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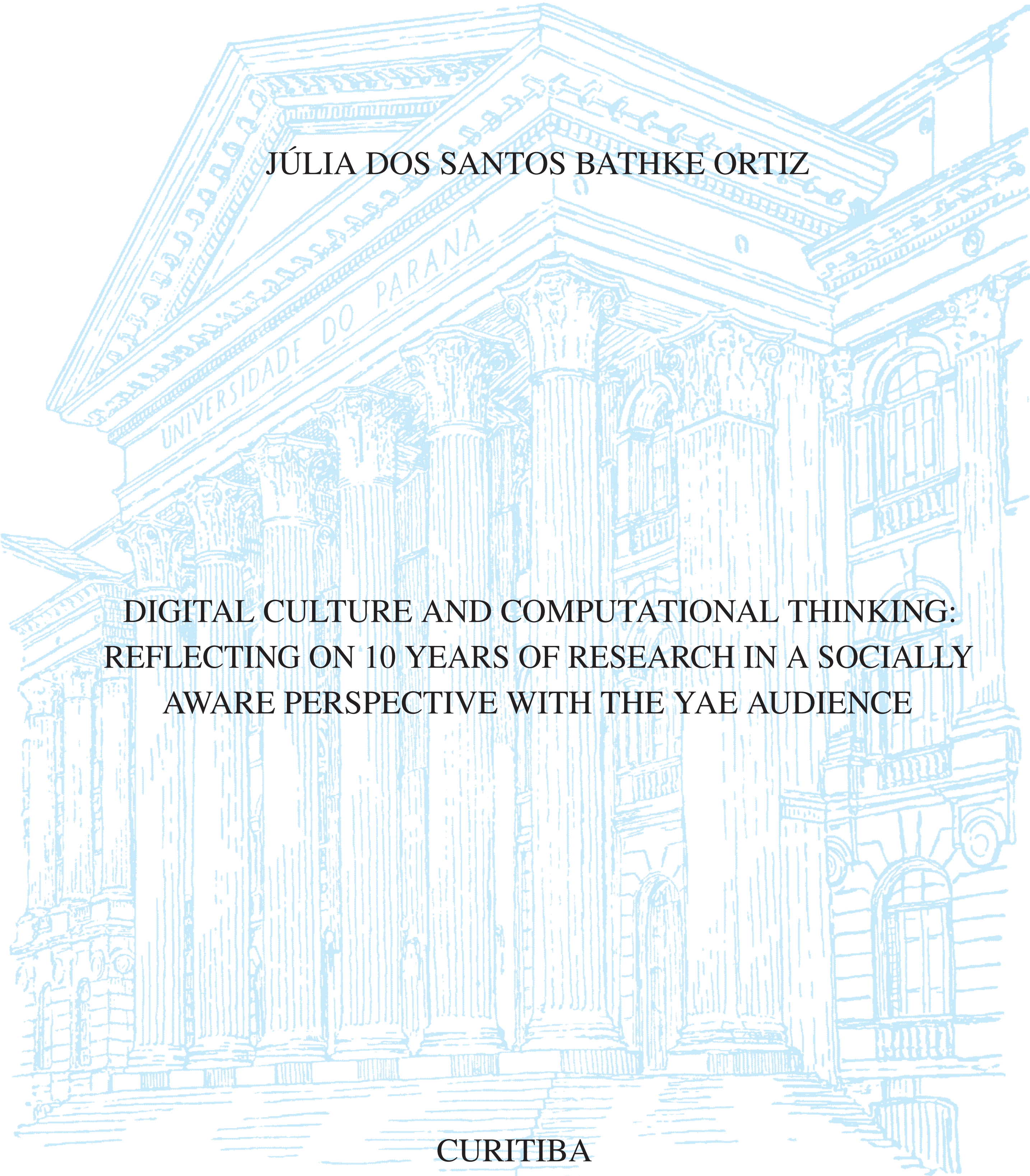

JÚLIA DOS SANTOS BATHKE ORTIZ

DIGITAL CULTURE AND COMPUTATIONAL THINKING: REFLECTING ON 10 YEARS OF RESEARCH IN A SOCIALLY AWARE PERSPECTIVE WITH THE YAE AUDIENCE

CURITIBA
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Tese apresentada como requisito parcial à obtenção do grau de Doutor em Informática, no Programa de Pós-Graduação em Informática, setor de Ciências Exatas, da Universidade Federal do Paraná.

Área: *Ciência da Computação*.

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Os membros da Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação INFORMÁTICA da Universidade Federal do Paraná foram convocados para realizar a arguição da tese de Doutorado de **JÚLIA DOS SANTOS BATHKE ORTIZ** intitulada: **Digital Culture and Computational Thinking: reflecting on 10 years of research in a Socially Aware perspective with the YAE audience**, sob orientação do Prof. Dr. ROBERTO PEREIRA, que após terem inquirido a aluna e realizada a avaliação do trabalho, são de parecer pela sua APROVAÇÃO no rito de defesa.
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For from Him [all things originate] and through Him [all things live and exist] and to Him are all things [directed]. To Him be glory and honor forever! Amen.
(Romans 11:36, AMP)

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"Tudo posso naquele que me fortalece." (Filipenses 4:13 ARA)

RESUMO

Os alunos da Educação de Jovens e Adultos (EJA) enfrentaram diversas barreiras ao longo de suas vidas e muitas vezes carecem de experiências digitais e necessitam de ajuda para adotar a tecnologia. Na sociedade mediada pela tecnologia em que vivemos hoje, o pensamento computacional (PC) tem sido considerado essencial, e as pesquisas sobre o ensino dessa habilidade têm se concentrado principalmente em alunos do ensino fundamental ao médio. Embora o PC possa ser útil para os alunos da EJA, eles têm recebido menos atenção. Acreditamos que, por meio de atividades que promovam a interação com dispositivos tecnológicos, a prática de habilidades como abstração e algoritmos fomenta a familiarização e o aprendizado sobre tecnologia. Sendo assim, esta pesquisa de doutorado teve como objetivo responder a questão de pesquisa: *Como devemos compreender e abordar o público da EJA para oferecer experiências que promovam/favoreçam a familiaridade com a tecnologia?* Este doutorado é o encerramento de 10 anos de pesquisa no âmbito da EJA e tem como objetivo principal *fornecer conhecimento prático e teórico para a concepção de iniciativas na EJA que visem promover a familiaridade com a tecnologia por meio da interação com dispositivos tecnológicos e da prática de habilidades do pensamento computacional*. Esta pesquisa iniciou-se pela consolidação do referencial teórico sobre a EJA, a perspectiva socialmente consciente, o PC e a cultura digital. Em seguida, foram realizadas duas iniciativas práticas com os alunos da EJA, as quais foram informadas pelo referencial teórico previamente articulado. Cada iniciativa teve objetivos específicos, e os dados sobre os resultados dos alunos foram coletados e discutidos. Os resultados e achados durante as iniciativas práticas e o referencial teórico foram sintetizados para responder à questão de pesquisa e para elaborar diretrizes práticas para a concepção de iniciativas na EJA para promover a familiarização com a tecnologia. A tese que esta pesquisa defende é que, ao visar favorecer o aprendizado de tecnologia com os alunos da EJA, existem barreiras multifacetadas a serem enfrentadas *antes* de focar no aprendizado da tecnologia, como a concepção equivocada de que "tecnologia não é para mim". Portanto, as iniciativas com o público da EJA devem, antes de tudo, ter uma perspectiva socialmente consciente para serem capazes de identificar e abordar essas questões com respeito e, então, propor atividades que envolvam conhecimentos e tecnologias que façam sentido no contexto dos alunos. Em seguida, as iniciativas devem ser autorreguladas, nas quais os resultados de uma oficina informam a concepção das seguintes, e a autonomia e a participação devem ser incentivadas em todos os momentos. Como principais contribuições originais, esta pesquisa propôs: abordar o PC como uma ferramenta para organizar a progressão das atividades, o referencial teórico consolidado sobre os principais conceitos-chave envolvidos nesta pesquisa, o modelo da perspectiva socialmente consciente para abordar o público da EJA, que possui princípios para informar a iniciativa, etapas para criar as oficinas, propósitos para informar a progressão da iniciativa e como praticar as habilidades de PC para promover a familiaridade com a tecnologia de acordo com cada propósito. Além disso, esta pesquisa apresenta a descrição de 10 anos de iniciativas práticas com o público da EJA, com materiais e resultados para inspirar e informar outras pesquisas. Assim, a pesquisa apoia a concepção de mais iniciativas que visem abordar a familiaridade dos alunos da EJA com a tecnologia.
Palavras-chave: pensamento computacional, inclusão digital, informática na educação, educação em computação.

ABSTRACT

Youth and Adult Education students have faced several barriers throughout their lives, and often lack digital experiences and need help adopting technology. In the technology-mediated society we live in today, computational thinking (CT) has been considered essential, and research on teaching this ability has mostly focused on elementary to high school students. Even though CT can be helpful to YAE students, they have received less attention. We believe that through activities to promote interaction with technology devices, the practice of abilities such as abstraction and algorithms fosters familiarization and learning about technology. Hence, this doctorate research aimed to answer the research question: *How should we understand and approach the YAE audience to offer experiences that promote/favor technology familiarity?* This doctorate is the closure of 10 years of research within the YAE and has the main goal of *providing practical and theoretical knowledge to design YAE initiatives aiming at promoting technology familiarity through interaction with technological devices and the practice of computational thinking abilities*. This research began by consolidating the theoretical background on YAE, the socially aware perspective, CT, and digital culture. Following this, two practical initiatives with the YAE students were conducted, which were informed by the theoretical background previously articulated. Each initiative had specific goals, and data on students' outcomes were collected and discussed. The outcomes and findings during the practical initiatives and the theoretical background were synthesized to answer the research question and to elaborate practical guidelines for designing YAE initiatives to promote technology familiarization. The thesis this research defends is that when aiming to favor technology learning with the YAE students, there are multifaceted barriers to deal with *before* focusing on technology learning, as the misconception of "technology is not for me". Hence, initiatives with the YAE audience must, before anything else, be of a socially aware perspective to be able to identify and address these issues with respect and then propose activities involving knowledge and technologies that make sense within the students' context. Then, initiatives must be self-regulated, in which the outcomes of a workshop inform the design of the following ones, and autonomy and participation must be encouraged at all times. As key original contribution this research proposed: the approaching CT as a tool to organize the progression of the activities, the theoretical consolidated background regarding the main key concepts involved in this research, the socially aware perspective model to address the YAE audience, which has principles to inform the initiative, steps to create the workshops, purposes to inform the initiative's progression and how to practice CT abilities to promote technology familiarity according to each purpose. In addition, this research presents the description of 10 years of practical initiatives with the YAE audience, with materials and outcomes to inspire and inform other research. Thus, the research supports the design of more initiatives aiming to address YAE students' familiarity with technology.
Keywords: computational thinking, digital culture, informatics in education, computer education.

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LIST OF ACRONYMS

BNCC	*Base Nacional Comum Curricular*
CBIE	*Congresso Brasileiro de Informática na Educação*
CIEB	*Centro de Inovação para a Educação Brasileira*
CSTA	Computer Science Teachers Association
CT	Computational Thinking
DINF	Informatics Department
EJA	*Educação de Jovens e Adultos*
HCI	Human-Computer Interaction
ICT	Information and Communications Technology
ISTE	International Society for Technology in Education
MM	Mental Models
PC	*Pensamento Computacional*
PPGINF	Programa de Pós-Graduação em Informática
SAwD	Socially Aware Design
SBC	*Sociedade Brasileira de Computação*
UFPR	Federal University of Paraná
UN	United Nations
UNIVALI	*Universidade do Vale do Itajaí*
YAE	Youth and Adult Education

CONTENTS

1 Introduction

"People only seek treasure if they believe that work will pay off. Faith makes the difference."

(Mangalwadi, 2012)

Research concerning computational thinking is not recent; Papert (1980) mentions aspects of this ability in his book Mindstorm, where he has used this name for, as far as we know, the first time. Back then, the name did not spread widely. After Wing's seminal paper (Wing, 2006), computational thinking drew attention from Informatics in Education and Computer Education researchers. According to Ortiz and Pereira (2019b), derived from Wing's definition, this ability is often addressed as a set of abilities to understand and solve problems related to various fields of knowledge, not only computing.

Computational thinking relevance became enhanced due to the growing insertion of information and communications technology (ICT) in many areas of society: digital banks, asking for a driver, video calls, signing documents, shopping, and even official identification documents, all of these services are now a touch away – for digitally included citizens. Several times, computational thinking has been listed as essential for children's education, teenagers, and even for undergraduate students of several courses (Barr and Stephenson, 2011; Council, 2010). The authors Valente et al. (2017) raise concerns about this essentiality, claiming that there may be economic reasons behind this assertion. Even so, addressing computational thinking in basic education has become increasingly frequent, and evidence for this is its rapid insertion in elementary school curricula in many countries such as England, the United States, Israel, and Australia (Valente et al., 2017).

In Brazil, in 2015 there was the first workshop part of the Brazilian Congress on Informatics in Education (CBIE) dedicated to discussing the teaching in computational thinking, algorithms, and programming - WAlgProg[1]. In 5 years of this workshop, over 60 research regarding computational thinking's aspects were published, beyond the ones published in bigger events. In 2018, the Center for Innovation for Brazilian Education (CIEB) proposed a technology and computing curriculum that aims to guide schools and teachers regarding essential learning about technologies and computing premises (Raabe et al., 2018), in which computational thinking is one of the axes to be approached proposed by the curriculum. In Brazil, a tendency has been approaching computational thinking through games, mathematics, and robotics, mostly in basic education, but also with teachers and professors, aiming to train them to encompass this ability in their classes. In addition, most of the basic education research being conducted, and systematic mappings conducted about computational thinking in education focus on children, and not on adults who are seeking to finish their basic studies, usually digitally excluded people who still face many barriers to even consider accessing digital services a possibility for them.

The Youth and Adult Education[2] (YAE) is an adult audience that faces several obstacles at once: besides having not completed their primary education at a young age – probably due

[1]More information available at: https://walgprog.gp.utfpr.edu.br/ - Last Access: November/2024.

[2]Translated from Portuguese: *Educação de Jovens e Adultos*.

to financial restrictions that may still be impacting their lives today – they lack basic reading and writing skills, lack experience with technological devices and knowledge on how to operate information (collect, interpret, and represent), in addition to aging barriers that may affect memory, vision, among others. Atkinson et al. (2016) explains that the obstacles adults face in accessing technology are beyond the more clearly understood barriers, as age-related cognitive, perceptual, or motor changes, but that technology anxiety, fear of online risks (e.g., fraud and identity theft), and attitudes and motivations framed by social and cultural factors are significant barriers to the adoption of digital technology by older newcomers. Obstacles like these were observed in the works of Ortiz and Raabe (2016); Ortiz et al. (2019a); Flauzino et al. (2020). This combination of social, economic, cognitive, and digital difficulties prevents YAE from accessing knowledge, developing their digital experiences, living fully in a digital society, and exercising their citizenship, keeping them stuck in the digital divide.

