childhood education (Snaider, 2018). Possibly due to the political purpose of the discussions, parents and policy makers have also focused on the scientific benefits of early childhood education on their child's development and school-readiness, including neuroscientific outcomes of development and measurable, comparative outcomes to other children.

Within Country Variation in School-Readiness. This prioritization of school-readiness and academics is greater for lower-income and minoritized students than for higher-income students. Research findings suggest that there has been a greater increase in teachers' beliefs of the importance of academic skills for incoming kindergarteners for teachers of classrooms with majority low SES and non-white students (Bassok et al., 2016). Research suggests that this pattern, in which teachers in low SES and marginalized communities more highly prioritize school-readiness than teachers in higher SES and less-marginalized communities, is consistent in countries around the world. In Singapore, researchers compared two schools and the pedagogies of teachers in the kindergartens: a community-based school serving middle and high SES students and a private school serving low-middle SES students (Aman, 2016). The teachers at the lower-SES school focused on school-readiness and emphasized these traditional literacy practices in their classroom practices, while the teachers at the higher-SES school described themselves as more adverse to traditional literacy methods such as worksheets, repetition, and homework.

Balancing Academics and Social-Emotional Learning

Kindergarten teachers also are balancing learning priorities in their curricula, specifically academic and social-emotional learning. Different policy makers take different approaches to the balance between these two school-readiness priorities, and multiple possible justifications exist for each policy practice.

An illustrative example of a country that emphasizes social emotional learning as it's school-readiness priority over academic learning is Israel (Shemesh & Golden, 2022). In the traditional philosophy of Israeli early childhood education, teachers have rejected academic readiness as the goal of kindergarten, focusing instead on emotional readiness. Emotional readiness is the primary consideration in retaining a child for an extra year in kindergarten before beginning formal school. That said, even kindergarten in Israel is become more schoolified in regard to literacy (Sverdlov et al., 2014). Curricular changes making kindergarten teachers partially responsible for first grade performance have led to the integration of literacy practices such as book-reading, letter songs, and encouraging children to add pre-writing alphabetic activities to pretend play (such as including a recipe in a game of cooking).

In contrast, the policies such as the Common Core Literacy Standards have led to an increased prioritization of academic skills over social emotional skills in United States kindergartens. This practice does not necessarily match teachers' ideals for their instruction and curriculum, as teachers would ideally prioritize both common core and social emotional learning (Gaias et al., 2018). However, although US teachers would ideally spend more time on social emotional learning than they currently are, they still would ideally spend more time on academic learning than social emotional learning.

Balancing Academics and Play

Building off the multiple perspectives on school-readiness, developmentally appropriate learning goals, and the true purpose of kindergarten, stakeholders around the world hold multiple perspectives on pedagogies and priorities for kindergarten programs. However, the two priorities of play and learning are not in exclusive tension, as there has always been a belief in and a movement for play-based learning. As is described above, the learning of developmentally appropriate academic topics through play has a long history in kindergarten movements. Historically, this scaffolded, play-based, and child-led pedagogical model of learning has been seen from the toys and kindergarten classrooms of Froebel (Allen, 1986). This practical use of learning through play was expanded on through research by Piaget, who understood play as providing a child space to engage in assimilation without accommodation, or to engage with concepts in a theoretical sense before reintegrating those schemas with reality, leading to a child's intellectual development (Piaget, 1962).

However, although this understanding of playful learning and an integration between play and academics has existed since the beginnings of kindergarten and exists in kindergartens around the world, it is not universal, and beliefs about the integration of these two areas can vary both within and between countries. For example, researchers developed profiles of kindergarten teachers' philosophies in Ontario, CA (Pyle & Danniels, 2017). There were two philosophies that emerged in their findings. Some teachers viewed play and academic learning as discrete processes. To these teachers, all play in the kindergarten classroom should be child-led free-play without teacher intervention. In practice, the teachers in these classrooms were dividing their time between academics and free play. The other philosophy that emerged was of the teachers who saw play and academics as integrated pedagogically in kindergarten. These teachers believed that play could be scaffolded, inquiry-based, and child-centered without being child-led.

In Ontario, the teachers' beliefs, or which profile their beliefs aligned with, were not dependent on the location of their school (urban or suburban), on their years of experience, or on their prior training in play-based pedagogy (Pyle & Danniels, 2017). The authors of that paper did not describe a clear pattern to the teachers' beliefs. However, other research suggests that the two philosophies can vary between countries. Wu and Rao found that between teachers in China and Germany, teachers held one of the same two philosophies as found by Pyle and Danniels, but the profiles varied by country and were culturally dependent (Wu & Rao, 2011). Child-led play is a belief in the German teachers, and scaffolded play is a more common pedagogical belief for the Chinese teachers.

National cultures may also impact teachers' philosophies about the integration or lack thereof of play and academics in the curriculum. For example, when discussing student outcomes and the purpose of kindergarten, teachers in New Zealand emphasized free-play and school-readiness, but were uncomfortable describing structure, even going so far as to acknowledge that "curriculum" was a "dirty word" (McLachlan et al., 2006). This aligned with *Te Whāriki*, the national kindergarten policy, which focused on the free-play structure for kindergarten classrooms.

Additionally, there is variation in how pedagogies and curricula integrating play and academic learning are spread within and across countries. One pedagogy that emerged in Italy but has since spread to and inspired schools in other countries as well is Reggio Emilia, named after the town in Italy in which it originated (Hewett, 2001). Reggio Emilia is a progressive model of preschool education based on the practices of researchers including Vygotsky and Dewey that focuses on investment in staff, child-led practices of research and artistic creation, the co-construction of knowledge and learning between the teacher and the children, and the documentation and sharing of children's work (Hewett, 2001). The pedagogy has been disseminated around the world, including to teachers and schools within the United States, Latin America, and Africa (Foerch & Iuspa, 2016). Teachers in New Zealand saw similarities between *Te Whāriki* and Reggio Emilia, allowing Reggio Emilia philosophies to integrate naturally into their kindergarten programs (Bayes, 2006). However, although the pedagogy was intended to be implemented such as to benefit low-income children in the United States, Reggio Emilia and other related child-led pedagogies most typically serve children of middle and high income families (Foerch & Iuspa, 2016; S. C. Smith, 2014).

A limitation of play-based learning in kindergarten is a lack of assessment tools designed specifically for play-based learning programs (Pyle & DeLuca, 2017). Teachers using a play-based learning curricula for the integration of play and academic learning used conversations and playing alongside children, video and observational methods, and individually pulling students for traditional assessments as means to evaluate academic learning through play-based programming. However, video and documentation methods are limited by parents who do not give consent for their children to be photographed in the classroom. In practice, the most commonly used method observed by researchers was individually pulling children for traditional assessments (Pyle & DeLuca, 2017).

Because assessment outcomes are highly prioritized by policy makers, districts and teachers are incentivized to center the pedagogies and instructional domains that match the assessments when selecting curricula. This effect has been seen in the increased focus on literacy and math topics and decreased focus on technology and art topics since the introduction of standardized tests alongside NCLB in the United States as described above (Pederson, 2007). Similarly, a lack of assessments for play-based learning programs could discourage districts from using said programs in favor of more structured academic curricula that better “teach to the test.” For this reason, it is important to know not only how to assess students involved in play-based curricula, but also if traditional assessments can equally assess students learning from play-based learning and academic-only pedagogies.

This dissertation explores if kindergarten teachers’ orientations towards the integration of academic learning and play relate to classroom outcomes from a play-based coding curriculum. Therefore, in addition to understanding pedagogies and philosophies of play and academic learning, we need to understand early childhood computer science programs, their pedagogies, and the ways in which they can be implemented.

Early Childhood Computer Science

Constructionism

The idea of teaching computer science to young children was proposed by Seymour Papert, who developed the LOGO computer science language back in the late 1960s. LOGO was a language for embodied mathematics, but rather than a pedagogical tool for the purpose of teachers to teach math, LOGO was a tool with which children could explore their world and create art, learning the principles of coding and mathematics along the way. With LOGO, a child controlled the turtle, a robot that could move on the floor and rotate 360°, as well as hold a pen or marker to assist the child in creating art. Working with LOGO offered opportunities for children's creative expression, and the children's learning process through LOGO was intended to be self-guided – a child interested in drawing repeated semi circles would explore different strategies, skills, and mathematical principles than a child interested in drawing a house, who would play with right angles and precise measurements. In both scenarios, the child would be driven in their exploration and learning by their personal motivation and by an affective love for their projects and the materials they were engaging with (Papert, 1980b).

Papert referred to this philosophy of learning by affective and self-guided exploration and doing as Constructionism and was focused on how the engagement with these powerful ideas could lead to a child's cognitive development (Bers, 2020b; Papert, 1980b, 1980a). Constructionism as a philosophy was understood to stand in direct contrast to another philosophy Papert referred to as Instructionism. Instructionism referred to educational philosophies or pedagogies that were teacher-led, focused on direct instruction or instruction with the aim of teaching to a specific standard. In modern educational settings, this model is reflected in the presence of educational standards and objectives for teachers to teach, scripted and guided teacher-led or online curricula for teachers to follow, and assessments to identify the progress of students towards these identified learning objectives (Code.org, 2016, 2021; ISTE-S, 2016; Ramagoni & Brylow, 2023).

Papert would have identified each of these features as in direct conflict with a true Constructionist philosophy, which did not include explicit content learning goals. However, these specific learning objectives are often what motivate and fund computer science programming, as policy makers, parents, and administrators attempt to prepare children for a high-tech society, economy, and labor market (Jara et al., 2018). This tension between child-led Constructionism and economy-led Instructionism mimics the tension in kindergarten pedagogies between play-centered and academics-centered pedagogies. Therefore, we could expect to see teachers with different orientations towards school readiness and play transfer those different philosophies towards their pedagogies and implementation of computer science education programs.

Coding as a Playground

The Coding as a Playground pedagogical philosophy was developed by Marina Bers, expanding on Constructionism as a philosophy and focusing on developmentally appropriate coding environments for young children. The metaphor of coding as a playground defines a playground, whether that playground is physical or virtual, as scaffolded "subsets of reality" designed for the purpose of play (Bers, 2020b). These playgrounds went further than constructionism microworlds, also subsets of reality, which were focused on primarily on providing space for an individual's cognitive development (Bers, 2020b). In the coding playground, the world was designed for playful and scaffolded development of the whole child. These spaces are designed with intentionality for children to encounter opportunities for development in multiple domains, such as social, emotional, physical, and moral in a safe space.

The playground is an intentionally designed environment for scaffolded free play at a developmentally appropriate level.

The pedagogy compares the coding environment to the developmentally appropriate physical playground – a well understood area of development across multiple domains. On the physical playground, children can choose between a variety of activities, such as climbing the ladder to the slide, trying the monkey bars, and playing in the sandbox. In each activity, children have opportunities to face developmentally appropriate challenges – climbing to a new height, fighting with a peer, building in a new way – and each of these opportunities can lead to growth in motor, social, emotional, or character development. Adults stay to the side, letting children lead their own play with peers, but stepping in to scaffold and assist as needed. However, the physical environment itself also provides developmentally targeted scaffolding for the child's learning. A playground for three-year old children is designed with much more scaffolding and safety protections than a playground for eight-year-old that contains more opportunities to take risks and explore. This is seen in variation in swing type, slide height, or climbing structures. A climbing structure for eight-year-old children may include a miniature rock wall, bars, or a ladder, while a structure for three-year-old children would be much shorter consisting of stairs. Even the building materials of physical playgrounds are differentiated by age with Massachusetts regulations stating that gravel and woodchips, building materials acceptable for children's playgrounds, may not be used on infant playgrounds (Standards for the Licensure of Approval of Family Child Care; Small Group and School Age and Large Group and School Age Child Care Programs, n.d.).

The coding playground translates this understanding of the playground to the technological world. The coding platform and the teacher together create coding playgrounds where the children make behavioral choices and practice values, scaffolded by the teacher who promotes virtues and values (Bers, 2021). Similarly, the Coding as a Playground metaphor proposes that developmentally appropriate coding environments can scaffold children's experiences such that the coding environment provides multiple opportunities for child-led play, challenge and risk, and growth across domains led by the child's exploration. Like the physical playground, the coding playground is designed to be developmentally appropriate for the child, with built in features scaffolding the environment such that a playground for young children is different than one for adults. On the coding playground, children can engage in child-led programming, exploring and creating projects, and in doing so guide the learning necessary for the project they are creating. For example, a child interested in creating a project with multiple interacting characters may explore skills of coordination, while another child may be more interested in the design aspect of their characters and explore skills relating to character design.

However, it is important to note that a coding platform is not inherently a coding playground. The teacher or learning facilitator (i.e., parent, older sibling) plays a role in co-creating the coding playground context with the technology. Although a platform can be inherently restricting, limiting its ability to be a coding playground for a child, the adult can also limit a child's ability to playfully, intentionally, or curiously engage with the coding platform and as such create an instructionist play pen. Facilitators create coding playgrounds both by using the coding platform to create engaging and open-ended learning experiences for the child as well as by promoting children's positive engagement with the platform through their instructional plans, physical classroom setup, and interactions with the children (Levinson, 2022). One of the tools developed to create coding playgrounds is ScratchJr.

Positive Technological Development

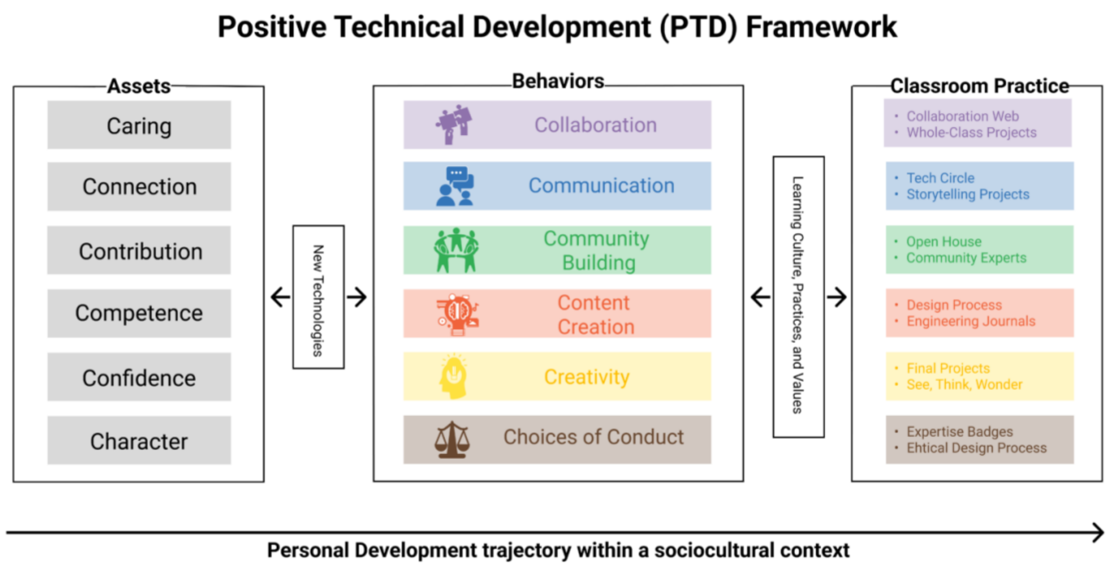
On the coding playground, like on the physical playground, children engage in a variety of behaviors that can lead to their character development. In the Positive Technological Development (PTD) framework, Bers highlighted six behaviors seen on the coding playground that relate to positive development: collaboration, communication, community building, creativity, content creation, and choices of conduct (BERS 2012). These behaviors are obviously not exclusive to the coding context. Each is also seen in other contexts including in the general kindergarten classroom and on the physical playground. For example, a kindergarten teacher may include community building activities in a Morning Meeting or content creation activities during an art activity, and children may display choices of conduct during a Dramatic Play center or as they navigate the rules of tag on the playground during recess. That said, in the context of the PTD framework, the 6 Cs specifically refer to how these behaviors present within the coding or technological context.

