

Early Childhood Teachers' Perceptions of Programming Learning Materials for 4- and 5-Year-Old Children

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Abstract. *This paper reports the results of a focus group with Early Childhood Education teachers, conducted to investigate their perceptions of programming education for young children and to present and analyze lesson plans for teaching programming concepts to 4- and 5-year-olds. A semi-structured group interview was conducted, followed by a presentation and discussion of the lesson plans to collect feedback and suggestions. Teachers recognized the potential benefits of teaching programming concepts to young children and the suitability of such instruction for Early Childhood Education. They approved the materials, provided suggestions for improvement, and expressed interest in implementing the proposed activities. The results suggest support for the development and adoption of programming activities in Early Childhood Education.*

Keywords: *Technologies, Programming, Childhood Education.*

1. Introduction

Children have been using technology passively, often without benefits to their development or for problem-solving purposes [Menezes et al. 2023, Silva Neto et al. 2021]. Research has shown that, from an early age, children can develop skills in logic, sequencing, and problem-solving through participation in computational thinking (CT) activities [Bers 2019, Dietz et al. 2023]. Programming has been considered an effective approach to promote such learning in Basic Education [Alves 2019, Amaral et al. 2015, Araújo et al. 2015, Bordin and Quepfert 2018, Bordini et al. 2016, Brasil 2018, Ferri and dos Santos Rosa 2016, Gomes et al. 2016, Pires and Prates 2019, Silva et al. 2016, Souza and Mombach 2016] and Early Childhood Education [Fu et al. 2023, Gao et al. 2023, Kalyenci et al. 2021, Kim et al. 2024, Levinson et al. 2025, Lin et al. 2023, Metin et al. 2024, Metin et al. 2023, Metin 2020, Montuori et al. 2023, Murcia et al. 2024, Papadakis 2022, Relkin et al. 2020, Somuncu and Aslan 2021, Turan and Aydoğdu 2020, Umam et al. 2019, Wu et al. 2024].

Early Childhood Education teachers generally lack training or experience in programming [Zeng et al. 2023, Greifenstein et al. 2021], so it is important to support them by providing conditions that enable them to engage in these activities. The literature presents initiatives for teaching programming to young children worldwide; however, it is

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also important to investigate teachers’ perceptions and suggestions within the local context to adapt educational materials accordingly.

The objectives of this study were: (1) to investigate the perceptions of early childhood educators about the teaching of programming to young children; and (2) to gather their contributions to refine a set of ten lesson plans (available at anonymous.4open.science/r/PlanosAtividades-27B6) designed to teach programming concepts to 4- and 5-year-olds. The lesson plans addressed the following concepts identified in a systematic literature review (SLR)—conducted by the authors—regarding the worldwide teaching of programming to children in this age group: (01) input–processing–output, (02) algorithms and sequencing, (03) abstraction, (04) memory and variables, (05) conditionals, (06) events, (07) repetition, (08) decomposition, (09) modularization, and (10) bugs and debugging. Table 1 presents the elements that make up the lesson plans. The Activity Development component describes the pedagogical practice through five stages: (1) circle time discussion, (2) playful introduction, (3) core activity—describing the playful action itself— (4) reflection and feedback, and (5) artifact production.

Table 1. Elements included in the Lesson Plans

lesson plan header	21st-century skills	tips and variations
computing knowledge	BNCC ¹ strands and skills	optional technological extension
lesson scenario	required materials	connecting to my world
objectives	activity development	assessment

Source: Prepared by the authors

Two research questions were defined:

- **RQ1:** What are the perceptions of early childhood education teachers about technology and programming learning in the present and future of young children?
- **RQ2:** How can teachers contribute to the development and improvement of activity plans to teach programming to 4- and 5-year-old children?

A Focus Group (FG) consisting of Early Childhood Education teachers participated in two meetings, after which a thematic analysis of the collected data was performed. The findings are presented in this article. Teachers demonstrated awareness of technology’s influence on young children and of the potential benefits of learning programming for their lives. Suggestions were also provided to improve the presented material.

2. Methodological Approach

This study is characterized as a qualitative, exploratory, and descriptive study, conducted in partnership with an early childhood school in the city of Passos, Minas Gerais (Brazil).

2.1. Participants

All teachers of 4- and 5-year-old children in a private preschool in the city of Passos were invited to participate. Five teachers with 1 to 22 years of teaching experience and no programming or programming teaching experience participated, and their identities were kept confidential in accordance with the provisions of the Informed Consent Form (ICF).

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2.2. Data collection procedures

Two meetings were conducted and audio-recorded with the teachers' permission, as documented in the Authorization for Record and Use of Oral Testimony Form (ARUOTF).