According to the latest available demographic census, in 2022 there were almost 12 million adult - beyond the age of 15 - illiterate Brazilian citizens[3]. Initiatives by the Brazilian government demonstrate the importance of addressing this situation, as a pact launched by the Educational Ministry in 2024[4], which provides funding to create more schools and positions for illiterate citizens to become YAE students.

The lack of literacy is not a problem that affects Brazil exclusively. According to the United Nations[5], 103 million youth lack basic literacy skills worldwide. Efforts are still necessary to ensure quality education at all levels of life worldwide, and the Sustainable Development Goals promoted by the United Nations include this topic. Goal #4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all - aims to gather forces to design and offer quality education, explicitly mentioning *lifelong* learning opportunities, highlighting that adults also require quality education, suitable for their period of life. Although advances have been achieved in the last twenty years, initiatives that have the potential to contribute to education at all stages of adult life, and with current topics (such as technology), are very much necessary, and systematic mapping reviews have shown that the YAE audience is not often reached by initiatives to teach computational thinking and technology, compared to other audiences (Ortiz and Pereira, 2019b; Farias et al., 2023).

Understanding the importance of this audience and the shortage of work in this context, since 2015 I[6] have investigated the YAE and computational thinking, motivated by the benefits this ability can offer to multiple audiences. My research started under the undergraduate degree in Computer Science at the Vale do Itajaí University[7]. During that time, there was not much common understanding of how to promote learning and adoption of technology within such a specific audience as this. My first experience (Ortiz and Raabe, 2016) had the goal of teaching computational thinking to YAE students. After a set of workshops with two different YAE groups, we understood that through activities that practiced computational thinking, it was possible to encourage young and adult students to learn about this ability and also about ICTs, leaving fear and resistance to technology aside. However, there was much more to consider about this audience than we could preview.

[3]According to the 2022 survey – which is the most recent data on this indicator. The survey is available at https://censo2022.ibge.gov.br/panorama/, last accessed on November/2024.

[4]Available at https://www.gov.br/mec/pt-br/assuntos/noticias/2024/junho/mec-lanca-pacto-nacional-para-valorizacao-da-eja last access on November/2024.

[5]Available at https://sdgs.un.org/goals last access on November/2024.

[6]As the research is based on an analysis of my experience and interpretation over 10 years of practice, I will favor the use of the first person singular/plural throughout the text.

[7]From the Portuguese: *Universidade do Vale do Itajaí - UNIVALI.*

My investigation about the YAE and technology continued in my Master's Degree at the Federal University of Paraná (UFPR), mainly to understand more about the audience's characteristics, considering how to responsibly approach these students, respecting them as citizens, as students, as people that are seeking knowledge and should receive appropriate learning opportunities for their life moment, needs, and characteristics. Based on this background, we have conducted a new set of workshops with the YAE audience. Derived from this experience we proposed the Socially Aware Model for promoting Computational Thinking initiatives for Youth and Adults Education (Ortiz and Pereira, 2020) to support the design, planning, and conduction of initiatives to support the progression of the YAE students' experiences with technology.

During this study, we understood that especially with audiences with such a unique combination of characteristics – but eventually with all kinds of public – it is extremely important to consider social and contextual aspects of the audience to achieve the most of the learning experience. Students are at school, but they have a family, live in a place, have friends, have interests, doubts, life stories, and understanding all that *before* the design of activities for the audience is important to produce suitable and useful ones, e.g., understanding education from a socially aware perspective (as it was already explored by Nicastro et al. (2018) and Carbajal and Baranauskas (2019)). Regarding digital culture and inclusion, we had evidence that computational thinking abilities work as the basis for promoting participatory and universal access to knowledge, as it contributes to understanding and interacting with ICTs. Evidence indicated that experiences arising from practice in computational thinking when using technologies in a socially aware perspective had the potential to foster the development of digital culture.

After the Master's Degree finished, there were still more things we wanted to investigate. So far, the investigation and the literature research have informed us that initiatives designed for YAE students must first be of a socially aware view, starting with the understanding of the audience's context; it is necessary to comprehend the students' experiences regarding technology to propose suitable activities for developing positive experiences; the most likely stage these students may be found regarding digital experiences is the digital divide, so the development of digital culture must start from the early stages; and computational thinking has the potential to organize the activities with technology, easing the progression and complexity. This time, we got interested in exploring computational thinking abilities concerning the progression of familiarization and adoption of technology.

The continuity of this research, now under the Doctorate, is still based on the same motivation: understanding that adult students require suitable materials and experiences to learn. This understanding comes from the assumption that technology is for everyone and has the potential to benefit different audiences in different ways and that computational thinking contributes to helping newcomers expand their digital experiences. Based on what the literature has shown us so far, there is still space to reflect on how to understand the YAE audience, how to design experiences that favor approaching technology with them, how computational thinking can be a helpful tool to organize the activities' progression, how to overcome and take advantage of challenges in the field, among others.

Based on this background, the research question investigated in this doctoral research is: *How should we understand and approach the YAE audience to offer experiences that promote/favor technology familiarity?* The main goal of this research is *to provide practical and theoretical knowledge to design YAE initiatives aiming at promoting technology familiarity through interaction with technology and the practice of computational thinking abilities*.

The specific goals of this research are:

- SG1. Synthesize a theoretical background for YAE initiatives to sustain a socially aware understanding and the adoption of computational thinking
- SG2. Identify and analyze the panorama of YAE research to promote technology learning in Brazil
- SG3. Elaborate practical guidelines on how initiatives to promote familiarity with technology in YAE can be designed and conducted according to the understanding proposed
- SG4. Analyze the results achieved by the students in technological familiarity while participating in initiatives guided by the proposed understanding and practical guidelines
- SG5. Update the Model for proposing CT initiatives with YAE to incorporate the results and knowledge produced in this doctoral research

This research is not based on a conventional case study; it is not a fragment. On the contrary, this is a qualitative, situated, participatory, critical, and reflective research. The body of knowledge of this research was constructed over years of experience on the literature that informed the team of researchers participating in the initiative (me, my advisor, and other researchers from the IHC-UFPR laboratory) to conduct the initiative the way we did, on the challenges we have faced, on the lessons learned throughout the years, and on the discussions we had about these experiences. The methodological steps to accomplish the specific goals are:

To achieve SG1: systematize and consolidate the theoretical bases on youth and adult education, socially aware approaches suitable to education, computational thinking, and digital culture for the articulation of the research's theoretical background. The main concern was to align *coherent* theoretical bases according to the character of this research (qualitative, situated, participatory, and critical), the YAE audience, and its characteristics. This step also encompassed a reflection between these theoretical bases and our experience from the whole initiative. Chapter 2 presents the theoretical background articulated.

To achieve SG2: conduct a literature review searching for research aiming at promoting technology adoption, learning and usage with the YAE audience. The focus was to get to know the current scenario of initiatives, specially focusing on the theoretical background they have followed in the initiatives' design and the difficulties these studies faced. The product of this research is presented in Chapter 3.

To achieve SG3: translate theoretical (from the background) and practical (from the original initiatives) knowledge into practical actions through analysis and discussion among the members of the research team. The idea was to synthesize the activities we have created/adapted, the outcomes we have obtained, and our experience in conducting the activities. This knowledge updated our previous model, and resulted in the addition of 2 principles, 3 categories, 4 purposes, 1 step to design workshops and 13 tasks, as well as a collection of activities we have designed, that will be posted on the Platform of Digital Educational Resources[8], an open-access platform for teachers and educators sustained by the Brazilian Ministry of Education. The answer to the research question, the updated model and all its components are presented in Chapter 4.

To achieve SG4: design and conduct 2 original initiatives inspired by the socially aware understanding for YAE initiatives according to the theoretical consolidated background of the research. All activities were planned, informed, and conducted by the team of researchers, the

[8]https://mecred.mec.gov.br/perfil/38443

YAE teachers, and other stakeholders from the school. We collected data on students' outcomes from these initiatives, specifically regarding their technological familiarity, and analyzed the results through qualitative analysis by coding. Chapter 5 of this document presents a condensed summary of the former initiatives and the 2 original initiatives conducted under this research. The experiences and data collected from the conduction of these original initiatives are discussed in two papers: "*Computational Thinking for Digital Culture Development: discussions based on a practical experience*", published in the proceedings of the X Latin American Conference on Human Computer Interaction (2021), and "*Computational Thinking and Mental Models: Promoting Digital Culture in the Youth and Adult Education*", published on the Interacting with Computers Journal (2023).

To achieve SG5: synthesize how to understand and approach the YAE audience in accordance with the consolidated theoretical and practical knowledge, the results of the initiatives and the lessons learned. We have critically analyzed the data obtained and the researchers' experience from the original initiatives under this research, along with the results and the body of knowledge built from the former initiatives, comparing and reflecting with the theoretical background of the research. This critical analysis constructively updated our conception of how to understand and approach the YAE audience. This was an iterative incremental dynamic on conduction SG3 and SG4. Chapter 4 presents the updated model and all its components, resulted from the iterations between these steps.

Derived from this research, the main thesis we defend is: for the YAE audience there are barriers from multiple natures that prevent students from considering technology usage as a possibility for them, and these barriers are the first to be addressed in order to foster digital culture development; suitable initiatives require addressing socio-cultural aspects of the students, and a socially aware perspective with a set of principles can inform the practical experiences to consider these aspects. In addition, the practice of computational thinking abilities working as tools has the potential to organize the activities and lead students from introduction to understanding and interacting autonomously with technology.

2 Theoretical Background of the Research

"by situating computing education in real-world contexts that matter to students, we can engage more people in computing"

(Tissenbaum et al., 2019)

This chapter presents the theoretical background of the research, starting with a brief history and conceptions of Youth and Adult Education. Thereafter, the concepts of Digital Divide and Computational Thinking are presented and discussed, particularly focusing on the YAE characteristics. Later in this chapter, we present the core theoretical inspirations of the research. Cecilia Baranauskas and Paulo Freire already inspired the Master's dissertation. In addition, for this research we include the work from John Dewey as part of the core theoretical background, and from this team of authors, we present their ideas and list the specific topics we have selected from their work as foundation for this research. Finally, the last section of the chapter presents the Socially Aware Model for Computational Thinking with YAE, the product of the Master's degree research, which is also background inspiration for the theoretical foundation of this research. From this theoretical background, and our experience in practice with the YAE audience, we updated and extended our Socially Aware Perspective, presented in Chapter 4.

2.1 Youth and Adult Education history

Youth and Adult Education is a Brazilian modality aimed at adults who did not complete primary and secondary education within the target age range for conventional schooling. The law n. 9.394, of December/1996[1] establishes the guidelines for National Education in Brazil. Regarding the YAE modality, the mentioned law determines that attending its classes is free of charge, that appropriate educational opportunities "considering the characteristics and interests of the student" are ensured, and that the knowledge and skills acquired by students through informal means will be measured and recognized. The minimum age to attend YAE classes is 15 years old for elementary school and 18 years old for high school.

In 2022, there were almost 12 million adult Brazilian citizens beyond the age of 15 who did not know how to read and write[2], a condition that strengthens barriers to digital, social, economic, and educational development. Concerning reasons for school dropout, Neri (2009) presents that the major one is the need to start working to financially assist their families, along with a lack of motivation to continue studying. Economic struggles affecting people's education, and in turn, the lack of literacy decreases economic development. As mentioned before, efforts to eradicate illiteracy worldwide are being promoted and encouraged by the UN, specifically

[1] Available at http://www.planalto.gov.br/ccivil_03/leis/l9394.htm, last access on June 20th. PT only

[2] According to the 2022 survey – which is the most recent data on this indicator. The survey is available at https://censo2022.ibge.gov.br/panorama/ last access on November/2024.

in Goal #4 - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

The YAE audience has unique characteristics, social and cultural contexts, needs, and expectations hampered by a lack of education. For YAE students, going to school represents an attempt to regain lost time. Before the issue of *using* technology, there are social, economic, and psychological challenges that hinder students' *access* to technological services. Hence, only providing devices to students – providing them with smartphones– is far from enough to contribute to their digital development. These characteristics came not only from the students but from the historical approach of adult education. Drawing on (Piletti and Piletti, 2021), we present below a brief history of adult education in Brazil and its social and cultural aspects, to highlight important characteristics of this audience.

Education was introduced to Colonial Brazil by the Portuguese to transmit their traditions. The colleges began to be established in 1570, addressing only the elite of the population who lived there. In 1759, with the Pombaline Reforms, there were changes in education, still according to the interests of the Portuguese administration, and still covering only the elite of the society. In the imperial period, there was no substantial change in education, which continued to be restricted to a small part of society. In 1824, free primary education for Brazilian citizens was determined, but it was nevertheless far from promoting elementary changes. In 1854, education was restructured, and primary instruction classes for adults were proposed. In 1878, a decree was issued establishing evening courses for workers. Although adult students began to be considered in this decree, teaching remained irregular.

In 1897, the constitution guaranteed the vote to literate citizens. In 1910, 340 years after colleges began to be established in Brazil, illiteracy in the country was perceived as a concern (85% of Brazilians were illiterate). In 1930, Youth and Adult Basic Education began to be part of education in Brazil, the first time that an initiative with an organization encompassed the general public, beyond the elite. In 1945, the "Laubach" method of teaching adults was imported from the USA and widely disseminated in Brazil. This method consisted of teaching adults a reading lesson, practicing together, and asking them to teach it to other adults, and so on (each one, teach one) – a method widely used in Latin American countries. This method had relevant results in the years of its application, including Brazil.

In 1947, adult education gained national attention through the Campaign for Adult Education. This initiative could correct misconceptions about adults who remained illiterate, as their intellectual abilities were usually considered the same as those of infants. After this campaign, illiterate citizens started to be seen as productive and capable of reasoning and solving their problems, despite their lack of reading and writing ability. Even though these illiterate adults came to be seen as productive by society, this does not mean they automatically came to perceive themselves as mentally productive as much as literate citizens, despite their lack of ability. However, a few years later, the campaign lost vigor and was extinguished. Other campaigns followed, until in 1960 Paulo Freire inaugurated a new understanding of Brazilian education, that the literacy process of adults should be connected to their lives. Some of the theoretical grounds of Freire's work (e.g. Vieira Pinto (2013)) already defended this idea. Many teachers and researchers may have used this methodological approach ever since (e.g. Schultz et al. (2018), and Duarte et al. (2024)); nonetheless, it is not a standard approach.

This description brings to light the following concerns: a) illiterate adults have been kept aside from educational initiatives for more than 300 years in Brazil; b) the concern about illiteracy among adults started more than a century ago; c) almost 150 years after the establishment of evening courses for workers and 26 years after the law that establishes the YAE modality, there are still 12.1 million Brazilian citizens lacking literacy; d) still today, illiterate adults may overlook their own capabilities due to being considered "less mentally productive" than literate ones, either by others or by themselves; e) the proposition of educational services for adults does not mean providing quality education; f) Brazil is not alone in this battle and is not the only one suffering, the UN recognizes the lack of literacy as one of the leading global problems needed to be overcome (according to the UN's goals); and g) historically, people have been excluded by lack of literacy, and the digital divide acts as another level of exclusion, widening the barriers to personal development, autonomy, and the exercise of citizenship.