The PTD framework was inspired by the Lerner & Lerner model of Positive Youth Development, which describes positive character traits, specifically of adolescents, which lead to positive outcomes such as graduation outcomes (Lerner 2009, 2015, 2021). These character traits are known in the model as the “C’s.” The original Lerner & Lerner model included 5 C’s: competence, confidence, connection, character, and caring. However, later research suggests that when youth have high levels of these traits, this leads to a sixth C, contribution, which is seen in prosocial behavior and community engagement. The 6 C’s model of PYD has been studied in a variety of contexts and in adolescents around the world, including in American youth such as those involved in youth groups such as 4-H (Gestsdóttir & Lerner, 2007; Jelicic et al., 2007), in Salvadorian youth involved in ministry programming (Tirrell et al., 2019, 2023), and among Roma youth in Europe (Dimitrova & Ferrer-Wreder, 2017). In each of these settings, the PYD traits are understood to be bidirectionally related to the individual adolescent's context, and the understanding of the PYD traits varies across each settings' cultural context. This means that the culture of the youth and their context relates to their PYD development, but their PYD also relates to how they engage with their developmental context, including adult mentors and educational environments.

Positive Technological Development is inspired by the 6 C's PYD model, but addresses how to design interventions that will promote specific behaviors, related to the PYD traits, that can emerge when children engage with technological playgrounds (Bers et al., 2009; Strawhacker & Bers, 2018). The PTD model proposes that within the context of the coding playground, the assets of PYD are bidirectionally expressed as and developed through the behaviors of PTD (Figure 1; Bers, 2018). Through curricula use, and mediated by classroom culture, values and routines, specific classrooms will develop their own practices so these behaviors can emerge. Unlike the C's of PYD which are traits of the child, the C's of PTD are behaviors. As such, these behaviors are contextually relevant states rather than stable traits, meaning that a child may display greater or lesser amounts of each behavior depending on the day, activity, coding environment, or physical context (Levinson, 2022).

Figure 1

The Positive Technological Development framework (Bers, 2018)



The PTD behaviors are on their own value-neutral, meaning that they can be expressed in both positive and negative ways. For example, children are communicating when they are saying harsh and unkind words as they do so or can be engaging in content creation when the content is a robot to throw a ball at their peer. How can a teacher create a coding playground in which these behaviors are positive? Bers proposed the metaphor of Coding as a Palette of Virtues (Bers, 2021, 2022). This metaphor proposes that in a coding environment, children, teachers, and other participants can intentionally choose which values, or virtues, to bring to their space. Bers proposed ten values on the initial palette of virtues based on character traits and values previously seen in coding classrooms, but Bers' philosophy proposes that individuals not only identify virtues from the palette to use, but also mix virtues in combinations and may bring their own virtues not on the palette. This is like a painter's palette, where an artist may use a single color of paint from the palette, may mix colors in combination, or may add an additional paint as they see appropriate for the painting.

Practices of integrating institutional and individual virtues into coding environments are often explicit in informal STEM education programs. For example, Middle East Entrepreneurs of Tomorrow (MEET), a binational computer science and entrepreneurship program for Israeli and Palestinian high school students to work towards a shared society has six explicit values. The values guide students' behaviors in the technology context, such as their collaboration or design processes (Azenkot et al., 2011). Similarly, the URJ Six Points Sci Tech Academy, an overnight Jewish summer camp specializing in STEM programming, identifies five values for children and staff to practice in combination, as well as a sixth value "of your choice" for community members to add (*Jewish Life at Camp*, n.d.). The camp developed their model of the "your sixth" value from pedagogies of experiential education, which like constructionism, emphasizes the learner's agency in intentionally engaging with themselves and their contexts (Itin, 1999).

In the pedagogy of experiential education, the role of the adult is to create and scaffold the learning experience so that the learner can experience challenge, success, risk, and failure, engaging not only intellectually with their experiences but also emotionally, socially, physically, and spiritually. Similarly, the pedagogy of the coding playground emphasizes the role of the adult in creating the environment of the playground. As mentioned above, individual coding languages and platforms are not inherently playgrounds or constructionist environments for children's engagement. In fact, constructionist learning environments such as Scratch can be taught with rigid curricula that some might consider to be instructionist, such as traditional special education educational methods (Almeida et al., 2018). Instead, in the coding playground, it is on the adult to understand their role in scaffolding a child-centered learning experience that values holistic and experiential learning and promoting children's positive engagement with the platform and each other by promoting the PTD behaviors (Levinson, 2022). The unique context of the coding playground is developed when a teacher combines these child-centered classroom practices and pedagogies with a developmentally appropriate coding platform and can use multiple options of coding curricula.

As policy-makers and stakeholders around the world aim to introduce computer science education into early childhood classrooms, the philosophy of the coding playground has been used to create developmentally appropriate coding platforms and playful computer science curricula that integrate creative learning and holistic development with student-directed and personally-meaningful content learning. This dissertation explores how teachers' beliefs about the relationship between play and learning impact teaching practices and student outcomes from one such playful curriculum, the Coding as Another Language curriculum for ScratchJr.

CHAPTER 3: METHODS

The research questions for this dissertation were: 1) What do kindergarten teachers in the United States and Argentina believe about the integration or divergence of play and academic-readiness?; 2) How do teacher beliefs towards the integration or divergence of play and academic-readiness relate to their students' outcomes in coding knowledge and computational thinking?; and 3) What factors lead to variation in students' coding and computational thinking outcomes among teachers with different beliefs about the integration or divergence of play and academic-readiness? I used a sequential mixed-methods approach to evaluate a subset of data from two large studies of teachers and students who taught the Coding as Another Language curriculum for ScratchJr (CAL-ScratchJr), a coding curriculum based on the Coding as a Playground philosophy to kindergarten students in the United States and Argentina (Edmonds & Kennedy, 2017; "Mixed Methods Designs," 2017).

The CAL-ScratchJr Studies

In both the Argentina and the United States, as part of two larger projects, we conducted cluster-randomized control trials of the CAL-ScratchJr curriculum in kindergarten, first, and second grade classrooms (Bers, Blake-West, et al., 2023; Bers, Levinson, et al., 2023; Levinson et al., Under review). The two studies were similar, using the same curriculum and a similar research study design, but there were a few differences in the study design and study findings. The next few sections will introduce the CAL-ScratchJr curriculum, briefly describe the participating schools, and detail the protocols of the two CAL-ScratchJr studies.

The Coding as Another Language Curriculum

The Coding as Another Language curricula for ScratchJr (CAL-ScratchJr) were designed to integrate coding and literacy along with social emotional learning (Bers et al., 2022; DevTech Research Group, 2021). The curricula are built on Bers' pedagogies described above of coding as a playground, coding as another language, and coding as a palette of virtues (Bers, 2019, 2020b, 2020a; Bers et al., 2022). This dissertation worked with the CAL-ScratchJr curriculum because its lessons include opportunities for play, the promotion of approaches to learning skills and social emotional development through activities based on the PTD framework and the Palette of Virtues metaphor, and integrated curricular activities that align with kindergarten academic standards – each of which could promote school-readiness across a variety of domains (DevTech Research Group, 2021). Play specifically was seen in two ways. "Unplugged" and embodied games like "Red Light, Green Light" in Lesson 16 taught powerful ideas of computational thinking like conditionals using traditionally-structured childhood games. Three open-ended coding projects and ScratchJr exploration time provided the classic coding playground environment with which children could create personally meaningful projects, explore the platform according to the challenges of their project, and develop intellectually and holistically.

Additionally, the CAL-ScratchJr curriculum was designed with built-in opportunities for teachers to flexibly adapt lessons to their classroom context through grouping, selection of contextually relevant books, and the identification of values that resonate with their classroom culture. For these reasons, CAL-ScratchJr curriculum could offer teachers the opportunity to bring their beliefs on play and academic learning to their curriculum implementation.

The curricula are centered around ScratchJr, a free coding application for iPads, tablets, computers, and Chromebooks designed for children ages 5-8 and used in homes and schools around the world (Bers & Resnick, 2015; Flannery et al., 2013; Leidl et al., 2017; Unahalekhaka & Bers, 2021). ScratchJr includes both computational and artistic components; the app is designed with a format that users design characters in a design stage with increasing skills of complexity, and then create programs using a simple symbolic language for their characters to show on a design stage (Figure 2). ScratchJr builds from the legacy of the original LOGO programming language, which emphasized embodied learning through the programming of motion. The ScratchJr program functions are based around movement, sound, and appearance, in addition to more complex control structures, so children are able to create animations and expressive stories of varying complexity (Unahalekhaka & Bers, 2022). Each coding block is represented by a symbol rather than a word, so prereaders and children who are still learning to read can engage in coding with ScratchJr. In addition, the platform is designed to promote literacy; programs are coded left to right similar to written sentences in many languages, including both English and Spanish (Flannery et al., 2013).

Figure 2

ScratchJr Interface

The CAL-ScratchJr curricula were developed for kindergarten, first, and second grade classrooms in the United States in alignment with Common Core standards (Bers et al., 2022; National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010b, 2010a), but has been translated and adapted for countries around the world including Argentina and Israel (Ben Ari et al., 2023; DevTech Research Group, 2021). The curriculum includes 24 45-minute lessons (for a total of 18 hours of instructional time). The curriculum includes both structured and unstructured activities, including songs, unplugged computational thinking games, ScratchJr instruction, exploratory free-play with the ScratchJr app, book read-alouds, and student-guided coding projects based on the curricula's storybooks (Bers, 2021; Bers, Blake-West, et al., 2023; DevTech Research Group, 2021). According to the CAL pedagogy, the coding and computational thinking domains and disciplines can be integrated with and used to leverage instruction of other domains and disciplines. As an example, the debugging process and the process of revising and editing written work can be integrated and taught alongside each other, with debugging serving as a model teachers can reference when students are working on debugging (Hassenfeld & Bers, 2020). In the CAL curricula, lessons on debugging include examples of “buggy words” and “buggy sentences” alongside buggy programs, so that students can experience debugging and editing both written and coding languages (DevTech Research Group, 2021).

The CAL curricula are designed to be flexible and allow for modification by the teacher. The timing of the activities can be adjusted by the teacher to suit the classroom, students, and individual curricular needs (Bers, 2021). This is done both through adapting the selection of materials, through prioritizing specific curricular activities, or through the selection of social emotional domains for a teacher to emphasize within a lesson. For example, one teacher might focus on collaboration through turn taking and materials, one might focus on patience and problem solving and debugging, one might do mindfulness in debugging, one might focus on generosity by emphasizing literacy with thank you note activities. Teachers can also adapt curricula to serve their local contexts; while the curricula are written to include specific books, teachers or local districts can select to use other books of their choosing that integrate with their local curricula or standards.

The CAL curricula have been introduced, researched, and piloted in multiple regions of the United States and around the world. Two cluster-randomized control trials, one in two states in the United States, and one in two states in Argentina, have also been conducted to evaluate the curriculum as “evidence-based.” In the United States, there was a significant effect of participating in the CAL curriculum on student coding knowledge compared to students in the control group, and in Argentina, students who participated in the CAL curriculum had significantly higher growth in coding knowledge and computational thinking than students in the control condition (Bers, Blake-West, et al., 2023; Bers, Levinson, et al., 2023). At the time of writing this dissertation, the curriculum has being translated for and piloted in seventeen countries around the world, as well as in California (Bers, Levinson, et al., 2023; DevTech Research Group, 2023b). The curriculum has been translated to Hebrew, where the CAL-ScratchJr curriculum in Hebrew in a Hebrew-speaking Israeli kindergarten in Haifa also found significant growth in student coding knowledge, and to Greek, where teachers have created their own culturally-relevant storybooks to adapt CAL to their local context as described above (Ben-Ari et al., 2023; Bers, Levinson, et al., 2023).

Participating Schools

In the United States, schools in two states (Massachusetts and Rhode Island) participated in the CAL-ScratchJr evaluation study which was sponsored by the United States Department of Education (Table 1) (Bers, Blake-West, et al., 2023; Bers, Levinson, et al., 2023). All the schools in the United States were public, including charter schools. Schools in Rhode Island were urban, suburban, and rural. Schools in Massachusetts were all in the same urban school district.

Table 1

The CAL-ScratchJr Studies

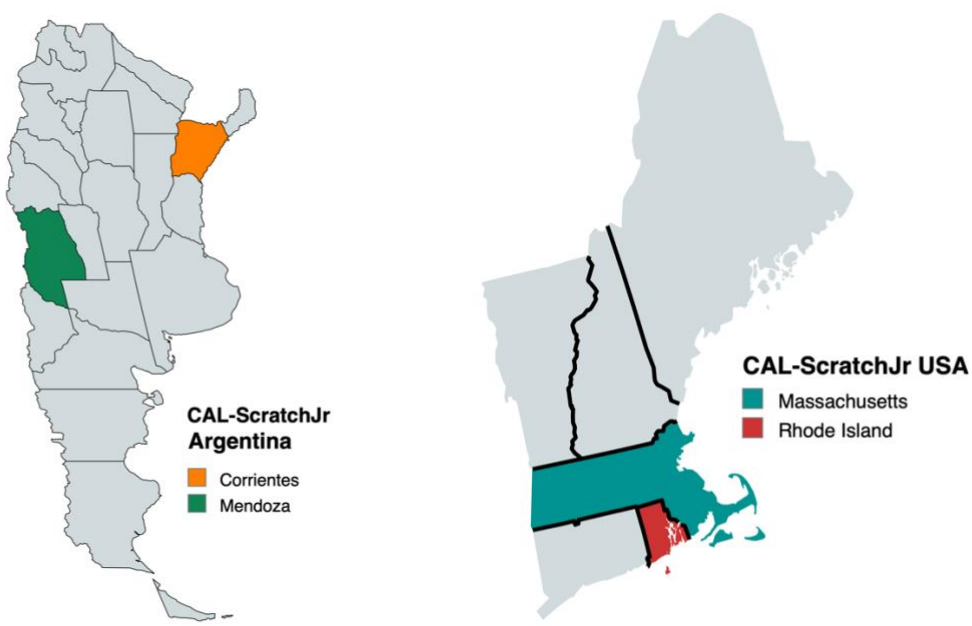
State/Province	Schools	Teachers	Students
Argentina	17	62	613
Rhode Island	44	183	2,445

In Argentina, the CAL-ScratchJr evaluation study was conducted in partnership with the Varkey Foundation and included schools in rural and urban regions of the Mendoza and

Corrientes provinces (Table 1) (Bers, Levinson, et al., 2023; Levinson et al., 2024). Public schools participated in both rural and urban regions, and private schools were also included in the urban regions. A map of the four regions (Mendoza, AR; Corrientes, AR; Rhode Island, USA; and Massachusetts, USA) is included in Figure 3.

Figure 3.

Maps of the Included Regions



Note. 3a. A map of Argentina highlighting the participating regions in the CAL-ScratchJr RCT (the provinces of Mendoza and Corrientes). 3b. A map of the New England region of the United States highlighting the participating regions in the CAL-ScratchJr RCT (the states of Massachusetts and Rhode Island).

Protocols

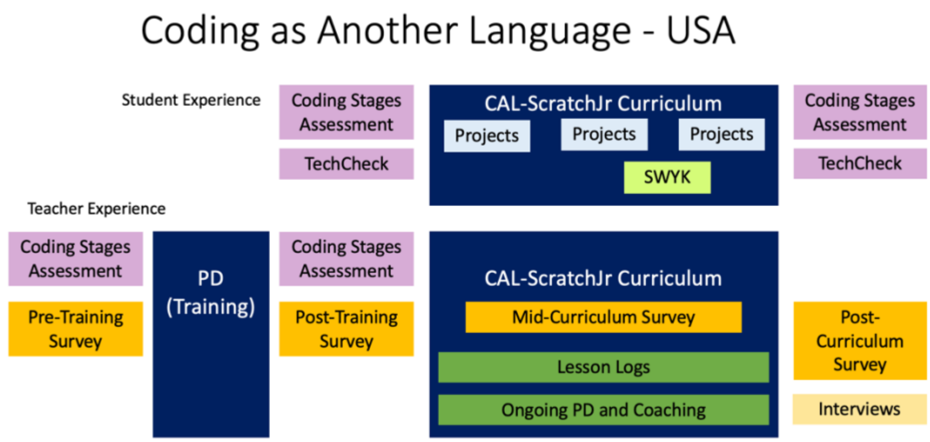
Teachers were given professional development training on the CAL pedagogy, the ScratchJr coding language, and the CAL curriculum. After the training, teachers taught the CAL-ScratchJr curriculum. Depending on the school, the curriculum was taught either by the student's classroom teacher or by an enrichment teacher, such as computer or library teachers, who taught the curriculum to multiple grades or classes. As mentioned above, in Argentina, the curriculum was translated to Spanish. This included the selection of alternate or translated books.

