Chapter 2
An International Community of Practice Through ScratchJr: The Coding as Another Language Curriculum Around the World

Francisca Carocca P., Jessica Blake-West, and Marina U. Bers

Abstract The Coding as Another Language—ScratchJr (CAL-ScratchJr) International Community of Practice, formed through the CAL-ScratchJr Special Interest Group (SIG) of the Scratch Education Collaborative, is comprised of 21 teams in 12 countries across the globe. Through the shared interest of ScratchJr organizations, they had the opportunity to engage with the DevTech Research Group, the Scratch Foundation, and each other throughout their first year to ideate on how to bring coding education to their local settings. Together, organizations explored DevTech's Coding as Another Language pedagogy and the Positive Technological Development (PTD) theoretical framework, working to understand it, adapt it, and implement these ideas in their local contexts across the globe. Throughout the experience, organizations put the theory into practice by exercising all the behaviors identified in the PTD framework through their own work within the group, and as a result, evolved beyond a special interest group into an international community of practice. Additionally, it was found that members of the international community of practice shared many common motivations for joining the initiative and positive views of the experience's impact on the organization and their local communities.

P. Francisca Carocca (✉) · J. Blake-West · M. U. Bers
DevTech Research Group, Boston College, Chestnut Hill, MA, USA
e-mail: caroccaf@bc.edu

J. Blake-West
e-mail: jess.blake-west@bc.edu

M. U. Bers
e-mail: marina.bers@bc.edu

S. Papadakis and M. Kalogiannakis (eds.), *Education, Development and Intervention*, Integrated Science 23, https://doi.org/10.1007/978-3-031-60713-4_3

1 Introduction

The rapid evolution of technology in recent decades has accelerated globalization and the interconnectedness of cultures worldwide. With this comes great educational opportunities and responsibilities. Following what authors such as [1–3], among others, have proposed, the local is not opposed to the global. Rather, the two create a network of differential relationships which are strengthened by the existence of the other. People can expand their ideas and perspectives on the world and themselves by being educated about their local and global contexts. However, educational materials and frameworks must be culturally and linguistically responsive to reflect an awareness of diversity, support students' construction of knowledge, and recognize the interconnection and interdependence of their language and culture [4].

To address the interconnectedness between local and global, both teaching and learning practices can be strengthened when educators are able to support each other's professional growth through a community of practice [5, 6]. Defined as a group of professionals and other stakeholders pursuing a shared learning enterprise, commonly focused on a particular topic, communities of practice support professional growth, which helps close the gap between research and practice, encouraging collaboration and leadership opportunities. For researchers who embark on collaborative practice-research efforts, this approach requires a fundamental shift from working *on* to working *with* the world of practice [7]. Through analyzing how meanings, beliefs, and understandings are negotiated and reflected in certain practices, it is found that learners within communities of practices can effectively develop competence in different topics, thus suggesting the power of a community of shared knowledge [8].

Educational communities of practice originated in response to barriers to professional development that were thought to exist within the culture of American schooling and within institutions of higher education responsible for preparing educators. These barriers included the separation of research and practice, the isolated nature of teaching, weak or poorly articulated theoretical frameworks for embracing specific educational practices, and the lack of consensus about the goals of education and what constitutes recommended practices [9]. Thus, communities of practice can improve achievement as they become spaces for people to discuss challenges and build skills, which is crucial to deploy opportunities for mentors, facilitators, and members of a particular relational network to engage in shared learning experiences and form social relationships [4, 10].

Communities of practice for educators have emerged to address pedagogical approaches, content materials, assessment instruments, or socio-emotional strategies [11]. Over the last two decades, virtual spaces have become increasingly common settings for communities of practice, as practitioners can interact, share interests and knowledge, set up common goals, and create a sense of togetherness with others from around the world, all while sitting in front of a computer, which would not typically be accessible without modern communication methods [12]. Access to new technologies and the speed of communication have fostered the transition toward

creating virtual communities of practice, understood as a "multifaceted network" transcending resources, geography, and individuals [13].

In this paper, we investigate the formation and development of a community of practice that emerged from the Coding as Another Language (CAL)-ScratchJr Special Interest Group (SIG), which began in the Fall of 2022 through the Scratch Education Collaborative (SEC), an international effort to connect Scratch educator communities worldwide. Focusing on the Coding as Another Language (CAL) curriculum to introduce children to the ScratchJr programming language [14, 15], led by the DevTech Research Group at Boston College, 21 teams from 12 countries in five continents came together to learn from, adapt, and distribute the CAL-ScratchJr curriculum into their local contexts.

The SIG is a two-year collaborative cohort experience centered around learning, experiencing, and practicing the four core principles of the DevTech research group: coding as a playground, coding as another language, coding as a bridge, and coding as a palette of virtues [16]. These principles are based on the Positive Technological Development theoretical framework (PTD) [17, 18] and are operationalized in the Coding as Another Language (CAL) curriculum. Through understanding and engaging with the PTD framework, this special interest group has transformed into an international community of practice. The members of this community of practice learned how to teach coding, computational thinking, and socio-emotional skills in the early childhood classroom while practicing the core ideas of DevTech's pedagogy. Through communication, collaboration, creativity, and more, members established strong social and professional networks centered around bringing CAL-ScratchJr to children worldwide in culturally responsive and pedagogically positive ways.