2.2 Digital: Divide, Inclusion, Culture

The digital divide has been a topic of research, and organizations have started seeking to overcome its effects for several years, for example, The Internet Society[3], and the former Digital Divide Network - an online community interested in sharing knowledge to help bridge the digital divide - launched in 1999. Developed countries may be concerned about the digital divide because it directly impacts the country's performance in the economy and in the race for technological advancement to achieve competitiveness in a global scenario (Afzal et al., 2023). However, a primary concern about the digital divide is the effects on the *lives* of the digitally divided citizens, both youth and adults.

The definition of the digital divide is often described in terms of whether one has access to the Internet and the skills needed to operate devices, such as "the gap between those who have access to and can effectively use technology and those who do not" (Afzal et al., 2023). However, informed by the adult education history, we adopt the perspective that the digital divide is the absence of possibilities and means to access and develop the necessary abilities to use technology autonomously. For the YAE audience, digital divide means being trapped within their current limitations. When technological resources and adequate conditions for the *development* of the necessary skills to operate devices are provided, we are combating the digital divide. The question raised here is: what are adequate conditions to foster the development of the necessary skills to operate technologies among the YAE audience?

The availability of the services, the low cost and accessibility of devices, the skills for operating them are all necessary for technology inclusion. However, the requirements list should include more elements. Often hidden conditions, but essential to be addressed include educational and socio-cultural aspects, such as the lack of literacy, the self-perception of incapability, and, related to technology, digital fear and anxiety. These aspects should be addressed by initiatives aimed at fostering digital inclusion for the YAE.

One of the strategies to promote digital inclusion is contextualizing it in the activities carried out in the school environment. The Common National Curriculum Base[4] (BNCC) encompass the digital culture ability as part of the General Competency No. 5, which states: "understand, use and create *digital information and communication technologies* in a critical, meaningful, reflective, and ethical way in various social practices to communicate, access, and disseminate information, produce knowledge, solve problems, and exercise protagonism and authorship in personal and collective life". In this curriculum, a competence is defined as the mobilization of knowledge, skills, attitudes, and values to solve complex demands of everyday life, the full exercise of citizenship, and the world of work. Hence, BNCC recommends orienting pedagogical decisions and actions towards the development of these abilities.

[3]https://www.internetsociety.org/action-plan/community-networks/

[4]From the Portuguese: *Base Nacional Comum Curricular*.

Derived from the BNCC and other sources[5], the Center for Innovation for Brazilian Education[6] (CIEB) also proposed a technology and computing curriculum to support the teachers regarding essential learning related to technologies and the principles of computing (Raabe et al., 2018). This curriculum presents 3 axes, 10 concepts, and 147 abilities, all derived from the BNCC's computational competencies. It provides many pedagogical practices from kindergarten to elementary school for practicing the recommendations of the BNCC. One of the structuring axes presented in this curriculum, highlighting the essentiality of the topic, is Digital Culture.

According to the CIEB curriculum, digital culture is related to the interdisciplinary relationship between computing and other areas of knowledge, and seeks to promote fluency in the use of computational knowledge to express solutions and cultural manifestations in a contextualized and critical way. The digital culture abilities are organized into these concepts: 1. *Digital Literacy*: addresses the development of skills related to the use of equipment and their software with proficiency. 2. *Digital Citizenship*: addresses the responsible and appropriate use of technology. 3. *Technology and Society*: addresses advances in information and communication technologies and the new challenges these advancements cause in social contexts, such as communication, working, deciding, thinking and living. These three concepts are interrelated, and in practice, they are simultaneously influenced and developed, culminating in the development of digital culture. Thus, the concept of digital culture as defined by CIEB is adopted here to encompass these interconnected areas.

Brazil is offering more and more digital services and resources online. Issues arise when these services are available *exclusively* through digital means – for example, when a citizen needs to access a public service, and there is no other way to access it but through technology. In this case, the existing exclusion due to lack of literacy is deepened to digital exclusion. Therefore, combating the digital divide is not only a matter of following the curriculum and recommendations of BNCC and CIEB but also a matter of combating a systematic exclusion that has persisted for decades. Among the YAE students, there are necessary aspects to be addressed *before* developing skills to use technology, such as technology anxiety, fear, the misconception that technology is not for them, rejection, among other factors. It is fundamental to start addressing the digital divide by promoting familiarity with technology, presenting it as something that can be part of their personal lives. Following this, students can understand that they can use technology if they are motivated to do so, and the next step is to support them in the development of the necessary skills for using ICTs (according to CIEB and BNCC).

2.3 Computational Thinking

Computational thinking has received several definitions since its first mention (Papert, 1980) and the seminal paper "Computational Thinking" by Wing (2006), in which she described various scenarios of daily life in which Computer Science principles are applied to achieve improved solutions. The Computer Science Teachers Association (CSTA) and the International Society for Technology in Education (ISTE) developed the operational definition[7] that computational thinking is a problem-solving process that includes (but is not limited to) the following characteristics: a) formulating problems in a way that enables people to use a computer

[5]As the training references for Basic Education of the Brazilian Computer Society (SBC), Technology curricular component of the Australian curriculum, Computing curriculum of the United Kingdom (National Curriculum for Computing) and Next Generation Science Standards curriculum (NGSS) of the United States of America.

[6]From the Portuguese: *Centro de Inovação para a Educação Brasileira*.

[7]Available at: https://cdn.iste.org/www-root/Computational_Thinking_Operational_Definition_ISTE.pdf Last Access August 2024.

and other tools to help solve them; b) logically organizing and analyzing data; c) representing data through abstractions such as models and simulations; d) automating solutions through algorithmic thinking (a series of ordered steps); e) identifying, analyzing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources; and f) generalizing and transferring this problem-solving process to a wide variety of problems. One of the characteristics we highlight from this definition is the use of a computer (or device) as optional, and generalizing the problem-solving techniques to problems not necessarily related to computing.

According to Nardelli (2019), computational thinking is the thought process involved in modeling a situation and specifying how an agent can effectively operate within this situation to achieve specific goals. For this author, this ability is more encompassing than mere problem-solving, since solving a problem is only one instance of a situation in which a specific objective is sought. From the authors' definition, we highlight the comprehension that computational thinking can be applied to the *situation* in which the agent operates, instead of focusing solely on the problem to be solved. For Nardelli, computational thinking is developed through the study and practice of computing.

Offering a different perspective, the authors Li et al. (2020) argue that computational thinking is not simply about learning how to use computers or software. They contend that, just as "*just learning to drive a car does not mean that one develops mechanical thinking*", computational thinking is not developed only by using computers; it is much more about thinking than about computing; it is more about knowing how to collect, interpret, and manipulate information than about computing it. From this definition we highlight that computational thinking does not require the use of a computer or software, it can be practiced unplugged and still contribute to develop a different way of thinking.

According to the BNCC, computational thinking encompasses abilities such as understanding, analyzing, defining, modeling, solving, comparing and automating problems and their solutions in a methodical and systematic way, through the development of algorithms. According to the Brazilian curriculum, this ability is listed as relevant because students are already required to translate a given situation into other languages, such as transforming mathematical problem situations described in the natural language into formulas, tables and graphs, and vice versa, thus they can also practice translating into algorithms. A document supplementary to the BNCC – Computing, establishes guidelines for the inclusion of Computing in Basic Education. In this document, specific skills, abilities and knowledge in Computing were defined to support the school in the development of these abilities.

According to this document, the premises to the development of experiences with computing for the k-12 audience encompass some of the computational thinking abilities, as the development of pattern recognition, create and test algorithms, decomposing problems into smaller parts, identifying steps, stages and generalize or reuse solutions for other problems. One of our highlights from their definition is that ICTs are not obligatory for the development of computational thinking. The requirements listed in this document, and the activities presented for all stages of basic education (from k-12 to high school) explicitly presents unplugged activities for practice. This subscribe the ideas from Wing, CSTA, ISTE, and Li et al. (2020).

Based on this framework, subscribing the highlights from each definition, we adopted the understanding that computational thinking helps: a) describing an abstract situation in concrete information; b) understanding and specifying the aimed valid final situation, e.g., the desired solution; c) describing the concrete actions needed to move from the initial to the final situation, e.g., from the problem to the solution, being steps to be performed or instructions of an algorithm, and d) do not have the ICTs as an obligation to be practiced with.

Alongside with computational thinking definition, researchers also specify different set of skills related to this ability (Council, 2010). The skills considered by Barr and Stephenson (2011) are: data collection, data analysis, data representation, pattern recognition, problem decomposition, abstraction, algorithms and procedures, automation, parallelism, and simulation. The Brazilian Computer Society[8] (SBC) understands computational thinking as an axis of computing that concerns the ability to systematize, represent, analyze and solve problems, and highlights the following skills as its pillars: a) abstraction: understanding and using appropriate models and representations to describe information, processes, and techniques to build algorithmic solutions; b) automation: being able to describe solutions through algorithms that can be executed by machines, as well as building computational models for complex systems; and c) analysis: critically analyzing problems and evaluating the efficiency of solutions, identifying and proposing automation and corrections, when possible (SBC, 2017).

According to the CIEB curriculum (Raabe et al., 2018), computational thinking is an axis (alongside the digital culture axis, from the former section) and is described as the ability to solve problems based on computing knowledge and practices, which encompass systematizing, representing, analyzing, and solving problems. The concepts of computational thinking proposed by the curriculum are: 1. *Abstraction*: involves filtering and classifying data, ignoring unnecessary elements, and focusing on relevant ones. It also involves ways of organizing information into structures that can help solve problems. 2. *Algorithms*: involves developing plans, strategies or sets of clear and necessary instructions to solve a problem. In an algorithm, instructions are described and ordered so that a specific objective is achieved. Algorithms can be written in the form of diagrams, pseudo-code (human language), or in codes, using a programming language. 3. *Decomposition*: works on the process by which problems are divided into smaller and easier to solve parts. It involves the practice of analyzing problems, identifying which parts can be separated, and how they can be reconstituted to solve a global problem. 4. *Pattern Recognition*: involves identifying similarities or common characteristics between problems and their solutions, which can be explored to design more efficient solutions. In accordance with the BNCC and the SBC, the CIEB curriculum also presents skills to be practiced each year at school, regarding these four concepts proposed in their curriculum.

The relationship between the computational thinking and the digital technology axes has been explored in research aimed at developing mental and technical skills that support people to master, create, adapt, and explore computing and its technologies. However, the relationship between computational thinking and digital culture has not been explored with the same attention, and few initiatives are found in the literature that could provide results and insights on this relation and its possible benefits. In systematic reviews and mappings of computational thinking (Werlich et al., 2018; Ortiz and Pereira, 2019b), the relationship with digital technology is demonstrated in the actions conducted and the audiences selected for the studies. In contrast, the relation of computational thinking with digital culture is nebulous both conceptually and practically.

2.4 Promoting Digital Culture through Computational Thinking in the YAE

Building on the topics discussed in this chapter, YAE students are usually not literate, may have limited trust in their own capabilities, and often have little or no previous experience using technology (especially autonomous experiences). These factors combined probably culminate in fear, embarrassment, and rejection of technology. In this context, it is easier to avoid

[8]From the Portuguese: *Sociedade Brasileira de Computação*.

the possibility of using technology by saying ”I am too old to use technology", or ”technology is not for me", rather than expressing ”I would like to use it, but if I still struggle with reading, let alone using technology, something I do not even understand how it works". Hence, the digital divide scenario deepens, and the main barrier to overcoming it is the students' willingness to start learning about technology so that fear may disappear. Then, experiences with technology can grow, they can test their own capabilities, and eventually discover whether or not they want to use technology and continue learning about it.

The core idea this research defends is that these aspects of fear, rejection, and shame need to be addressed *before* focusing on developing specific technology skills. This creates a secure environment for students to revisit their “presumed weaknesses", allowing them to engage in the activities, learn from it, and update their perceptions of technology and their own capabilities. According to the understanding built over these years of research, this is the primary goal for promoting digital culture with the YAE audience.

The approach chosen to address fear and rejection and foster digital culture development is through activities aiming to promote familiarity with technology. Once students notice that technology is already present in their lives and that they already have some informal knowledge on the topic (not technical aspects of technology, but the name, the purpose, and the icon that represents it), we slowly evolve the activities and experiences so that students start to progress their knowledge and grow their experience to the point where their own knowledge becomes sufficient to inform an autonomous new experience with technology. This way, the challenge level is reduced, and students are advancing at their own pace and building confidence in their abilities along the way.

In this approach, computational thinking is key to three main tasks: a) *extend the activities' complexity by proposing suitable goals within the student's reach*: the objective of a new activity will be proposed, taking the practice of computational thinking skills a step further. For instance, if in the previous activity, students interpreted an algorithm to perform a task, the following activity could order the steps of an algorithm, and the next one could describe the algorithm from scratch. This aligns with the core definition of computational thinking by CSTA, ISTE, BNCC, and SBC, which encompasses formulating problems, understanding and specifying a new desired solution, and breaking down a larger problem into more manageable problems. B) *stimulating logical thinking*: activities that practice computational thinking skills foster logical reasoning, which can be transferred and generalized to solve problems from different fields, sustaining the development of new experiences. This aligns with the CSTA, ISTE, Nardelli (2019) and Li et al. (2020) definition of computational thinking, which explicitly mentions the transferability and generalization, in addition to the problem-solving mentioned before. Finally, c) *identifying student's progression*: once students master an activity, it is understood that they have achieved a desired goal, and we can start developing the following activities, progressing the complexity a bit more. This is in accordance with Nardelli (2019) definition of computational thinking as understanding student progression allows us to adapt the situation (learning environment) for the agent (student) to effectively operate and achieve goals.

These three tasks generate a virtuous cycle in which computational thinking is the key to evolving the practice with technology, eventually reaching autonomous interaction. Computational thinking is not the subject of the activities but the tool to organize its progression. It means that activities do not have the goal of making students explicitly understand what computational thinking abilities are and how to apply them; it means that students get to interact with technology and the practice of abstraction, decomposition, pattern recognition, algorithm, and simulation facilitate their learning on how to interact with technology.

Following this idea, Ortiz et al. (2023) explains that for the YAE audience, the practice of computational thinking is on the basis level, sustaining the development of the other axes described by CIEB – digital culture and digital technology. When people are engaged in activities that make sense within their context and require them to practice computational thinking skills (e.g., abstraction, algorithms) while exploring and using computing technology, a context of similarities with how technologies function is created. This similar context helps students develop familiarity with technological devices, reducing rejection and fear of exploring new technologies: the more students explore and practice with daily activities, the more devices and services they tend to reach, and the more their context gets transformed. Hence, computational thinking has the potential to solidify a path to digital culture development.

2.5 Core Theoretical Inspirations

"When the parent or teacher has provided the conditions which stimulate thinking and has taken sympathetic attitude toward the activities of the learner by entering into a common or conjoint experience, all has been done which a second party can do to instigate learning."