Students were assessed on coding knowledge and computational thinking using the Coding Stages Assessment (CSA) (de Ruiter & Bers, 2021) and TechCheck (Relkin & Bers, 2021) assessment before and after completing the curriculum. The teachers also completed the CSA before and after the professional development training, so there was a pre-teaching indicator of the teachers' coding knowledge. Over the course of the study, teachers completed pre-implementation, mid-implementation, and post-implementation surveys. In both studies, the study design included post-implementation focus groups or interviews, but these did not include all teachers.

In the United States, the curricula were evaluated using a delayed randomized control trial in Rhode Island and Massachusetts (Figure 4). Schools were assigned to either a treatment condition, who received the curriculum in the first year of the study, or a control condition, who taught their curriculum as normal the first year and received the CAL curriculum the second year of the study. Multiple additional forms of student assessment data were collected to evaluate curriculum impact, including standardized assessment data, "Show What You Know" end of unit tests from the CAL curriculum, and ScratchJr projects.

Figure 4.

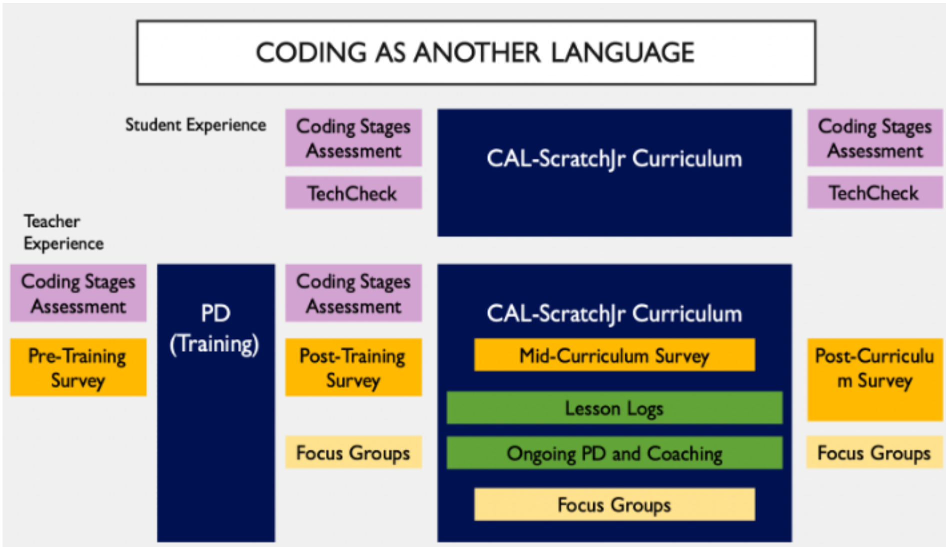
CAL Research Protocol



The CAL-Argentina project was only one year, meaning control schools did not receive the curricula. Photo and video data was collected from some schools, and focus groups were conducted with many teachers at three timepoints (pre-curriculum, mid-curriculum, and post-curriculum). Standardized assessment data and unit tests were not conducted and therefore not collected. The protocol for the CAL-Argentina project is summarized below in Figure 5.

Figure 5.

CAL-Argentina Research Protocol. (Levinson, Carocca, & Bers, 2024)



RQ 1: Kindergarten Teacher Beliefs

The first research question of the dissertation asked what the kindergarten teachers' orientations were towards the integration or divergence of play and academic-readiness. To answer this research question, we used a qualitative approach consisting of deductive coding of teacher interviews from the CAL-ScratchJr studies.

Dataset

Qualitative data were drawn from teacher interviews from the three participating cohorts of teachers from the CAL-ScratchJr studies in the United States and Argentina: 1) USA Cohort 1 teachers who taught the curriculum during the first year of the study (2021-2022 school year) and may have continued teaching during the second year; 2) USA Cohort 2 teachers who taught the curriculum during the second year of the study (2022-2023 school year); and 3) Argentina Treatment teachers who taught the curriculum during the study (2022 school year).

The original interviews in the CAL-ScratchJr studies were semi-structured and asked about teachers' experiences teaching the CAL curriculum, strengths and challenges of the curriculum, and connections the teachers saw between the curriculum and literacy. Interviews were conducted by the project manager for the local study, in English in the United States and in Spanish in Argentina. Spanish interviews were translated to English by an undergraduate research assistant. In the United States, the interviews were conducted as individual interviews at one timepoint (following completion of the curriculum), whereas in Argentina, the interviews were conducted as focus groups of between one and seven participants at three timepoints (after the professional development, during the curriculum implementation, and following the completion of the curriculum).

One limitation of the original interviews is the semi-structured questions directly asked about aspects of the Coding as Another Language, Coding as a Playground, and Coding as a Palette of Virtues pedagogies, which could have primed teachers to answer the questions with bias. For this reason, we conducted supplemental interviews with eight teachers to develop a richer dataset that includes answers that were not primed in this way. These additional interviews were conducted using an ethnographic and anthropologic format, as opposed to the semi-structured format used in the initial interviews. We reached out to teachers who were included in the initial dataset and invite them to participate in these optional interviews. These interviews were open-ended and were conducted in an ethnographic style to probe at teachers' beliefs without the bias or priming that may come from including descriptions of the CAL pedagogy in the interview. Classroom photos and videos were also taken in some classrooms and can provide additional information about the classroom context. These photos and videos were taken during instruction and are not available for all classroom teachers.

Sample

Teachers were included in the dataset if they 1) taught in a kindergarten classroom and 2) completed at least one interview. In both the United States and Argentina, the CAL curriculum was taught either by classroom teachers or enrichment teachers (such as library or computer teachers). This meant the teachers included in the dataset included both kindergarten classroom teachers and enrichment teachers who teach multiple classrooms including kindergarten. We excluded any descriptions of the first and second grade curricula, and when including classroom data for specific research questions as described below, we only included kindergarten-age students. There were four enrichment teachers included in the dataset. This included a computer teacher who cotaught the CAL program with the children's primary classroom teacher. Both teachers were interviewed and both teachers were included for qualitative analysis. In addition to the enrichment teachers and classroom teachers, one special education resource teacher took on the role of CAL teacher for two kindergarten classrooms at her school. Finally, one kindergarten teacher taught the CAL-ScratchJr kindergarten curriculum in a mixed-age afterschool setting.

In total, 35 teachers were included in the dataset (Table 2). All but one of the teachers were female, as has been typical for early childhood programs since the creation of Froebel's kindergarten programs (Allen, 1986).

Table 2.

Teachers included in the dataset.

	N Teachers				Years Teaching	
Region	Urban	Rural	Suburban	Full Sample	*M*	*SD*
Argentina						
Corrientes	8	3	0	11	12.14	5.40
Mendoza	4	0	0	4	8	1.41
USA						
Massachusetts	9	0	0	9	15	10.75
Rhode Island	2	1	8	11	14.82	8.09

Analytic Plan

To evaluate this research question, we used a qualitative analysis approach consisting of deductive coding with the codes deduced from existing research literature. The process consisted of first creating a codebook and coding process to identify teachers' orientations towards play and academic learning as either integrated or divided. (See Table 3 for Codebook). This codebook was based on the dichotomous descriptions of teachers' beliefs about play and academic learning as misaligned or connected found by Pyle and Danniels (2017). Then, a team of two researchers (consisting of the author and an undergraduate research assistant) coded each of the teacher interviews as either having an integrated or divergent understanding of play and academic learning. After each five interviews, the team met for a conference to ensure convergence and reliability on scoring. If there was uncertainty between the researchers, the researchers each presented the examples in the text that led them to arrive at the code they had selected. If after discussion, the researchers still disagreed, the author returned to the literature and revised the codebook. This revised codebook was then used by both researchers to recode the interviews as well as moving forward for the next set of interviews.

Table 3

Codebook for Teacher Beliefs of Play and Learning

Code	Definition	Potential examples in teacher
Integrated understanding	Teacher believes that play and academic learning are connected in kindergarten classroom	Description of play as learning; Description of play as a motivating factor for learning; Describing jobs balancing multiple factors relating to play (including the teachers' role in

		play, the balance between play and curricular needs)
Divided understanding	Teacher believes that play and academic learning are disconnected in kindergarten classroom	Describing play as solely child-led without teacher scaffolding; Describing difficulty balancing needs of academic curricula and time for play; Clear description of division between play-time and academic-time

RQ 2: Relationship Between Beliefs and Student Outcomes

The second research question asked how teacher orientations towards the integration or divergence of play and academic-readiness related to outcomes in coding knowledge and computational thinking. To answer this question, we used multilevel modeling of student performance clustered at the teacher level.

Dataset and Sample

The quantitative dataset consists of student assessment performance in the classrooms that taught the CAL-ScratchJr curriculum. As mentioned above, the CAL-ScratchJr studies consist of two assessments of student performance: the Coding Stages Assessment (CSA), which assesses students' developmental coding knowledge of the ScratchJr coding language, and the TechCheck assessment, which assesses computational thinking divorced from a coding language. Both assessments were performed at two timepoints, before and after the curriculum, to evaluate student growth over the course of the curricular intervention.

Children are included in the dataset if they were enrolled in one of the CAL-ScratchJr treatment classrooms in Argentina or the United States during the time of the CAL-ScratchJr program, were in kindergarten, and completed the study's associated assessments (described below). Classrooms were removed from the dataset if the teacher was unable to be classified as having an integrated or discrete understanding of play and academic learning in the first research question. The co-teachers described above had the same belief classification, so no decision needed to be made in that case regarding which of the two teachers to use for that classroom. In total, 335 children across nineteen classrooms were included in the final dataset, with an average of 17.63 students per classroom. Slightly fewer students (312) completed the TechCheck assessment at both timepoints, with an average of 16.42 students per classroom for the TechCheck model.

Measures

Coding Knowledge. The CSA is an adaptive assessment consisting of up to 30 open ended questions (Figure 6), administered in six-question "stages" (de Ruiter & Bers, 2021). These stages are based on the Coding Stages framework, which proposes that students learn to code in developmental stages, similar to theories of reading stages (Bers, 2020a). The five developmental coding stages are *Emergent, Coding and Decoding, Fluency, New Knowledge,* and *Purposefulness*. Students who are not yet in the Emergent stage are in a pre-coding state. Each stage has six questions in the CSA, apart from purposefulness questions which are interspersed throughout the assessment, to represent that students can be purposeful while coding at any level of coding knowledge. Students must answer five of six questions correctly in a stage to move to the next stage of the assessment. Each child was administered the assessment individually in their own language. The assessment has been validated for use in English and Spanish (de Ruiter & Bers, 2021; Levinson et al., 2024).

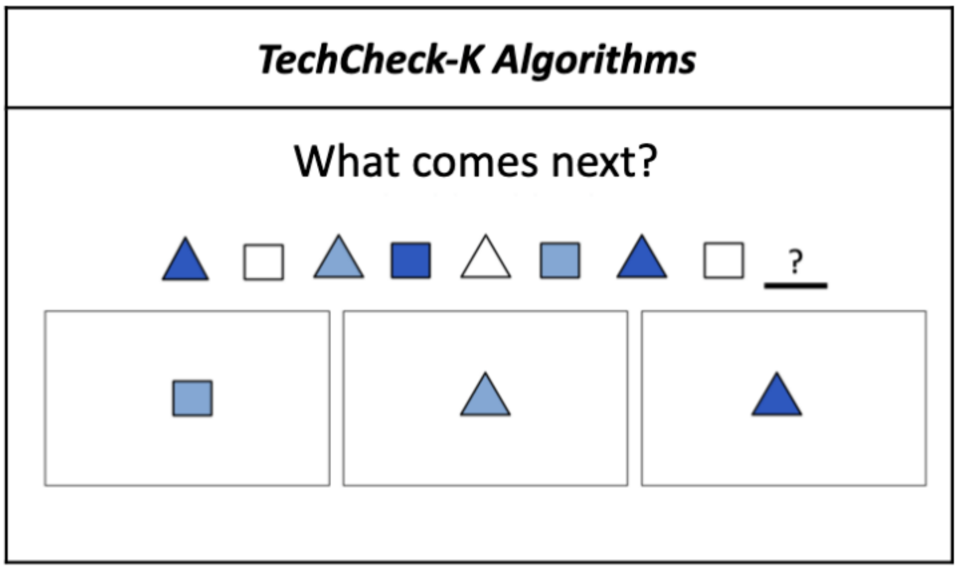
Figure 6.

Example question from the Coding Stages Assessment for ScratchJr (DevTech Research Group, 2023a)

Computational Thinking. TechCheck is an "unplugged" assessment of computational thinking, meaning that it is divorced from any one coding language (Relkin, 2022; Relkin et al., 2020, 2023; Relkin & Bers, 2021). Students are assessed on the developmentally appropriate powerful ideas of computational thinking for children, but through shapes and familiar concepts. Validated versions of the TechCheck assessment exist for preschool, kindergarten, first, and second grade (Relkin, 2022; Relkin et al., 2020, 2023; Relkin & Bers, 2021). The assessment consists of fifteen multiple choice questions with three choices each (Figure 7). Students receive a summed score of the number of questions they answered correctly. Like with the CSA, each child was administered the assessment individually in their own language. The assessment has been validated for use in English and Spanish (Levinson et al., 2024; Relkin et al., 2023; Relkin & Bers, 2021).

Figure 7.

Example question from the TechCheck kindergarten assessment (DevTech Research Group, 2023c)



Teacher Beliefs. Teacher beliefs towards the relationship between academic learning and play were dichotomously coded as “integrated” or “divergent” based on the results from RQ 1.

Analytic Plan

We estimated two multilevel regression models of pre-curriculum scores on post-curriculum scores using teacher as the nesting factor and teacher beliefs (with discrete beliefs as the reference group) as the level-two predictor of the intercept and the slope. The first of these models used pre- and post-curriculum CSA scores (1) while the second used pre- and post-curriculum TechCheck scores. As the purpose of this study was to understand the relationship between teachers' beliefs with student outcomes, students were nested by the teacher who taught the CAL curriculum rather than by classroom (which would have overrepresented and overweighted individual teachers in the model). The state/province was added as a second-level predictor with Massachusetts as the reference group. It was not added as a third-level nesting variable because there were only four states/provinces, which was not enough clusters to create statistical power as a clustering variable. State/province was included in the model instead of country because in both Argentina and the United States, educational policies are implemented at the state/provincial or district level rather than at the federal level.

$$PostCSA_{ij} = \beta_{0j} + \beta_{1j}(PreCSA) + r_{ij}$$
$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Beliefs) + \gamma_{02}(RhodeIsland) + \gamma_{03}(Corrientes) + \gamma_{04}(Mendoza) + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + \gamma_{11}(Beliefs) + u_{1j}$$

(1)

$$PostTechCheck_{ij} = \beta_{0j} + \beta_{1j}(PreTechCheck) + r_{ij}$$
$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Beliefs) + \gamma_{02}(RhodeIsland) + \gamma_{03}(Corrientes) + \gamma_{04}(Mendoza) + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + \gamma_{11}(Beliefs) + u_{1j}$$

(2)

However, as will be described in the results section, the TechCheck model when initially ran was singular (meaning it was overfitted to the data), so we updated the model by removing the random effects of the intercept (3). Random intercepts were removed instead of random slopes because we were interested in maintaining the cross-level interaction and evaluating and controlling for the impact of teacher beliefs on the relationship between pre- and post-curriculum learning. This also allowed for the greatest similarity between the TechCheck and CSA models.

$$PostTechCheck_{ij} = \beta_{0j} + \beta_{1j}(PreTechCheck) + r_{ij}$$
$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Beliefs) + \gamma_{02}(RhodeIsland) + \gamma_{03}(Corrientes) + \gamma_{04}(Mendoza)$$
$$\beta_{1j} = \gamma_{10} + \gamma_{11}(Beliefs) + u_{1j}$$

(3)

Analysis was conducted in R version 4.0.2 using the tidyverse, lme4, and lmerTest packages (Bates et al., 2015; Kuznetsova et al., 2017; R Core Team, 2020; Wickham et al., 2019). Graphs were created using the ggplot2 package and the wesanderson color palettes (Ram & Wickham, 2018; Wickham, 2016).

