Computer Science Education

ISSN: 0899-3408 (Print) 1744-5175 (Online) Journal homepage: www.tandfonline.com/journals/ncse20

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To cite this article: Tess Levinson, Francisca Carocca P & Marina Bers (2026) Coding as another language: an early childhood programming curriculum in Argentina, Computer Science Education, 36:2, 278-298, DOI: 10.1080/08993408.2025.2455339

To link to this article: https://doi.org/10.1080/08993408.2025.2455339

Published online: 23 Jan 2025.

COMPUTER SCIENCE EDUCATION
2026, VOL. 36, NO. 2, 278–298
https://doi.org/10.1080/08993408.2025.2455339

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Coding as another language: an early childhood programming curriculum in Argentina

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ABSTRACT

Background and context: Early childhood computer science (CS) education is a high-priority focus worldwide, but early childhood CS tools are primarily developed and researched within the United States and Europe. As an example, the Coding as Another Language ScratchJr (CAL-ScratchJr) curriculum is used in multiple countries but was developed and evaluated in the United States.
Objectives: This paper describes the implementation and evaluation of an adapted CAL-ScratchJr curriculum in Mendoza and Corrientes, Argentina.
Method: We used mixed methods and a cluster-randomized control trial to evaluate curriculum success, measured by validated assessments and teacher interviews.
Findings: The curriculum significantly improved student coding knowledge and computational thinking. Teachers saw the curriculum as successful across multiple domains.
Implications: These findings reinforce that the success of CS education programs should be evaluated not only with internationally validated assessments but also by local understandings of success..

ARTICLE HISTORY
Received 3 April 2024
Accepted 15 January 2025

KEYWORDS
Computer science education; scaling; design-based research; early childhood education

Computer science (CS) education is now a high-priority area worldwide, as seen through local and international policies and the development of educational technologies and curricula to teach CS to students of all ages. The United Nations has highlighted CS education as a path to improving economic growth and removing gender disparities within their Sustainable Development Goals (UNESCO, 2017). Organizations such as Code.org and the Raspberry Pi Foundation have paired policy initiatives such as Hour of Code with technologies and curricula to promote CS education in schools worldwide (About CSforAll, n.d.; Code.org, 2016; UNESCO, 2017). In recent decades, countries all over the world have scaled up CS education in primary and secondary schools. Coding languages for students, such as Scratch and ScratchJr, are available in over 70 languages and used in over 200 countries and territories, including all 193 UN nations (About CSforAll, n.d.; M. Bers & Sullivan, 2019; Jara et al., 2018).

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Research has highlighted the importance of early intervention in CS education as well as broader childhood initiatives (M. Bers et al., 2022). Developmental and educational interventions have greater returns-per-dollar the earlier they occur in a child's life (Heckman, 2012). This effect is seen across the development of the whole child, including cognitive and character skills development. There are also specific benefits to starting CS education at an early age. Young children do not yet have preexisting gender stereotypes that might limit their participation in STEM (Science, Technology, Engineering, and Math) fields, and introducing CS education at an early age can reduce the effects of such stereotypes on CS outcomes and participation (Sullivan & Bers, 2016; UNESCO, 2017). Additionally, coding learning experiences can provide opportunities for success for children with language related barriers in the classroom, such as children who do not speak the dominant classroom language or with language-related disabilities, both of which could potentially lead to both overall academic empowerment for these students and the reduction of STEM gaps for marginalized communities (Levinson & Bers, 2022).

Given this, there has been a new focus on developing technologies, pedagogies, and curricula specifically to serve young children in their learning of coding (the language and syntax of computer languages) and computational thinking the cognitive skills necessary for CS and coding, such as abstraction and sequencing. These have been traditionally developed within the United States and Europe although they are in demand and in use worldwide (M. Bers & Sullivan, 2019). This global use speaks to a need for culturally and linguistically relevant and meaningful pedagogical resources, to enhance motivation and academic performance of learners in educational contexts around the world.

Pedagogies for early childhood CS education

International attention on early childhood CS education has led to different pedagogies for introducing these concepts to young children. One widely used approach has been coding games in the style of leveled video and computer games, which can quickly increase students' self-efficacy and attitudes toward coding but offer limited creativity (Kalelioğlu, 2015). Other approaches, such as the coding as a playground model proposed by M. Bers (2019), focus on creating developmentally scaffolded, open-ended environments for expressive exploration and self-guided discovery in which learning to code can become an experience akin to learning another language (M. Bers, 2018, 2020; M. Bers et al., 2019). Like a physical playground, the coding playground allows children to creatively play with code and make projects based on their interests. Just as the physical playground is developmentally appropriate to a child's age, with preschoolers playing on a separate structure than 10-year-olds, a coding playground should be appropriately designed and scaffolded so that a child can take independent risks.

On the coding playground, children can also engage with each other and develop their communication, social, and emotional skills. The Positive Technological Development (PTD) framework encapsulates these behaviors, as they are seen in technology-rich environments, which relate to students' positive engagement with the coding playground environment (M. Bers et al., 2012; Strawhacker & Bers, 2018; Bers et al. 2009; Bers et al., 2018). The six behaviors – content creation, creativity, choices of conduct, communication, collaboration, and community building – are not in and of themselves exclusive to technological environments but are relevant to PTD when they are in the technology context.

Technology: ScratchJr

The ScratchJr app is the most widely available coding playground around the world. This free introductory programming language for children ages 5–7 is available on tablets, phones, Chromebooks, and computers and has been used in multiple settings including schools, afterschool programs, summer camps, formal family programs, children's museums, and at home (Bers, Blake-West, et al., 2023; M. U. Bers & Resnick, 2015; Govind & Bers, 2020; Govind et al., 2020; Portelance & Bers, 2015; Unahalekhaka & Bers, 2021). It offers an open-ended coding platform for children to create animations of varied complexity, ranging from a single character to a single motion or a complex game with multiple interacting elements (Unahalekhaka & Bers, 2022; Unahalekhaka & Govind, 2021). Since 2014, ScratchJr has been downloaded over 45 million times, translated into 22 languages, and used in over 200 countries and territories, including all 193 UN nations (Blake-West & Bers, 2023; Flannery et al., 2013; Unahalekhaka & Bers, 2021). In Argentina specifically, ScratchJr is widely used with over 260,000 users recorded nationwide. In addition, the Ministry of Education of the City of Buenos Aires, Fundación Telefónica Movistar, and ProFuturo have introduced ScratchJr professional development opportunities, creating a 15-hour online course for teachers in 2021. Organizations like Ámbito Educativo in San Juan, another Argentinian province, promote educators' digital skills development by offering access to this free online course. This course is certified by the National Ministry of Education with a score for the Classification Board (Navarro, 2022, Scratch, 2021).