(Dewey, 1916)

The main researchers on which we grounded this research are Paulo Freire, Cecília Baranauskas, and John Dewey. The first two were key influences since the Master's Degree research. John Dewey was selected to complement the concept of experiential learning and thinking. The ideas from their theories selected to establish our theoretical background are detailed below. The main topic in which the three authors converge is contextualizing learning in the student's context. All three emphasize the importance of grounding learning in the students' sociocultural context and addressing, through the initiative (activities, workshops, and contents), relevant and meaningful topics for the students' lives. From this central premise, other corollary ideas emerge: addressing students' former knowledge, students playing an active role in learning and designing practical experiences so students can test theoretical ideas before advancing in complexity to the following activities.

Paulo Freire was undoubtedly one of the researchers who had studied and addressed YAE the most in Brazil. Freire had as influences in his work, Vieira Pinto (2013), and Anísio Teixeira, a *Nova Escola*'s movement researcher, that was Freire's advisor. Anisio Teixeira brought from his own advisor - John Dewey - many ideas to inspire his pupil, so there already are a connection between Dewey and Freire's ideas. The most important contribution of Freire's work to this research is regarding the social aspects of the students. Freire subscribed to Dewey the idea that "*teaching is not the transference of knowledge, but creating possibilities for its production*" (Freire, 1997, pg. 24) , and extended this idea by posing the need to be intentional in looking at what surrounds students, not only in the classroom but especially outside of it. The following Freire ideas inspired this research:

A) The importance of starting initiatives by addressing social aspects, recognizing that technology is used by people with needs, goals, and interests, in a place with other people. Learning technology initiatives that disregard these aspects are weak to produce knowledge that can be incorporated in real daily lives because there will probably be issues in this incorporation that they cannot recognize – because understanding the social is not a goal of the initiative – and something that as not recognized cannot be treated and overcame. In this context, the author says: "*why not discuss with students the concrete reality to which the subject whose content is taught should be associated?*" (Freire, 1997, pg. 32).

B) Reading the world precedes reading the word. Reading the world and understanding what technologies students have access to, which will help them and which they are willing and interested in using precedes learning about this tech. Inverting this order - teaching some tech that is not related to the students' context (do not have access to and are not interested in learning) can extinguish motivation, engagement in the activity and active participation. About this topic, Freire highlights that respecting the students' understanding of the world is not a strategy educators make to become *likable* by the students. One goal in promoting technology knowledge with the YAE is students using technology *in their world*. Understanding and addressing the students' current world before considering ways that techs can help students is a sign of respect, generosity, and citizenship. On the other hand, the initiative cannot have a narrow view of the world. We recognize that people's world is constantly changing and evolving, and bringing students close to tech can actually contribute to that, so addressing the students' context needs to be a recurrent task.

C) Respect and involve previous knowledge from the students. Freire mentions "*why not establish an intimacy between the fundamental curricular knowledge of students and the social experience they have as individuals?*" (Freire, 1997, pg. 32). Students from YAE are usually adults, with many life experiences, more than often students are older than teachers. It is, at the very bottom, decent to recognize that students have previous knowledge and experiences. Adding to that, once this knowledge is involved in the practice, it can enrich the experience in multiple levels: for the student sharing its knowledge: by sharing their experience, creating connections between what is already known and what is being learned now, experiencing the role of teacher, and submitting their knowledge to validation. For other students: by being inspired to share their knowledge as their colleagues and by creating knowledge about something that was spiced by colleagues' experiences. For the teachers: for learning something new, for taking advantage of that to create more dynamic and flexible activities, and for becoming aware of the student's thoughts, ideas on the topic and willingness to share their "vulnerabilities". About this topic, Freire also says that the one who teaches, can learn through teaching, and the one who learns, teaches while learns as well (Freire, 1997).

D) Autonomy. Freire also defends the autonomy of students in the learning experiences as an important factor to continue achieving goals. About this topic, Freire says that educators role is "*to support the student so that he himself can overcome his difficulties in understanding the object and so that his curiosity, compensated and gratified by the success of the understanding achieved, is maintained and, thus, stimulated to continue the permanent search that the process of knowing implies*" (Freire, 1997, pg. 116).

As mentioned before, one of the influences of Freire's work was the philosopher John Dewey, that proposed the Experiential Education theory. The main idea of this theory is that learning occurs through experience. Dewey affirmed that mere activity does not provide the elements for a complete experience, and instead of delivering preordained knowledge, experiences should be created as teaching tools. In his words, "*to learn from experience is to make a backward and forward connection between what we do to things and what we enjoy or suffer from things in consequence*" (Dewey, 1916). The ideas from Dewey that inspired this research are:

E) Experience. In Dewey's theory, experience involve two elements, trying and undergoing its effects. Separating these elements would cause serious damage to the learning outcomes. The first element, trying, is when students have the opportunity to try their hypothesis on some problem/activity, come up with plans, think and propose solutions and strategies to achieve the desired goal. Students must have the space and a suitable background knowledge to autonomously think of ideas to try. The second element is undergoing its effects, which means that the students "*enjoy or suffer*" the consequences of their trying actions, not as a physical suffer, but that they will actually be positive or negative impacted by the occurrence of their propositions. This way, students have the opportunity to think about the problem, propose solutions autonomously, test this solution, directly observing the outcomes, think/reflect on new trying options, and make new attempts.

In the context of experiential education, there are important aspects to produce a genuine situation of experience: a) activities should involve subjects in which students are interested *for their own sake*, not imposed interests; b) that the difficulty of new problems should be large enough to challenge thought, and small enough so there shall be familiar spots to the knowledge students have; c) that students will have the opportunity to develop their solution in an orderly way, should be able to test and discover its validity on their own; d) students must be closely "related" to the consequences of their solutions; participants and not spectators. Dewey defends that students will not engage in meaningful thinking about the problem/solution unless the consequences of its action have some effect on their lives (positive or negative). The author explains that, if students can do something to turn the consequences into positive consequences, they will be motivated to do so. Also, achieving a good solution should produce more than meeting the school approval requirements; the consequences should preferably change their lives as citizens, not only as students. In our research, this is another reason why activities should value the students' former knowledge – so that students can start practicing thinking and proposing ideas that will be useful for their day-to-day chores, that are related to their context, so students can see that learning it will cause an impact in their lives. Experiential education encourages active participation, autonomy, reflection, and real-world application of concepts.

F) Teachers' role as facilitators, guiding the experience. As facilitators, the teacher's attributions are: planning activities that are under the reach of the students, identifying when students are struggling and offer different tools and strategies to overcome these blocks. Teachers should guide students in the direction of developing knowledge, and not transmitting a corpus of knowledge that relates to little or nothing to the students' former knowledge. The author says *"In such shared activity, the teacher is a learner, and the learner is, without knowing it, a teacher - and upon the whole, the less consciousness there is, on either side, of either giving or receiving instruction, the better"*.

G) Learn by creating. Dewey also affirms that teachers should "*give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking, or the intentional noting of connections; learning naturally results*". The author's view is similar to what Papert defends. The educational philosophy constructionism, proposed by Papert, defends that learning is particularly effective when people are engaged in creating something meaningful to them. Papert, the creator of the LOGO programming language, was one of the first authors to mention the ability of computational thinking, as Nascimento et al. (2018) and Kaminski et al. (2021) recognize. In Mindstorm, Papert (1980) describes ideas of integrating computers in children's education in a meaningful and powerful way, using the computer not to program the child but that the child can program it. Papert's work also impacted this research with the idea that learning about technology involves thinking at multiple levels of abstraction and that creating things is a good way to drive learning.

What we understand and propose about experience and inclusion is that activities need to be contextualized; it must make sense to the students; it cannot be just any activity. Moreover, creating activities is a challenge that requires being informed by the authors' ideas presented above, and translate them into practical activities. In our research, we designed practices informed by the students context through a socially aware model proposed by the Brazilian computing researcher, Cecilia Baranauskas.

H) The Socially Aware Design (SAwD) model guides the design and conception of computing technology activities with social responsibility in a participatory way (Baranauskas, 2014; C. Baranauskas, 2021).

The SAwD model proposes to investigate more than just understanding "what the software needs to do". It encourages a more careful and deeper look, going beyond the surface of what the problem "appears to be". The model encourages designers, coding professionals, stakeholders, and users to, together, create an understanding of the problem and design what valid solutions would be, *before* implementing them. SAwD defends and supports that for interactive computing technology design, before designing any kind of solution, it is necessary an understanding of the problem, involving possible users and different stakeholders (i.e., interested parties) that are or will be directly affected by the problem or by a prospective solution, and to analyze the problem context in different dimensions.

One example of a socially aware approach applied in health context would be when someone has a health problem and before the doctor gives any prescription or recommendation, they listen to the patient and investigate what the real problem is (not only what appears to be), so then they - also together, and sometimes even with the family - can come up with the best treatment for that patient, considering technical aspects, as the patient's health condition, and the quality and efficiency of the different treatments, but also considering non-technical aspects, as the patient routine, financial profile, needs, what could be "easier" for them to incorporate in their life, whenever there are options to choose from, and so on. That is why SAwD is a socially aware and responsible model: it focuses on understanding the surrounding where the problem is before anything else; the extension of this understanding goes beyond just technical aspects of the problem and covers informal (i.e., culture and values) and formal (i.e., rules and procedures) dimensions of the problem and context of use; and this investigation is conducted with the participation of those who are/will be impacted by the problem or its solution, resulting in a co-design where society impacts the design and design impacts back. SAwD has been applied in different scenarios and contexts, including educational ones (such as Nicastro et al. (2018); Carbajal and Baranauskas (2019); Panaggio et al. (2019); Moreira et al. (2019); Mendoza and Baranauskas (2020)).

SAwD is in accordance with the propositions brought from John Dewey's theories by seeing the students as participants, actively responsible for their knowledge development. As well, SAwD ideas are in accordance with Freire's propositions brought to this research too, by the social view both authors recognize and defend to be considered when interventions are proposed (Baranauskas et al., 2024). The following ideas were inspired by the SAwD model:

H.1) Context Awareness: In the YAE, it is expected to have a group of students of various ages, from different regions of Brazil, with different professions and different family structures, among others. Derived from the SAwD, we understand that when creating experiences to promote learning on some topic, there has to be an understanding of the socioeconomic and cultural reality of the students first. The technology will be adopted by a person who has a family, lives in a house, with neighbors, speaks a language, and has responsibilities, among others. It is necessary to become aware of this context to design activities that will favor adopting technology in the students' context. The idea is to propose technological activities for students from what is already known and is close to them, and then keep evolving from that.

H.2) Participatory Sensemaking: In the YAE context, participatory sensemaking means that the initiative is not previously determined, having established what technologies to encompass, how to make sense of that technology and how it should be used in the students' routine. We are not the ones saying, "*WhatsApp has tremendous possibilities for many of the problems you have, so let us focus on WhatsApp now, and next week I want to see who has used WhatsApp at* *home*". On the contrary, the group discusses technology, making sense of it, and understanding its purposes, strategies, and experiences so that the students can practice and develop their knowledge on the proposed topic. It is the students saying "*you know... I would like to use the WhatsApp to call my sisters, because I miss them*", and then the workshop is built. Students then become co-creators of the initiative, because experiences evolve from this participatory sensemaking of technology.

H.3) Iterative incremental cycle: The students' context keeps evolving as life goes by, and at each workshop, more participatory sensemaking is also built. The SAwD also inspired us to constructively implement each workshop based on the outcomes from the former one, as a virtuous cycle. The results and experiences achieved in one workshop serve for more sensemaking for the design of a new workshop.

H.4) Autonomy: YAE students' autonomy must be enhanced and respected. We recognize that students are primarily responsible for creating their own knowledge. All researchers can do is propose experiences to unfold this learning process based on the previously – and participatory – discussed and proposed topics, and support the student throughout the process. However, students ultimately decide to participate and create knowledge.

2.6 Socially Aware Model for Computational Thinking with YAE

The Socially Aware Model for promoting Computational Thinking initiatives for YAE was a product of my Master's Degree project (Ortiz and Pereira, 2020, 2021). The model aims to support the design, planning, and conduction of initiatives to foster the progression of YAE students' experiences with technology. As this doctoral research advances in the same research focus, we present this model as part of the theoretical basis that has inspired this research. Drawing from this theoretical background and the practical experiences with students, we have developed an updated understanding, which is presented later in this document. The Socially Aware Model for promoting Computational Thinking Initiatives for Youth and Adult Education offers three main steps, as Figure 4.3 shows.

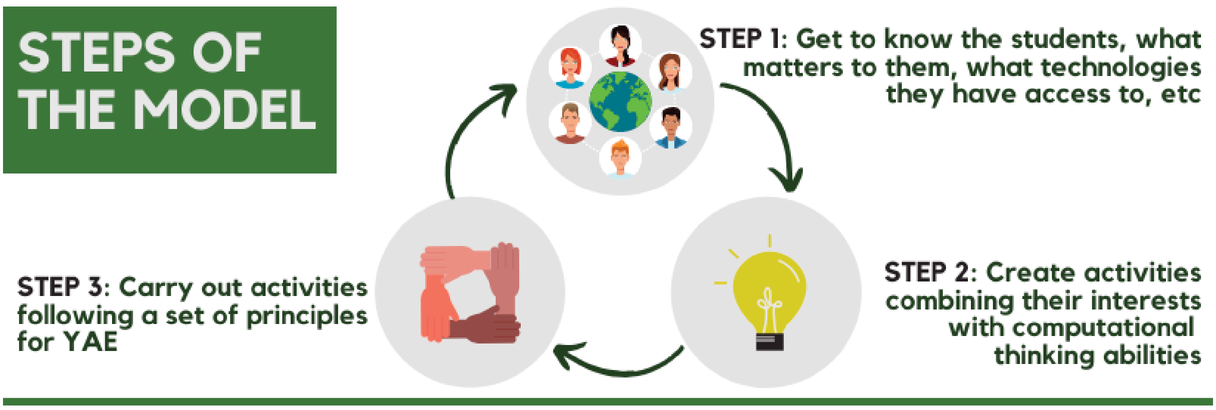

Figure 2.1: Steps of the Socially Aware Model for CT initiatives with YAE audience

Step 1 – get to know the students: Comprehend students' world view and understand what is relevant and useful to them to determine what technology to use and what contents and activities to explore involving CT abilities. This step must start an open and trustful working environment for all the participants. Important issues to identify are students' expectations, needs, knowledge, contents they are studying in the regular class, technologies they know or have access to, and the ones they would like to learn more about. Different techniques or strategies can be put into practice to raise this information in a positive, natural, and funny way (e.g., games and storytelling). The key point is to engage people in meaningful and positive experiences with technology usage, promoting well-being and a feeling that we are all learning together.

Step 2 – create activities: Combine all the information previously raised to determine the contents and technology to be addressed, and CT skills to be practiced in activities to engage students. Each activity must address relevant and useful issues students want to learn, and must explore possibilities with devices they may have access to, naturally exploring CT concepts and skills with them. New activities can be elaborated, or existing ones can be adapted, as long as they incorporate relevant aspects of students' context and follow the principles for practices with YAE students (see Section 4.1). Activities must be as universal as possible to attend the diversity of students. Defining activities to be conducted, outcomes to be evaluated, and elaborating the necessary materials to their conduction are also part of this step.

Step 3 – carry out activities: When putting activities into practice, be aware of important particularities of the YAE audience. This step also encompasses socialization and evaluation, which may occur in different ways according to the goal of each initiative (*e.g.*, students' progress, what they have learned with the activity, their perception of technological devices usage, etc.).