RQ 3: Understanding Variation in Beliefs and Outcomes

The final research question asked what factors in CAL teaching practice and experience were unique or shared among teachers with different orientations towards the integration or divergence of play and academic-readiness. This question was intended to provide further context for understanding the variation in coding knowledge and the lack of variation in computational thinking outcomes among students of teachers with different orientations towards the integration or divergence of play and academic-readiness.

Dataset and Sample

The qualitative data were composed primarily of the initial and supplementary interviews from the CAL-ScratchJr studies used to answer the first research question. These interviews are described above. The dataset consisted of pre-curriculum focus groups, mid-curriculum focus-groups, post-curriculum focus-groups, post-curriculum individual interviews, and follow-up individual interviews for teachers who had been identified as having a discrete or integrated understanding of the relationship between academic learning and play, as described in Research Question 1. For this reason, although only 29 teachers were included at this stage, there were 35 interviews included in the dataset.

Analytic Plan

To evaluate this research question, we used a conventional content analysis approach to analyze the teacher interviews (Hsieh & Shannon, 2005). Conventional content analysis first begins with reading each interview through to familiarize oneself with the data; this was accomplished through the process of analysis for RQ1. We then derived initial codes for quotes capturing features relating to teaching experiences of the CAL curriculum and observations of student experiences with the CAL curriculum. Throughout this process, we took notes of our initial impressions and thoughts. As Hsieh and Shannon describe, some codes emerged during this process as relating to more than one quote or thought. These codes were then sorted into clusters of concepts with categories and subcategories. Finally, we numerically compared the distribution of these concepts across the two teacher beliefs of play and academic learning to understand which factors were unique to one category of teacher belief and which were shared across teacher beliefs. Coding was completed by a single author in NViVo (Lumivero, 2023).

CHAPTER 4: RESULTS

RQ 1: Kindergarten Teacher Beliefs

The first research question involved identifying teachers as having either divergent or integrated beliefs about play and academics. Of the participating teachers in the study, 18 were identified as having integrated beliefs (IB) and 11 were identified as having divergent beliefs (DB). Six teacher were not able to be classified based on the interview responses available, as they only directly answered questions about the CAL curriculum. These teachers were removed from the dataset at this point.

When considering the classification of the teachers, there was no national pattern or unique profiles underlying the teachers' beliefs and orientations (Table 4). Both Argentinian and American teachers held IB and DB beliefs, and both sets of beliefs were present in urban, rural, and suburban schools. Additionally, both sets of beliefs were held by all types of participating teachers, including classroom teachers and library media specialists. There was no significant difference in years of teaching experience for teachers according to their beliefs ($p = 0.12$).

Table 4

Descriptive table of teachers with IB and DB beliefs

	IB Teachers (n)	*DB Teachers (n)*
Country (*n* teachers)		
Argentina	5	6
United States	13	5
School type (*n* teachers)		
Urban	10	8
Rural	2	1
Suburban	6	2
Teacher Type		
Classroom Teachers	14	6
Specialty Teachers	4	5

Years Teaching Experience	11.89 (3.8)	15.27 (3.0)

RQ 2: Relationship Between Beliefs and Student Outcomes

Preliminary Analysis

Coding Knowledge. Overall, the students in the two countries (n = 335) had an average gain of 6.89 points on the Coding Stages Assessment between pre-curriculum (M = 2.64, SD = 1.80) and post-curriculum (M = 9.53, SD =4.20) assessments, $t(453.6) = -27.716$, $p < 0.001$.

A visual examination of the distribution of post-curriculum CSA performance, as well as the kurtosis and skew values, showed that the values were approximately normally distributed (Table 5). There was an average of 17.63 students per teacher who completed two timepoints of CSA. The ICC of the null model for CSA clustered by teacher was 0.17, meaning that 17% of the variance in students' post-curriculum coding knowledge was between-teacher variance.

Table 5

Descriptive Information for Student Assessments and Class Information

Student Scores	*M*	*SD*	kurtosis	skew
Post-Curriculum Weighted CSA	9.53	4.18	3.55	0.26
Post-Curriculum TechCheck	9.14	2.70	2.54	-0.14

Computational Thinking. The students in the two countries (n = 312) also had significant gains on the TechCheck assessment of computational thinking, with an average increase of 2.02 points on the TechCheck assessment of computational thinking between pre-curriculum (*M* = 7.13, *SD* = 2.37) and post-curriculum (*M* = 9.14, *SD* = 2.70) assessments, $t(612.1) = -9.92$, $p < 0.0001$.

A visual examination of the distribution of post-curriculum TechCheck performance, as well as the kurtosis and skew values, showed that the values were approximately normally distributed (Table 5). There was an average of 16.42 students per teacher who completed two timepoints of TechCheck. The ICC of the null model for post-curriculum TechCheck clustered by teacher was 0.32, meaning that 32% of the variance in students' post-curriculum computational thinking was between-teacher variance.

Coding Knowledge and Teacher Beliefs on Play and Learning

To assess if growth in coding knowledge was related to teachers' beliefs about play and learning, we estimated a multilevel regression model of pre-curriculum CSA scores on post-curriculum CSA scores, nested by teachers (Table 6). The model included fixed effects of the teachers' play orientations and province, and random effects of the intercept and slope. This model was a significantly better fit to the data than the empty model ($\chi^2(7) = 31.019$, $p < 0.0001$).

The model found a significant impact of teachers' play orientation and of state/province on students' post-curriculum coding knowledge (Figure 8). For students with a pre-curriculum CSA score of zero, post-curriculum CSA scores were 1.81 lower for students of IB teachers than students of DB teachers, controlling for state/province ($p < 0.05$). However, there was also a trending impact of play orientation on the relationship between pre and post curriculum scores; in classes with IB teachers, there was a 0.58-point higher increase in post-curriculum CSA score per point in pre-curriculum CSA than in classes with DB teachers ($p < 0.1$). There was no relationship between pre-curriculum CSA on post-curriculum CSA when controlling for teacher beliefs and region ($\beta = 0.02$, $p > 0.1$).

Figure 8

Relationship between pre- and post-curriculum coding knowledge for IB and DB teacher

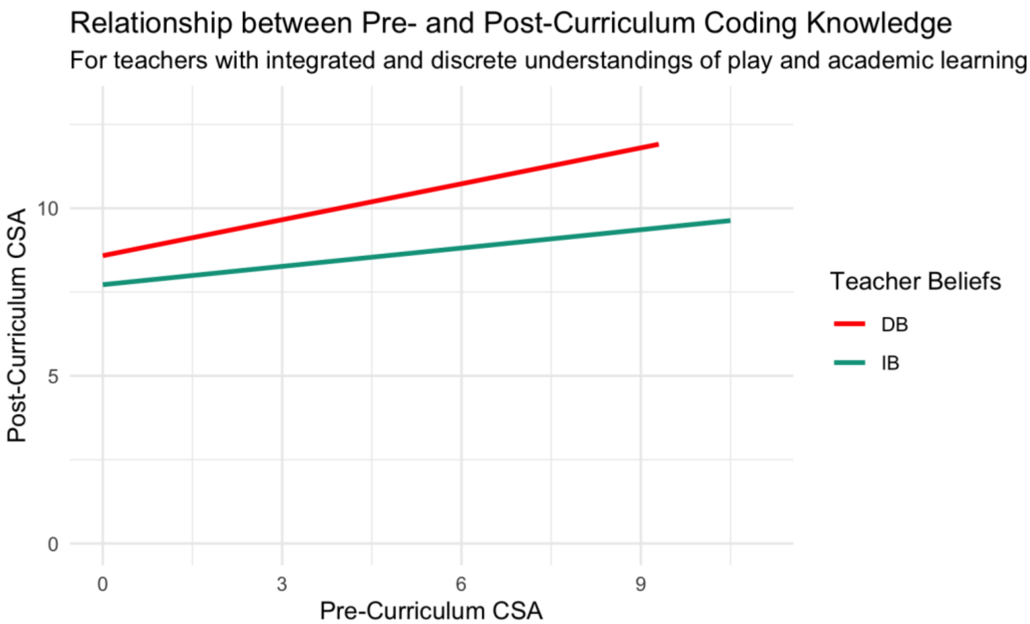


Table 6

Unstandardized results from multilevel regression of teacher beliefs and coding knowledge

Variable	Null model		Model	
	Coeff.	SE	Coeff.	SE
Level 1				
Intercept	9.33***	0.45	8.65***	0.84
Pre-Curriculum Scores			0.03	0.24

Level 2			
Teacher Beliefs		-1.81*	0.89
Beliefs * Pre-Curriculum Scores		0.58	0.31
Rhode Island		0.62	0.73
Mendoza		-3.84*	1.39
Corrientes		3.26***	0.82
Interclass Correlation	0.17	0.03	

Computational Thinking and Teacher Beliefs on Play and Learning

To assess if teacher beliefs about play and learning in kindergarten were associated with computational thinking performance from the CAL curriculum, we also evaluated the same model of pre-curriculum and post-curriculum assessment scores using the TechCheck assessment of computational thinking. Pre-curriculum TechCheck was centered at the overall mean. Again, the model included fixed effects of the teachers' play orientations and province, and random effects of the intercept and slope. However, this model was singular (meaning it was overfitted to the data). We updated the model by removing the random effects of the intercept. This updated model was a significantly better fit to the data than the empty model ($\chi^2(6) = 62.726$, $p < 0.0001$).

The updated computational thinking model (Table 7) found a significant impact of pre-curriculum computational thinking and of state/province on students' post-curriculum computational thinking but found no significant impact of teachers' beliefs on play and learning (Figure 9). For every one-point increase in pre-curriculum TechCheck, there was a 0.50-point increase in post-curriculum TechCheck when controlling for teacher type and region ($p < 0.001$). There was no significant effect of teachers' beliefs of play and learning on either post-curriculum TechCheck for students with an average pre-curriculum TechCheck controlling for region ($p > 0.1$). There was also no significant effect of the teachers' belief on play and learning on the relationship between pre-curriculum and post-curriculum TechCheck scores when controlling for region ($p > 0.1$).

Figure 9

Relationship between pre- and post-curriculum computational thinking for IB and DB teachers

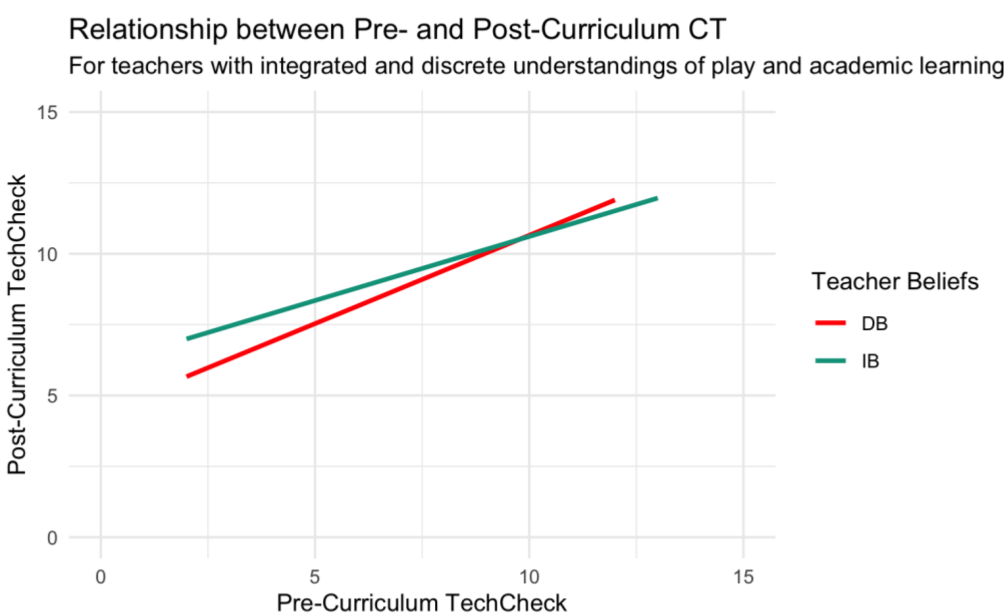


Table 7

Unstandardized results from multilevel regression of teacher beliefs and computational thinking

	Null model		Model	
Variable	Coeff.	SE	Coeff.	SE

Level 1				
Intercept	8.95***	0.39	7.66***	0.33
Pre-Curriculum Scores			0.50***	0.09
Level 2				
Teacher Beliefs			0.26	0.27
Beliefs * Pre-Curriculum Scores			-0.17	0.11
Rhode Island			0.97**	0.34
Mendoza			2.41***	0.5
Corrientes			2.71***	0.38
Interclass Correlation	0.32		0.004	

Post Analysis Screening

Post-analysis screening determined that both models met the assumptions of the hierarchical linear regression. At the lowest level, the residuals of both models were normal and homoscedastic. There was no correlation between the residuals and pre-curriculum assessment scores for either model. The level-two residuals of both models were normal and homoscedastic and were not correlated with any predictors at either level.

RQ 3: Understanding Variation in Beliefs and Outcomes

The final research question asked what factors in CAL teaching practice and experience were unique or shared among teachers with different orientations towards the integration or divergence of play and academic-readiness. This question was intended to provide further context for understanding the variation in coding knowledge and the lack of variation in computational thinking outcomes among students of teachers with different orientations towards the integration or divergence of play and academic-readiness.

Teaching the CAL Curriculum

A major problem expressed by both DB and IB teachers was difficulty meeting time constraints when fitting the curriculum into their schedules (n = 17). This was for a variety of reported reasons, including that the curriculum was introduced late in the year, that there was limited administration support for the program, that there was limited time in the day when considering other curricula, that there was limited time in the day when technology was available, or that the lesson time was cut short by technological difficulties. However, although both IB and DB teachers reported difficulties in teaching the CAL-ScratchJr curricula; the two groups of teachers diverged in their practices for resolving issues of time constraints in the classroom and the CAL-ScratchJr curriculum.

IB teachers (n = 10) were more likely than DB teachers (n = 2) to report not finishing the curriculum. However, these teachers were also more likely to expand on lessons and described themselves as flexibly using time when teaching the CAL curriculum, most often with the goal of expanding and prioritizing open-ended ScratchJr time. As mentioned above, the curriculum lessons were designed to be 45 minutes long with set times for unplugged activities, direct instruction, guided exploration, and open-ended ScratchJr work time (Bers, Blake-West, et al., 2023). However, these teachers would describe extending the curriculum and shortening or extending specific activities to fit the interests of their students. One teacher explained:

> We started the session saying, “All right, we're gonna take a half hour and we'll go down to the library and we'll do our lesson and then the activity that goes with it.” And you know slowly that half hour might have turned into “well, they're still really engaged, and

> no one else is coming to use the library for a few more minutes. Let's just take a little more time.” Or I would say, “you know what? You're really interested in this. I'm going to stop my teaching here. Put a sticky note, and we'll finish next week. (USA, Integrated)

Additionally, four IB teachers reported integrating ScratchJr into their other curricular programs, even though they did not finish the formal CAL curriculum. One teacher explained:

> We were still setting aside time in the classroom, but we weren’t always following the CAL curriculum. We still called it CAL time, but just for less confusion for the kids. We were doing nursery rhymes…we got a little bit away from it, but I’d say we got up to lesson 14 or 15 that we were following it pretty strictly. (USA, Integrated)

In contrast, some of the DB teachers (n = 5) also described discrete use of curricular time as it related to ScratchJr, and to other curriculum as well. These teachers would describe the CAL lesson time as being separate from the open-ended exploration time, sometimes even describing open-ended ScratchJr time as a separate activity from the ScratchJr lesson or the ScratchJr project. Relatedly, some DB teachers described a teaching pattern of first teaching the “step by step” coding instructions for the coding project, followed by allowing for open ended play after children completed the assigned project. However, although these teachers described a discrete separation between open-ended creation and curricular work, they did not report a lack of open-ended ScratchJr project time in their classrooms – simply that this open-ended work time took place after the completion of the formal ScratchJr lesson and project. One teacher described how this looked in her classroom:

> So, if it was the race, I would have them all do that and show me each step. So, we'd be sitting in a circle, and I'd say, ‘Okay, show me what you have so far.’ And they turn it, and I could see it really quickly and be like, ‘Okay, move on.’ And then they knew once they

> finished that project for the day or whatever they needed to do for the day, they were able to do Free Scratch. And so, I think that motivated them to do what the assignment was, and then they got to like play around with it. And some of them were able to create these great stories with like they were using, the voice memo or whatever the voice part recording. (USA, Discrete)

Teachers' Observations

Curricular Connections. Both IB and DB teachers observed curriculum overlap between CAL and their existing curriculum. These descriptions were slightly more common in teachers with integrated understandings of play and academic learning, of whom 83% (n = 15) of teachers described these relationships in their interviews, compared to teachers with discrete understandings, of whom only 55% (n = 6) of teachers described these connections.