The ScratchJr interface (Figure 1) consists of puzzle-shaped programming blocks color-coded by function and arranged left-to-right to form programs. The blocks feature symbols rather than words to be accessible to children who cannot yet read. Children can select characters to program, which can be customized using a paint editor tool that, like the program blocks, offers a high ceiling of complexity. The output of the programmed characters is then seen on the programming stage, where children can watch their animations or interact with their programs.

Curriculum: coding as another language

The Coding as Another Language for ScratchJr (CAL-ScratchJr) curricula were developed by the DevTech research group to teach ScratchJr alongside and integrated with literacy and social-emotional development (Bers, Levinson, et al., 2023). The curricula, freely available online for kindergarten, first, and second grade, consist of 24 45-minute lesson plans and associated materials for teachers to teach ScratchJr skills through storybook readings, songs, games, unplugged computational thinking activities, and open-ended ScratchJr projects. These resources are based on a pedagogical understanding of coding as a language that can be used for creative expression, like spoken or written languages (M. Bers, 2019). Teaching coding alongside literacy can produce better coding and computational thinking outcomes for the students, so literacy is integrated into the curriculum through ScratchJr projects retelling and expanding on narratives and stories

Figure 1. ScratchJr interface.

(Hassenfeld & Bers, 2020). Each curriculum features a nonfiction book highlighting a woman or minority figure in STEM and a fiction book with a social-emotional component and a strong narrative element.

The curricula have been implemented and evaluated in the United States as part of a pilot program and a multi-state cluster-randomized control trial (Bers, Blake-West, et al., 2023, Yang et al., 2023). Students who participated in the CAL-ScratchJr curriculum had increased coding knowledge compared to students in the control group, but there was no significant effect of CAL-ScratchJr on computational thinking. Computational thinking and coding language knowledge are both needed to code successfully and are therefore both taught in CS curricula, but some programs emphasize one over the other. The lack of effect of the curriculum on computational thinking was believed to be because students in the control condition received educational programming within their existing curricula that promoted the development of their computational thinking, but were not receiving existing coding language programming, so the CAL-curriculum was filling a gap for the coding knowledge portion of the CS education. The curriculum has also been piloted outside of the United States (Ben-Ari et al., 2023; Bers, Levinson, et al., 2023), but until now, there has yet to be an experimental validation of the curriculum with a control group outside of the United States.

CS education in Argentina

Argentina is the fourth-most populous country in Latin America, with a population of approximately 46 million people (Instituto Nacional de Estadística y Censos, n.d.-a). Broad educational policies, such as the mandatory ages of education (4–17), are set at the national level, but provincial ministries of education manage most educational policies. Over 85% of five-year-old children from the Corrientes province in the Northeast and over 90% of children in the Mendoza province 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.). At the national level, approximately 30% of students attend private schools for initial (preprimary) education, which are also administered, overseen, and often subsidized by provincial ministries (OECD, n.d.).

As mentioned above, CS education has become increasingly prioritized worldwide, which is also true within Latin America and Argentina. A 2018 report found that in most of Latin America, supporting economic development and promoting STEM careers were the primary drivers of K-12 CS education proposals and policies in Argentina (Jara et al., 2018). Non-economic social goals, such as developing students' higher order thinking skills, increasing motivation for schooling, and improving gender equity, also motivated CS educational policy in Latin America but were less relevant in Argentina specifically. As mentioned above, provincial ministries create and implement most educational policies, but some national policies and initiatives push CS education across Argentinian classrooms, including early childhood and early elementary programs. Some of these programs have included Program.AR in 2012 and Connected Learning in 2018 promoting CS and robotics education in all public initial, primary, and secondary schools nationwide (Jara et al., 2018). However, these programs have not been implemented equally across schools and provinces.

Current study: coding as another language in Argentina

As mentioned above, the CAL program has never been validated outside of the United States, and we chose Argentina as the first country outside of the United States to study the curriculum for a few reasons. To clarify, validation in one country outside of the United States does not answer if the curriculum will be successful in all contexts but does answer the initial question of if the curriculum can be successful in in a context outside of the United States. The early education systems of the United States and Argentina have similar histories, with kindergartens rooted in playful learning and the pedagogies of Froebel (Allen, 1986), and teachers in both countries value play when teaching coding and CS (T. G. Levinson, 2024). Additionally, both countries have decentralized educational systems primarily run at the state or provincial level, even though there is national or federal education policy (Cardini et al., 2020; Kamerman & Gatenio-Gabel, 2007). However, a major difference between the two countries is the placement of kindergarten – kindergarten in Argentina, although mandatory, is part of the pre-primary system while kindergarten in the United States is already embedded in the formal elementary school system. Finally, literacy education varies between the two countries, as Spanish has a one-to-one letter to sound correspondence, while English literacy is more complex, meaning that children in Argentina learn to read much more quickly. Finally, although we were only evaluating the curriculum in one country, we did so in multiple educational contexts (public, private, urban, and rural schools in two socioeconomically distinct provinces). Evaluating the curriculum across a variety of Argentinian contexts could increase understanding of how early childhood CS programs and pedagogies, including the CAL-ScratchJr program, could be implemented in multiple Latin American educational contexts, which includes over 150 million children (UNICEF, 2020).

We partnered with a local NGO to adapt, implement, and study the Coding as Another Language for ScratchJr curriculum in two provinces in Argentina, Mendoza and Corrientes. The Varkey Foundation is an international NGO focusing on improving educational outcomes for underprivileged children worldwide, including through educational technology. The organization has a long history and considerable community relationships in Latin America and Argentina specifically, and their Latin American offices are based in Argentina. As such, the Varkey Foundation was uniquely positioned to adapt a CS curriculum to the Argentinian context. The two project coordinators from the Varkey Foundation led the translation process, with a second team of undergraduate research assistants checking the Spanish translation for content validity against the original curriculum version.