2 Background

2.1 The PTD Framework

The Positive Technological Development (PTD) theoretical framework, developed by Bers, informs the design of technology-rich tools, interventions, and, as described in this paper, communities of practice, taking into consideration the individual attitudes and the psychosocial processes influencing the positive uses of technologies by children in the context of their developmental trajectories [17–19]. PTD describes positive behaviors in technologically rich settings and provides a model for how those can be promoted. PTD draws on two bodies of work: Constructionism [20, 21], which looks at the role of creative uses of computers in education, and the Positive Youth Development approach proposed by applied developmental science (e.g., [22, 23]. As a framework for design, implementation, and evaluation, PTD takes a stance regarding positive ways for youth to engage with technology, and the use of the term "positive" connotes the promotion of individual characteristics (i.e., developmental

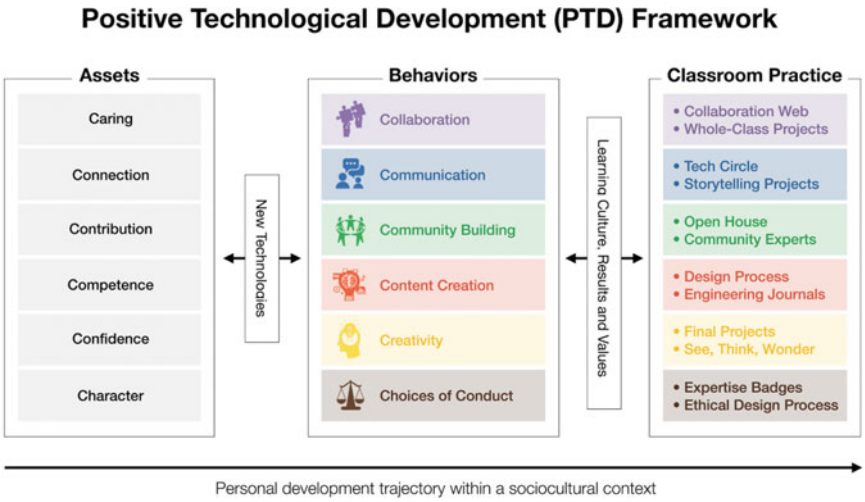

Fig. 1 The PTD framework shows the bidirectional relationship between developmental assets and technology-supported behaviors [24]

assets) and behaviors that would lead a young person toward a good developmental trajectory (i.e., development toward improvement of oneself and society).

PTD focuses on behaviors. As shown in Fig. 1, there is a bidirectional relationship between developmental assets and technology-supported behaviors. This relationship is mediated by the context of the environment's culture, rituals, and values. The use of technology to achieve certain goals, to act in the world, and to make things does not happen in a vacuum but within a particular sociocultural micro- and macro-cultural context.

The PTD framework examines the developmental behaviors of a child growing up in the current digital era and, therefore, informs the design of technologies, technologically rich interventions, and curricular materials to support children in becoming active agents in their own development and in contributing to society [18] by engaging in six positive behaviors referred to as the six "C"s: collaboration, communication, community-building, content creation, creativity, and choices of conduct. Table 1 shows the definition of each of the Cs and their operationalization in the context of both children's learning and the community of practice described in this paper. The PTD framework is inspired by an old question: "How should we live?" and invites to focus not only on computer science (CS) mastery and skills but also on experiences that enable children to develop a sense of identity, values, and purpose [16, 18, 25].

With this goal, PTD is in alignment with the Framework for twenty-first Century Learning, which emphasizes the integration of technical skills with an understanding of the ethical and social issues surrounding the use of new technologies [26] and the International Society for Technology in Education Student Standards, which identify digital citizenship, collaboration, and communication as fundamental technology skills alongside CT or troubleshooting skills. The PTD framework allows for the

Table 1 6C's definitions and contexts

6 C's behavior	Behavior definition	In an early childhood classroom utilizing the CAL curriculum	In this community of practice
Collaboration	Collaboration is defined here as getting or giving help with a project, programming together, lending or borrowing materials, or working together on a common task	Engaging children in a learning environment which promotes working in teams, sharing resources, and caring about each other while working with their ScratchJr programs, the early childhood classroom creates a collaboration web: a tool for fostering collaboration and support. Children also write or draw thank you cards to other children with whom they have collaborated	Collaboration in this community of practice was encouraged through different meetings, like whole and small group workshops, where the teams had to share their challenges and ideas to learn from other teams' experiences. As a result of this first year of working together, five teams will collaborate and propose a cross-country research study
Communication	Mechanisms that promote a sense of connection between peers or with adults	For example, in a classroom working with the CAL curriculum, communication is promoted through technology circles when children stop their work, share their ScratchJr creations, and explain their learning process. Technology circles present a good opportunity for problem-solving as a community because children sit together in an open classroom area and discuss what worked and what did not work for them	Communication between the partners is mediated by the facilitator, who guides the discussions, workshops, and chats. However, there were occasions when the teams established communication outside the meetings to engage in further collaboration opportunities, like the cross-country project

(continued)

Table 1 (continued)

6 C's behavior	Behavior definition	In an early childhood classroom utilizing the CAL curriculum	In this community of practice
Content creation	The engineering design process of building and the computational thinking involved in programming foster competence in computer literacy and technological fluency	While children imagine, design, and program their projects in ScratchJr, they develop skills that allow them to create new unique content using computational thinking and literacy skills to tell a story or program a character	After deciding which path to take, each team created the necessary resources, materials, or content to implement the CAL curriculum in their local settings. For example, a team in Greece created a fiction and non-fiction book to adapt the CAL curriculum to the educational context
Creativity	Making and programming personally meaningful projects which require problem-solving in creative, playful ways and integrating different media such as recyclable materials, arts and crafts, and a tangible programming language	In classrooms implementing the CAL curriculum, the final ScratchJr project is a good example of children engaging in a creative learning process. Based on the books or themes embedded in the curriculum, children must develop their representation of those stories, designing and programming what they want to express	DevTech gives access to and guides the international community of practice teams to implement the CAL curriculum in their settings. However, each team must be creative to find the most appropriate implementation way, use the resources, and engage children and educators in meaningful learning experiences. For example, a Portuguese team created an online professional development course for educators in their region to learn about CAL pedagogy and ScratchJr. Based on TeachCAL, they adapted and created a meaningful cultural and linguistic session