Every workshop must be designed in this movement from Step 1 through Step 2, and Step 3. During the practice of activities in Step 3, new interests, doubts, and needs may arise and serve as input for a new cycle, creating an iterative and constructive movement.

The model is composed of nine principles designed to orient the initiative. These principles are fundamental to consider when working with YAE students, as they directly influence the structure, purpose, materials, and methods of prospective activities. While not exhaustive or definitive, they are understood as a core set of principles essential for planning and conducting initiatives with the YAE audience.

1. Socio-culturally Contextualized: activities must be as close as possible to the students' socio-cultural context. The content must make sense to the students' context so that the knowledge they are creating can be applied and related to their needs, interests, desires, curiosities, difficulties, etc. This principle requires investigating the mentioned aspects even if the team conducting the initiative already knows the students because "predicting" them based on what is already known about the students does not favor participation and can result in a biased activity.

2. Useful: activities must involve useful things for students, things they can use for some purpose in their daily lives, and, preferably, contents they could apply or use immediately. Because of YAE's characteristics and because students are trying to make up for the time they were out of school, the usefulness of the discussed topics must be clear for them, to favor the feeling that they are progressing and learning more.

3. Relevant & Appropriate: activities must contemplate needs, expectations, and interests that *matter* to students – preferably, the most relevant situations for students should be considered in the activities. Also, activities must explore students' previous knowledge. However, because some polemic subjects could arise in their personal preferences, such as religion and politics, these issues must be approached carefully.

4. Participatory: conduct activities stimulating everyone in the role of participants: we are practicing and learning together. Naturally, some participants play the role of mediator, but everyone should participate when practicing with the YAE (students, researchers, and teachers). It is a sign of respect and honor, as students have many life experiences to share too. When conducting activities with YAE students, participants should engage in all activities dynamically and responsibly. Be sure to encourage them to recognize themselves as capable and responsible for creating their own knowledge. When working in a participatory way, the topic addressed must consider aspects and experiences of all the participants, enriching the learning experience.

5. Universal: activities must be designed to account for differences, to be suitable for the most different levels of abilities found in the respective group of students. The same activity (with the same materials) must be applied for all the participants, especially concerning limitations or difficulties in terms of movement and vision. In cases of severe disabilities (such as deafness or blindness), and depending on the nature of the activity, some specialized resource may be necessary. However, the designed solution must be suitable for as many people as possible, avoiding segregating the participants.

6. Self-contained: due to the irregular attendance in the YAE, activities must be independent, starting and finishing in the same workshop. If students miss any activity, they may find no impediment to participating in the next ones. Even when activities are linked to the previous ones, a new student must be able to start participating.

7. Differentiated & Attractive: the environment in which practical activities take place should be different from the conventional classroom style (lines of individual desks directed to the board) in order to stimulate creativity and participation. Formats in which students are arranged in a circle, divided into teams or other ways that favor direct contact, communication, and collaboration with each other are recommended. Activities should be presented in an inviting and attractive way to raise students' interest.

8. Trans-disciplinary: activities must involve a combination of different contents, prioritizing the work in thematic problem situations instead of specific contents. Because CT can be useful to solve different types of problems, being described as a trans-disciplinary ability, involving concepts of more than one subject enhances CT's potential. Therefore, students may see several examples to apply the learned skills.

9. Progressive: the complexity of activities and contents must evolve progressively. Students may need time to reflect on some content or practice, try, test, work on new hypotheses, and so on. When working with students of different profiles and ages, it is expected that they take different times to assimilate the contents. Their time should be respected: instead of speeding up students who have not finished their activities, offer additional activities for those who have already finished, ask them to help other students, or show what they have done and learned.

2.7 Highlights of the Chapter

Although the YAE is characterized by age (*youth and adult* education), this audience has historical, social, and political particularities, and had been kept away from formal education opportunities for a long time. YAE students have been systematically excluded from opportunities, and the digital divide they still face today only deepens this exclusion. For the YAE audience, promoting digital culture is more than using digital technology; it is existence and autonomy in a world permeated by digital technology, is practicing the students' citizenship. Our practical experience and theoretical background suggest the approach of computational thinking abilities - algorithm, pattern recognition, problem decomposition, and abstraction, among others - as tools to organize activities to support the students in learning and developing knowledge toward technology interaction. This learning must occur through experiences of thinking, testing, and reflecting on what is obtained in response Dewey (1916), in which students play an active role in learning, instead of a passive one. In addition, the learning experience is not any experience; it has to be a social one, critical, reflective, autonomous, supported by previous experiences, situated in the students' context Freire (1997). Being situated in the students' context does not imply the proponents of the initiative making sense of the students' context and making assumptions as to what will be helpful to them, how they will use some technology, or what they think about something; it is the whole group (participants and teachers) making sense together, creating the understanding together Baranauskas (2014). From this shared understanding among the whole group, suitable practical activities can be designed, computational abilities can be practiced, technology can be adopted, and digital culture can be promoted.

The highlights of this chapter are enhanced below:

- Youth and adults lacking literacy have been kept aside of formal education for a long time in Brazil. For these citizens, initiatives to promote learning have a great potential to change their lives.
- Youth and adults who are seeking education and literacy have several barriers to accessing technology that precede even the lack of technological experiences, such as economic, social, and cultural barriers.
- Addressing the barriers that hold back the understanding of "I can learn about technology if I want to" is what should be addressed first in order to achieve inclusion to the digital world.
- Providing opportunities for the development of the skills needed to operate digital devices is a step towards combating digital divide, but there has to be a concern in how these opportunities will be conceived.
- Addressing the social context of students is crucial for meaningful learning experiences. It is important to think about the learning technical aspects, but considering the social context where the interaction will occur, acknowledging the aspects in between, and designing experiences that combine creating, trying, and experimenting the consequences. This way students get engaged in learning because they are learning what they have curiosity about, what they see purpose and usefulness of incorporating in their lives. This approach to design YAE initiatives about technology is an originality of our research.
- Computational thinking has the potential to support learning about technologies, from the early beginning to the more complex ones, organizing and guiding the progression of activities. In the YAE audience, computational thinking is a tool for the development of technology knowledge and digital culture. This approach is also an originality of this research.

3 Related Research

This chapter discusses the current scenario of initiatives aiming to promote technology learning and usage among the YAE audience and older adults in general, contrasting them with our research. To achieve this, we conducted an exploratory literature review, focusing on Brazilian and international studies that describe practical activities with this audience. We selected papers based on the following criteria: a focus on YAE or older adults (especially when mentioning literacy challenges), a description of practical experiences and outcomes, and a focus on teaching technology, ICTs, or computing. A discussion of computational thinking was not a mandatory criterion. Based on this search, we selected five key studies for a comparative analysis. Details on the studies are presented in Table 3.1. Later in the chapter, in Section 3.2 we articulate the differentiators of our research, in contrast with the scenario identified. Finally, Section 3.3 presents other related studies.

3.1 Review of Technology Education Initiatives for the YAE

We selected three Brazilian and two international research studies to discuss the scenario of initiatives aiming at teaching about technology for the YAE audience or elderly students in general. Table 3.1 presents a summary of the five studies we have selected.

Cunha and Gurgel (2016) conducted six classes to promote the digital inclusion of YAE students through theoretical-practical lessons on Computer Start-up (Switching On/Off), Operational Systems (Introduction to Windows), Office Package (Word and PowerPoint), and the Internet. The initiative happened in the state of Rio Grande do Norte/Brazil. The authors developed didactic material in printed form at the beginning of each meeting. The paper mentions that before the proposal was implemented, a survey was conducted to find out the profile of the participants, as well as their computer knowledge. This could indicate an approach sensitive to the students' context. Nevertheless, the paper does not mention if the activities' content came from the students' context or were pre-determined. In addition, the paper does not inform whether a theoretical background was adopted to elaborate the initiative and the activities, and whether specific aspects' of the YAE were considered in elaborating the materials. The YAE students addressed were from the equivalent of Elementary School (and not in the initial levels), and 93% of the students were aged between 15 and 20 years, and the oldest 30 years old. According to the students' learning self-assessment, 87% answered a positive perception of their learning from the classes. The paper further mentions difficulties and barriers their students faced in their initiative, such as "fear of 'breaking' the computer" and "low self-esteem", which is curious as their audience is predominantly youth. Hence, we conclude that these barriers do not only occur to adults and elderly students, but with the YAE in general.

Silva et al. (2019) describe an initiative with 10 classes – 4 hours duration each – with the goal of teaching basic informatics. The group had 20 YAE students, from 17 to 42 years old, and the project team was composed of 2 teachers and 9 undergrad informatics students, all from the Federal University of Alagoas. Initially, the aim was to get to know the participants' profile, as well as their previous knowledge about using hardware and software, so that the technological content to be taught could be tailored to the audience, a characteristic in common with the Socially Aware Perspective. However, the authors were surprised by the students' [lack of] digital abilities. They have noted that the majority of the class had never had contact with a computer (desktop) before, and were unaware of simple things such as holding the mouse and positioning their hands correctly when typing. Then, the team had to redesign the lessons and start by addressing these starting topics. The initiative then addressed computer start-up, systems, the history of the computer, file and equipment explorers, Internet use, and the LibreOffice package (Writer, Impress, Calc). The authors also mentioned they have created a workbook adopting a simpler language, to be accessible by the students. There is no mention of theoretical or conceptual background involved to guide the practice, the proposition of contents, and the elaboration of materials. The paper also does not mention having addressed social aspects of the students, such as needs and interests, even though they used the students' level of abilities as an input to rebuild the initiative. Regarding student outcomes, the paper mentions a student that, after participating in the classes, got a job as receptionist, due to the skills she acquired, and another student, a nail designer, who started to manage her business through the computer. About the difficulties faced, the authors mention they were surprised by the students' abilities, which we can infer that the students' context was not investigated previously to the initiative start. Still, after the adaptation to the students needs, at least two students had their lives positively impacted by the classes. Even if only one student got transformed, it would have already been worth to conduct the initiative.

Table 3.1: Summary of the Technology Education Initiatives

Paper (Location)	**Goal of the Initiative**	**Audience**	**Content Taught**	**Difficulties Faced**	**Results/Outcomes**
Cunha and Gurgel (2016) (Rio Grande do Norte, Brazil)	Digital inclusion of YAE students	YAE students (15-30 years)	Basic informatics (Windows, Office)	Fear of 'breaking' the computer, low self-esteem	87% of students had a positive perception of their learning.
Silva et al. (2019) (Alagoas, Brazil)	Teaching basic informatics	YAE students (17-42 years)	Basic informatics (LibreOffice)	No prior contact with computers, lack of basic skills	Students applied skills to get jobs and manage businesses.
Martins et al. (2023) (Minas Gerais, Brazil)	Literacy through programming	YAE students (48-75 years)	Scratch activities	Lack of basic computing abilities (mouse, keyboard)	Could not go deep in computing content due to limited time.
Atkinson et al. (2016) (Location not mentioned)	Tailored one-on-one tutoring for specific needs	Older adults	User-defined needs	Fear of using technology	Shift from fear to positive expectations toward technology; students felt they were "keeping pace".
Ngiam et al. (2022) (Singapore)	Smartphone use for digital inclusion	Older adults of low socioeconomic status	Predefined smartphone topics	Lack of motivation and confidence, fear of online scams	Increased abilities and satisfaction; more frequent smartphone use.

Martins et al. (2023) describes three classes – 1h40min duration each – with 17 YAE students in a school in Minas Gerais/Brazil. The students were from multiple levels of the YAE, and their ages varied from 48 to 75 years. The initiative was based on Creative Computing, developed by MIT, and theoretically inspired by the Constructionism theory, by Seymour Papert. The initiative used unplugged and plugged activities to contribute to the students' literacy. The paper describes that activities were pre-selected, not explicitly considering the context of the students, as well as their needs and usefulness in their daily lives. The authors reported a very challenging characteristic in working with the YAE audience, the heterogeneity of the group, not only in age, but in level of abilities and literacy, a very unique characteristic of this modality. The authors mention that they could not go deep in the contents about computing, because only 3 classes were conducted. Regarding the students' difficulties during the classes, the paper mentions lack of computing abilities, as using the mouse and the keyboard, difficulty in understanding abstract concepts of programming, such as loops and repetition, and social difficulties, as the students' lack of engagement to participate, and fear of using the computer. This is in accordance to what was observed before in the previous studies. Even though the research had been guided by a theoretical background, it was not related to the YAE audience, and so the main difficulties the research had faced could have been identified and handled by a theoretical background specifically developed to this audience. This is similar to what has happened in the 2015 initiative (presented in Section 5.1). The Socially Aware Perspective explicitly combines a theoretical background that considers the characteristics of the YAE modality, being an approach that not only handles the YAE characteristics, but is built from that.

Still about the work from Martins et al. (2023), this is the only related work that explicitly uses a Computational Thinking-based approach. In this research, computational thinking was practiced through unplugged activities and the Code.org platform, and the computational thinking abilities were involved as the subject of the activities, aiming to teach the essential concepts of algorithms and programming logic. This contrasts directly with our perspective, in which the computational thinking abilities are not the content to be taught, but the tool to organize the practice and progression on the activities. We argue that the barriers of fear of using and lack of engagement in learning can be eased by using the computational thinking abilities as a means rather than an end in the activities, by starting from a very initial practice and evolving its complexity according to the students development. The students' focus remains on a concrete, useful, and contextually relevant activity. This way the practice of computational thinking abilities foster their development on digital experiences.

Addressing international initiatives, Atkinson et al. (2016) conducted an initiative with older adults about technology. The paper describes that "*rather than delivering predefined training sessions, we invite learners to come to us with their specific [technological] needs. We then tailor our one-on-one tutoring sessions accordingly*". The authors mention the Social Cognitive Theory (SCT) from Albert Bandura, in which the key concepts are self-efficacy – when a person trusts their own capability of succeeding, observational learning – when students learn by observing the tutors, and social persuasion – positive feedback and words of encouragement contributing to raise the students' self-confidence. However, the paper does not provide information about how materials and lessons were built, and how many classes were offered, only that they were intergenerational, with university students teaching the older adults. Regarding the outcomes, the authors describe a change in the students' expectation towards technology, from fear of using technology, or breaking it, to positive expectations, after being able to complete the tasks they wanted to learn, such as calling family. As a student's testimony about the classes, she said "*the sessions make me feel like I am keeping pace with technology; that makes me feel good*". These results highlight the benefits of individual tutoring, and the SCT approach, whose focus on the students' social aspects is a similar aspect to this research. In addition, although the paper does not explicitly mention computational thinking abilities, it mentions a sequence of steps as a teaching strategy multiple times, which we recognize as algorithms.