One strategy of curriculum adaptation that is frequently used is localization, which is defined by Bird et al. (2011) as presenting lesson materials through concrete applications relevant to specific contexts in order to engage students' interests. This approach involves creating culturally relevant instructional resources that resonate with students' backgrounds. However, our partners focused on translation in their adaptation process, rather than the replacement of materials, as they believed that the materials were as relevant for the Argentinian context as for the United States context. For example, many books in the CAL-ScratchJr curriculum were available in Spanish, or alternate books about the same characters were selected. This was done to support the curriculum's learning goal of educating children about historical women in STEM. The songs, which were created for the original CAL curriculum, were based on melodies that were also familiar in Argentina, and so were translated but not replaced. However, translation was not always enough to support meaningful engagement for all students in all regions of the country, so teachers were encouraged to make any necessary additional adaptions. Further adaptation of the curriculum, including songs, games, or lesson structure, was made at the classroom level by individual classroom teachers. The decision made most consistently by teachers was not to complete the unit test at the end of the curriculum. This perceived fit of the original curriculum materials to the Argentinian context, and the subsequent decision to translate but not replace materials, had not been seen in pilot projects localizing the curriculum in other countries (Ben-Ari et al., 2023).

This paper used a convergent-parallel mixed methods approach to understand the international scaling and local implementation of the CAL-ScratchJr curriculum in two Argentinian provinces, Mendoza and Corrientes. We asked two primary research questions:

(1) Did the CAL-ScratchJr program improve Argentinian students' coding knowledge and computational thinking compared to students in a controlled setting?
(2) What aspects of the curriculum did the teachers perceive as successful or unsuccessful when implementing the curriculum locally?

Methodology

This study used a convergent-parallel mixed methods approach to understand the implementation and impact of the CAL-ScratchJr curriculum in two Argentinian provinces through two lenses: 1) the traditional, internationally validated assessments of student performance that had been used when originally evaluating the curriculum, and 2) local teachers' understandings of the success of the curriculum when implemented in their schools and classrooms. Traditional measures of student success were evaluated using a cluster-randomized control design and hierarchical linear modeling of student assessment scores, and teacher perceptions of curriculum success were evaluated using qualitative analysis of teacher focus groups.

Both student and teacher data were collected as part of a larger cluster-randomized control design study implementing the curriculum in Corrientes and Mendoza, Argentina (Figure 2). The schools served as the clustering level, as teachers work within school communities. Seventeen schools across the Corrientes and Mendoza provinces took part in the CAL-ScratchJr Argentina Project. Schools were randomly assigned to teach the CAL-ScratchJr curriculum or the control condition. Schools in the control condition participated in their daily activities, with teachers receiving only their standard professional development and teaching their standard curriculum. This did not include a standardized CS program, although some of the students had technology time in their schools.

The CAL-ScratchJr curriculum was implemented at the classroom level either by the classroom teacher or by an enrichment teacher who received prior training. Enrichment teachers were either computer, library, or English teachers who led technology or language art sessions for the school and typically taught or co-taught CAL-ScratchJr lessons for more than one classroom within that school. Before teaching the CAL-ScratchJr curriculum, teachers received six sessions of an hour-long professional development on the Coding as a Playground and Coding as Another Language pedagogies, the ScratchJr coding language, and the CAL-ScratchJr curriculum. Before and after this professional development training, teacher surveys were distributed, and teachers completed an assessment of their coding knowledge. After the professional development, teachers in the treatment condition completed focus groups with in-country project coordinators,

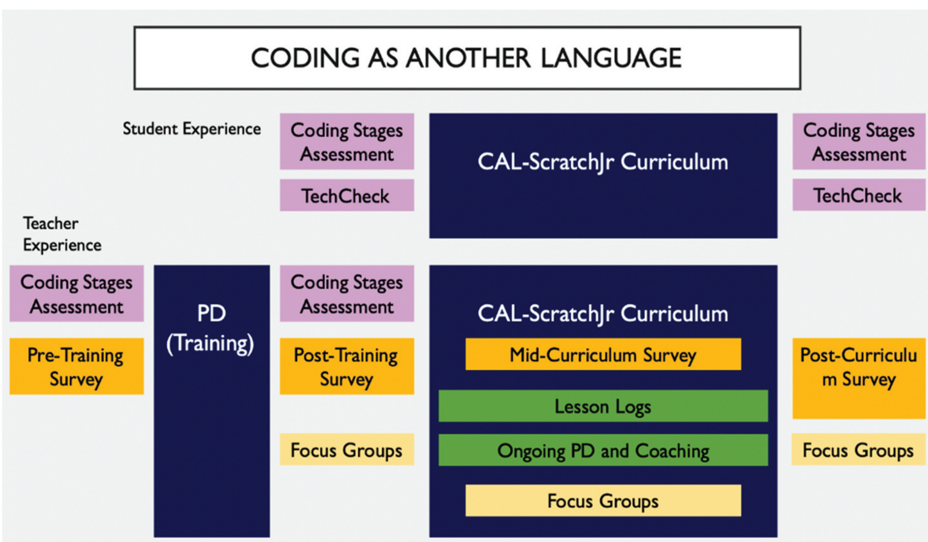

Figure 2. Study protocol.

and students completed pre-curriculum assessments of coding knowledge and computational thinking. Teachers then implemented the 24-lesson coding curriculum in the classroom. During the curriculum, teachers were given a mid-curriculum survey and completed a second focus group. Finally, following the curriculum, the teachers completed additional focus groups and surveys, and students completed post-curriculum assessments. The protocol is summarized in Figure 2. Teacher completion rates for surveys were extremely low, so the surveys were unable to be meaningfully analyzed, and the results were not included in this paper. Additionally, the teacher CSA results are not included in this paper, as teacher learning is outside of the scope of this paper and will be reported in future papers.

This study was approved by [AUTHORS' INSTITUTIONAL IRB] under protocol code [#########].

Participants

This paper includes data from students and educators. RQ 1, evaluating student performance on internationally validated assessments, used quantitative student data from both treatment and control groups, while RQ 2, studying teacher understandings of the curriculum, used qualitative teacher data from the treatment group.

Students

Five-hundred fifty-six kindergarten, first, and second-grade students participated in the study by completing at least one assessment time point (Table 1). There was an attrition rate of 19.1%, with 450 students completing both time points of assessment. As mentioned above, these children were from 17 schools, 9 in Corrientes and 8 in Mendoza. The sample included public and private schools in urban and rural educational settings.