(continued)

Table 1 (continued)

6 C's behavior	Behavior definition	In an early childhood classroom utilizing the CAL curriculum	In this community of practice
Choices of conduct	As a program developed following the PTD approach, the focus on learning about coding is as important as helping children develop an inner compass to guide their actions in a just and responsible way	Providing children with the opportunity to experiment with "what if" questions and potential consequences and to prompt examination of values and exploration of character traits while working with ScratchJr. This behavior happens when children learn more about the app and can make their own decisions to create things on it	For the international community of practice, this behavior is hard to trace. However, we believe that by being part of this community, these teams are already choosing to impact their knowledge and practices, and we hope the same for each of their local contexts
Community building	Opportunities to engage with peers in different activities that happen in the same environment. Contribution of ideas, shared challenges, and community solutions result from this behavior in practice	Through scaffolded opportunities, children can form a learning community that promotes the contribution of ideas. Final projects done by children are shared with the community via an open house, demo day, or exhibition. These open houses provide authentic opportunities for children to share and celebrate the process and tangible products of their learning with family and friends. Each child can run their program and play the teacher's role as they explain how they built, programmed, and worked through problems with their family	This behavior has developed in the international community of practice over the year. Meeting for different activities and following a regular work schedule, the teams learned from each other and built a community with common goals, networks, and support. However, this behavior needs more encouragement and promotion during the second year of the community of practice

integration of nonacademic and academic developmental standards. In the experience described in this paper, the participating members of the SIG came together to learn about new pedagogical approaches and tools, such as the one proposed by the Coding as Another Language curriculum and the free ScratchJr app, to bring it to their local educational contexts. Becoming members of a global community of practice, the teams began to put the theory into practice [25].

2.2 Coding as Another Language (CAL) Curriculum

The Coding as Another Language (CAL) pedagogy posits that coding is literacy for the twenty-first century and, as such, coding education can borrow strategies from teaching other literacies. The CAL approach and curriculum explore the parallels between programming and natural languages, including their communicative and expressive functions. The CAL curriculum puts computer science in direct conversation with powerful ideas from literacy through a comprehensive scope and sequence [14, 15] consisting of 24 lessons of 45 min each for kindergarten, first, and second grade, centered around two books: a nonfiction book focusing on an underrepresented group in STEM and a fiction book focusing on socio-emotional development. Each lesson, moreover, includes songs, body movement, and group work, which are distributed across a warm-up activity, opening and closing "tech circles" where children are given a space to discuss and reflect on topics of the lesson, unplugged time, word time, and free or structured ScratchJr exploration. The PTD theoretical framework informs the CAL curriculum as each behavior is worked on and developed along the lessons (Table 1). Four core principles regarding the role of coding in educational settings serve to guide the implementation of the CAL curriculum. These are written in the form of metaphors [16].

Coding as a Playground: This metaphor compares the implementation of CAL and the use of ScratchJr to playing on a playground. On a playground, children play and explore freely and engage in all areas of human development: cognitive, socio-emotional, language, moral, physical, and spiritual. The Coding Playground promotes opportunities for open-ended exploration, the creation of personally meaningful projects, imagination, problem-solving, conflict resolution, and collaboration. This metaphor could also be applied to this international community of practice as this is a space where teams can explore what to do with the resources offered, engage with other teams, learn from each other, establish new relationships, look for creative solutions, and grow as human beings by developing the positive behaviors mentioned above.

Coding as Another Language: This pillar positions the teaching and learning of programming as a new way of thinking and expressing ourselves. Just like writing natural languages, mastering a symbolic representation system that is socially situated, such as programming languages, opens up opportunities for communicative and expressive functions. In this case, learning to code becomes a creative and expressive activity, producing something meaningful and shareable, not just a set of problem-solving skills. The CAL pedagogy promotes the exploration of the similarities and differences between natural and artificial languages for the creation process, their syntax and grammar, and their potential to empower individuals. In the international community of practice, this pillar is essential because when bringing together teams from different parts of the world, communicating using a common language is essential to transfer knowledge, build a stronger community, and impact the learning experiences of children and educators.

Coding as a Bridge: Programming languages are universal. People who speak a diversity of natural languages and who are different from each other can use them to create things together to engage in a shared activity. This metaphor helps us understand how a coding playground can be set up in such a way as to create bridges through which people can interact with others, connect in new ways, and create meaningful relationships through dialogue, encounters, and the production of shared artifacts. In the international community of practice described in this paper, understanding coding as a bridge positions the activity of programming in the realm of social-emotional learning, not just a cognitive activity.

Coding as a Palette of Virtues: The metaphor of a palette of virtues is reminiscent of the painter's palette. Like the artist who makes her palette out of new colors and mixes and matches them, the coder also has a palette of dynamic virtues that she uses. From over 20 years of work, DevTech has identified ten common virtues that arise in the coding playground: curiosity, perseverance, open-mindedness, optimism, honesty, patience, generosity, gratitude, forgiveness, and fairness [27]. However, this list is not exhaustive and can always be added to and adapted. Creative programming can be a path for character development because it supports children and educators to explore the socio-emotional and ethical dimensions of learning. Within the international community of practice, members can exercise these virtues when working together, encountering barriers to their work, and taking on new responsibilities in their local contexts.

2.3 Professional Development: TeachCAL

In addition to providing the CAL curriculum to partners, the DevTech Research Group developed a free online professional development asynchronous course, TeachCAL, to further support teams being introduced to CAL. TeachCAL synthesizes the research conducted around the CAL approach and its pedagogical foundations and targets early childhood educators and practitioners aiming to implement ScratchJr and the CAL-ScratchJr curriculum in their respective teaching and learning settings. TeachCAL consists of 5 modules: a course overview, the CAL pedagogy, ScratchJr, and the Show What You Know (SWYK) formative assessment, and the CAL-ScratchJr curriculum, which each includes an overview, introduction, guided exploration, main ideas, reflection, and activities. Completing it takes an average of four to six hours, but the progress can be saved to divide the working time into many shorter sessions. In addition, the course is structured in a way that learners explore the "why" behind coding in early childhood before diving into the "what" and "how" of ScratchJr and the CAL-ScratchJr curriculum. All teams were suggested to complete this module before beginning their work with CAL-ScratchJr in their respective settings.