Also in the international context, Ngiam et al. (2022) describe an initiative in Singapore that addressed 138 older adults of low socioeconomic status. The initiative's goal was to teach students about phone use from the basic level – such as making calls and sending messages – to more advanced functions – such as accessing government websites, making purchases, or paying bills online. The article reports that 25,4% of the participants had no formal education, 41,3% completed primary education, 29% secondary education, and 4,3% had a diploma or higher education level, but no further information about the students' education level was given. This is also an intergenerational research, in which the tutors are youth volunteer students from the university, that are teaching elderly students. The initiative also adopts individual tutoring. The authors describe that they designed 6 topics to work with the students, such as communication, life-style, and cyber-security, but the paper lacks information about how activities were designed, or the conceptual and theoretical view of the initiatives. The students could choose which of the lessons they wanted to learn – which does acknowledge the students preference and curiosity, but only from a limited pool of topics. As difficulties, the paper mentions the students lack of motivation and confidence, and fear of online scams, and as results, the paper mentions that the students had a great increase in their abilities, turning to use the smartphones more often, and were very satisfied with the classes at the program.

3.2 Articulating the Socially Aware Perspective: A Comparative Discussion

These investigations corroborated that not only technical but several other issues are still hindering the YAE students' development regarding technology adoption, and sometimes these issues stand *before* the learning process starts. A differentiator of the Socially Aware Perspective is that it proposes to focus on the first stages towards technology interaction development, addressing the students' early barriers to technology, that can be the thought that technology is not for them, that is something no one should bother to teach them because they are "too old" to learn, or they do not deserve to learn, or even they are not smart enough to use. After addressing these first social and cultural barriers that students can become active and responsible and engaged in learning about technology.

These studies also reveal the need for a theoretical background specifically designed for working with the YAE audience, that takes into account the main characteristic of this audience, which is the multiple combination of age, abilities, interests, and life stories of its students. Many studies fail to mention the theoretical background used to design the initiative, and many barriers these studies have reported, as lack of motivation and fear, would have been identified and addressed by a socially aware initiative designed for this audience. This means there is a gap not only in the national but also in the international scenario, in which no theoretical background specifically designed for the YAE is being adopted by initiatives that address this audience. That is a theoretical gap that this doctoral research aims to fill, by providing theoretical and practical knowledge to design initiatives for the YAE audience. In the Socially Aware Perspective, beyond addressing the students context, interests among others, one of its main distinct characteristics, inspired by Baranauskas et al. (2024), is the Self-regulated principle (presented in Section 4.3), which means that the workshop's outcomes inform the content and activities of the next ones.

Hence, informed by this principle, the initiative is not adapted or redesigned, it is constantly *built from* the students' outcomes.

About the teaching, individual tutoring has demonstrated good results in these initiatives, but sometimes it is not viable, as it requires a larger team of facilitators. To fill this pedagogical requirement, one alternative strategy we used in our initiatives was to have advanced students tutoring the new beginners. Inspired by the Progressive principle (presented in Section 4.3), this strategy provided more attention to the students. All of them practiced the same content at the same time, but with different approaches: some as learners, and others reinforcing their knowledge by acting as teachers.

Once a workshop addresses the students' social context and interests, is sensitive to their barriers, promotes ways to ease them and successfully engages students in learning, the next step is to involve technology. Regarding this topic, one differential of our research is the strategy to organize the progression of the interaction with the technology according to the practice of computational thinking abilities. Once an ability is mastered with and through the interaction with the technology, respecting the individual time each student takes, both the activity and the workshop goal can evolve to a next level of complexity. This progression will lead the student to experience more and more interactions with technology, in which the knowledge they have developed in the former experience will sustain the development of new experience with technology. This virtuous cycle leads to the development of digital culture. In our research, this progression on the workshops' goals is presented by the purposes of the workshop, described in Section 4.4.

These four aspects, the focus on early barriers to the students development, the theoretical foundation, a pedagogical strategy, and the proposal of computational thinking as a tool to the development of digital culture, are some of the key differentiators of our research that can fill the gaps found in the scenario of the YAE research regarding technology.

3.3 Other studies with similar topics to this research

The first paper describing practical activities about computational thinking with the YAE was published 10 years after the seminal paper of Wing (2006), by the authors (Ortiz and Raabe, 2016), and is about a practical initiative we have conducted in 2015 (presented in Section 5.1). This information was revealed by a systematic mapping review that covered the range from 2006 until 2017, in national and international basis (Ortiz and Pereira, 2019b). After 2017, some of the latest Brazilian mapping studies have disregarded YAE as an audience to be included in the mapping, even though these studies purported to address the Brazilian basic education: both Farias et al. (2023) and Silva and Nunes (2021), considered basic education but does not mention YAE, and both Grebogy et al. (2021) and Oliveira et al. (2022), investigated only initiatives involving elementary school.

Costa (2014) has conducted an investigation with the YAE audience. The research proposes a set of pre-defined activities to practice computational thinking through the app ForEJA, developed by the author. The research, then, shares details about the app's development. In the practical case study, the paper mentions having conducted the classes with the students. Though the paper presents qualitative results about the conduction of the classes, the focus of the evaluation is the app, in which the author asked questions as "Did you find using forEJA difficult?" or "Have you encountered any problems while using forEJA?".

In a broader work, Gomes et al. (2021) present some initiatives and proposals to include Computational content in Brazilian education at all levels. The paper highlights the importance of addressing the YAE audience for promoting digital culture and describes initiatives that have had "promising results", such as Ortiz (2019), Ortiz and Raabe (2016), and Ortiz and Pereira (2017). A project proposal is presented to teach how to send messages, make calls, and take pictures, but the paper does not describe its conduction, audience, and steps.

Also related to YAE students, teaching their teachers is a topic that has also been explored. Medeiros (2022) proposed a pedagogical guide[1] to teach computational thinking to YAE teachers: the guide was elaborated from a course with five YAE teachers of a school in the state of Rio Grande do Norte. Later, Medeiros and Tedesco (2024) presents a toolkit for YAE teacher formation in the development of computational thinking skills.

This body of research may indicate that there has been a shift to start focusing more on computational thinking with the YAE audience. This highlights even more the need for a theoretical background capable of informing the practice with the YAE, which means, specifically designed for dealing with the many aspects regarding this audience, but also that proposes a transdisciplinary and progressive approach of the computational thinking abilities, embedded in the practice of interaction with technology. This way, the computational thinking abilities work as the tool, and not the content and primary goal of the activities.

During the COVID-19 pandemic, some papers have focused on discussing the YAE experience and difficulties regarding the migration of classes to online formats. The researchers Santos et al. (2021) surveyed the challenges 3 teachers faced during remote education with YAE students. One of the questions was: "*Have you had any difficulty working (...) with the YAE students in the remote format?*". Teachers responded: "*The biggest difficulty is access to the internet by the students*", and "*WhatsApp group (student who does not have internet or telephone), broken devices, lack of internet access (as some students reported not even having money for food). All of this hinders this interaction between teacher and student*". No difficulty was mentioned about the students' interaction with these technological resources and platforms, probably because the infrastructure problem came first.

Favero and Cardoso (2021) conducted a survey with YAE students to investigate their relationship with technologies within the context of pandemic education, and 29 answers were obtained. According to the research, the authors defended that, from the students' point of view, the COVID-19 pandemic has negatively affected their performance and motivation. The authors mention that students had to share the smartphone (probably belonging to someone else); only 20% of the respondents said they could complete the activities; and the students could rank their experience's difficulty level from 1 up to 5, and 79% of the students perceived it as 3+. The authors conclude the paper by stating "*There is a need for the subject [technology] to be addressed in the classroom, not just because of the pandemic and the possibility of new periods requiring remote education happening again, but also because we live in a globalized world, which makes use of technologies daily to obtain information and communication*".

3.4 Highlights of the Chapter

- The literature research revealed a gap: research both in the national and international scenario lacks a theoretical background specifically designed for the YAE audience that addresses specific aspects and characteristics of this audience.

- The main difficulties these studies faced are from multiple natures, not only technical, and are highly related to a lack of previous knowledge on the audience, a consequence of not adopting a theoretical background specifically proposed for the YAE audience.

[1] Available at: https://sorayaroberta.com/PensaEJA/

- The pandemic also revealed some important difficulties the initiatives with YAE have had, including the lack of access to technological resources and cultural, social, and cognitive barriers to technology access.
- Although there has been a shift from informatics in education research to focus more on computational thinking with the YAE audience, the systematic review mappings conducted on the topic are still not looking to this audience with attention.
- The Socially Aware Perspective proposed in this research presents characteristics that can fill the gaps found in the scenario of the YAE research regarding digital culture development.
- The main differentiators of the Socially Aware Perspective are the focus on early barriers to the student's development, the theoretical foundation, a pedagogical strategy, and the proposal of computational thinking as a tool for developing digital culture. These aspects demonstrate the originality and contributions of this doctoral research to the field.

4 Understanding the Socially Aware Perspective in the Youth and Adult Education

During the years of this research, our understanding was deepened and updated by the theoretical background of this research, and situated within our experience in practical initiatives with the YAE audience. This chapter starts with the key concepts frequently used with an explanation of their meaning within this socially aware context. We then directly answer the research question: *How should we understand and approach the YAE audience to offer experiences that promote/favor technology familiarity?*. The chapter continues by outlining the characteristics of a socially aware initiative, followed by a set of 11 principles to support the design and conduction of socially aware initiatives. The chapter further presents four distinct purposes for the workshops, each accompanied by a list of suggestions for practicing computational thinking abilities to support the interaction with technologies. This chapter concludes by detailing the steps for designing workshops within an initiative, each step with its own tasks to be completed.

The model produced during the Master's Degree was updated and reviewed to be presented in this research. As original production of this Doctorate research, we detach:

- 2 new principles: *10. Autonomy and 11. Self-regulated* + the update of the 9 pre-existent principles.
- organization of the principles in 3 categories: *1 - Base for establish a socially aware perspective and conduct the workshops, 2 - Base for designing activities, and 3 - Base for designing workshops.*
- 4 distinct purposes for workshops within the initiative: *1. Establish foundation and contextual understanding, 2. Promote technology familiarity, 3. Promote learning on how to use the tech, and 4. Advancing the interaction with the tech.*
- A list of computational thinking abilities suitable to practice according to each purpose of the workshop within the initiative.
- 1 new step to design workshops: *0. Get informed about the context in which the initiative will be conducted.*
- 3 updated steps to design workshops: *1. Produce Activities and Workshops, 2. Conduct the workshops, and 3. Describe Results and Reflect.*
- 13 tasks, organized across the steps for workshop design.

4.1 Key Concepts

These are 4 key concepts we have elucidated in this research and that we consider relevant for the comprehension of our understanding. Following, there is an explanation of the meaning we adopted to each one.

Students - are participants, the main responsible for creating their own knowledge. The learning process requires students to be engaged in the experience. Without their involvement, little can be done to increase their knowledge, beyond creating engaging learning experiences. This is another reason why we claim there is a need for the initiative to be socially contextualized: because it encourages, it raises the engagement in the students to participate in the experience. As Dewey (1916) has said, students are more motivated to learn when they feel that the consequences of something they act upon will have impact in their lives. When students realize that what they are learning at school is close to what they need in real-life outside school, when students realize that participating in the activities can positively impact their lives, they will likely be more inclined to engage in the initiative.

Activities/experiences - are opportunities for students to *act on* a situation. When there is a problem in adopting technology in real-life, for example, "not knowing how to send audio messages", activities with the goal of addressing this problem would offer the students the possibility to elaborate and test actions to solve the problem. Whenever possible, activities need to involve a real-life problem, and not merely a 'classroom problem' dictated by the teacher (as Dewey pointed out). Also, whenever possible, the solution students proposed and tested for the problem must be the solution for the problem in life outside of school, with little or no adaptation. Hence, students can more easily perceive that real-life problems are approached in school and that solving that problem, at school, with the help of the teacher, will contribute to solve that problem in real life. Activities should be built with this goal, and solving a set of activities will contribute to solve the whole problem. In this context, we call experience the action of thinking, testing and reflecting on the outcomes of a solution within an activity.

Teacher - act to facilitate the learning process to occur. Teachers are not primarily responsible for creating knowledge in/for the student, or transmitting knowledge (as Freire criticizes). Teachers design experience, propose activities, share thoughts, ideas and information, guide the process, correct the mistakes, give insights, offering the opportunity to learn together, at school, through the means that the school offers. Students are not dependent on teachers in a way that if there is no teacher, there is no learning at all; students are the main character in the process of acquiring knowledge. This makes special sense in the YAE since its students have been away from school for a long time, but have learned so much during their lives, and have so much knowledge to share. Teachers are like a swimming pool trampoline, helping students get farther faster, but if the students are not engaged in diving into the pool of experience and knowledge, the trampoline is not of much help.

Evaluation - based on our understanding, our approach to evaluating YAE students differs. We are not interested in measuring mere processing capacity or achievement metrics, as reproducing 'correct' outcomes does not guarantee true learning, method mastery, or sustained technological interaction. Instead, we consider evidence such as students' familiarization with technology, their perception of learning, and observed increases in intimacy with ICTs. Their personal statements of successfully using technology autonomously are among the most trustworthy indicators for comprehending student progression.

4.2 Answer to the research question: how should we understand and approach the YAE audience to offer experiences that promote/favor technology familiarity?

From the baseline we stated, we defend that initiatives with the YAE audience must be of a socially aware perspective, e.g., that look beyond a group of students inside a classroom but see them as people and citizens. To support the design of workshops that have this characteristic, we propose the Socially Aware Model for CT initiatives with the YAE, which was first proposed during my Master's Degree but was updated during this research by the theoretical background and practical initiatives. The updated version is presented following in this chapter. To unfold this understanding we refer to, we split it into the following small topics.

From the adult education history, we understand that YAE students have tremendous potential, usually higher than they think, but this potential has been historically disregarded. Our approach is always to enhance their perception of potential and autonomy and keep reminding them about that. Ways to act in this direction are valuing the students' previous knowledge in the activities and designing activities matching the required knowledge to the knowledge students have. Inviting the students to participate in the initiative and not assuming their willingness to participate is also a strategy to show them we respect them and that they have the right to decide whether or not they want to learn how to use technology.

From our years of experience, we understand that the YAE audience has multiple barriers to considering using technology a possibility for them. Our approach is to identify and help the students to ease some of them. From the SAwD model, we understand that these multiple barriers the students face can be more clearly identified when we look beyond a group of students inside a classroom, but when we see them as people, citizens, mothers, and fathers, having history, i.e., when we see the cultural and social context that surrounds them. Our approach to identifying these barriers is to consider the students' socially aware context, and inspired by the Socially and Culturally Contextualized principle of the model, we do that through a conversation, talking to the students to ask what they think about some topic, what difficulties they have, what they think it would be beneficial for their learning, among others. Some of the barriers may be beyond our reach. However, to ease some of the ones we can reach, our strategy is to use problem decomposition and break the big problem of using that technology autonomously into minor breakpoints, such as engaging in learning about the tech, introducing the tech, interacting with it once, reflect on the interaction, offer guidance to evolve the interaction, and so on.

From Dewey's Experiential Learning theory, we understand that for YAE students to engage in learning requires comprehending that knowledge's purpose, utility, and applicability. Hence, our approach to stimulate students' engagement in learning is addressing topics they are already interested in learning about, that make sense to their daily lives, routines, and context in general. To do so, we investigate with the students which technologies they have access to, which they want to learn more about, and they know the purpose, among others. From this pool of ideas, we select a few to work with them in the workshops.