Teachers

In all, 62 educators were enrolled in the study. Of these, 30 teachers were included in our treatment condition and therefore included in our dataset for RQ2. This sample included classroom teachers, enrichment teachers, and administrators. The educator sample was 90.3% female. Teachers in the treatment condition had an average of 10.93 ($SD = 5.8$) years of classroom experience, ranging from 1 to 24 years. However, the teachers did not have high levels of programming experience; only 24% had prior experience with the ScratchJr programming language, and only 35% had any prior training or experience with programming.

Table 1. Distribution of students by gender, condition, and grade.

Condition	Kindergarten	First Grade	Second Grade
Treatment			
Girls	64	30	32
Boys	74	40	34
Total	128	70	66
Control			
Girls	56	41	41
Boys	70	52	56
Total	126	93	97

Instruments

Student performance

Coding stages assessment. Coding knowledge, defined as knowledge of the ScratchJr coding language and its' syntax, was evaluated using the Coding Stages Assessment (CSA) (de Ruiter & Bers, 2021). As mentioned above, the CSA is based on the Coding Stages Framework, which proposes that children learn to code in developmental stages like the developmental stages in which children learn to read (M. Bers, 2019). The framework proposes five stages: *Emergent, Coding and Decoding, Fluency, New Knowledge*, and *Purposefulness*. Each stage has six questions, and the assessment is designed so that children move to the next stage if they correctly answer five of the six questions within a stage. However, the "*purposefulness"* questions are spread throughout the assessment at varying levels of difficulty, to capture the potential intentionality of coding that can exist at any stage of coding development.

The CSA has been previously validated in English-speaking children and adults (de Ruiter & Bers, 2021). To adapt, administer, and validate the Spanish CSA in Argentina, a Varkey Foundation team member translated the assessment into Spanish. The assessment was then back translated to English by an undergraduate research assistant at DevTech. The original English assessment and the back-translated assessment were evaluated for content validity by a third research assistant who rated the items on a 0–2 scale as "not the same", "somewhat similar", or "same" found 89.8% of the items to be conceptually the same between the two versions, and 99.3% of the items to be somewhat similar or the same. The assessment was administered individually in Spanish by research team members and took approximately five to forty minutes, depending on the child's ability. Teachers in the treatment condition were assessed with the CSA before and after the professional development, and all children were assessed at the beginning and end of the program.

TechCheck. The TechCheck assessments evaluated computational thinking, as defined by the cognitive skills necessary for coding (e.g. sequencing, abstraction) divorced from any one coding language (Relkin & Bers, 2021; Relkin et al., 2020, 2023). TechCheck is designed to be developmentally normed for a child's grade; the kindergarten, first, and second-grade versions were used in this study. The assessment consists of fifteen multiple-choice questions, with three (kindergarten) or four (first and second grade) answer options.

Like the CSA, TechCheck-K, TechCheck-1, and TechCheck-2 have been previously validated in English (Relkin & Bers, 2021; Relkin et al., 2020, 2023). A member of the Varkey Foundation team translated the three assessments into Spanish to administer the three assessments in Argentina. A research assistant back translated the assessments into English. The original English assessment and the back-translated assessments were evaluated for content validity by a third research assistant who found 93.4% of the kindergarten items, 89.5% of the first-grade items, and 93.4% of the second-grade items to be a conceptual match between the English and Spanish assessments. The assessments were administered individually in Spanish to all children at the beginning and end of their participation in the CAL-ScratchJr curriculum implementation.

Teacher understandings of success

Interviews and focus groups. Nineteen teachers participated in focus groups and interviews three times during the CAL-ScratchJr curriculum implementation study: at the curriculum's beginning ($n = 19$, 3 focus groups), middle ($n = 12$, 3 focus groups), and end ($n = 10$, 3 focus groups). Questions were asked about teachers' expectations, experiences, successes, and challenges with the curriculum and research experience. The focus groups were conducted virtually over Zoom by Varkey Foundation project coordinators and were recorded and transcribed into English by a research assistant. A fourth end-point interview was recorded with poor internet quality and was therefore not transcribed or translated.

Analysis

This study used quantitative and qualitative analyses to evaluate the impact of the CAL-ScratchJr curriculum on students and teachers in Argentina's Corrientes and Mendoza provinces. Quantitative analyses were conducted in R using the tidyverse, moments, performance, lme4, and lmertest packages (Bates et al., 2015; Komsta & Novomestky, 2015; Kuznetsova et al., 2017; R Core Team, 2020; Wickham et al., 2019). All graphs were created using the ggplot2 and wesanderson packages (Ram & Wickham, 2018; Wickham, 2016).

Student performance

Our first research question examined student outcomes from the coding curriculum on coding knowledge and computational thinking. This study was designed as a cluster-randomized control trial, so to answer this research question, we used a three-level multilevel growth model with students' assessment scores as the independent variable, nested at the student level and finally at the school level. The school was chosen as the clustering level for the analysis because the school was the location of clustering for the intervention, and the implementation was administered at the school level, with school administrators making decisions about how to administer the curriculum in each school. Timepoint was a predictor at level 1, and condition was added as a time-varying predictor at level 3. Random intercepts were removed from the model. The model was predicted twice: once with coding stages assessment scores as the dependent variable and once with TechCheck assessment scores as the dependent variable. The equations are included below.

Level 1: $Y_{ijk} = \beta_{0jk} + \beta_{1jk}\left(timepoint_{ijk}\right) + R_{ijk}$

Level 2: $\beta_{0jk} = \gamma_{00k} \qquad \beta_{1jk} = \gamma_{00k}$

Level 3: $\gamma_{00k} = \delta_{001}(condition_{00k}) + u_{001}$

$$\gamma_{10k} = \delta_{101}(condition_{10k}) + u_{101}$$

Teacher understandings of success

Our second research question examined curriculum success as defined locally by teachers. For this, we conducted a thematic analysis involving discovering, interpreting, and reporting patterns and clusters of meaning within the data (Boyatzis, 1998; Braun & Clarke, 2006; Joffe, 2012). We engaged in a hybrid deductiveinductive coding structure, following the three levels of coding and analysis outlined by Wolcott (1994), emphasizing, analyzing, and interpreting participants' answers relating to successes and unsuccessful moments in the curriculum implementation. We decided to use a hybrid method due to its' theoretical flexibility – narrowing in on moments when teachers discussed success without imposing our existing theoretical frameworks on their understanding of success (Clarke & Braun, 2013).