2.3.1 ScratchJr

ScratchJr is the programming environment around which the Coding as Another Language curriculum is centered. ScratchJr is a free app that introduces children from 5 to 7 years old to fundamental programming concepts through open-ended creation and exploration. It is available on various devices, including iPads and iPhones, Android devices, Amazon tablets, Chromebooks, and many Macbooks and Windows 11 machines. Through funding from the National Science Foundation (DRL-1118664), ScratchJr was created through a collaboration with the DevTech Research Group, the MIT Lifelong Kindergarten Group, and the Playful Invention Company. The app is now maintained by the DevTech Research Group and the Scratch Foundation, which provides the funding to keep the app freely accessible around the world. Since its launch in 2014, ScratchJr has acquired over 45 million users in 193 countries as of August 2023. 194 million projects have been created, 321 million projects have been edited, and 7 million projects have been shared.

ScratchJr is inspired by Scratch, created by the LifeLong Kindergarten group at MIT Media Lab [28] and aimed at children 8 and up. Both programming environments utilize visual block-based programming, bright colors, and fun animations to create a welcoming, playful, and creative environment for all users, including novices [29]. While Scratch is designed for ages eight and up, ScratchJr caters to a younger demographic of children ages 5–7. Rather than using words to communicate block commands, ScratchJr utilizes icons for all blocks, so children still learning to read can still engage in programming concepts without the reading barrier. Additionally, ScratchJr streamlines its set of functions to create an appropriately low floor and high ceiling for this age demographic [15].

Within ScratchJr, children can animate characters by creating programs. The programming blocks are colorful, icon-based, puzzle-shaped blocks that snap together to create sequences. ScratchJr naturally lends itself to storytelling through the multiple-page feature, which allows children to create multi-page projects that connect via the programs. Additionally, ScratchJr offers functions such as speech bubbles, voice recordings, character interactions, and customizable characters and backgrounds, allowing children to engage in creative coding and storytelling. Through the Coding as Another Language curriculum, children explore different ways to tell and retell stories on ScratchJr, illuminating the vast expressive power of programming languages [15].

3 The ScratchJr-CAL Experience: From a SIG to an International Community of Practice

3.1 Partners

The ScratchJr-CAL international community of practice started its first cohort comprising 21 organizations (Table 2) from 12 countries on five continents (Fig. 2). All the teams are non-profit organizations working with or for educators and children interested in bringing the CAL curriculum for ScratchJr to their localities. In this cohort, there are three teams in Asia focused on children's STEAM skills development, four teams in Africa focused on disabilities and rural gaps closure, four teams in Europe dedicated to educating in and pre-service teachers, seven teams in North America focused on adding the CAL approach to the compulsory ELA curriculum, and four teams in Latin America committed to increasing access and knowledge in CS skills.

Table 2 International partnership organizations

Country of origin	Organization's name
Argentina	Varkey Foundation
Brazil	Inovar e Aprender
Ecuador	Fundación Openlab Ecuador
Greece	University of Crete
Israel	Bloomfield Science Museum Jerusalem
Nepal	Smart Cheli
	Code Chautari
Nigeria	Online Hub Educational Services
	TeenTech Hub
	Webfala Digital Skills for all Initiatives
Portugal	Arcacomum Associação - Arcacomum Association
Spain	Interaction, Technology and Education (ITED)
Tunisia	Auptimisme
USA	Academies of math and science
	Cornell Tech, K12 Team
	Department of Education Studies, University of California San Diego
	EiE, Museum of Science, Boston
	MSU Extension Center for 4-H Youth Development
	University of St. Thomas Playful Learning Lab
	Paragon Mills Elementary School

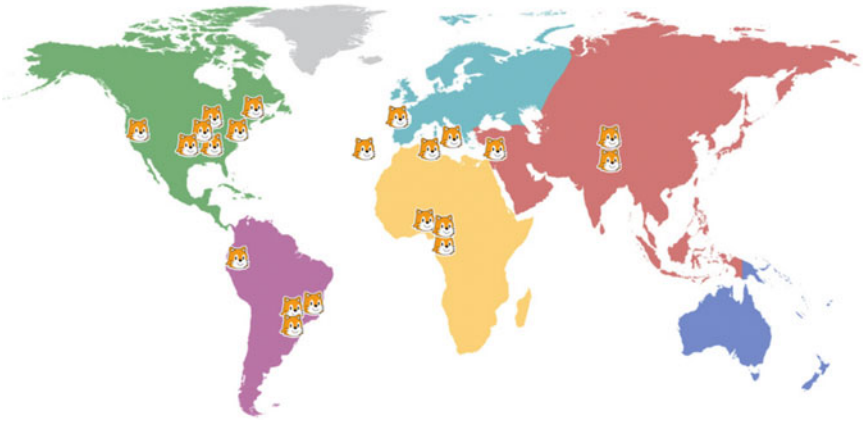

Fig. 2 ScratchJr-CAL international community of practice map

3.2 Partners' Engagement

All the ScratchJr-CAL international community of practice teams have three possible engagement paths with DevTech: Learn and Teach CAL, Adapt and Translate CAL, and Research and Evaluate CAL. "Learn and Teach CAL" refers to educators unlearning, relearning, and teaching programming and coding skills using our creative, playful approach based on the PTD theoretical framework and the four principles: coding as a playground, coding as another language, coding as a bridge and coding as a palette of virtues. This path allows teams to use the CAL curriculum's available resources and implement them in their local communities. "Adapt and Translate CAL" involves localizing the curriculum materials to a specific cultural context and language. This path requires teams to find books and songs that meet the needs of the CAL curriculum, for example, offering sequencing events and role models in STEM in their respective cultures and adapting the lessons to those new resources. In addition, teams may translate the curriculum into their own languages and offer that resource for the whole community of practice and beyond through curated publishing on the CAL website. Finally, "Research and Evaluate CAL" requires teams to collaboratively design a study, collect data, and analyze students' and/or teachers' outcomes using DevTech's validated instruments. Regardless of the engagement pathway, all 21 teams in the first cohort met and worked together, completed surveys and interviews, and participated in virtual, synchronous reflection sessions.