The most discussed connections teachers observed between the CAL-ScratchJr program and existing curricula were in the areas of literacy, science and engineering, and math. Literacy was the most observed area of curricular connection, with ten IB teachers and four DB teachers describing the connection observed between children's use of the CAL-curriculum and their literacy curriculum and behaviors. Teachers observed connections in the areas of sequencing storybooks, writing their names, and the role of text as representation (as seen through creating titles for projects and labels for characters).

Science and engineering curriculum were described as connecting with the CAL-ScratchJr curriculum by both IB (n = 6) and DB teachers (n = 4). The most common points of curricular connection were animals and habitats and engineering and construction, and about a third of teachers from each category described ScratchJr directly connecting with these topics in their existing curriculum. Teachers expressed specifically how ScratchJr provided an opportunity for children to express their knowledge about animals and habitats, with one teacher expressing an intention to use ScratchJr in her animal lessons in the future.

Only one DB teachers described curricular connections with math. However, this domain was described by a third (n = 6) of IB teachers. When describing this domain, these teachers focused on connections with addition, numbers, and early multiplication. One teacher described:

> [My students] were beginning to make connections to multiplying, which I thought was very advanced. One of the boys says, "well, I want him to jump up and down, and I want him to do it 4 times, so it's almost like I'm going to see him move. He goes up, down, up, down, up, down. That's 2 movements 4 times, so I should see some movement 8 times on that screen." I'm like, "Okay, all right, yep. The math skills are coming into play." (USA, Integrated)

In contrast, a DB teacher who saw connections between CAL-ScratchJr and math described a similar connection to those seen by the IB but noted that they did not focus on this connection at the time.

> Out there we do not realize that we were teaching mathematics, but we were teaching it, for example, when instead of repeating the blocks, one repeated 10 times or rotated as many times, there we were using the table of numbers, maybe not what we identify as math, but they were studying numbers. (Argentina, Discrete)

Developmental skills of early childhood not associated with traditional academic domains were also discussed as curricular connections, but exclusively by IB. These areas of connection observed and discussed included social and emotional learning (n = 3), approaches to learning skills (n = 2), and motor development (n = 1).

Student Autonomy. Another feature of the CAL-ScratchJr program valued by teachers was student choice and autonomy (n = 11). This feature was exclusively discussed by IB teachers. These teachers described student autonomy during the curriculum's ScratchJr projects, allowing students to make decisions about characters, backgrounds, or aspects of the projects of prioritize. For example, one teacher described student choice in her classroom during the mid-point project:

> When we were creating our teddy bears, somebody took the polar bear and colored it brown instead of actually drawing and making their own. And so, I'm like, 'there is no right way.' Just kind of being freeing, knowing that kids learn in different ways, and giving them that opportunity to explore in their own way and not just project, 'nope we're going to use the paint tool.' So, I showed them how to use the paint tool, we did the demonstration, but some just didn't feel comfortable with that… just giving them that autonomy and freedom to do it the way they want. (USA, Integrated)

Some IB teachers also described student autonomy in letting children decide what components of the ScratchJr experience they wanted to highlight. For example, one teacher explained:

> It was interesting, because some kids were more into just the design aspect of it, like creating the characters, like the artistic side. Others didn't want to change anything and just wanted to figure out how to move things around and almost like looking at it more like a video game, kind of. Just seeing the different personalities come out in what they were creating. (USA, Integrated)

"Letting All Students Shine"

Both IB and DB teachers described how CAL and ScratchJr could serve as an opportunity for success for students who were not otherwise demonstrating success in school. The question was not prompted, but 45% (*n* = 5) of DB teachers and 28% (*n* = 5) of IB teachers described in their interviews how the program provided success for categories of students who were not otherwise showing success in academic programs.

Success for Students with Disabilities. One group of students who both IB and DB teachers described as demonstrating success from the CAL-ScratchJr program was students with disabilities. This category, as included in teachers' descriptions, included students with learning disabilities, motor disabilities, cerebral palsy, autism, and speech and language impairments including selective mutism. Half of teachers who described success for students with disabilities described students with motor delays or learning disabilities, with both disability categories described by teachers with integrated and discrete understandings of academic learning and play. Teachers highlighted how students with motor delays who struggled with the physical aspects of writing and drawing had success expressing their ideas through ScratchJr.

> [ScratchJr] evened the playing field for them with their peers, and where they can't hold a pencil or crayon with an inefficient grip to really to draw much of anything, they could use a stylus or their finger and create detailed drawings in the program to tell their stories that I wouldn't have seen on paper in the classroom (USA, Integrated)

Teachers also described a discrepancy between the comprehension and expression performance of students with learning disabilities in traditional literacy activities and in ScratchJr activities, with one describing:

> I have one kid, who he is one of my special ed kids in the inclusion seats, and he struggles. He struggles to write his name, he struggles to identify letters that do sounds,

> counting maybe we got up to 20 by the end of the year…He ended up creating these amazing stories on Scratch with a beginning, a middle, and an ending, and it totally made sense. And this was his way of actually showing it. If I were to read a story and ask him what happened in the beginning, I don't think he could tell me. (USA, Discrete)

There were a few other successes described by teachers for students with disabilities from the CAL-ScratchJr program. One teacher described how ScratchJr providing a student with cerebral palsy and a vision impairment an opportunity for sporadic peer connection and collaboration with their typically developing peers, allowing the student with the disability to collaborate and more inclusively participate. Two teachers described a student with language-related disabilities (selective mutism and a speech impairment) using ScratchJr as a means of literal expression, programming their character to speak and communicate for them.

Empowerment for Traditionally Underperforming Students. Another feature described by both IB and DB teachers was how success with ScratchJr was an opportunity for children who were traditionally unsuccessful in class to also show success for their peers and gain confidence. Two teachers described how the CAL-ScratchJr was a success for children who were generally shy or anxious with school, giving them a chance to be successful and comfortable at school.

> I have students, you know who are super worried about [how] everything has to be perfect and really struggling with things like school and anxiety and if something didn't go right, like crumpling up the paper… They've now been able to sort of be the leaders feel comfortable in their own skin, exploring things, willing to share and help each other. I think families are just super excited about the social parts or just like being a human being. They can now see their kids kind of you know, comfortable with what we're doing when school has been overwhelming I guess. (USA, Integrated).

This feature of CAL-ScratchJr was not unique to children with disabilities. One teacher explained how the CAL-ScratchJr program provided a leadership opportunity for an English Language Learner in her classroom to confidently share his knowledge with his peers:

> One of the most exciting things that I found was one of my beginning ESL students who, during our literacy time we had been talking about ecology and different environments that animals live in. He didn't have the English ability to share where animals lived. Like which ones belong in the Arctic, which belonged in the jungle, but he was able to use ScratchJr to actually put each animal in their correct habitat, even some that we hadn't even talked about yet. And because he was able to do that, he was able to show his friends, and he was so excited and proud of himself. (USA, Discrete)

Additionally, multiple teachers highlighted how the ScratchJr program provided a source of empowerment and confidence for their students with disabilities, through the opportunity for success described above.

CHAPTER 5: DISCUSSION AND CONCLUSION

This dissertation aimed to understand teachers' beliefs about play and academic learning, specifically the relationship between the two, and how their beliefs about this relationship impacted outcomes from a play-based computer science curriculum. To evaluate this, I conducted a mixed-methods secondary analysis of data from two randomized control trials of a play-based computer science curriculum for early elementary school in four states and provinces in the United States and Argentina.

Understanding teacher beliefs

To answer my first question and understand teacher beliefs about play and academic learning, I categorized teachers' beliefs about play and learning as either integrated or divergent according to criteria from previous research. The results suggested that the teachers in the United States and Argentina had beliefs that fit within existing frameworks from prior literature in other countries (Pyle & Danniels, 2017; Wu & Rao, 2011). As described above, previous research suggests teachers' beliefs and priorities of play and learning do not exist on a binary, as learning through play is both a research-supported phenomenon and a pedagogy that has held space in kindergarten classrooms for as long as kindergarten has existed. However, there does seem to be a binary set of teacher beliefs about the relationship between play and academic learning in kindergarten, with some teachers embracing the integration of the two constructs in their own teaching practices and others believing that the two phenomena are separate and discrete. Our findings support past research suggesting this binary of teacher beliefs.

A key takeaway from this finding is that although the teachers hold distinct beliefs about the *relationship* between play and learning in the kindergarten classroom, each of the teachers still believed both play or learning belonged in the kindergarten classroom. For all the kindergarten teachers, both play and learning were key to kindergarten, and the variation was regarding how these two phenomena related and should be implemented in the classroom space.

Previous research has been inconclusive about the role nationality or location played in teachers' beliefs. Some research suggested variation in beliefs was dependent on country, finding that teachers in China and Germany held beliefs on play and learning that were more associated with their national culture, while other research suggested that variation existed both within country and within region (Pyle & Danniels, 2017; Wu & Rao, 2011). We found that both sets of beliefs were held by teachers in all four regions, as well as in urban, rural, and suburban schools. Our findings support the conclusions of Pyle & Danniels, who found that teachers within Canada held both sets of beliefs, suggesting that country is not the determining factor in the teachers' orientation towards play and learning in the kindergarten classroom (Pyle & Danniels, 2017). Our findings suggest that this phenomenon of distributed teacher beliefs was also true in both the United States and Argentina.

Effect of Beliefs on Student Outcomes

The second research question used hierarchical linear regression to evaluate the effect teachers' beliefs held on student outcomes from a play-based coding curriculum.

The first finding was that students of teachers who believed that play and academic learning were discrete features in kindergarten performed significantly better on post-curriculum assessments of coding knowledge than students who believed that play and learning were integrated features of kindergarten. This results suggests that teachers' beliefs about play and learning can play a role in impacting student learning outcomes. Existing literature had been unclear in the impact that teachers' beliefs would have on teaching practices and student outcomes. Previous research has shown that teachers' beliefs as determined through their self-reported teaching styles and pedagogies can affect teaching practices and student outcomes on tasks related to coding comprehension and computational thinking (Strawhacker et al., 2018). However, teachers' beliefs about play and academic prioritization are not always directly aligned to how the they implement these practices in the classroom (Fesseha & Pyle, 2016; Gaias et al., 2018; Strawhacker et al., 2018). The findings of this dissertation suggest that teachers' beliefs about play do play a role in students' outcomes when teaching a curriculum designed around integration between play and learning.

However, not all student outcomes were affected by teacher' beliefs. Teacher beliefs about play and learning did not significantly predict students' scores on post-curriculum computational thinking assessments. Both coding and computational thinking are core to computer science. Coding itself is the act of writing a computer program using a coding language, while computational thinking is a set of powerful ideas, concepts, and ways of thinking that enable students to engage with computers and the digital world, such as algorithms or decoding (Bers, 2020a; Brennan & Resnick, 2012; Relkin & Bers, 2020; Wing, 2008). Previous research and theoretical work have sought to define computational thinking and understand its' relation to and distinctions from both coding and other cognitive domains such as logic or executive functioning (Bers, 2020a; Wang et al., 2021)

The finding that teacher beliefs predicted coding knowledge but not computational thinking reinforces previous work suggesting coding and computational thinking, although related, are distinct (Levinson, 2023; Relkin & Bers, 2020; Wang et al., 2021; Wing, 2008). As policy-makers, educators, and researchers prioritize computer science education, questions about the importance of both coding knowledge and computational thinking arise, including important questions about the definition and boundaries of the field of computational thinking. Many ask if there is a boundary between computational thinking and coding, and this work reinforces that computational thinking and computational thinking outcomes are different than coding and coding outcomes from a related curriculum.

Understanding Teachers

The next question to emerge is obviously why teacher beliefs impacted coding outcomes but not computational thinking, which we examined through the final and qualitative research question of this sequential explanatory mixed methods study. For this question, we used content analysis to evaluate teacher interviews and understand the teaching practices and experiences of teachers with discrete and integrated understandings of academic learning and play during the CAL-KIBO program.

Differences in Teaching Practices

One trend observed between IB and DB teachers was that teachers with an integrated understanding of play and learning were less likely to finish teaching the curriculum than teachers with a discrete understanding did. Although we did not have the lesson-completion data for all teachers, and therefore did not have the statistical power to calculate the impact of lesson-completion on final score, it stands to reason that classrooms who did not finish the curriculum would score lower on assessments relating to the curricular material than classrooms who had. It would therefore make sense for reduced curricular completion to explain some of the discrepancy seen between coding scores for IB and DB classrooms.

Not completing the curriculum was not the only difference in teaching practice between IB and DB teachers. Both groups of teachers made modifications to the curriculum when teaching, but their modifications looked different. Teachers with integrated understandings of play and learning prioritized the open-ended and play-based components over the direct-instruction pieces of the curricula. These teachers were more flexible with their instructional practices, shortening or removing activities to prioritize the open-ended and playful times within the curricula. In contrast, their peers with discrete understandings separated the content-instruction areas of the curricula from the free-play, sometimes going so far as to give children direct instruction on what would be open-ended projects and allowing for free-time after the coding portion of the lesson and precisely-completed projects were done. However, an important conclusion from this finding was that although the teachers approached their modifications differently, both found time for the open-ended and play-based elements of the ScratchJr curriculum.

An opportunity for student success

Although the two groups of teachers had variation in their curricular practice, both saw value in the program specifically for their underperforming students. Prior work has suggested that for students with disabilities, computer science can be an opportunity for success outside of traditional assessments and classroom domains (Levinson et al., 2021). Teachers with both beliefs saw coding with ScratchJr as a chance for their students with disabilities, English language learners, and children still acclimating to school to be successful in the classroom and in front of their peers. Of note, when defining success for these students and in their program, neither type of teacher talked about student performance on assessments but about the students' ability to create with the program and share their ideas and stories both with the teacher and with their peers. This suggests that although the teachers' beliefs affected their curriculum implementation, their understanding of the value for students centered on the opportunities for open-ended choice, play, and creativity and did not differ according to their beliefs on academic learning and play.

The Coding as Another Language curriculum is partially based on the pedagogical understanding of coding as a playground, a developmentally appropriate space in which children can create personally-meaningful projects and through this self-guided creation process develop cognitively and across other key domains such as in language, motor development, and morals (Bers, Blake-West, et al., 2023; Bers, Levinson, et al., 2023). The coding playgrounds pedagogy is based on constructionism, which in its truest form, abandoned the idea of structured curriculum (Bers, 2020a; Papert, 1980a). Here, we see that both sets of teachers valued the coding playground aspect of the curriculum. On the open-ended coding playground, they celebrated opportunities for success for their students, and both found space in their teaching practice for this open-ended learning and engagement. It was where the open-ended coding playground was integrated with curriculum that we saw differences in the teaching practices of the teachers with the two sets of beliefs.

Coding and computational thinking: What is measured?

Understanding differences in teacher fidelity to the curriculum could give insight to the differences seen between classrooms with the two types of teachers, and possibly begin to explain why these differences were seen in student coding knowledge and not computational thinking. As mentioned above, this finding reinforces that there is a difference between the two constructs. A coding language is a system of representation and syntax a teacher can explicitly teach to a child, while computational thinking is a set of skills and thinking strategies. In other words, knowledge of a coding language is measurable and objective content. Either a child knows the syntactic meaning of a Start on Tap block, or they do not. In contrast, debugging as a skill involves considering multiple strategies, understanding when to use which strategy, considering the problem, and/or repeatedly testing your program (Brennan & Resnick, 2012). Each time a student encounters debugging, the problem will look different and require different debugging knowledge and strategies. In this way, computational thinking is a more nebulous series of objectives than the discrete construct of ScratchJr knowledge.