Our process included first identification and open coding by two authors of teacher quotes relating to perceptions of success (or lack thereof) in curriculum implementation. The two authors were two education graduate students at a R1 research university in the Northeast United States. One author is a white American woman who was born, educated, and has always lived and worked in the United States. The other author is a Latin American woman who received formal and university education in Chile and in the United States, where she also worked as a teacher and a researcher.

After open-coding the data, we created a unified code book and identified themes within the codes. If there were disagreements between the two coders, we discussed these to reach agreement at this stage. In the final stage, we interpreted the data to answer the research question. Finally, as this was a mixed methods study, we also examined whether our findings of the teachers' understanding of student success from the curriculum converged with the findings from the success metrics from our first research question.

Results

Student outcomes

Our first research question was whether the CAL-ScratchJr curriculum effectively improved coding knowledge and computational thinking in Argentina. We first looked at coding knowledge as measured by the performance on the coding stages assessment at two time points, using a three-level regression nested by students and schools (Figure 3). The ICC of this model was 0.10. There was a small but significant difference in score between the CAL-ScratchJr and control groups at baseline, with students in the CAL-ScratchJr group scoring lower than students in the control group ($\beta_{0jk} = -0.60$, $p < .01$). Relevant to our research question, there was an overall significant effect of time on coding knowledge ($\delta_{0jk} = 2.11$, $p < .001$), but there was a highly significant 5.30-point difference between the growth seen in the CAL-ScratchJr group and the growth seen in the control group ($p < .001$).

We then looked at computational thinking as measured by the performance on the TechCheck assessment, again at two points, using a three-level regression nested by student and school (Figure 4). The ICC of this model was 0.11. There was no significant effect of condition on TechCheck at baseline ($p = .40$). Relevant to our research question, there was an overall significant effect of time on coding knowledge ($\delta_{0jk} = 1.06$, $p < .001$), as well as a 1.07-point difference between the growth seen in the CAL-ScratchJr group and the growth seen in the control group ($p = .02$).

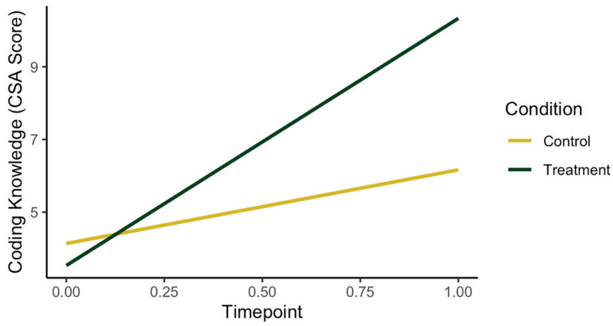

Figure 3. Coding knowledge before and after the CAL-ScratchJr Curriculum.

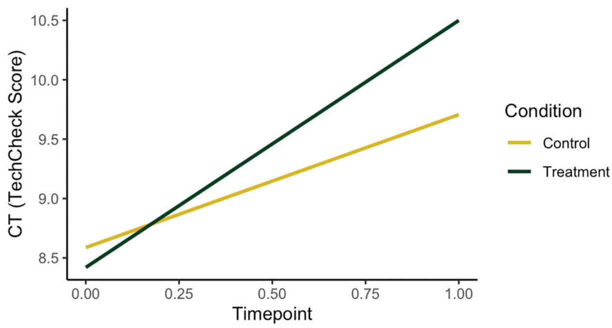

Figure 4. Computational thinking before and after the CAL-ScratchJr Curriculum.

Teacher understandings of student success

A few major themes emerged in how teachers described student success: descriptions of student success related to academics, descriptions of student success related to social-emotional learning (SEL) and approaches to learning (ATL), descriptions of student success related to student engagement with the material, and descriptions of student success that were highlighted by the teacher as externally observed and validated. Teachers did not describe the curriculum as non-successful or as not fitting their classroom culture.

Academic-related success

Academic-related success was described in multiple ways, but the most common was teachers describing the students successfully creating content with the ScratchJr program. As one teacher described, "They [the students] assembled their characters as they wanted to, where they wanted to, and to go how they wanted to, what they were called ... this gave me a lot of satisfaction. It is really nice to see those results". Teachers also focused on the ease with which the children created this content. A teacher described how his students spent multiple sessions creating a project only to lose the project due to a power outage. However, when he brought the students another computer, they could recreate the project within an hour and a half.

Another academic-related theme was vocabulary growth. This growth was not originally intended to be a curricular focus from the CAL-ScratchJr program, with one teacher going as far as to call the vocabulary growth "unintentional". However, when asked about academic literacy outcomes, teachers identified the quantity and quality of the new words students were learning. Vocabulary growth was seen "in terms of programming, in terms of the blocks, what they are called, and how they move beyond writing or not writing". One teacher described, "As the classes progressed, they acquired new words and described what they were doing".

Interestingly, teachers highlighted not only vocabulary knowledge gain as a sign of student success but also the lack of such increase as a sign that a student was unsuccessful with the curriculum. One teacher described frequent absences as a challenge in her class and how she noticed that "it was difficult for [children with absences] to adopt the vocabulary … which presented a challenge in my room".

Finally, teachers described coding in ways that related to the Coding as Another Language pedagogy, after which the curriculum was named and on which the teachers received formal training. When describing success in coding as another language, teachers described how coding and the CAL-ScratchJr curriculum allowed the students to express themselves. "I worked on a story, and they, based on the story, first wrote it, and then we did it with ScratchJr, the different images, the narrative sequence, and they remembered the story that we had written together … then that was the story of the final project we did, and there they started looking for images … and there they discovered a lot of things".

Social-emotional and approaches to learning

The second theme to emerge was success relating to social-emotional learning (SEL) and approaches to learning (ATL) skills (Hayashi et al., 2022; Li-Grining et al., 2010). Descriptions of student success with ATL skills emerged from the teacher interviews, including creativity and imagination, perseverance, patience, curiosity, and organization. One teacher described these behaviors together when describing students successfully engaging the curriculum, explaining that "they [the children] were investigating, exploring the tool more, and if after this, together we saw that they had to follow the steps, that we could not jump at all because they had started with the error … they were not distressed, but they said that they had to wait".