3.3 Partners' Experience

To analyze the teams' experience, data was collected at many different instances throughout the first year of the international partnership. The first instance was a Welcome Survey comprising 21 questions regarding teams' demographics, capacities, and intentions. For our purposes, only two open-ended questions about the organization's mission and expectations as members of this community of practice will be considered. This survey had a response rate of 100%. In addition to those questions, we examine answers collected during a collaborative workshop hosted at the midpoint of year 1. Participants wrote their responses in different formats via a Google Jamboard, an interactive communication tool. They also responded to one another's answers, allowing us to gather team reflections and thoughts about their motivations and benefits obtained from this community membership. 18 teams joined this meeting and completed the activity, resulting in a response rate of 85.7%. An Evaluation Survey was also sent at the end of the first year. The purpose of this instrument was to conduct a formative evaluation that allowed DevTech to assess and help formulate goals and priorities for the second year of the international partnership. This learning-focused evaluation, responded to by 76% of the teams, aimed to obtain real-time feedback to make strategic decisions and help us understand how contextual and cultural dimensions interact with the program design, implementation, and operations. Moreover, throughout the experience, individual interviews with teams were conducted, allowing deeper discussions and elaboration on survey responses, a safe space to ask questions, and an opportunity to engage in collaborative brainstorming with a DevTech researcher about how best to implement their practice. The questions considered in this study were about the value of this overall experience and its impact on their practice and knowledge.

Considering that our partners have different cultural backgrounds, and English is, for most of them, their second language, the questions included in all surveys and the interactive board were formulated and revised by three people to ensure cultural and linguistic responsiveness. Focusing on open-ended questions allowed us to learn more about each organization's mission and role in their local contexts and why they wanted to be part of this community of practice to impact their educators' and children's learning processes.

Through all of these methods, we sought to investigate three research questions.

- RQ1: What were the participants' motivations for joining the ScratchJr-CAL special interest group?
- RQ2: To what extent has this community of practice impacted their knowledge and practice and contributed to their local context's educational development?
- RQ3: To what extent does engaging in the 6Cs of the PTD framework lead to forming a community of practice?

3.3.1 Analysis

We conducted a thematic analysis involving discovering, interpreting, and reporting patterns and clusters of meaning within the data [30–32]. We engaged in a hybrid deductive-inductive coding structure, emphasizing, analyzing, and interpreting participants' stories about their educational, cultural, and linguistic context as members of this community of practice. This methodology allowed us to create a codebook (Table 3) and identify quotes that best represent the story of our participants' experiences related to our research interests. All quotes are written as participants typed them, with content only redacted for confidentiality. No grammar or spelling was changed, and organizations' and team members' names were omitted to ensure anonymity.

Table 3 Codebook

Code	Definition
Motivations	The desire that organizations had to be at the service of a specific goal awakened the need to establish a social connection with this community of practice
Learning and teaching	Recognition of the need to learn and then teach others new knowledge
Closing gaps	Awareness that new knowledge and skills reduce the differences in the quality of education and increase the possibilities children can access
Gender inequality	Discrimination based on gender. Typically, men are routinely privileged or prioritized over women
Opportunity awareness	Becoming part of this virtual community of practice was a good chance for advancement or progress
Impact	Recognized effects from the ScratchJr-CAL international community of practice, including materials, actions, technology access, and pedagogical strategies
Innovation	Introduction to new methods, practices, and technology
Localization	Process of adaptation and/or translation of the CAL curriculum
Contributions	What the international community of practice gave to its members' educational local context due to the impact generated
Community formation	Connections among the teams participating in the ScratchJr-CAL international community of practice

4 Results and Discussion

4.1 Motivations

Our first research question inquired about participants' motivations for becoming members of this community of practice. Some themes were the need to learn and teach this new content in their local communities, provide new skills to their countries' educators to close existing gaps in their educational systems, decrease gender inequality, and generate new opportunities for the children of their localities. A key response that emerged in more than one of the surveys was that the mission of these organizations is to provide quality education to develop their local communities further because access to a good education will likely increase job opportunities in the future, triggering a chain of life improvements.

Specifically, a team in Nepal told us, "We are a female led social enterprise working to create gender balance in the STEAM field. We are targeting young girls, through mentorship and STEAM based programs. We have initiated [organization's name] to decrease the prevailing gender gap in the STEAM Field in Nepal. We aim to enhance critical thinking, cultivating their imaginations and problem-solving skills and to get exposure to the STEAM from an early age." Another team added, "We believe that Scratch [Jr] provides important skills and we are motivated to help fill the gaps in the society and local population." Moreover, others mentioned that "Our mission is to empower underprivileged children, girls, youths and women in Nigeria (53% of whom live under the poverty line) with STEM education and digital literacy skills that will enable them to create their own future and compete favorably in this digital age."