2.2.1. Meeting 1 – presentation and interview

The first meeting was held in person with all FG members. An initial contextualization was provided regarding the influence of technology on young children and the significant benefits of learning computing and programming concepts. The participants signed the ICF and the ARUOTF. A semi-structured interview was conducted to investigate teachers' perceptions of technology's influence on children's daily lives, their experiences with computing-related content, and the feasibility of teaching computing and programming to young children. At the end of the meeting, printed educational material was presented and made available to read before the discussion planned for the second meeting.

2.2.2. Meeting 2 – discussions

Due to scheduling difficulties, the second meeting was conducted remotely via the *Google Meet*² platform in two separate sessions. In the first one, two teachers participated and reported that they had not previously read the material, so it was presented via screen sharing. All elements composing the activity plans were explained. The concepts addressed and the planned activities were also presented and discussed. At the end of the session, the teachers provided feedback and discussed the activity plans.

In the second session, three other teachers participated after reviewing the material. Using screen sharing, the researcher explained the concepts and the activities proposed in the lesson plans. During the discussions, teacher feedback was collected.

2.3. Transcription of the recordings

The sessions generated three audio files. The first meeting's record was transcribed using the TacTiq³ Chrome extension. The recordings of the two parts of the second meeting were transcribed using the Google Meet transcription tool. A careful review of the transcripts was then conducted to remove duplications, colloquial interjections that could impair content fluency, and errors in speaker identification.

2.4. Analysis procedures

A thematic analysis with a codebook was conducted. Initially, fourteen codes were identified by extracting the code itself, a contextual description, a speech excerpt referring to it, and the session in which it occurred, as illustrated in Table 2. Subsequently, the generative Artificial Intelligence (AI) tool ChatGPT⁴ was used to support and expand the code extraction process, yielding 30 code items. The analysis of the combined set yielded 26 codes, categorized into 5 groups (Table 3), which were considered appropriate to the study's context.

²<https://meet.google.com/landing>

³<https://tactiq.io/pt-br>

⁴<https://chatgpt.com/>

Table 2. Example of the extraction of codes associated with meeting excerpts

Code	Context	Excerpt	Meeting
Affective relationship with children	Statements highlighting emotional bonds and affection toward their students	“Children are very affectionate; whatever we say is law to them”	1

Source: Prepared by the authors

3. Results

The identified codes and groups are presented in Table 3. The results are presented separately for each of the defined research questions.

Table 3. Codes and their groups

Group	ID	Code	Meeting
Teaching Identity and	I1	Long-term experience in Early Childhood Education	1°
	I2	Vocational calling	1°
	I3	Expanded academic background	1°
Professional Trajectory	I4	Affective relationship with children	1°
	I5	Perception of an educational and formative role	1°
Perceptions of Technology and CT	P1	Technology as a Permanent Challenge	1°
	P2	Future Importance of CT	2°-1
	P3	CT as Support for Cognitive Development	1°, 2°-1
	P4	Difference Passive Use X Educational Use	1°
	P5	CT as a Citizenship Skill	1°, 2°-1
	P6	CT Beyond Computing Professions	2°-1
Challenges and	C1	Maintaining Children's Attention	1°
	C2	Activity Duration Limits	1°, 2°-2
	C3	Organization of the School Routine	2°-2
Work Conditions	C4	Availability of Time for Study and Preparation	2°-1
	C5	Communication and Access to Information	2°-2
Pedagogical Strategies and Classroom Routines	S1	Use of Circle Time Discussions	1°, 2°-2
	S2	Step-by-Step Work	2°-2
	S3	Children's Autonomy in Simple Tasks	2°-2
	S4	Production of Artifacts and Records	2°-2
Evaluation of Activity Plans	E1	Interest in the Activity Plans	2°-1
	E2	Need for Time Adjustments	1°, 2°-2
	E3	Suggestions for Alternative Materials	2°-1
	E4	Compatibility with Classroom Routine	2°-2
	E5	Perceived Clarity of the Material	2°-2
	E6	Structured Documentation and Feedback	2°-2

Source: Prepared by the authors

3.1. RQ1 results – what are the perceptions of early childhood education teachers about technology and programming learning in the present and future of young children?

The predominance of codes related to teacher identity and perceptions of technology and CT, groups I and P (RQ1), occurred mainly during the first meeting.

The teachers held degrees in Pedagogy; two had more than one degree, and one had completed postgraduate studies (code I3), with 1 to 22 years of teaching experience (code I1). They demonstrated a strong identification with Early Childhood Education (code I2) and a high degree of affection toward young children (code I4). They also expressed satisfaction in participating in the research and willingness to implement the activities in their classrooms (code I5).