We understand that for YAE students to consider adopting some technology in their lives, they need to be familiar with that technology, and have the idea that they can learn about technology if they decide to. Our approach to promoting familiarity with techs can only be effective after barriers have been identified and eased, the topics they want to learn are identified, and the students are engaged and have decided to learn. Then, activities toward familiarity will be effective.

We approach familiarity with techs through computational thinking abilities, breaking the "interaction with techs" into smaller tasks. Computational thinking abilities are already part of their lives to some extent, even though they have probably never heard about it. It is similar to Wing (2006) described in her paper: there are some logical decisions we make by observing the best solution that is the same logic behind computer programming. With the YAE students, creating a scenario of similarities between instructing someone to do something their way (such as cooking beans or baking a cake) and receiving instructions to interact with the computer makes them understand that there is a way, there is a logic behind interacting with technology, there is a list of steps to achieve a final scenario. Once they understand that, they can practice this list of steps; they can recognize what the technology is asking them to do, they can understand how the technology works, and once they are not afraid of using that technology, once they have materials to support them in the interaction, then familiarity with that technology occurs, resulting in increased motivation to learn and explore it, expanding their experiences with techs, developing digital culture and so on.

So we argue that the YAE audience needs to be addressed through a socially aware initiative, with the primary goal of promoting familiarity with technology through the practice of computational thinking abilities, and as a result, digital culture is developed.

4.3 The principles to guide the initiative

Derived from the understanding that initiatives with the YAE must be socially and culturally aware, we have identified principles that can inform the design of socially aware initiatives with computational thinking practices toward digital culture development with the YAE audience. These principles translate the theoretical background of this research and our years of experience with the YAE into concrete actions, expressing whether the initiative is in accordance to a Socially Aware Perspective. Although the set of principles is not exhaustive or definitive, we understand them as fundamental to the design of socially aware initiatives. The rationale of the initiative will always be guided by these principles, as much as possible. Figure 4.1 shows the 11 principles selected. As the principles focus on informing the design of socially aware initiatives, the Socially and Culturally contextualized is the core principle that inspire and guide all others.

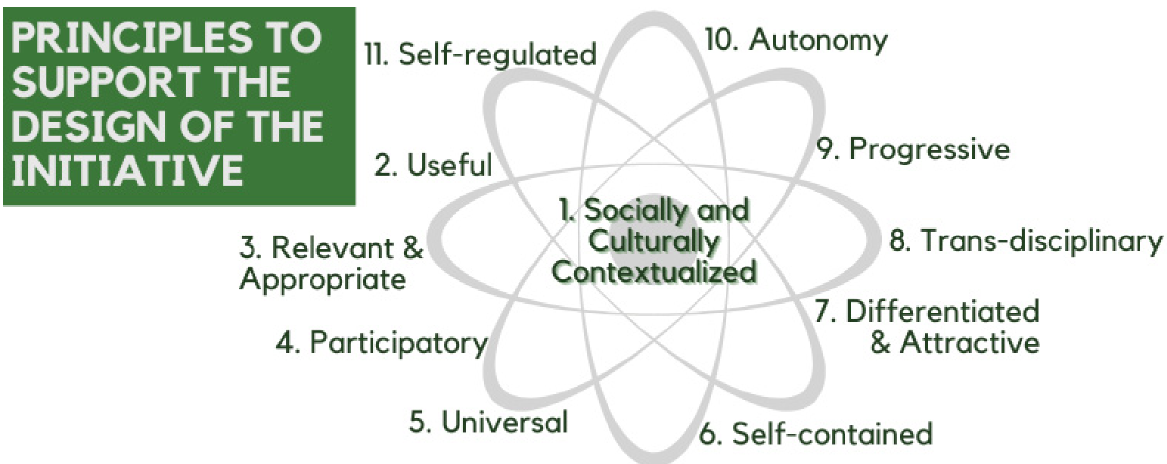

Figure 4.1: The set of principles to support the design of the initiative

All principles are important in all times. Sometimes, some principles may be more evident or significant than others, but they all express the values and knowledge derived from our practical experience and conceptual research toward a socially aware initiative. To facilitate their assimilation and application, we organize the 11 principles into three categories: Category 1 - Base for establishing the Socially Aware perspective and conduct the workshops, Category 2 - Base for designing activities, and Category 3 - Base for designing workshops. Table 4.1 presents the explanation and the principles within each category.

Table 4.1: Categorization of the Socially Aware Principles

Categories	Explanation	Principles
1 - Base for establishing a socially aware perspective and conducting the workshops	These are the core principles that shape the facilitators' understanding and posture. They are present throughout the initiative's life-cycle and guide decision-making during the conduction of the workshops.	1. Socially and Culturally Contextualized 4. Participatory 7. Differentiated & Attractive 10. Autonomy
2 - Base for designing activities	These principles are most relevant when conceiving a specific activity. It is recommended to evaluate whether the activity design respects and reinforces these principles.	2. Useful 3. Relevant & Appropriate 5. Universal 8. Transdisciplinary
3 - Base for designing workshops	These principles are most relevant for structuring an entire workshop session. They ensure that the workshop is coherent and effective, even with the particularities of the YAE audience.	6. Self-Contained 9. Progressive 11. Self-Regulated

1. Socially and Culturally Contextualized

The initiative must be deeply connected to the students' social and cultural context. This ensures that the knowledge created in school links directly to their lives, former experiences, interests, desires, curiosities, difficulties, etc. This principle strongly recommends investigating the mentioned aspects before proposing activities of interaction with techs. Although the team conducting the initiative may already know the students, this investigation should not be neglected, because their interests and situations regarding techs can change quickly, and "predicting" them based on what is already known about the students does not favor participation, exploration of students' curiosity and interests, and can result in biased activities.

The following list presents key aspects that manifest a socially aware initiative. This is not an exhaustive list, but it summarizes important aspects we have identified in our initiatives. This is how we understand and approach the YAE audience to offer experiences that promote/favor technology familiarity.

- Researchers investigate and consider aspects of the students' context before proposing any activity in the school.
- Students are co-creators, effective interested parties in the initiative.
- No assumptions are made on the students' behalf. First, experiences are created so we can make sense of things together.
- The researchers, students, teachers and other people in the classroom compose a group of participants, and all sense making is done together within the group.

- The activities produced encompass the students interests, former knowledge, doubts, suggestions, being closely related to the students' context.
- Understand and respect the students' former knowledge.
- The path of the initiative is built according to the outcomes obtained in previous workshops.
- Respect and enhance the autonomy of students.
- Create experiences to reinforce thinking, testing, and reflecting on the topic approached.
- Set a respectful and trusting working environment for all participants.
- Consider each student's personal time and rhythm to complete the activities.
- Respect the student's doubts and help answer them (especially by proposing thinking, testing, and reflecting).
- Create a connection between the addressed topics, the school aspects and contents, and the students' sense-making.
- Propose a time to reflect on the activities conducted and their outcomes.
- Propose a scenario for the students to develop their learning.
- Propose constructive activities, in which conceptual ideas or physical objects are built.

This principle is in accordance to Freire's idea of discussing the concrete reality, and that reading the world precedes reading words. This principle is also related to Dewey's Experiential Learning theory, as the author defends that students should work on activities that matter for them as citizens, not only in the school context. In addition, this principle is highly inspired in the SAwD model by Baranauskas, that investigate the social context to the be considered in the core of designing solutions.

Example of this principle in our initiative: In 2019, approaching the ATM was a decision 100% driven by the interest and needs of the students. We would probably think of many other ICTs to address *before* this one. However, this technology was the one that the students were most interested in, the one that would promote the higher independence from others, and probably the one they would be more excited to learn about, because they could learn at school something that could solve some personal real-life problem. Hence, engaging the students in the activity was something that occurred naturally by the subject approached.

2. Useful

Activities must address useful topics for students, things they can use for some purpose in their daily lives, and, preferably, topics they could apply or use *immediately*. Because YAE students are trying to make up for the time they were out of school, the usefulness of the addressed topics must be easily perceptible for them, to create engagement, to use outside of school the knowledge they have gathered, contributing to a perception that they are progressing and learning. Many times, for ICT beginner students, abstract examples of why some topic is important for them to learn would not contribute to the engagement in the activity. Real-life situations are the best place to find concrete useful topics to start addressing in the initiative.

Example of this principle in our initiative: In 2023, Workshop 2, our intention was not to address taking pictures again. However, this is a subject that matter for all our students. They like to take pictures, create memories of many moments of their lives to later share this with colleagues and relatives, or just to have the picture to remember the moment. Also, taking pictures can serve for a lot of purposes beyond registering moments to remember later: register the name/phone of a store they want to visit later, taking pictures of a product they are running out of, so someone else can buy, or even themselves can buy later, etc. So based on the usefulness of the function of taking pictures, we decided to address this topic again.

3. Relevant & Appropriate

When looking at students' real-life situations in which using an ICT could help, many situations would probably arise. This principle informs us to, at planning each activity, consider addressing the topics of interest that matter the most for the students – preferably, the most relevant topics for students should be addressed first. In such an heterogeneous group of students, as usually is in the YAE, balancing what matters for all students in just one activity may be challenging, but alternating topics from time to time may be an easy way to circle-back this challenge. In addition, what *matters* for the students is different than what we consider it could matter for them, or what we see that could be of a great help for them.

In addition, activities must accommodate students' previous knowledge on the topic, since it is something they are already interested about. Nevertheless, some polemic commentaries may arise when addressing topics that matters for the group, such as religion, family, and politics, and so these issues must be approached carefully.

Example of this principle in our initiative: In 2018, the Workshop 3 was held days before the second round of the elections for President, we proposed to address the voting topic. Then, with the help of some technologies, we simulated a voting with all the steps conducted in real-life process (confirming their personal documents, confirming identity by scanning fingerprint, going to the voting booth, etc). This is a relevant topic as citizens, and many students did not know how to vote, or use the ballot box, but they wanted to vote, wanted to exercise their citizenship. Some of them even described the act of voting as painful and discomforted, because they felt exposed by not knowing how to use the machine, and could not get help from anyone. Nevertheless, we have not mentioned names of candidates, parties, or similar, because we understood this could be a polemic topic, and the responsibility to discuss of this subject was not a task delegated to us.

4. Participatory

Conduct the activities stimulating that all people in class that wants to participate be in the role of participants (in opposition of spectators), practicing and learning together. Naturally, there will be a mediator/facilitator, but everyone else should participate in the same role (students, researchers, and teachers). It is a sign of respect and honor, of putting titles aside. Be sure to encourage students to recognize themselves as capable and responsible for creating their own knowledge through all activities. When setting this participatory configuration, participants will engage dynamically and responsibly, and the topics and discussions must consider all participants' aspects and experiences (whether teachers, students, everyone), enriching the learning experience.

Example of this principle in our initiative: As an example of researchers and teachers participating in the activities in the same role: in 2018, workshop 6, teachers, researchers and students were part of the groups in the competition. Independently of the role, they were all participating together. As an example of students in the role of participants: in 2023, with Student

I, when from a position of passiveness (waiting to receive the correct answer to the question) she was invited and encouraged to try on her own and she was able to complete the activity and actually learned from it. The teachers' participation during our initiative is also as example of this principle: their participation with us had some limitations, both on our part in terms of availability to be involved in the school, and on the teachers' part, in terms of time availability to take on a new commitment. However, this limitation was observed in our context, but it is not a limitation of our understanding or the principles; on the contrary, it is an indication that even with limitations, it was possible to set an environment of participation with the school and teachers.

5. Universal

Activities must be designed to account for differences, avoiding segregating the participants. Materials should be designed considering a range of different combinations of levels of abilities found in the respective group of students. The same activity and its materials must be as much suitable for all participants as possible, especially concerning limitations or difficulties in terms of movement and vision. In cases of severe disabilities (such as deafness or blindness), and depending on the nature of the activity, some specialized resource may be necessary. However, the designed solution must be prepared to allow this adaptation, whenever needed.

Example of this principle in our initiative: In 2019, from workshop 3 on, the non-functional prototype created was made of cardboard, and so allowed easy adaptation in case it becomes needed. Other printed materials were printed on a larger scale, so as to facilitate vision. The cards to vote were also made of cardboard which would allow adaptation for Braille, in case someone with vision limitations start to participate in our group.

6. Self-contained

In one workshop, there can be one or more activities. But each activity must start and finish in the same workshop. Due the irregular attendance in the YAE, every activity must be independent, so if students miss any activity, they may find no impediment to participate in the next ones. Also, if new students arrive in a sequence of workshops, they must be able to participate in the activity and learn something new from that workshop on. In some cases, there are students that only participate in one workshop from the whole initiative, still activities should be designed in order to allow the students to engage in the activity and learn something new from it. This principle was deeply inspired by our experience with the YAE modality.

Example of this principle in our initiative: In 2019, workshops 3 to 5 were dedicated to discuss the ATM, and during these period there were 5 students that only participated in one of the three workshops, regardless of which one. This is common in the YAE audience. So, we took an extra concern in starting and finishing the activities in the same workshop, not letting any homework to the students, or letting some part of the activity to be finished in the following workshop, and not creating a big gap between workshop to workshop too. This way any new student could join in the workshops at any time, without lacking any material.

7. Differentiated & Attractive

The environment in which activities take place should inspire action, creativity, testing, conversation, discussions, experimentation, etc. The conventional classroom style (lines of individual desks directed to the board) tend to set a place of silence, of copying things from the board, of thinking by itself, and this hinders the manifestation of principles we have listed here.

Formats in which students are arranged in a circle, divided in teams or other ways that favor communication and collaboration are recommended. Activities should be designed to be inviting and attractive, to contribute for raising students' engagement. This principle was deeply inspired by our experience with the YAE modality.

Example of this principle in our initiative: Almost all of our classes were conducted in the library, in circles, in small groups, with games, talking about subjects they like, as music, recipes, etc, all to offer a differentiated environment, something that it is nice to participate. One time, in an activity to withdraw money from the ATM, instead of the machine deliver fake bills to the students, the machine delivered chocolate. In some other activities, chocolate was given as prize to the winners. These elements serve as an extra engagement to participate in the activity, other than the real and most important factor: addressing topics that matter for the students.

8. Trans-disciplinary

Activities about an ICT can encompass more than only the interaction with that tech, exploring reading, writing, and other topic students may have also been learning at school. Computational thinking is useful to solve different types of problems, and also to transport the solution to different domains, being described as a trans-disciplinary ability. Activities, then, can explore this potential of computational thinking by addressing different aspects of the same topic, this way students can see several examples to practice the learned skills. In addition, problems in real-life can frequently be approached by different perspectives, so bringing this trans-disciplinarity to the activities resembles to what they can find in life, and may encourage them to think of addressing problems from different perspectives in real-life as well.

Example of this principle in our initiative: In 2019, after selecting the ATM as the technology to involve, we proposed a set of reading activities with words from the ATM context. This is transdisciplinary, because it focused beyond the technical aspects of the interaction, but contributed to another ability they were learning. This way the reading activity contributed to the interaction practice by presenting different words and offering a contextualized motivation to this learning, by the idea that reading can favor the use of techs.