All teams recognized that giving access to STEAM knowledge, specifically coding skills, to their communities is essential to giving educators and students from diverse backgrounds better opportunities in the future. Focusing primarily on the education of young children, the organizations recognize that giving children access to this knowledge at an early stage of their educational processes will help these students to access better jobs, give back to their communities, and transform their destinies in the future. In their words, they wanted to become part of the ScratchJr-CAL community of practice to "inspire a lifelong love of science in everyone" and to "[…] promote the integration of technology to improve learning and foster processes of innovation, inclusion and personal growth," in addition to "promote open culture, strengthening communities of digital creators and educators."

In addition to technical skills, organizations mentioned their motivations being driven by the parallels to literacy and expression that CAL emphasizes. Members indicated that their "[…] expectations are that students can identify blocks of code and how to use them but also want to build their literacy skills by creating projects that allow them to use their writing skills." Other members said that they want to "learn how to ensure that the learning goals for Literacy and CS are met […]" or "[…] see a connection to how to integrate tech/CS into the two subjects that get mostly taught in elementary: math and ELA (Reading and Writing)", because "I believe

ScratchJr is the solution to this and has so many other child development benefits, creativity, social/collaboration, communication, problem-solving. True twenty-first century skills with so much rigor and joy."

4.2 Impact and Contributions

Our second research question examined how engaging in the international community of practice impacted members' knowledge about the CAL pedagogy, coding skills, ideas, methods, or resources after attending the meetings held during the year. The subcodes that emerged from this theme were related to the contributions to each team's local contexts' pedagogical and technological innovation, the localization of the resources used, and the generation of networks with other members of this community of practice.

As a measure of impact, some teams mentioned that having access to innovative ideas allowed them to bring technology closer to educators and classrooms, which ensured meaningful experiences of creation and expression while also developing computational thinking skills and interacting with the environment through collaboration. Although all the teams' answers highlighted the importance of learning to code, they all emphasized that it is a process that takes time and requires "to learn, unlearn, and relearn" to "create flexible instructional design and best practices for teachers […]" to then "promote the democratization of creative learning, […] the development of computational thinking, inclusive education, equity, and technologies for innovative education […]."

Within the sub-theme of pedagogical innovation impacts was the explicit impact on literacy knowledge development and other communication methods. Members have revealed that the most remarkable contribution to their students' learning development is "the clear literacy connection to this program […]" allowing "teachers to see the power of ScratchJr as another way for kids to share their knowledge in literacy. Storytelling components/standards of teaching and reaching are so attainable using ScratchJr to extend learning." This curricular alignment allows educators to connect the activities to other curricular domains, helping a broader spectrum of learning styles to succeed. International teams have mentioned that this connection will allow them to "develop students' literacy (English and local language) while coding." Others have mentioned that "[this] participation would help [them] to promote the proposal specifically designed to train teachers from all over Latin America in ScratchJr, free of charge, and provide pedagogical strategies to be able to attend to the diversity and diverse contexts of their communities. We believe that ScratchJr and the CAL curriculum is certainly a tool that can assist teachers with students who have had their literacy affected during the pandemic."

Localization was necessary in many contexts outside and within the US school system. For many of the organizations from the US, the CAL curriculum for ScratchJr was indicated as a resource to help young learners improve their communication skills and "to be able to better leverage code as a way of understanding language and cultural

exchange." Or to offer an alternative way of teaching to "[…] our low-income and English Language Learner population because this curriculum reinforces our core curriculum." Another relevant topic in the participants' responses is the development of new knowledge that educators in their communities could access and consequently pass on to young learners. To accomplish that, international teams recognized the need to localize the resources first to implement them later. Since "our target group is not well versed with English […]" "by localizing CAL, it will be much easier for the educational community to implement it in their classrooms!".

Establishing social networks in the community of practice was another relevant topic that teams mentioned in their surveys and workshop answers. Being part of this community allows them to articulate and share connections with other teams worldwide, influence one another so that they all work together to build a cumulative body of knowledge, and have "An experience rich in learning and encounters, very useful in practice and to broaden our fields of action and our vision of creative coding." Another team added, "We were able to learn about the global context on how people were integrating ScratchJr in their classroom." Finally, they said, "Learning and sharing experiences and knowledge/practices with other organizations, curriculums, strategies and pedagogy."

4.3 Formation of Community

The last research question we sought to answer is how the 6Cs of the PTD framework manifested in organizations' practices and how they contributed to forming an international community of practice. The 21 organizations originally came together as a special interest group (SIG) set up by Scratch Foundation's SEC; however, over the time spent working together, the SIG evolved into an international community of practice through practicing the behaviors highlighted in the PTD framework. Community members established common working methods, networks, and shared objectives through these behaviors.

The most prevalent example of the first C, *Content Creation,* is the emergence of the international community of practice as a whole. Since the project began, DevTech has created and customized the experience to all the teams' needs by hosting talks about relevant topics, creating new spaces to develop skills and knowledge, and distributing needed materials. Mirroring DevTech's focus on creating content, the organizations created their own novel content for their local contexts, making this experience relevant to them, the educators, and the children of their countries. A notable example of this behavior was the efforts of the team in Greece to write their own fiction and non-fiction books to integrate into the CAL curriculum using a more significant story for their children. Incorporating elements of their mythology, scientific concepts, and developmentally appropriate illustrations, they adapted and translated the CAL curriculum for kindergarten, first, and second grade.

Another example of content creation emerged from how teams interacted with the TeachCAL module. During the year, seven teams used TeachCAL to train educators in

their communities. Each team used this resource differently, translating and adapting as needed and creating new supplemental content to strengthen its usefulness and relevance to their contexts and educational settings. For example, our partners in New York City divided and expanded TechCAL into six smaller sessions that one person led for 40 early childhood teachers as a PD series. In a different version, they taught the sessions for 13 professors training pre-service teachers in a Higher Education institution. Our partners in Argentina also divided the module into smaller online sessions with a weekly meeting for teachers implementing the curriculum to dive more deeply into concepts from TeachCAL, practice new content with one another, and reflect on their experiences. The team in Uruguay created a longer and more comprehensive PD session that was available country-wide—one hundred twenty hours divided into 12 weeks of instruction, including TeachCAL content and other relevant topics for their context.