Similarly, multiple teachers described student growth in social development emerging from the curriculum, particularly regarding communication and community engagement and in connection with ATL skills. One teacher described collaboration alongside successful persistence, describing how "when they were solving the problem, they had been seeing how they could solve it so they were testing different possibilities to be able to fix this error and that comradery came from them; therefore, they said 'Good, you have to do this and if you do this, we will solve it'." Similarly, another teacher described how "there was active participation between them – the creativity, the decision-making they had to do with each proposal … when they had to build a scene or to make a story, create audio with their voice, it was decisions they were making based on the phrase that was given, and they decided how to do it". A third teacher summarized how this academic success led to social-emotional competence, explaining, "I love seeing the progress of the students and seeing the confidence they have".

Student engagement with the material

The third theme of student success that emerged from the teachers' interviews was student engagement with the material, including with the games and books. Teachers described the children's autonomy, happiness, motivation, and participation in the curriculum as forms of success. One teacher explained that "it is important that they have done it with a lot of happiness, they loved it, they ask 'Teacher, can we go to have ScratchJr programming?' . . . and they are very happy to do their homework". Another teacher further emphasized the role of engagement in understanding success with the curriculum, explaining that "to see them motivated, to see them participate and to have learned it, what they can achieve, I believe this is the most important thing".

Importantly, these behaviors were not only an indicator of success but also behavior that could promote student engagement and lead to further curricular success. One teacher described a scenario where a child had completed the assigned work, saying that "I said to [the] student, 'Well, create something that you want with everything we learned', and he ended up creating a *Mario Bros* game, so it's playing and also awakening the creativity and imagination of the kids". In this example, the engagement with ScratchJr and the curriculum led to autonomy, creativity, and motivation, leading to further advanced content creation and complex projects. As such, these behaviors that the teachers viewed as successful could also serve as pathways for other student successes.

External validation

The final theme was the external validation the teachers received about their students' success with the curriculum. As described above, the teachers named many forms of success, but across domains, teachers included descriptions of or references to how their success was perceived by administrators, parents, or other teachers.

This external validation took multiple forms and referenced multiple domains of success. One teacher described local study coordinator visiting the school and seeing the children's happiness. Multiple teachers described showing off the students' creations at an open-house celebration to other school community members, including the students' ScratchJr programs, drawings of their planning process, and presentations describing their work. The open house was attended by other classes, parents, and school administration, and teachers highlighted students' social and emotional behaviors during this showcase. "They [the students] gave a class on what they did, and it was incredible how they waited their turn to speak with the microphone to show what they did".

Finally, one teacher described how parent satisfaction and buy-in were indicators of project success, as it would lead to future project iterations. At the beginning of the project, some parents were hesitant about participating in a research program but were pleased after seeing the open house and the student results. This emphasis on gaining parental and administrative buy-in through the sharing of work was described as in contrast to teachers' prior experiences centering standardized assessments, with one teacher explaining that "we are in a rural area and generally the training possibilities are always given by the score, and if there is no score, there is not much motivation".

Discussion

This paper examined the implementation and evaluation of an adapted coding and literacy curriculum, CAL-ScratchJr, for early elementary schools in two provinces in Argentina using quantitative and qualitative measures of student and teacher success. We found that students who took part in the curriculum had significantly higher growth in coding knowledge and computational thinking than those in the control condition. We also found that teachers named student success relating to traditional academic metrics, SEL and ATL skills, and student engagement with the curriculum. Teachers also highlighted programmatic successes across domains as seen by outsiders, such as administrators, parents, and researchers.

Student growth and outcomes

As mentioned above, student growth was found in computational thinking and coding knowledge and was described by teachers in terms of students' vocabulary growth, the ability to create complex projects, and the use of the gained skills in other academic contexts. Prior work has evaluated the CAL-ScratchJr curricula and pedagogy in the United States, where it was initially developed and evaluated like many early childhood CS programs (Bers, Blake-West, et al., 2023).

This is the first paper to evaluate the CAL-ScratchJr curriculum and pedagogy outside of the United States, where the curriculum significantly improved students' coding knowledge compared to students in a control group but not students' computational thinking (Bers, Levinson, et al., 2023). As such, one key takeaway from the findings is that the curriculum and pedagogy can be adapted and applied beyond the United States educational settings. With adaptations, the curriculum succeeded in many domains for teachers and students in a country with a different cultural, linguistic, and educational context. Arguably, the curriculum had a greater impact in Argentina than in the United States in improving student outcomes, as in Argentina, the curriculum had a significant impact on computational thinking compared to the control group, while in the United States, there was not.

It is possible that this is due to the adaptation efforts, including the allowance of further modifications at the teacher level, as in the United States, the curriculum was more strictly standardized across schools, districts, and regions. It is also possible that students in Argentina receive fewer coding or computational thinking opportunities in their existing curriculum than students in the Northeast United States, so accessing an opportunity such as the CAL-ScratchJr curriculum benefits the Argentinian students' development in more ways than students in the United States. To evaluate if the students' experiences in the control group were different between the two countries, future research should examine and compare the control experiences of students in the two countries.

This paper found that teachers also cared about success beyond academic outcomes, as seen in behaviors that related to the early childhood pedagogical approaches of Coding as a Palette of Virtues and Positive Technological Development on which the CAL-ScratchJr curriculum was developed in the United States (M. Bers, 2021). Some SEL and ATL behaviors that the teachers described as curricular successes were behaviors that fit within the PTD and Palette of Virtues framework and metaphor, respectively, such as Persistence and Curiosity from the Palette of Virtues and Creativity and Content Creation from the PTD framework. The teachers described that the students developed patience and collaborative problem-solving skills during the curriculum implementation, which supported their coding and literacy development. None of these findings were unique to Argentina. This both aligns with prior research about the beliefs and impacts of CS education on students and teachers in the United States, and suggests that these may be universal goals of classroom teachers when teaching CS to young children.

Again, this was the first time evaluating the curriculum outside of the United States, but these findings suggest that this pedagogical approach, when adapted to local educational contexts, can be successfully applied to early childhood contexts in Argentina and potentially be applied to early childhood contexts globally.

Validating teacher successes

We also found that teachers defined success through external validation, specifically the observations of parents, peers, and administrators. Traditionally and for traditional subjects, metrics of external validation are testing and scores. In Argentina, testing begins in third grade, although one teacher described already feeling pressure in her early elementary class. However, the CAL-ScratchJr program offered teachers external validation in several domains that they themselves also viewed as successful, even if these were not traditionally assessed. As such, the creation-based and integrated curriculum allowed teachers to show their students' creativity, projects, emotions, and motivation and receive external success metrics outside of the traditional assessment format.