Additionally, although both coding knowledge and computational thinking were evaluated in the CAL-ScratchJr studies, the research assessments used would not be accessible to or used by a classroom teacher. When considering the assessment materials used by teachers, ScratchJr coding knowledge, unlike computational thinking, is the direct and measurable outcome of the Coding as Another Language curriculum. In addition to the Coding Stages Assessment, the classrooms complete a unit test that measures the students' coding knowledge, and many teachers identify students' ability to successfully code as a measure of student success from the curriculum (Bers, Blake-West, et al., 2023; Levinson et al., Under review). Meanwhile, because the TechCheck assessment itself is an unplugged assessment of computational thinking, the assessment is measuring the abstraction of a students' computational thinking skills to the unplugged setting, not a child's ability to use computational thinking in the curriculum with the coding language. In other words, while computational thinking as measured by TechCheck is measuring the transference of skills taught on the curriculum to other settings, coding knowledge is the measurable outcome and objective of the curriculum for teachers.

If we understand teachers with a discrete view of play and learning as prioritizing the measurable curricular outcomes compared to teachers with an integrated view of play and learning, this variation in prioritization could partially explain the difference in instructional fidelity seen between the two groups of teachers. Lesson objectives in the CAL curriculum relate more often to the blocks children will learn rather than to the powerful ideas of computational thinking associated with the lesson (DevTech Research Group, 2021). Similarly, although policy makers and researchers are prioritizing the domain of computational thinking for students, many teachers do not identify "computational thinking" as a successful outcome of a computer science curriculum (Levinson et al., Under review). A teacher who is teaching to the test, to the curriculum's objective, or to their understood definition of curricular success would prioritize coding knowledge as the successful indicator of learning. Teachers who have a discrete understanding of the relationship between learning and play may therefore prioritize learning coding knowledge over computational learning in comparison to their peers with an integrated understanding. However, if computational thinking is not the instructional priority for these teachers and is in fact being not even considered as a measurable objective, it may not be getting this additional boost.

It makes sense to examine how the two groups of teachers differently prioritize elements of the curriculum considering the teachers' understanding of the integration between CAL and their existing kindergarten curricular programs. Although both types of teachers saw connections between CAL-ScratchJr and their existing programs, connections to math and approaches to learning domains were primarily seen by teachers with integrated understandings of play and learning. In contrast, teachers with discrete understandings of learning and play saw the connections that were more explicit, such as literacy (which was made explicit throughout the curriculum including in the curriculum's name: Coding as Another Language) and science and engineering. This further suggests that teachers with discrete understandings of play and learning understand the explicitly presented learning objectives as the learning goals of the curriculum, while teachers with integrated understandings of play and learning had a more expanded view of the curriculum's learning goals. This difference in understanding could also transfer to prioritization of coding and computational thinking, with teachers with discrete beliefs more highly prioritizing the coding knowledge objectives that the curriculum explicitly presents.

Powerful ideas vs. key content

Overall, our findings suggest that teacher beliefs related to prioritization of and fidelity to the direct-instruction portions of the curriculum, which may have served as the vehicle by which beliefs related to coding knowledge. It's then possible that the open-ended activities in the curriculum – which both groups of teachers made space for, albeit in different ways – have the greater impact on computational thinking. Papert talked about the importance of powerful ideas, which were the ways of thinking and understanding that came out of open-ended learning opportunities, rather than the specific content (Bers, 2017; Papert, 1980b). Computational thinking is centered around powerful ideas, while the action of coding integrates powerful ideas with the practical knowledge of coding syntax and language knowledge.

Content and powerful ideas are both central in kindergarten education. For example, kindergarten literacy and mathematics involve a lot of core content competencies which can only be learned through memorization. Children need to know the sounds of letters and to recognize key sight words to be able to read, and research suggests that early reading abilities predict later reading comprehension and English language and literature skills through elementary, middle, and high school (Sparks et al., 2014). However, powerful ideas need to be individually discovered by children; these and other non-content skills, such as approaches to learning or hypothesis generation in the scientific method, cannot be taught through direct instruction.

Our findings suggest that at least with computer science, when teachers have discrete understandings of play and academic learning, they identify and prioritize both content knowledge and play components of the curriculum, which leads to success in both realms. However, when teachers have integrated understandings of play and academic learning, they may minimize the content area at the expense of the open-ended play-based learning. These teachers would be correct in their assumption and understanding that children learn through play, but because learning through play is open-ended, some content knowledge may be missed.

One of the key features of a coding playground is that play is open-ended and self-directed. In a classic example of learning through such open-ended play, you might have two children, one who is focused on creating a character who speaks and one who is interested in animating a dance to a specific song. If the children are left to their own open-ended learning goals, the child focused on creating a character may engage with the ScratchJr design features and record blocks, but not with additional syntax or movement blocks. The child focused on animating a dance may learn about syntax and sequencing as they focus to make their precise program, but the child could create this program only learning movement blocks. If the teacher took on the role of direct instructor, the children may not be as self-guided in their learning, but the teacher can ensure and prioritize that the students know all the blocks and syntax before moving on to their open-ended creations. If the goal is simply for students to engage with powerful ideas of computational thinking, prioritizing the play-based learning may be enough, because that is where the children can engage. However, if the goal is for the children to know the material, a coding playground with student choice in activities will not require all students to learn all skills. This reinforces work by Dan Willingham, who has suggested that people need background knowledge in order to engage and learn from open-ended learning environments (Willingham, 2021). By first offering the students the necessary background knowledge (through direct instruction on the coding language and syntax), DB teachers provided the students a learning context with which they could meaningfully and comfortably engage with the coding playground and discover its powerful ideas.

To meet the competing needs of our learning environment, students need both the open-ended play to engage with powerful ideas and the direct instruction to ensure that they learn the content that they do not personally opt to engage with. Although many are discouraged by the prioritization of assessment in education, these assessments tell educators what areas of content learning are essential so that the educators can balance between essential content and spaces for play and engaging with powerful ideas (Brown et al., 2020). As computer science education in early childhood becomes more mainstream, we need to determine the standards and goals for this programming. Is the purpose to teach children the total syntax of the ScratchJr language or to have them engage with powerful ideas and creation? From this answer, we can shape our curricula, policy, and practices.

Implications for policy-makers, practitioners, and curriculum developers

Define the learning objectives

This dissertation found that regardless of belief on the integration of play and learning, both teachers prioritized the play-based elements of the program. However, teachers with an integrated understanding of play and learning taught the curriculum with less fidelity and were less able to finish the curriculum, and their students performed lower on the direct measure of coding knowledge – or the explicit academic material taught by the program. Both sets of teachers valued the program for its open-ended play components and made sure to prioritize these components in their teaching practice. Both sets of students saw growth in their computational thinking, and both sets of teachers saw the open-ended components of the program as an opportunity for success for students who were not traditionally successful in the classroom. For the teachers, the success of the curriculum was in its ability to create opportunities for successful expression for students who were not necessarily successful in traditional academic programming – not specific coding knowledge or traditional measures of computational thinking.

These findings suggest that teacher beliefs can have an impact on student learning and assessment outcomes, but whether that impact is meaningful depends on the learning goals determined by policy-makers and administrators. As a reminder, policy-makers often care about introducing early childhood computer science for the goals of teaching technological literacy, 21st century ways of thinking, and improving equity in computer science education (Jara et al., 2018). The existing standards for computer science education are also more centered on powerful ideas – neither the K-12 computer science framework or the ISTE standards mention any specific content knowledge in its learning objectives (ISTE-S, 2016; K-12 Computer Science Framework Steering Committee, 2016). In this way, although students of teachers with integrated understandings of play and learning preformed lower on the direct measure of play and learning, there weren't differences between the two groups on the outcomes that related to the key policy goals.

That does not minimize though that there *were* differences in content learning though between the two groups. Specifically, within the field of early childhood computer science, policy-makers should consider if the standards should include content knowledge in addition to ways of thinking, or if the powerful ideas of computer science and digital literacy are the true learning goals. Depending on the choices they make, recommendations for teacher training, curricula development, and policies may change as well. If we prioritize the powerful ideas of computer science without fixating on specific coding and syntax knowledge, then early childhood computer science can become an opportunity for teachers to lean into the play-based learning that they are on their own making space for. If we prioritize content knowledge, coding language, and syntax, we may need to encourage teacher fidelity in the direct instruction portions of curricula.

Implications for Practitioners

Create semi-flexible curricula. If it is the open-ended and play-centered elements of the curriculum that relate to policy goals, then a key finding of this dissertation was that both sets of teachers made time for those elements. The teachers implemented these elements differently in the classroom, but they were celebrated and prioritized by all the teachers, leading to successes in these measures for all students. The curriculum provided the scaffolding for the teachers to introduce the open-ended play-based coding playground according to their beliefs and pedagogies. Each set of teachers did modify the program in some way (whether constraining projects and adding additional free-time or expanding open-ended project time at the cost of direct instruction). Previous research shows that appropriate teacher modification from experienced teachers can lead to better outcomes from curricula, while high fidelity is more important for new teachers who are not yet able to adapt and modify the curriculum appropriately (Quinn & Kim, 2017). Embracing teacher's individual beliefs and providing them with well-constructed and open-ended coding platforms and curricula could lead to greater success in teaching the powerful ideas of computer science and computational thinking than prioritizing strict fidelity.

However, some key content is obviously central to learning computer science. Allowing teachers to center the open-ended coding playground without making clear the content learning objectives can lead to students missing key content. Key skills and content knowledge should be identified and made clear to teachers, so that they can ensure that students receive that instruction. If teachers skip the direct instruction section of a lesson believing that the open-ended coding playground is more important, the students will only have that knowledge if they themselves choose to engage with it on their personal coding playground. Teachers should know what the key content goals of a curriculum are, so that any modifications they make aren't at the expense of necessary content and learning material. This can be made more explicit in curricula, through meaningful standards, and in professional development trainings. These explicit content goals can be included in a semi-flexible curriculum, making clear where teachers can be flexible and where higher fidelity may be needed.

Selecting assessments. It is known that the selected assessments, their measured outcomes, and findings from these assessments influence understanding of curricular programs and policy relating to program implementation (Pederson, 2007). Currently, both the Coding Stages Assessment and TechCheck assessment are used as research tools, not classroom assessments, and there are not standardized classroom assessments to evaluate children's outcomes from computer science programs. We suggest that policy-makers should interrogate what the intended outcomes of a curriculum are if they intend to assess these curricula and implement them. If a district explicitly prioritized coding knowledge with the taught coding language, then teachers who explicitly prioritize coding knowledge could produce higher test scores in their classroom. However, if a district prioritized transferable skills such as computational thinking, teacher beliefs may not necessarily affect student outcomes so long as curricula and schedules allow for teachers to find time for open-ended and playful experiences in the way that makes sense for their classrooms and personal pedagogies.

Finding time for teachers. Finally, it is important to note that both sets of teachers identified time barriers to their ideal implementation of the curriculum. Their response to these time barriers was played out in the teaching practices primarily of teachers with integrated understandings of play and learning, whether it be prioritizing some material over others or not completing the curriculum. Time is one of the major barriers for teachers in classrooms around the world, and if policy makers are intending to introduce a whole new content domain of computer science into an already packed schedule, they need to find time and support teachers in teaching this program. A value of a play-based computer science program is that it offers a space for playful learning, but teachers are not necessarily looking to replace limited play-time in their curriculum, especially if they already view play and academic learning as discrete and playtime as a limited commodity. Our suggestion to policy-makers is to find the time for teachers to introduce these open-ended student-centered programs so that teachers don't have to limit their teaching and make prioritization choices within the curriculum.

Limitations of the Dissertation

Like all research, this dissertation had limitations, primarily driven by its use of a dataset consisting of secondary data, and data from two separate randomized control trials.

Curriculum completion

As described throughout our findings, some teachers did not complete the curricula, but the completion status of the curriculum was not collected as part of the randomized control trial for all settings, meaning that we only had this data as it was reported in the teacher interviews. If the initial studies had collected data on curriculum completion and we had this data for all teachers, we would be able to include it in an updated quantitative model and see if it explained the effect of teacher beliefs on student coding outcomes.

Inequivalent datasets

Additionally, although the two studies were closely aligned and contained similar data, some data only existed in one dataset. A key example of this is that we did not have equivalent student demographic data from all four demographic regions. This was both because the two studies collected demographic data differently, but also because student demographics are not equivalently identified between the United States and Argentina. For example, the two countries had different understandings of ethnic-racial identity, meaning that the impact of the curriculum on minoritized students would not be able to be equivalently compared. Only in the United States dataset did we have information on student disability status, English language learner status, or socio-economic status. For this reason, we were not able to include these student demographics in our model and quantitatively evaluate how teacher beliefs impacted students from various populations. We were able to partially explore this question through our qualitative data and analysis, for example, when both sets of teachers reported the success of the curriculum for underperforming student groups including students with disabilities and bilingual students. This reinforces the value of mixed-methods research in answering complex questions about classrooms and student outcomes, as the qualitative data was able to answer a question the quantitative data was not able to.

Future Research Directions

Interaction between teacher beliefs and student coding knowledge growth

One quantitative finding was a trending but not significant result suggesting that the relationship between pre-curriculum and post-curriculum coding knowledge was larger for students of IB teachers than for students of DB teachers. Because the effect was not significant, it was not further explored in this dissertation. However, if meaningful, this could suggest that the curriculum had a greater impact on student learning for students of IB teachers, with low-preforming students of IB teachers making larger gains than equally low-performing students of DB teachers. In this case, it could be possible that students of DB teachers are scoring higher simply they are better at testing than students of IB teachers. As there is always the potential for trending but not significant results to be the result of low power, future studies replicating this research should reexamine this question to determine if there is a meaningful impact of teacher beliefs on the relationship between pre- and post-curriculum coding knowledge.

National determinants of teacher beliefs

Like all projects, this dissertation also left us with future questions for further research. The first relates to teacher beliefs across regions and countries, and what shapes them. Our finding in this dissertation was that teacher beliefs were heterogenous within our United States and Argentinian samples. This finding aligned with previous research from Canada, which found heterogeneity in teacher beliefs within nation and across region there as well (Pyle & Danniels, 2017). However, other research in China, Germany, and New Zealand has suggested that teacher beliefs on play and learning were shaped by a country's national culture or curriculum (McLachlan et al., 2006; Wu & Rao, 2011). This leads us to questions on the homogeneity or heterogeneity of teacher beliefs across countries. Is there something about the Americas that leads to more heterogeneous beliefs, or is there some feature of Argentinian, Canadian, and American schools that is more accepting of heterogenous beliefs while other countries shape their teachers' beliefs more? Future research should continue to investigate teacher beliefs on play and academic learning across more countries to determine the answers to these questions.

Effects of curriculum incompletion

Additionally, as mentioned above, we were not able to evaluate the effect of teachers' curriculum incompletion on student coding outcomes. With two of our major findings being teachers with integrated understandings of play and learning both taught fewer lessons and had lower post-curriculum coding scores, it is important to evaluate if these two findings were related. It is easy to imagine that not completing the curriculum could mediate lower scores on post-curriculum coding knowledge. As the Coding as Another Language program is introduced and evaluated across more countries, researchers should explicitly collect data on curriculum completion, and specifically the last lesson completed, so that this can be evaluated. Additionally, future implementation of the CAL-ScratchJr program should introduce the curriculum with more time for teachers to complete the curriculum and see if that removes differences between outcomes based on teacher belief. This study could also evaluate if the variation in completion or fidelity were due to a lack of time for teachers. If teachers still had variation in completion with more time to teach, that would suggest that additional policies were needed to encourage teachers to complete curricula, while if this variation vanished, that would suggest that teachers simply need more time.