Creativity is tightly linked to *Content Creation as* all pathways for engagement required some level of content creation as teams worked to adapt and expand upon the curriculum. Creativity naturally played a role in these adaptations as the teams thought deeply about how to change the content for their local needs in the best way. One of the most creative adaptations arose from the organization in Tunisia, which worked to adapt the curriculum to a pictorial communication system and help autistic children gain this new knowledge. They "tr[ied] to be faithful to the philosophical and pedagogical direction that the designers of ScratchJr have established, to build an adaptation for autistic children on an already proven and tested basis." Connecting the two expressive systems was not only original and creative but highly impactful, as it brought CAL-ScratchJr to a population that does not typically have access to the same number of resources and support around ScratchJr.

Another example of creativity was found in the efforts of organizations and local teachers to incorporate new pedagogies that were formerly unfamiliar to them. For example, teachers in New York focused on incorporating the "Coding as a palette of virtues" metaphor into their practice. However, understanding how to do this in the context of a technology class was a fairly foreign idea to them. They were "mind-blown" about this challenge and worked closely with DevTech members to create authentic materials, reflecting the original CAL approach and aligned with the guidelines of their own schools, "I incorporated more components of the curriculum with my recent set of teachers, and this was really due to meetings that pushed my thinking hosted by the SIG." By embracing new ideas and content, teachers in New York were pushed to think outside the box to bring these ideas to their own setting.

Regarding the C of *communication,* the most common and effective form of communication was via email. This asynchronous communication method was used to share information about events, distribute materials, and connect groups seeking further collaboration opportunities. In one instance, an organization from New York, USA, was interested in learning more about how the organization in Greece trained their pre-service teachers using the TeachCAL module. Through email correspondence, they were able to engage in cross-team collaboration.

Another way in which communication played a large role in community formation was through monthly synchronous meetings. Each meeting introduced a variety of

modalities for synchronous, virtual communication. Many of the meetings were "working meetings" where groups received editable links to shared documents and/or joined breakout rooms to communicate verbally while working. In other instances, groups were asked to share reflections, questions, and ideas on Google Jamboard—allowing them to share thoughts on sticky notes and respond to one another in real time. Finally, small group meetings based on shared interests and practices (those on the research track, for example) allowed for more in-depth discussions between members to share experiences, challenges, and goals. At the beginning of the year, most synchronous meetings had very low participation, with most communication being done asynchronously through the DevTech coordinator. As the year progressed, however, the interaction between the teams improved dramatically, demonstrating that a community of practice was forming as its members felt more confident and secure to participate and share their thoughts aloud with one another.

Collaboration was promoted during the year by offering different engagement paths to the organizations and creating smaller sub-groups with shared goals, materials, and strategies to work together. As part of the year's agenda, we hosted smaller meetings to discuss the methodologies and challenges for each of the three paths of engagement. For example, in the "Research and Evaluate CAL" meeting, the teams in Spain and Portugal met with DevTech members to outline the next steps before implementing the CAL curriculum in each setting. During that meeting, the teams learned more about data collection logistics, discussing the study design, assessment instruments, and desired timeline. As a result of these smaller, more focused meetings, teams interested in following the same engagement path but in different locations could set common goals, think about possible challenges together, communicate more concretely, and guide each other through the research process. Through working together on common problems, groups ultimately strengthened each other's work despite working in different localities. Another remarkable example is the collaboration that occurred in Uruguay. After learning of previous experiences and starting fluid communication with DevTech, the organization in Uruguay decided to engage in research by implementing the CAL curriculum nationwide, which was modeled for them by the organization in Argentina, which had already completed a large CAL study the year prior. Using the curriculum translated into Spanish by the team in Argentina and learning from their previous experience, the team in Uruguay is embarking on a large project.

Choices of Conduct was observed through each of the organizations' choices to participate and commitment to continue their engagement throughout the process. Team members consciously chose to honor their commitment to one another and their own goals by deciding to be part of this community and registering, joining, and participating in the meetings. A substantial method we used to measure this is the participation and response rates obtained during the year, which remained above 75% for all surveys, meetings, and workshops.

Finally, regarding the C of *Community Building*, it is possible to say that the SIG transitioned into an international community of practice because of all of the above. Due to all the communication mechanisms, we were able to promote collaboration opportunities for and among the participants, enabling their content creation and

creativity, giving them choices of conduct that they took to implement the CAL curriculum in different ways in their local settings, building a community that is currently ready to start a second year of work, challenges, and growth. Concerning this, a team member mentioned, "Meeting with [facilitator's name] helped motivate me to engage more teachers in the philosophy and teaching of ScratchJr. I incorporated more curriculum components with my recent set of teachers, and this was really due to meetings that pushed my thinking hosted by the SIG."

5 Implications and Conclusions

The work described in this paper shows the transformation of organizations with a special interest in working with ScratchJr and CAL into an international community of practice. The formation of a global community of practice happened not only because of their shared interest but through the explicit design of meetings, brainstorming sessions, collaborative group work, and collaborative opportunities guided by the PTD theoretical framework. Each of the six C's was put into practice in a different way. The ScratchJr-CAL curriculum was created by DevTech with versatility and distributed in ways to facilitate adaptation and creative editing so each organization could customize it depending on their interests and needs. Furthermore, opportunities for communication and collaboration led to making choices and community-building, so organizations worldwide and languages with a shared interest could construct knowledge together. Participating teams learned from each other, exchanged strategies and challenges, established professional and social relationships, and created a support network to exchange learning experiences. The members' cultural and linguistic diversity allowed them to consider global educational trends and turn them into significant experiences at the local level, generating a dynamic conversation between global and local contexts.