All participants agreed that Early Childhood Education requires playful activities that engage and sustain children's attention (code C1), a challenge when working with this public. Regarding prior contact with CT or programming teaching initiatives for children, all responses were negative. Regarding digital technologies (computers, tablets, smart-phones), the teachers stated that they had standard knowledge from work-related activities (preparing tests, creating activities, managing schedules, etc.), with some more recent advances stemming from the spread of AI tools. Regarding computational technologies such as programming, robotics, and CT, the teachers mentioned only a superficial approach in a computer-related course taken during their undergraduate studies (code P1).

Regarding the importance of mastering digital and computational technologies in teacher education, all participants unanimously agreed that such knowledge is important (code P6). When asked whether this knowledge would become even more necessary in the future, their responses included “certainly” and “without a doubt” (code P2). One more experienced teacher stated that she learns “a little every day.” This reflects a perceived need for continuous updating and professional development (codes P1 and C4).

The discussion also addressed that knowledge of computing and programming can benefit not only computing professionals (code C6) but all individuals, including in the full exercise of citizenship (code C5). The teachers considered programming education for young children highly important, particularly for fostering behavioral norms that go beyond electronic games or negative experiences (code C4), enabling children to make decisions and use devices appropriately, and fostering faster reasoning skills (code C3). They mentioned that this is the best stage for this learning and that learning can occur in a positive, purposeful, and guided way (code C4). When asked whether they perceived any risks or negative aspects in teaching programming to 4- and 5-year-olds, one teacher mentioned the possibility that children might misuse such knowledge; otherwise, no.

The teachers had never previously encountered educational materials for teaching programming in Early Childhood Education. They considered hands-on practice the most appropriate approach for teaching programming to 4- and 5-year-olds and believed that implementing this content in their current school context would be feasible. When asked whether they would be willing to analyze and provide suggestions on lesson plans for this age group that align with their own classes, they answered: “Certainly, yes”.

Finally, participants were asked whether they had anything else to add, but none did. The material was then presented and made available in printed form.

3.2. RQ2 results – how can teachers contribute to the development and improvement of activity plans for teaching programming to 4- and 5-year-olds?

The discussions on working conditions, pedagogical strategies, and lesson plans for groups C, S, and E (RQ2) were effective during the second meeting with the teachers (two in the first session and three in the second).

The two teachers who participated in the first session of the second meeting found the presented material highly interesting (code E1), clear (code E5), and easy to follow (code S2), and found it addressed a current and highly valuable topic. They highlighted the need for more time to invest in their own training on the subject (code D4). Although they did not initially suggest modifications, they noted that new proposals might emerge after a more detailed analysis. The researcher introduced an adjustment to the first activity's output stage, replacing "evaluate the robot's output" with "identify the input command" to avoid implying that the robot had made a mistake. Teachers suggested using materials (e.g., cardboard) to create or complement activity components (code E3), as well as adapting the activities to practices already present in teachers' daily routines (code E4).

The second session involved the remaining three teachers. They considered the proposed duration of the activities too long (codes C2 and E2), since activities with young children usually last around 30 minutes (code C3). After the stages composing the activities were explained in greater detail, including the Conversation Circle (code S1), an activity already used by the teachers (code E4), the Playful Introduction, the Core Practice, Reflection and Feedback, and Artifact Production (code S4), they suggested dividing the activities across multiple days. They commented that working on an activity throughout the week could be an effective approach, allowing children to gradually overcome difficulties and complete stages while also promoting autonomy (code S3), with continuous opportunities to revisit and review previous actions. The teachers also stated that additional considerations and suggestions could emerge through practical application. In addition, they suggested creating a group on a messaging app to facilitate communication and access to materials (code C5).

In both sessions of the second meeting, the lesson plans were presented, and a proposal was made to exhibit the children's artifacts (code S4) at the conclusion of the activities. A proposal for assessing children's participation and performance in activities (code E6) was presented, which the teachers reported as similar to the assessment form they already use in their practice (code E4). Table 4 summarizes the second FG meeting.

4. Discussion

The discussion in this study is organized around the research questions.

4.1. RQ1 discussion - perceptions of technology and programming education in the present and future lives of young children

The findings indicate that teachers recognize the presence of technology in young children's lives and the need to guide them through playful, hands-on learning experiences that promote appropriate and meaningful use of digital devices, as viewed in [Bers 2019, Brasil 2018]. Participants understood the research findings on the cognitive benefits and the development of skills considered essential for all individuals in the 21st century

Table 4. Summary of the second meeting

ID	Addressed Element
AE01	The material was considered highly interesting, very clear, and easy to follow.
AE02	The topic was considered current and highly valuable.
AE03	Need for training focused on technology and computing knowledge.
AE04	Adjustment in Activity 01: ‘output evaluation’ = ‘input command identification’.
AE05	Supplementation of components used in the activity.
AE06	Adaptation of the proposed activities to actions already carried out.
AE07	Reduction of activity duration (replaced by AE08).
AE08	Division of the activity into more than one day (possibly throughout the week).
AE09	Promoting children’s autonomy.
AE10	Practice of reviewing previously completed actions.
AE11	Communication and access to materials through a messaging group instead of email.
AE12	Proposal for an exhibition of artifacts created at the end of the process.
Source: Prepared by the authors	

through programming education, as in [Fu et al. 2023, Ferri and dos Santos Rosa 2016], which is viewed as an innovative and valuable practice within Early Childhood Education.