As the CAL-ScratchJr program becomes a suitable pedagogical model, expanding to more countries and regions, this finding provides an added incentive for teachers to join the study. Research from the United States suggests that when standardized assessments are prioritized in validating teachers' and classrooms' performances, teachers limit time teaching additional non-assessed subjects and incorporating play-based and child-led activities (Brown et al., 2020; Pederson, 2007). As such, a curriculum that provides both demonstrated success through formal assessment and an opportunity for teachers to receive validation on alternate metrics of success in domains of student motivation, creation, social and emotional growth, and happiness could offer the best of both worlds. Teachers who want to show their students' success in these alternate domains can receive credit for doing it with the CAL-ScratchJr program while also demonstrating success according to validated quantitative growth metrics in coding knowledge and computational thinking.

Curriculum adaptation

Although our work with our community partner focused on curriculum adaptation, the majority of the adaptation process focused on translating the curriculum and materials rather than creating new materials. As is mentioned above, this is because the coordinators at the Varkey Foundation felt that the original materials were not irrelevant to the Argentinian context and met learning goals of the local community. Lack of cultural understanding or relevance was not identified as a challenge by teachers in teaching the curriculum, who described storybook-related projects as one of the successful elements of the curricula.

An example of the success of this learning-goal centered adaptation process was seen in the storybooks. Many adaptation processes highlight the pedagogical practice of localization, which emphasizes using local stories and materials to help students see themselves in the material and improve interest and motivation (Bird et al., 2011). However, one of the secondary learning goals of the books in the original CAL curriculum was to celebrate historical women in CS. This goal was identified as locally meaningful by our community partners, who wanted to reflect and empower young girls in STEM as a secondary goal of the CAL-ScratchJr program. Although there were alternate and translated books available about the characters highlighted in the curriculum (Grace Hopper, Ada Lovelace, and Katherine Johnson) there were not alternate books available about Latin American women in CS. This practice stood in contrast to some traditional ideas of "localization", (namely, a focus on finding locally meaningful and culturally relevant materials) but speaks to the importance of local team members who understood the local goals, as well as to the universality of many of the goals of CS education. (As an aside, this is perhaps a call to action for more children's books recognizing female and culturally non-dominant figures in STEM from more countries, so that these do not need to be competing goals for future educators and curricula.)

We strongly recommend all global projects include local team members who can identify local learning goals. We also recommend that curriculum writers clearly define all learning goals and objectives of their programs, so that local team members can identify if these learning goals and objectives are relevant to their communities. This knowledge would empower local team members to create adaptations that prioritize relevant learning goals with less concern of impacting irrelevant goals.

Limitations and next steps

A key limitation of this project was the limited teacher data collected. Not all teachers completed surveys for all time points, which limited our ability to make statistical conclusions about teacher self-efficacy across the program. The value of the mixed-methods approach of the study was that the qualitative analysis of teacher interviews allowed us to make conclusions such as that the teachers perceived the curriculum as successful, their students as performing well across many domains, and the experience as successful as seen through external observers. These findings suggest high feelings of self-efficacy for teachers. However, future project iterations should emphasize survey completion so that these questions can also be answered quantitatively.

Conclusion

In conclusion, our findings suggest that the CAL-ScratchJr curricula, which combine powerful ideas from CS and powerful ideas from literacy, were valuable tools for teachers to promote coding, computational thinking, language, and social-emotional growth in the Argentinian provinces of Corrientes and Mendoza. These resources, like many early childhood CS materials, were developed and initially evaluated in the global north, but our work suggests that they can be adapted in locally relevant ways for students outside of the United States and in Latin America. Future work should continue to offer, adapt, and implement the curriculum for countries worldwide to support teachers' mission to educate the global citizens of the 21st century.

Acknowledgments

We want to thank Pamela Gonzalez, Hernan Gonzalez, Carolina Gimenez, and the team at the [ANONYMIZED] for their partnership on the CAL-ScratchJr Argentina project. We would also like to thank Jessica Blake-West, Maria Segarra, and Mia Andraca for their work on the project.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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References

About CSforAll. (n.d.). *CSforAll: Computer science for all students*. Retrieved December 9, 2020, from https://www.csforall.org/about/

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

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/10.18637/jss.v067.i01

Ben-Ari, A., Levinson, T. G., Umaschi Bers, M., & Rosenberg-Kima, R. B. (2023). *Coding as a self-expression tool*. https://doi.org/10.1145/3545947.3573244

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

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

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

Bers, M., 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., Doyle-Lynch, A., & Chau, C. (2012). Positive technological development: The multifaceted nature of youth technology use toward improving self and society. In C. C. Ching & B. J. Foley (Eds.), *Constructing the self in a digital world* (pp. 110–136). Cambridge University Press.

Bers, M., González-González, C., & Armas-Torres, M. B. (2019). Coding as a playground: Promoting positive learning experiences in childhood classrooms. *Computers & Education*, *138*, 130–145. https://doi.org/10.1016/j.compedu.2019.04.013

Bers, M., 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*. ISLS.

Bers, M., Lynch, A. D., & Chau, C. (2009). Positive technological development: The multifaceted nature of youth technology use towards improving self and society. In C. C. Ching & B. J. Foley (Eds.), *Technology, learning, and identity: Research on the development and exploration of selves in a digital world*. Cambridge University Press 110–136.

Bers, M., Strawhacker, A. L., & Vizner, M. (2018). *The design of early childhood makerspaces to support positive technological development: Two case studies*. Library Hi Tech. https://doi.org/10.1108/LHT-06-2017-0112

Bers, M., Strawhacker, A., & Sullivan, A. (2022). The state of the field of computational thinking in early childhood education. *OECD education working papers No. 274*. OECD Education Working Papers. https://doi.org/10.1787/3354387a-en

Bers, M., & Sullivan, A. (2019). Computer science education in early childhood: The case of ScratchJr. *Journal of Information Technology Education: Innovations in Practice*, *18*, 113–138. https://doi.org/10.28945/4437

Bers, M. U., & Resnick, M. (2015). *The official ScratchJr book*. No Starch Press.