Impacts of teacher beliefs in other content domains

Finally, if we were to generalize this finding to assessment, learning, and play more broadly in kindergarten, the results suggest that teacher beliefs can affect instruction of content material but have fewer effects on the teaching of powerful ideas and ways of thinking. When it comes to kindergarten and future school-readiness, both content material and ways of thinking are important. For example, children need to learn phonics at the instructed time to progress to later reading. Although there is disagreement within and between teachers, researchers, and policy makers as to the amount of reading knowledge a child needs in kindergarten, this material is content that children need to learn to progress in their reading and perform well throughout school. In contrast, approaches to learning is a set of skills central to early childhood education that are more difficult to target through academic interventions and curricula but are also considered essential for later academic success. Both early literacy and approaches to learning are associated with success in later academic years and key non-academic outcomes, but like coding and computational thinking, one is a domain of content while the other is a set of cognitive skills and ways of thinking. While phonics and letter-sound recognition are assessed in traditional standardized assessment batteries but approaches to learning and problem-solving skills are not.

However, we also know that teachers prioritize areas of learning that are measured through the standardized assessments (Pederson, 2007). It is possible that because students were not formally assessed on computer science learning, teachers felt more at liberty to explore and modify the curriculum than they would with phonics or mathematics. Future research should examine if teacher beliefs on play and academic learning affect fidelity and content learning outcomes across kindergarten topics more broadly, or if this finding was limited to computer science as a non-assessed and optional domain of learning.

Concluding Remarks

Play and academic preparation have been priorities of kindergarten programs throughout history, and for as long as kindergartens have been in existence, educators have been developing and implementing play-based pedagogies in kindergarten for the academic and holistic development of children (Allen, 1986). Today, as these two phenomena are placed in increasing competition with increased schoolification and school-readiness priorities in early childhood, this dissertation suggests that teachers still value both and find ways to implement both in their classrooms. Overall, teachers do believe in both play and academic learning in kindergarten, but their understanding of the relationship between these two key phenomena can lead to differences in computer science program implementation. Some teachers who understand the two as integrated are more likely to modify curriculum to center the open-ended and playful activities, whereas others who view the phenomena as discrete are more likely to teach by the book, centering both academic learning and play as separate activities. As playful and open-ended computer science programs are developed and brought to early childhood classrooms, it's important to consider how curricula will be taught in practice, and what is the true purpose of introducing computer science at this young age. Creating play-centered and open-ended curricula allows space for the open-ended playful learning that leads to the development of powerful ideas and computational thinking, but direct instruction of content also ensures that students learn the material. However, if specific content is less important for early childhood computer science than powerful ideas and opportunities for creative engagement, perhaps early childhood computer science offers a space for open-ended play-based learning that is not available in other academic domains where content learning is essential. Findings from this dissertation reinforce that to truly integrate new academic domains like coding and computer science into kindergarten classrooms, we need to not only prioritize playful learning, but also determine what is the balance between our academic learning goals and play.

References

Allen, A. T. (1986). Gardens of Children, Gardens of God: Kindergartens and Day-Care Centers in Nineteenth-Century Germany. *Journal of Social History*, *19*(3), 433–450. https://doi.org/10.1353/jsh/19.3.433

Almeida, R., Almeida, M. E. B. de, & Fonseca, M. (2018). Scratch: Curricular experience with a student with special educational needs. *2018 International Symposium on Computers in Education (SIIE)*, 1–5. https://doi.org/10.1109/SIIE.2018.8586725

Aman, N. (2016). "I believe, therefore I practice": Teachers' beliefs on literacy acquisition and their classroom practices. In S. R. Elaine & W. Bokhorst-Heng (Eds.), *Quadrilingual education in Singapore* (pp. 39–56). Springer, Singapore.

Ashiabi, G. S. (2007). Play in the Preschool Classroom: Its Socioemotional Significance and the Teacher's Role in Play. *Early Childhood Education Journal*, *35*(2), 199–207. https://doi.org/10.1007/s10643-007-0165-8

Azenkot, S., Golfinopoulos, T., Marcus, A., Springmann, A., & Varsanik, J. S. (2011). Overcoming barriers among Israeli and Palestinian students via computer science. *Proceedings of the 42nd ACM Technical Symposium on Computer Science Education*, 667–672. https://doi.org/10.1145/1953163.1953348

Barnes, T. (2017). CS for all, equity, and responsibility. *ACM SIGCSE Bulletin*, *49*(2), 18–18. https://doi.org/10.1145/3094875.3094882

Bassok, D., Latham, S., Scott Latham, & Rorem, A. (2016). Is Kindergarten the New First Grade. *AERA Open*, *2*(1), 2332858415616358. https://doi.org/10.1177/2332858415616358

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*(1), 1–48. https://doi.org/doi:10.18637/jss.v067.i01

Bayes, C. (2006). Provocations of Te Whāriki and Reggio Emilia. In A. Fleet, C. Patterson, & J. Robertson (Eds.), *Insights: Behind early childhood pedagogical documentation* (pp. 289–299).

Ben Ari, A., Levinson, T., Bers, M. U., & Rosenberg-Kima, R. B. (2023). *Nurturing Computational Thinking in an Israeli Kindergarten with the CAL-KIBO Robotics Curriculum*. American Educational Research Association, Chicago, IL.

Ben-Ari, A., Levinson, T. G., Umaschi Bers, M. U., & Rosenberg-Kima, R. B. (2023). *Coding as a Self-Expression Tool*. 1266–1266. https://doi.org/10.1145/3545947.3573244

Bers, M. U. (2017). The Seymour test: Powerful ideas in early childhood education. *International Journal of Child-Computer Interaction*, *14*, 10–14. https://doi.org/10.1016/j.ijcci.2017.06.004

Bers, M. U. (2018). Coding, playgrounds and literacy in early childhood education: The development of KIBO robotics and ScratchJr. *2018 IEEE Global Engineering Education Conference (EDUCON)*, 2094–2102. https://doi.org/10.1109/EDUCON.2018.8363498

Bers, M. U. (2019). Coding as another language: A pedagogical approach for teaching computer science in early childhood. *Journal of Computers in Education*, *6*(4), 499–528. https://doi.org/10.1007/s40692-019-00147-3

Bers, M. U. (2020a). *Coding as a playground: Programming and computational thinking in the early childhood classroom*. Routledge.

Bers, M. U. (2020b). Playgrounds and Microworlds: Learning to Code in Early Childhood. In N. Holbert, M. Berland, & Y. B. Kafai (Eds.), *Designing Constructionist Futures: The Art, Theory, and Practice of Learning Designs*. The MIT Press. https://doi.org/10.7551/mitpress/12091.001.0001

Bers, M. U. (2021). Coding, robotics and socio-emotional learning: Developing a palette of virtues. *Pixel-Bit*, *Revista de Medios y Education*(62), 309–322. https://doi.org/10.12795/pixelbit.90537

Bers, M. U. (2022). *Beyond coding: How children learn human values through programming*. MIT Press.

Bers, M. U., Blake-West, J., Kapoor, M. G., Levinson, T., Relkin, E., Unahalekhaka, A., & Yang, Z. (2023). Coding as another language: Research-based curriculum for early childhood computer science. *Early Childhood Research Quarterly*, *64*, 394–404. https://doi.org/10.1016/j.ecresq.2023.05.002

Bers, M. U., Doyle-Lynch, A., & Chau, C. (2009). Positive technological development: The multifaceted nature of youth technology use towards improving self and society. *Constructing the Self in a Digital World*, 110–136.

Bers, M. U., Govind, M., & Relkin, E. (2022). Coding as Another Language: Computational Thinking, Robotics and Literacy in First and Second Grade. *Computational Thinking in PreK-5: Empirical Evidence for Integration and Future Directions*, 30–38.

Bers, M. U., Levinson, T., Yang, Z., Rosenberg-Kima, R. B., Ben-Ari, A., Jacob, S., Dubash, P., Warschauer, M., Gimenez, C., Gonzalez, P., & Gonzalez, H. (2023). Coding as Another Language: An International Comparative Study of Learning Computer Science and Computational Thinking in Kindergarten. In P. Blikstein, J. van Aalst, & K. Brennan

(Eds.), *17th International Conference of the Learning Sciences (ICLS)* (pp. 1659–1665). https://2023.isls.org/proceedings/

Bers, M. U., & Resnick, M. (2015). *The official ScratchJr book: Help your kids learn to code*. No Starch Press.

Bierman, K. L., Domitrovich, C. E., Nix, R. L., Gest, S. D., Welsh, J. A., Greenberg, M. T., Blair, C., Nelson, K. E., & Gill, S. (2008). Promoting Academic and Social-Emotional School Readiness: The Head Start REDI Program. *Child Development*, *79*(6), 1802–1817.

Bingham, S., & Whitebread, D. (2012). *School Readiness: A critical review of perspectives and evidence*. TACTYC.

Brennan, K., & Resnick, M. (2012). *New frameworks for studying and assessing the development of computational thinking*.

Brown, C. P., Da Hei Ku, & Barry, D. P. (2020). “Kindergarten isn’t fun anymore. Isn’t that so sad?”: Examining how kindergarten teachers in the US made sense of the changed kindergarten. *Teaching and Teacher Education*, *90*, 103029. https://doi.org/10.1016/j.tate.2020.103029

Brown, C. P., & Lan, Y. C. (2015). A qualitative metasynthesis comparing U.S. teachers’ conceptions of school readiness prior to and after the implementation of NCLB. *Teaching and Teacher Education*, *45*(45), 1–13. https://doi.org/10.1016/j.tate.2014.08.012

Bush, G. W. (2001). *No Child Left Behind.*

Caballero-González, Y.-A., Muñoz, L., & Muñoz-Repiso, A. G.-V. (2019). Pilot Experience: Play and Program with Bee-Bot to Foster Computational Thinking Learning in Young Children. *2019 7th International Engineering, Sciences and Technology Conference (IESTEC)*, 601–606. https://doi.org/10.1109/IESTEC46403.2019.00113

Cardini, A., Guevara, J. L., & Steinberg, C. (2020). *Mapa de la educación inicial en Argentina: Puntos de partida de una agenda de equidad para la primera infancia*.

Code.org. (2016). *Evaluation Summary Report 2015-2016*. https://code.org/files/EvaluationReport2015-16.pdf

Code.org. (2021). *Hour of Code*. https://hourofcode.com/us

Corcoran, T. (1926). The True Children's Garden. *The Irish Monthly*, *54*(635), 229–233.

de Ruiter, L. E., & Bers, M. U. (2021). The Coding Stages Assessment: Development and validation of an instrument for assessing young children's proficiency in the ScratchJr programming language. *Computer Science Education*, 1–30. https://doi.org/10.1080/08993408.2021.1956216

DevTech Research Group. (2021). *Coding as Another Language – ScratchJr*. Coding as Another Language. https://sites.bc.edu/codingasanotherlanguage/curricula/kibo/

DevTech Research Group. (2023a). *CSA-ScratchJr – DevTech Research Group*. DevTech Research Group. https://sites.bc.edu/devtech/assessments/scratchjr-instruments/csa-scratchjr/

DevTech Research Group. (2023b). *ScratchJr Studies – Coding as Another Language*. Coding as Another Language. https://sites.bc.edu/codingasanotherlanguage/research/research-studies/scratchjr-studies/

DevTech Research Group. (2023c). *TechCheck—DevTech Research Group*. DevTech Research Group. https://sites.bc.edu/devtech/assessments/techcheck/

Dimitrova, R., & Ferrer-Wreder, L. (2017). Positive Youth Development of Roma Ethnic Minority Across Europe. In N. J. Cabrera & B. Leyendecker (Eds.), *Handbook on*

Positive Development of Minority Children and Youth (pp. 307–320). Springer International Publishing. https://doi.org/10.1007/978-3-319-43645-6_19

Dupre, A. P. (2000). Transforming Education: The Lesson from Argentina. *Vanderbilt Law Review*, *34*(1).

Edmonds, W. A., & Kennedy, T. D. (2017). *An Applied Guide to Research Designs: Quantitative, Qualitative, and Mixed Methods*. SAGE Publications, Inc. https://doi.org/10.4135/9781071802779

Elkin, M., Sullivan, A., & Bers, M. U. (2016). Programming with the KIBO Robotics Kit in Preschool Classrooms. *Computers in the Schools*, *33*(3), 169–186.

Fesseha, E., & Pyle, A. (2016). Conceptualising play-based learning from kindergarten teachers' perspectives. *International Journal of Early Years Education*, *24*(3), 361–377. https://doi.org/10.1080/09669760.2016.1174105

Flannery, L. P., Silverman, B., Kazakoff, E. R., Bers, M. U., Bontá, P., & Resnick, M. (2013). Designing ScratchJr: Support for early childhood learning through computer programming. *Proceedings of the 12th International Conference on Interaction Design and Children*, 1–10. https://doi.org/10.1145/2485760.2485785

Foerch, D. F., & Iuspa, F. (2016). THE INTERNATIONALIZATION OF THE REGGIO EMILIA PHILOSOPHY. *Revista Contrapontos*, *16*(2), 321. https://doi.org/10.14210/contrapontos.v16n2.p321-350

Fromberg, D. P. (2006). Kindergarten Education and Early Childhood Teacher Education in the United States: Status at the Start of the 21st Century. *Journal of Early Childhood Teacher Education*, *27*(1), 65–85. https://doi.org/10.1080/10901020500527145

Gaias, L. M., Manuela Jimenez Herrera, Jimenez, M., Abry, T., Granger, K. L., & Taylor, M. (2018). Kindergarten Teachers' Instructional Priorities Misalignment and Job Satisfaction: A Mixed Methods Analysis. *Teachers College Record*, *120*(12), 1–38. https://doi.org/10.1177/016146811812001206

GEM Report UNESCO. (2007). *Argentina: Early Childhood Care and Education (ECCE) programmes* (Strong Foundations: Early Childhood Care and Education) [Country profile prepared for the Education for All Global Monitoring Report 2007]. GEM Report UNESCO. https://doi.org/10.54676/XJUU2512

Gestsdóttir, S., & Lerner, R. M. (2007). Intentional self-regulation and positive youth development in early adolescence: Findings from the 4-h study of positive youth development. *Developmental Psychology*, *43*(2), 508–521. https://doi.org/10.1037/0012-1649.43.2.508

Goldstein, L. S. (2007). Beyond the DAP versus standards dilemma: Examining the unforgiving complexity of kindergarten teaching in the United States. *Early Childhood Research Quarterly*, *22*(1), 39–54. https://doi.org/10.1016/j.ecresq.2006.08.001

Govind, M. (2022). *A Qualitative Examination of Second Grade Teachers' Experiences and Attitudes Around Coding and Robotics Education*.

Hamand, D. J. (2019). *The Use of Learning Centers in the Kindergarten Classroom* [Master's Thesis]. Northwestern College.

Hassenfeld, Z. R., & Bers, M. U. (2020). Debugging the Writing Process: Lessons From a Comparison of Students' Coding and Writing Practices. *The Reading Teacher*, *73*(6), 735–746. https://doi.org/10.1002/trtr.1885

Hewett, V. M. (2001). Examining the Reggio Emilia Approach to Early Childhood Education. *Early Childhood Education Journal*, *29*(2).

Hsieh, H.-F., & Shannon, S. E. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*, *15*(9), 1277–1288. https://doi.org/10.1177/1049732305276687

Ilgaz, H., Hassinger-Das, B., Hirsh-Pasek, K., & Golinkoff, R. M. (2018). Making the Case for Playful Learning. In M. Fleer & B. Van Oers (Eds.), *International Handbook of Early Childhood Education* (pp. 1245–1263). Springer Netherlands. https://doi.org/10.1007/978-94-024-0927-7_64

ISTE Standards For Students (p. 2). (2016). International Society for Technology in Education. iste.org/standards

Itin, C. M. (1999). Reasserting the Philosophy of Experiential Education as a Vehicle for Change in the 21st Century. *Journal of Experiential Education*, *22*(2), 91–98. https://doi.org/10.1177/105382599902200206

Jara, I., Hepp, P., & Rodriguez, J. (2018). *Policies and Practices for Teaching Computer Science in Latin America*. Microsoft.