References

1. Garcia Canclini H (1995) Consumidores y ciudadanos. Conflictos multiculturales y Globalización [Consumers and citizens: Globalization and multicultural conflicts]. Grijalbo
2. Mato D (2001) Estudios Latinoamericanos spbre cultura y transformaciones sociales en tiempo de globalizacion. Clasco, Buenos Aires
3. Mignolo W (2000) Local histories/global designs: coloniality, subaltern knowledge, and border thinking. Princeton University Press, Princeton
4. Scanlan M, Barstow Melley K, Placencio-Castro M, Ludlow L (2019a) Transforming communities of practice through networks. In: Scanlan M, Hunter C, Howard E (eds) Culturally and linguistically responsive education. Designing networks that transform schools. Harvard Education Press, Cambridge
5. Ladson-Billings G (2007) Culturally responsive teaching: theory and practice. In: Banks JA, McGee Banks C (eds) Multicultural education, 6th edn. Wiley, Danvers

6. Wei RC, Darng-Hammond L, Andree A, Richardson N, Orphanos S (2009) Professional learning in the learning profession: a status report on teacher development in the United States and abroad. National Staff Development Council, Dallas, TX. https://edpolicy.stanford.edu/sites/default/files/publications/professional-learning-learning-profession-status-report-teacher-development-us-and-abroad.pdf
7. Waddock SA (1999) Paradigm shift: toward a community-university-community community of practice. Int J Organ Anal 7:244302
8. Lave J, Wegner E (1991) Situated learning: legitimate peripheral participation. Cambridge University Press, New York
9. Palincsar AS, Magnusson SJ, Marano N, Ford D, Brown N (1998) Designing a community of practice: principles and practices of the GIsML community. Teach Teach Educ 14:5–19
10. Niesz T (2007) Why teacher networks (can) work. Phi Delta Kappan 88(8):605–610. https://doi.org/10.1177/003172170708800812
11. Palincsar AS, Herrenkohl LR (2002) Designing collaborative learning contexts. Theory Pract 41(1):26–32. https://doi.org/10.1207/s15430421tip4101_5
12. Preece J (2000) Online communities: designing usability, supporting sociability. Ind Manag Data Syst 100(9):459–460. https://doi.org/10.1108/imds.2000.100.9.459.3
13. Atkins B, Koroluk J, Stranach M (2017) Canadian teaching and learning centers on Facebook and Twitter: an exploration through social media. TechTrends Link Res Pract Improve Learn 61(3):253–262. https://doi.org/10.1007/s11528-016-0144-2
14. Bers M (2019) Coding as another language: a pedagogical approach for teaching computer science in early childhood. J Comput Educ 6(4):499–528
15. Blake-West JC, Bers MU (2023) ScratchJr design in practice: low floor, high ceiling. Int J Child-Comput Interact 37:601. https://doi.org/10.1016/j.ijcci.2023.100601
16. Bers M (2022) Beyond coding: how children learn human values through programming. The MIT Press, Cambridge, MA
17. Bers M (2006) The role of new technologies to foster positive youth development. Appl Develop Sci 10(4):200–219
18. Bers M (2012) Designing digital experiences for positive youth development: from playpen to playground. Cary, Oxford
19. Bers M (2008) A palace in time: supporting children's spiritual development through new technologies. In: Lerner R, Roeser R, Phelps E (eds) Youth, development and spirituality: from theory to research. Templeton Foundation Press, West Conshohocken, pp 339–358
20. Papert S (1980) Mindstorms, children, computers, and powerful ideas. Basic Books Inc., New York
21. Resnick M (1996) Distributed constructionism. https://repository.isls.org/bitstream/1/4098/1/280-284.pdf
22. Lerner RM, Jacobs F, Wertlieb D (2005) Applied developmental science: an advanced textbook. Sage, New York
23. Lerner RM (2005) Promoting positive youth development: theoretical and empirical bases. In: White paper prepared for the workshop on the science of adolescent health and development, National Research Council/Institute of Medicine. National Academies of Science, Washington, DC
24. Bers M (2020) Coding as a playground: programming and computational thinking in the early childhood classroom, 2nd edn. Routledge Press, New York, NY
25. Bers M, Strawhacker AL, Vizner M (2018) The design of early childhood maker spaces to support positive technological development: two case studies. Library Hi Tech 12:32–36. https://doi.org/10.1108/LHT-06-2017-0112
26. Partnership for the 21st Century Skills, Ohio Department of Education (2007) Framework for 21st century learning. Washington, DC. https://www.marietta.edu/sites/default/files/documents/21st_century_skills_standards_book_2.pdf
27. Bers M (2021) Coding, robotics and socio-emotional learning: developing a palette of virtues PIXEL-BIT. Revista de Medios y Educación 62:309–322

28. Maloney J, Resnick M, Rusk N, Silverman B, Eastmond E (2010) The scratch programming language and environment. ACM Trans Comput Educ 10(4):1–15. https://doi.org/10.1145/1868358.1868363
29. Resnick M, Maloney J, Hernández A, Rusk N, Eastmond E, Brennan K, Millner A, Rosenbaum E, Silver J, Silverman B, Kafai Y (2009) Scratch: programming for everyone. Commun ACM 52:60–67
30. Boyatzis RE (1998) Transforming qualitative information: thematic analysis and code development. Sage, New York
31. Braun V, Clarke V (2006) Using thematic analysis in psychology. Qual Res Psychol 3:77–101
32. Joffe H (2012) Thematic analysis. In: Harper D, Thompson A (eds) Qualitative research methods in mental health and psychotherapy: an introduction for students and practitioners. Wiley-Blackwell, Chichester, pp 209–224
33. Scanlan M, Hunter C, Howard E (2019b) Culturally and linguistically responsive education. Harvard Education Press, Cambridge, Designing networks that transform schools