Bird, D., Livesey, G., & Simon, P. (2011). *The integration of academic and technical skills in K-12 and community college classrooms: Contextualized teaching and learning as a key strategy*. Retrieved February 4, 2016, from https://goo.gl/SU4uZd

Blake-West, J. C., & Bers, M. U. (2023). ScratchJr design in practice: Low floor, high ceiling. *International Journal of Child-Computer Interaction*, *37*, 37. https://doi.org/10.1016/j.ijcci.2023.100601

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Sage.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://psycnet.apa.org/record/2006-06991-002

Brown, C. P., Ku, D. H., & 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 & Teacher Education*, *90*, 103029. https://doi.org/10.1016/j.tate.2020.103029

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*.

Clarke, V., & Braun, V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. *Psychologist*, *26*(2).120–123

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

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*, *32*(4), 388–417. https://doi.org/10.1080/08993408.2021.1956216

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* (pp. 1–10). https://doi.org/10.1145/2485760.2485785

Govind, M., & Bers, M. U. (2020). *Family coding days: Engaging children and parents in creative coding and robotics*. Connected Learning Summit.

Govind, M., Relkin, E., & Bers, M. U. (2020). Engaging children and parents to code together using the ScratchJr app. *Visitor Studies*, *23*(1), 46–65. https://doi.org/10.1080/10645578.2020.1732184

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

Hayashi, A., Liew, J., Aguilar, S. D., Nyanamba, J. M., & Zhao, Y. (2022). Embodied and social-emotional learning (SEL) in early childhood: Situating culturally relevant SEL in Asian,

African, and North American contexts. *Early Education & Development*, *33*(5), 746–763. https://doi.org/10.1080/10409289.2021.2024062
Heckman, J. J. (2012). Invest in early childhood development: Reduce deficits, strengthen the economy. *The Heckman Equation*, *7*(1–2).1–2
Instituto Nacional de Estadística y Censos. (n.d.-a). *Dinámica y estructura de la población [Data set]*. Sistema Integrado de Estadísticas Sociodemográficas (SESD): Educación. Retrieved June 26, 2023, from https://www.indec.gob.ar/indec/web/Institucional-Indec-indicadoresSociodemograficos
Instituto Nacional de Estadística y Censos. (n.d.-b). *Educación [Data set]*. Sistema Integrado de Estadísticas Sociodemográficas (SESD): Educación. Retrieved June 26, 2023, from https://www.indec.gob.ar/indec/web/Institucional-Indec-IndicadoresSociodemograficos
Jara, I., Hepp, P., & Rodriguez, J. (2018). *Policies and practices for teaching computer science in Latin America*. Microsoft.
Joffe, H. (2012). Thematic analysis. In D. Harper & A. Thompson (Eds.), *Qualitative research methods in mental health and psychotherapy: An introduction for students and practitioners* (pp. 209–224). Wiley-Blackwell.
Kalelioğlu, F. (2015). A new way of teaching programming skills to K-12 students: Code. org. *Computers in Human Behavior*, *52*, 200–210. https://doi.org/10.1016/j.chb.2015.05.047
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
Komsta, L., & Novomestky, F. (2015). *Moments: Moments, cumulants, skewness, kurtosis and related tests (0.14)*. https://CRAN.R-project.org/package=moments
Kuznetsova, A., Brockhoff, P. 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
Levinson, T., & Bers, M. U. (2022). Student centered computational thinking for children with disabilities. *American Educational Research Association (AERA) Annual Meeting*, San Diego, CA.
Levinson, T. G. (2024). *Teacher beliefs on play and academic learning with a kindergarten coding curriculum: A mixed-methods study in the United States and Argentina* [Doctoral dissertation]. Boston College.
Li-Grining, C. P., Votruba-Drzal, E., Maldonado-Carreño, C., & Haas, K. (2010). Children's early approaches to learning and academic trajectories through fifth grade. *Developmental Psychology*, *46*(5), 1062–1077. https://doi.org/10.1037/a0020066
Navarro, O. (2022, November 7). Inician las inscripciones a cursos online gratuitos de formación digital para docentes. *Ambito Educativo*. https://ambitoeducativo.com/inician-las-inscripciones-a-cursos-online-gratuitos-de-formacion-digital-para-docentes/
OECD. (n.d.). *Education GPS [Data set]*. Retrieved June 26, 2023, from https://gpseducation.oecd.org/
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 & Ideas*, *80*(6), 287–291. https://doi.org/10.3200/TCHS.80.6.287-291
Portelance, D. J., & Bers, M. U. (2015, June 21–25). *Code and tell: Assessing young children's learning of computational thinking using peer video interviews with ScratchJr*. *Proceedings of the 14th International Conference on Interaction Design and Children (IDC '15), Medford, MA*, ACM, New York, NY.
Ram, K., & Wickham, H. (2018). Wesanderson: A Wes Anderson palette generator. *R package version 0.3, 6, 2018*.
R Core Team. (2020). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/
Relkin, E., & Bers, M. (2021). TechCheck-k: A measure of computational thinking for kindergarten children. *2021 IEEE Global Engineering Education Conference (EDUCON)* (pp. 1696–1702). https://doi.org/10.1109/EDUCON46332.2021.9453926
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*.

Scratch, J. (2021). *Un curso de ProFuturo que te permitirá aprender un lenguaje de programación muy sencillo*. Fundacíon Telefónica Movistar. https://www.fundaciontelefonica.com.ar/noticias/scratch-jr/

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

Sullivan, A., & Bers, M. U. (2016). Girls, boys, and bots: Gender differences in young children's performance on robotics and programming tasks. *Journal of Information Technology Education: Innovations in Practice*, *15*, 145–165. https://doi.org/10.28945/3547

Unahalekhaka, A., & Bers, M. U. (2021). Taking coding home: Analysis of ScratchJr usage in home and school settings. *Educational Technology Research & 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

Unahalekhaka, A., & Govind, M. (2021). Examining young children's computational artifacts Bers, Marina. In *Teaching computational thinking and coding to young children* (pp. 265–294). IGI Global.

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

UNICEF. (2020). *(Rep.). Children in Latin America and the Caribbean: 2020 overview*. City of Knowledge.

Wickham, H. (2016). *ggplot2: Elegant graphics for data analysis*. 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

Wolcott, H. F. (1994). *Transforming qualitative data: Description, analysis, and interpretation*. Sage.

Yang, D., Yang, Z., & Bers, M. U. (2023). The efficacy of a computer science curriculum for early childhood: Evidence from a randomized controlled trial in K-2 classrooms. *Computer Science Education*, 1–21. https://doi.org/10.1080/08993408.2023.2279198