Jelicic, H., Bobek, D. L., Phelps, E., Lerner, R. M., & Lerner, J. V. (2007). Using positive youth development to predict contribution and risk behaviors in early adolescence: Findings from the first two waves of the 4-H Study of Positive Youth Development. *International Journal of Behavioral Development*, *31*(3), 263–273. https://doi.org/10.1177/0165025407076439

Jewish Life at Camp. (n.d.). URJ Six Points Sci-Tech Academy. Retrieved July 15, 2023, from https://6pointsscitech.org/about-us/jewish-life-at-camp/

K-12 Computer Science Framework Steering Committee. (2016). *K-12 computer science framework*. ACM.

Kamerman, S. B., & Gatenio-Gabel, S. (2007). Early Childhood Education and Care in the United States: An Overview of the Current Policy Picture. *International Journal of Child Care and Education Policy*, *1*(1), 23–34. https://doi.org/10.1007/2288-6729-1-1-23

Kuznetsova, A., Brockhoff, Per. B., & Christensen, R. H. B. (2017). lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software*, *82*(13), 1–26. https://doi.org/10.18637/jss.v082.i13

Leidl, K. D., Bers, M. U., & Mihm, C. (2017). Programming with ScratchJr: A review of the first year of user analytics. *Conference Proceedings of International Conference on Computational Thinking Education*, 116–121.

Levinson, T. (2022). *Quantifying the Coding Playground: A Pilot Study Creating and Attempting to Validate a Rubric for Positive Technological Development* [Master's Thesis]. Tufts University.

Levinson, T. (2023). Coding Languages: Coding and Computational Thinking in a Language-Diverse Preschool. *AERA 2023*. AERA 2023. https://doi.org/10.3102/IP.23.2004496

Levinson, T., Carocca P, F., & Bers, M. (2024). *International Scaling of the Coding as Another Language Curriculum through a Research- Practice Partnership in Argentina*. American Educational Research Association, Philadelphia, PA.

Levinson, T., Carocca P, F., & Bers, M. (Under review). *Coding as another language: An early childhood programming curriculum in Argentina.*

Levinson, T., Hunt, L., & Hassenfeld, Z. R. (2021). Including Students With Disabilities in the Coding Classroom: In M. U. Bers (Ed.), *Teaching Computational Thinking and Coding to*

Young Children (pp. 236–248). IGI Global. https://doi.org/10.4018/978-1-7998-7308-2.ch012

Ley de Educación Nacional, Pub. L. No. 26.206 (2006). https://www.argentina.gob.ar/normativa/nacional/ley-26206-123542

Lopreite, D., & Macdonald, L. (2014). Gender and Latin American Welfare Regimes: Early Childhood Education and Care Policies in Argentina and Mexico. *Social Politics: International Studies in Gender, State & Society*, *21*(1), 80–102. https://doi.org/10.1093/sp/jxt014

Lumivero. (2023). *NVivo* (Version 14) [Computer software]. www.lumivero.com

Lynch, M. (2015). More play, please: The perspective of kindergarten teachers on play in the classroom. *American Journal of Play*, *7*(3), 347–370.

Massachusetts Department of Elementary and Secondary Education. (2023, August 29). *Teacher Fields and Grade Levels*. Teacher Fields and Grade Levels – Office of Educator Licensure. https://www.doe.mass.edu/licensure/academic-prek12/teacher/field-grade-levels.html

McLachlan, C., Carvalho, L., de Lautour, N., & Kumar, K. (2006). Literacy in Early Childhood Settings in New Zealand: An Examination of Teachers' Beliefs and Practices. *Australian Journal of Early Childhood*, *31*(2), 31–41. https://doi.org/10.1177/183693910603100206

Mixed Methods Designs: Frameworks for Organizing Your Research Methods. (2017). In J. T. DeCuir-Gunby & P. A. Schutz, *Developing a Mixed Methods Proposal: A Practical Guide for Beginning Researchers* (pp. 83–106). SAGE Publications, Inc. https://doi.org/10.4135/9781483399980.n10

National Governors Association Center for Best Practices, Council of Chief State School Officers. (2010a). *Common Core State Standards for English Language Arts & Literacy*. National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington, D.C.

National Governors Association Center for Best Practices, Council of Chief State School Officers. (2010b). *Common Core State Standards for Mathematics*. National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington, D.C.

National Research Council. (2015). *Guide to implementing the next generation science standards*.

New Hampshire Department of Education. (2023, August 29). *Endorsements Available and Requirements*. Endorsements Available and Requirements – Credentialing HD Knowledge Base – Confluence. https://nhdoepm.atlassian.net/wiki/spaces/CHD/pages/193954145/Endorsements+Available+and+Requirements

Niikko, A., & Ugaste, A. (2012). Conceptions of Finnish and Estonian Pre-school Teachers' Goals in Their Pedagogical Work. *Scandinavian Journal of Educational Research*, *56*(5), 481–495. https://doi.org/10.1080/00313831.2011.599424

Niveles Educativos, Pub. L. No. 26.206, Educación, ciencia y cultura (2006). https://www.argentina.gob.ar/justicia/derechofacil/leysimple/niveles-educativos

OECD. (2023). *Education GPS* [dataset]. https://gpseducation.oecd.org/

Pagani, L. S., Fitzpatrick, C., Archambault, I., & Janosz, M. (2010). School readiness and later achievement: A French Canadian replication and extension. *Developmental Psychology*, *46*(5), 984–994. https://doi.org/10.1037/a0018881

Papadakis, S., & Kalogiannakis, M. (2020). *Learning Computational Thinking Development in Young Children With Bee-Bot Educational Robotics*. 289–309. https://doi.org/10.4018/978-1-7998-4576-8.ch011

Papert, S. (1980a). *Constructionism vs. Instructionism*. Proceedings from Japanese Educators Conference. http://www. papert. org/articles/const_inst.

Papert, S. (1980b). *Mindstorms: Children, computers, and powerful ideas*. Basic books.

Pederson, P. V. (2007). What Is Measured Is Treasured: The Impact of the No Child Left Behind Act on Nonassessed Subjects. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *80*(6), 287–291. https://doi.org/10.3200/TCHS.80.6.287-291

Piaget, J. (1962). *Play Dreams & Imitation in Childhood*. W. W. Norton & Company.

Prochner, L. (2011). “Their little wooden bricks”: A history of the material culture of kindergarten in the United States. *Paedagogica Historica*, *47*(3), 355–375. https://doi.org/10.1080/00309230.2010.513688

Pyle, A., & Danniels, E. (2017). A Continuum of Play-Based Learning: The Role of the Teacher in Play-Based Pedagogy and the Fear of Hijacking Play. *Early Education and Development*, *28*(3), 274–289. https://doi.org/10.1080/10409289.2016.1220771

Pyle, A., & DeLuca, C. (2017). Assessment in play-based kindergarten classrooms: An empirical study of teacher perspectives and practices. *The Journal of Educational Research*, *110*(5), 457–466. https://doi.org/10.1080/00220671.2015.1118005

Pyle, A., DeLuca, C., & Danniels, E. (2017). A scoping review of research on play-based pedagogies in kindergarten education. *Review of Education*, *5*(3), 311–351. https://doi.org/10.1002/rev3.3097

Pyle, A., Prioletta, J., & Poliszczuk, D. (2018). The Play-Literacy Interface in Full-day Kindergarten Classrooms. *Early Childhood Education Journal*, *46*(1), 117–127. https://doi.org/10.1007/s10643-017-0852-z

Quinn, D. M., & Kim, J. S. (2017). Scaffolding Fidelity and Adaptation in Educational Program Implementation: Experimental Evidence From a Literacy Intervention. *American Educational Research Journal*, *54*(6), 1187–1220. https://doi.org/10.3102/0002831217717692

Quirk, M., Nylund-Gibson, K., & Furlong, M. (2013). Exploring patterns of Latino/a children's school readiness at kindergarten entry and their relations with Grade 2 achievement. *Early Childhood Research Quarterly*, *28*(2), 437–449. https://doi.org/10.1016/j.ecresq.2012.11.002

R Core Team. (2020). *R: A language and environment for statistical computing* [Computer software]. R Foundation for Statistical Computing. https://www.R-project.org/

Ram, K., & Wickham, H. (2018). wesanderson: A Wes Anderson palette generator. *R Package Version 0.3*, *6*, 2018.

Ramagoni, S. G., & Brylow, D. (2023). The Impact of Certified CS Teachers on AP Computer Science Exam Scores: A Study in Wisconsin. *Proceedings of the 2023 ACM Conference on International Computing Education Research - Volume 2*, 30–31. https://doi.org/10.1145/3568812.3603486

Redondo, P. (2020). First childhood education in Argentina within a Latin American Perspective. *Early Years*, *40*, 387–398. https://doi.org/10.1080/09575146.2020.1825343

Relkin, E. (2022). *The Development of Computational Thinking Skills in Young Children* [Dissertation, Tufts University]. https://bpb-us-w2.wpmucdn.com/sites.bc.edu/dist/c/183/files/2022/08/080922RELKIN_FINAL_DISSERTATION.pdf

Relkin, E., & Bers, M. (2021). TechCheck-K: A Measure of Computational Thinking for Kindergarten Children. *2021 IEEE Global Engineering Education Conference (EDUCON)*, 1696–1702. https://doi.org/10.1109/EDUCON46332.2021.9453926

Relkin, E., & Bers, M. U. (2020). *Exploring the Relationship Between Coding, Computational Thinking and Problem Solving in Early Elementary School Students.* Annual Meeting of the American Educational Research Association (AERA), San Francisco, CA.

Relkin, E., de Ruiter, L., & Bers, M. U. (2020). TechCheck: Development and Validation of an Unplugged Assessment of Computational Thinking in Early Childhood Education. *Journal of Science Education and Technology*, *29*(4), 482–498. https://doi.org/10.1007/s10956-020-09831-x

Relkin, E., Johnson, S. K., & Bers, M. U. (2023). *A Normative Analysis of the TechCheck Computational Thinking Assessment*.

Repko-Erwin, M. E. (2017). Was Kindergarten Left Behind? Examining US Kindergarten as the New First Grade in the Wake of No Child Left Behind. *Global Education Review*, *4*(2), 58–74.

Santo, R., DeLyser, L. A., Ahn, J., Pellicone, A., Aguiar, J., & Wortel-London, S. (2019). Equity in the Who, How and What of Computer Science Education: K12 School District

Conceptualizations of Equity in 'CS for All' Initiatives. *2019 Research on Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT)*, 1–8. https://doi.org/10.1109/RESPECT46404.2019.8985901

Shemesh, M., & Golden, D. (2022). Local Appropriations of "Readiness" in a Global Era of Schoolification: An Ethnographic Study of Kindergarten Teachers in Israel. *Comparative Education Review*, 000–000. https://doi.org/10.1086/717553

Smith, M. (2016, January 30). Computer Science For All. *Whitehouse.Gov*. https://obamawhitehouse.archives.gov/blog/2016/01/30/computer-science-all

Smith, S. C. (2014). Parental Engagement in a Reggio Emilia Inspired Head Start Program. *Early Childhood Research and Practice*, *16*(1).

Snaider, C. (2018). Spotlight on early childhood education. A newspaper coverage analysis of universal preschool debate in Argentina. *International Journal of Child Care and Education Policy*, *12*(1), 1–21. https://doi.org/10.1186/s40723-018-0045-2

Sparks, R. L., Patton, J., & Murdoch, A. (2014). Early reading success and its relationship to reading achievement and reading volume: Replication of '10 years later.' *Reading and Writing*, *27*(1), 189–211. https://doi.org/10.1007/s11145-013-9439-2

Standards for the Licensure of Approval of Family Child Care; Small Group and School Age and Large Group and School Age Child Care Programs, Pub. L. No. 7.00, 606 CMR.

Strawhacker, A., & Bers, M. U. (2018). Promoting Positive Technological Development in a Kindergarten Makerspace: A Qualitative Case Study. *European Journal of STEM Education*, *3*(3). https://doi.org/10.20897/ejsteme/3869

Strawhacker, A., Lee, M., & Bers, M. U. (2018). Teaching tools, teachers' rules: Exploring the impact of teaching styles on young children's programming knowledge in ScratchJr.

International Journal of Technology and Design Education, *28*(2), 347–376. https://doi.org/10.1007/s10798-017-9400-9

Sturgess, J. (2003). A model describing play as a child-chosen activity—Is this still valid in contemporary Australia? *Australian Occupational Therapy Journal*, *50*(2), 104–108. https://doi.org/10.1046/j.1440-1630.2003.00362.x

Sullivan, A., Elkin, M., & Bers, M. U. (2015). KIBO robot demo: Engaging young children in programming and engineering. *Proceedings of the 14th International Conference on Interaction Design and Children*, 418–421. https://doi.org/10.1145/2771839.2771868

Sverdlov, A., Aram, D., & Levin, I. (2014). Kindergarten teachers' literacy beliefs and self-reported practices: On the heels of a new national literacy curriculum. *Teaching and Teacher Education*, *39*, 44–55. https://doi.org/10.1016/j.tate.2013.12.004

Tirrell, J. M., Dowling, E. M., Kibbedi, P., Namurinda, E., Iraheta, G., Dennis, J., Malvese, K., Abbasi-Asl, R., Williams, K., Lerner, J. V., King, P. E., Sim, A. T. R., & Lerner, R. M. (2023). Measuring Youth Perceptions of Being Known and Loved and Positive Youth Development: Cross-National Findings from Rwanda and El Salvador. *Child & Youth Care Forum*, *52*(5), 1093–1119. https://doi.org/10.1007/s10566-022-09725-6

Tirrell, J. M., Geldhof, G. J., King, P. E., Dowling, E. M., Sim, A. T. R., Williams, K., Iraheta, G., Lerner, J. V., & Lerner, R. M. (2019). Measuring Spirituality, Hope, and Thriving Among Salvadoran Youth: Initial Findings from the Compassion International Study of Positive Youth Development. *Child & Youth Care Forum*, *48*(2), 241–268. https://doi.org/10.1007/s10566-018-9454-1

Tocalli-Beller, A. (2007). ELT and Bilingual Education in Argentina. In J. Cummins & C. Davison (Eds.), *International Handbook of English Language Teaching* (pp. 107–121). Springer US. https://doi.org/10.1007/978-0-387-46301-8_9

Unahalekhaka, A., & Bers, M. U. (2021). Taking coding home: Analysis of ScratchJr usage in home and school settings. *Educational Technology Research and Development*, *69*(3), 1579–1598. https://doi.org/10.1007/s11423-021-10011-w

Unahalekhaka, A., & Bers, M. U. (2022). Evaluating young children's creative coding: Rubric development and testing for ScratchJr projects. *Education and Information Technologies*, *27*(5), 6577–6597. https://doi.org/10.1007/s10639-021-10873-w

UNESCO. (2017). *Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM)*. UNESCO. https://doi.org/10.54675/QYHK2407

Wang, L., Geng, F., Hao, X., Shi, D., Wang, T., & Li, Y. (2021). Measuring coding ability in young children: Relations to computational thinking, creative thinking, and working memory. *Current Psychology*. https://doi.org/10.1007/s12144-021-02085-9

Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis* [Computer software]. Springer-Verlag New York. https://ggplot2.tidyverse.org

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Pedersen, T. L., Miller, E., Bache, S. M., Müller, K., Ooms, J., Robinson, D., Seidel, D. P., Spinu, V., … Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, *4*(43), 1683. https://doi.org/10.21105/joss.01686

Willingham, D. T. (2021). *Why don't students like school?: A cognitive scientist answers questions about how the mind works and what it means for the classroom*. John Wiley & Sons.

Wing, J. M. (2008). Computational thinking and thinking about computing. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *366*(1881), 3717–3725. https://doi.org/10.1098/rsta.2008.0118

Wood, S. (2022, December 2). Where Is Kindergarten Mandatory? *U.S. News & World Report*. https://www.usnews.com/education/k12/articles/where-is-kindergarten-mandatory

Wu, S., & Rao, N. (2011). Chinese and German teachers' conceptions of play and learning and children's play behaviour. *European Early Childhood Education Research Journal*, *19*(4), 469–481. https://doi.org/10.1080/1350293x.2011.623511

Zosh, J. M., Gaudreau, C., Golinkoff, R. M., & Hirsh-Pasek, K. (2022). The Power of Playful Learning in the Early Childhood Setting. *Young Children*.