Considering children’s capacity for learning in early childhood, the teachers agreed with studies advocating the introduction of computational concepts from the Early Childhood Education stage, as in [Bers 2019, Fu et al. 2023]. The results also revealed a perceived lack of training in digital technologies and computing among the participants, highlighting the need to address these topics in teacher education and professional development programs, as presented in [Brasil 2018, Dietz et al. 2023]. This perception also contributed to the participants’ interest in the materials presented in this study, as noted by [Levinson and Bers 2024].

The teachers were receptive and willing to incorporate programming education into their daily practices, using the materials analyzed in this study as a resource.

4.2. RQ2 discussion - teachers’ contributions to the creation and improvement of activity plans for programming education

The second research question focused on obtaining teachers’ support in validating and improving lesson plans. The instructional material was positively evaluated and found to be appropriate, clear, and easy to implement. Teachers expressed satisfaction with the material, describing the language as suitable for Early Childhood Education teachers, the sections as well-structured and easy to understand, and the activities as appropriate and feasible for young children. They also envisioned implementing the proposed activities in their own classrooms.

Some suggestions were provided to better adapt the activities to children’s realities. The most substantial recommendation was to divide the activities, which ranged from 90 to 110 minutes, across multiple implementation days, based on the shorter time periods, approximately 30 minutes, typically allocated to activities involving young children. Since lesson plans are composed of smaller components that can be conducted separately, such adaptations can also support opportunities for review and knowledge consolidation.

Another positive point raised by the teachers concerned children's autonomy in performing age-appropriate tasks, as in [Menezes et al. 2023], and the use of simple materials, such as cardboard, metallic paper, and other low-cost resources, as pointed by [Bers 2019, Lin et al. 2023]. According to them, activities should be adapted as needed and preferably connected to children's everyday experiences, as in [Dietz et al. 2023, Kim et al. 2024, Menezes et al. 2023].

The results also highlighted the significant value of involving Early Childhood Education teachers in the review and critique of instructional materials, as pointed by [Greifenstein et al. 2021, Kim et al. 2024, Levinson and Bers 2024]. Drawing on their professional experience, the participants provided insights that improved the quality of the lesson plans intended for future implementation with Early Childhood Education groups.

4.3. Limitations

The participation of teachers from a single Early Childhood Education institution limits the generalizability of the findings and discussions. Furthermore, the division of the group during the second session may have affected the quality of the FG discussions, as a complete group could potentially have generated richer interactions and results.

4.4. Future work

Future work may include incorporating the suggested improvements into lesson plans, expanding partnerships with additional institutions and FG participants, investigating teacher education in Computational Thinking, implementing the activities in real educational settings, and analyzing the resulting outcomes.

5. Final Considerations

It is concluded that technology affects young children and that introducing programming is relevant; however, early childhood education teachers are not prepared to create and implement activities involving this content, a need that requires support for such tasks. This work sought the participation of teachers from an early childhood education school to better understand the topic and contribute to the development of material to support them in this type of activity. It is understood that the material was validated by the teachers, with some contributions for improvement.

This study contributed to the refinement of instructional materials better aligned with the realities of early childhood education, based on the perceptions of teachers experienced with 4- and 5-year-old children, which would otherwise be beyond the authors' reach. Its conclusion is based on the effective application of the guidelines to the developed activity plans, the implementation of which in the school environment has yet to occur.

Ethical Concerns

This study was conducted in accordance with Resolutions 466/2012 and 510/2016 of the Brazilian National Health Council (CNS) and was approved by the Research Ethics Committee (REC) of the Federal Institute of Southern Minas Gerais (IFSULDEMINAS), under CAAE number: 89787225.0.0000.8158.

Availability of Artifacts

The lesson plans analyzed and discussed in this study are available at the following link: anonymous.4open.science/r/PlanosAtividades-27B6

Statement on the Use of Artificial Intelligence

The generative AI tool ChatGPT was used to support the expansion of code extraction for the codebook generated during the thematic analysis of this study, as described in Subsection 2.4, and to help translate the content into English.

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