9. Progressive

The activities' complexity must evolve progressively. Students need time to organize their thoughts about the activities, practice, test, work on new hypotheses, and so on. When working with students of different profiles and ages, they are expected to take different times to assimilate the contents. Their personal time should be respected: instead of speeding up students who have not finished their activities, offer additional activities for those who have already finished, ask them to help other students, showing what they have done and learned. This way, students who are more experienced in the content can put their knowledge to test, and those who require more time to learn, can have their time respected, and can also get explanations from different people, which could help them assimilate the content differently. This way the progression of activities respect the learning rhythm of all students.

Example of this principle in our initiative: In 2023, workshops 3 to 5, the activities with the WhatsApp Audio message function were progressing from a simple task as following the introduction to this functionality to more complex ones, as ordering the algorithm to perform the function. In this set of workshops, we also offered the experienced students the opportunity to be tutors and help beginning students, which was received very well. In each step of performing the function, the experienced students were also thinking, checking if they were giving the correct answer, testing together with the students, and so on. So this way, all students were practicing together, respecting their personal time, and knowledge.

10. Autonomy

In the initiative, the students' autonomy must be respected and enhanced at all times, since the selection of the technologies to be discussed, until elaborating and trying their own solutions. Students must always be reminded that they can decide, perform the activities, and ask for help if they want to. Activities must be designed and the teachers posture during the workshops must always support and stimulate students' autonomy.

An example of this principle in our initiative: When asking for the students' votes after each workshop, we designed the cards to be understandable by the students only requiring abilities they have (there was no words to read in the card). This way, the students' autonomy to vote was respected. They did not depend on someone else to interpret the cards; they could do it on their own.

Autonomy is an original principle identified in this research, derived from our theoretical background and highlighted in the initiative with the students. As discussed in Chapter 2, YAE students often have little trust in their own capabilities, especially regarding technology abilities, and so they can become used to a passive attitude, that can be transferred to other life areas. As consequence, students may start not deciding things in their lives, and most critically, not recognizing themselves as having the right to decide things, because it is easier to ask others for help getting something done, than challenging themselves to do something when they already thinking that it is not going to work. Beyond that, very unfortunately we have heard from students reports of relatives taking advantage of the students' "dependence" to decide on their behalf if they were or not suppose to withdraw money to buy something they wanted, or deciding to do things at the convenient time for the student, but for their own, among others. So stimulating autonomy in the initiative can bring benefits for the students learning, and also for their lives. In this sense, autonomy play the role of an engine that stimulates students to learn more and more.

This principle is deeply related to our theoretical background. In parallel with Baranauskas' SAwD model, the respect for the students' autonomy can start by inviting them to share what technologies they would like to learn, and what problems they would like to solve with technology, and even if they want or not to participate in the initiative. According to the author, it is important that all stakeholders express their point of view about the topic and have confidence that they will be listened to and considered in the final proposal. Freire (1997) highlights that autonomy is an important factor to continue achieving goals, especially when the attempt of overcoming difficulties is gratified by the success of acquire understanding, which stimulate the trying and learning process to go on. For Dewey (1916), student's autonomy is stimulated through the design of experiences that are challenging enough for students to engage *on their own*, but that has some familiar spots for the student to recognize and have the base knowledge to think and design hypothesis to solve the problem. When this balance between the challenge and the familiar spots is not even, then the students' autonomy to design solutions is in danger. These are all expressions of autonomy that must guide decisions in the design and conduction of initiatives with the YAE audience.

11. Self-regulated

A socially aware initiative with the YAE is self-regulated, meaning that the outcomes of a workshop inform the design of the next ones. It means that the content each workshop will address, the decision of whether it is time to progress the workshops' purpose to a more advanced one, or if more workshops are needed to give students more opportunities to practice an ability, and some other questions will only be obtained during the workshops. Hence, it is not possible to predict or predetermine aspects that the initiative will address, as the technologies that will be involved, how many workshops it will take to practice some ability or some function, among other questions. Self-regulated means the path is built along the way.

An example of this principle in our initiative: In 2023, we wanted to address more technologies than WhatsApp, but after each workshop, we analyzed the outcomes and understood that the students would benefit from more workshops addressing the application. So, we kept working with WhatsApp until the end of the initiative.

This principle was already present in 2018's initiative, and was one of the major learning for me back then, that "*it was possible to use data from the former workshops to inform the next ones*"[1]. At that time, we have realized that "*conducting the initiative this way facilitated students to build a relationship between what they were learning and practicing at school with their personal activities outside school.*"[2]. In this research we understood the importance of highlighting this aspect because it is a direct consequence of initiatives that are Socially Aware.

This principle was inspired by the SAwD model, by Baranauskas, and is analogous to the life-cycle proposed in this model, in which the results and outcomes of each step will inform the next ones. This principle is also related to Dewey's Experiential Education theory, that proposes a thinking step, followed by an hypothesis being tested, and a reflection on the outcomes of the results. These outcomes will inform hypothesis, that will drive a new test, that will reflect on a new outcome, i.e., the process of experiential learning is in itself self-regulated, we only extend this cycle to the whole initiative. This principle is also in accordance with Freire, because this self-regulation follows the changes in the students context, and Freire's ideas defend grounding the learning initiative in the students concrete reality, which is constantly changing. This way, if the context is constantly changing, and we regulate the further workshops and activities in the students outcomes, results and new interests, we are addressing the students context in the initiative. In addition, this cycle of designing further workshops based on the results on the previous ones goes against the idea of "banking education", in which the teacher 'transfers' the knowledge to the students, not mattering whether it is attached to the students context or not, if they are following the reasoning or not, if they are curious about it or not, if they want to learn about it or not, etc.

This principle is also in accordance to the progression in the four purposes for the workshops, and the practice of computational thinking abilities across the purposes. We understand that the purposes serve to guide and inform the continuity of the initiative, but the transition between them will only occur according to the students development. We cannot pre-establish how many workshops will occur under each purpose. The students development that will dictate if is time to move on or not. And how will we know this? According to the students development and practice in the computational thinking abilities of each purpose. Once students have mastered the computational thinking abilities to be practiced in each purpose, with the selected technology, we will know they have developed and practiced the necessary abilities to achieve the next purpose and carry out the activities having the required knowledge to enhance and stimulate their autonomy.

[1] From the description of the 2018's initiative, in Chapter 5.

[2] From the description of the 2018's initiative, in Chapter 5.

4.4 The purpose of the workshops

One initiative is composed of a set of workshops. Not all the workshops will have the same goal to be achieved, the same purpose for which it is conducted. Workshops in general will progress in the initiative according to these core purposes: 1. Establish foundation and contextual understanding, 2. Promote technology familiarity, 3. Promote learning on how to use the technology, and 4. Advancing the interaction with the technology. Each purpose serves to inform the goal of the activities, to set a direction to follow, and computational thinking abilities to practice. The initiative's movement will always follow this sequence, as Figure 4.2 illustrates.

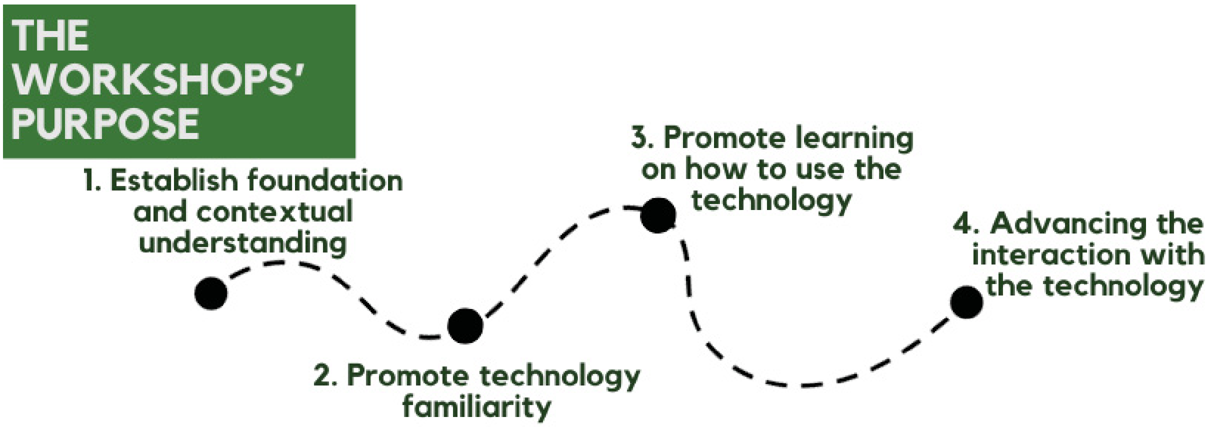

Figure 4.2: The progression of purposes

There is no rule for how many workshops should be conducted for each purpose; this will be determined based on the student's needs, development, and the complexity of the theme addressed. There will be cases in which one workshop will start in the purpose nº 2 and finish in the nº 3 or nº 4. – for cases when the technology and the activity are simple, but in other cases, more than one workshop can be conducted aiming at the same purpose.

Additionally, moving from the second purpose on implies starting to work and interact with techs. If in some point in the initiative it is decided to change from working with one technology to a different one, it is necessary to check the students' familiarity with the new tech, and this will be done in workshops with the second purpose again (to promote students' familiarity with the technology), and keep evolving to the following ones.

Retrieving the computational thinking discussion from Chapter 2, we understand computational thinking has at least 4 main goals in the workshops. The practice of computational thinking abilities: 1. breaks down the complex task of using a technology into smaller easier to accomplish tasks; 2. provide guidance in the interaction with the tech - prototype or functional device; 3. creates a context of similarity between the students giving instructions to others; the students receiving instructions to perform some task; the ICT receiving instructions to perform something, and the students giving the devices instructions to perform something, i.e., interacting with it; and 4. serves to identify whether the students are prepared to move forward on the purposes by mastering some ability. This is why we defend computational thinking is key to expand digital experiences with the YAE audience. To each of the four purposes we have identified in this research, there is a list of computational thinking abilities to be practiced.

1. Establish foundation and contextual understanding

Workshops with this purpose will be dedicated to getting to know the students and becoming known by them. Comprehending students' context and understanding what is relevant and valuable to them is necessary to consider what technologies to involve and what contents and activities to explore. This purpose must start with an open and trustworthy working environment for all participants.

During workshops with this purpose, essential topics to identify are students' expectations, interests, knowledge, contents they are studying in the regular class, if they already use technology, and if they do, which ones they use, if they have any struggle in approaching technology, what is their daily routine like; is there any technology that could help them; is there are any technology they would like to learn about, is there any technology they are afraid of or did not have a good experience with, what techs they have access to, what abilities and needs the group has, among others.

Different techniques or strategies can help design activities to raise this information in a positive, natural, and funny way (e.g., games and storytelling). The key point of workshops focusing on getting to know students is to engage people in meaningful and positive experiences, in a safe place, discussing the use of technology, promoting well-being, and the feeling that we are all learning together.

Depending on the need, one or more workshops can be conducted for this purpose. The output of these workshops is information about the students and a list of techs the students are interested in. Table 4.2 shows a list of suggestions for computational thinking abilities that can be practiced in activities to get to know the students.

Table 4.2: CT abilities to practice in workshops to establish foundation and contextual understanding

Algorithm	Comprehend the logic/organization of the dynamics.
Abstraction	Think about distinguishing digital technology from analogical technology.

2. Promote technology familiarity

Once we know students and the technologies they have access to and are interested in learning, we may advance the initiative's purpose to promote the students' familiarization with technology. With this focus in mind, there are many aspects to work within the activities, and most of the time, activities will be related to one technology or a group of techs specifically (not techs in general). The current goal is to prepare the students to learn about a specific tech. At this moment, the student's previous knowledge about the technology is raised (such as name, the purpose of use, and the context of usage), and knowledge is built on top of that. Informal and formal aspects of the tech's context and the required knowledge to use the technology are approached. For example, if using the technology would require reading, focusing on familiarization involves reading activities so students can practice and become familiar with words from the context. Initial activities should always be leveled considering the abilities at the beginning (according to the student's abilities).

Aspects to work focusing on promoting familiarity with techs are: what is the technology purpose, where it came from, how was life without it, how can life be with it, what is the needed knowledge to use the mentioned tech, what are main barriers students have to use it, what are the techs elements, its composition, if its icon resembles something in the real world, in which context it is used, if their relatives use the tech, among others.

Table 4.3 exhibits a list of computational thinking abilities to be practiced in activities aiming at promoting familiarity with a tech.

Table 4.3: CT abilities to practice in workshops to get familiarized with techs

Algorithm	Assimilate that there is a list of steps to conduct our actions Understand that knowing the list of steps may facilitate the conduction of practices Start to describe algorithms
Abstraction	Abstract information from the real world, to the practice located in the school
Simulation	Simulate the function of an ICT Simulate different settings to achieve better results
Data Analysis	Identify the necessary steps to use the technology Analyze suitable solutions for the practice
Problem Decomposition	Decompose a complex task into smaller tasks
Pattern Recognition	Recognize elements of the physical-world into the digital context (as the phone in the WhatsApp icon, the camera, etc) Recognize patterns in valid solutions to try to find more solutions

The goal of focusing on promoting the students' familiarization with techs is to offer experiences to be introduced to the tech, to get to know its purpose, its common elements, practice the abilities required to use the tech, and have an initial interaction with the tech.

3. Promote learning on how to use the technology

Once students are familiar with a particular technology, the initiative may advance the focus to learning how to use the technology. This purpose is dedicated to introducing how to use the tech. The activities can begin with an explanation about its elements, parts of the tech, how to use it, using it together (which many times can be the first time students actually use the tech), and reinforcing the steps performed to use it, with the help of a list of steps, which we know as algorithms. If appropriate, safety topics regarding using the technology should also be addressed.

Students may be afraid or shy about trying to use an unknown tech, so this purpose's first goal is to promote a positive first experience with the technology in a safe and entrusted environment, with support from the researchers. Once the students have this experience, another goal is to ask them to specify a list of steps on how they have performed the interaction with the tech, so students have the opportunity to reflect on these steps and memorize them. Table 4.4 exhibits a list of computational thinking abilities to be practiced in the activities aiming to promote learning about how to use techs.

Table 4.4: CT abilities to practice in workshops to promote learning on how to use techs

Algorithm	List steps Order steps Think about non-textual ways to describe the steps Describe algorithms
Abstraction	Abstract differences between the printed material, prototypes, and the real device Abstract the information from the practice in school from what students can apply in their lives
Simulation	Simulate the use of the ICT Simulate the use of an ICT with the help of a prototype Understand that the simulation resembles to the real use of a device
Data Analysis	Identify steps to insert in the algorithm Analyze the moment of the interaction (when the device is expecting a command, or processing a command) Analyze differences in the interaction with different prototypes of the same ICT
Problem Decomposition	Decompose tasks into smaller tasks Decompose using an ICT into using an ICT prototype
Pattern Recognition	Recognize differences and similarities between the prototype and the physical device
Automation	Use a device to operate part of the process they want to do

4. Advancing the interaction with the technology

Once students have created a list of steps to perform a function with a tech, the initiative's purpose can progress to advance the students interaction with the tech, focusing more on autonomy development. The main aspects for students to practice in this purpose are interpreting algorithms to use the tech, test algorithms, order algorithms' steps, adapt algorithms to perform different functions, teach/help someone how to use the tech, among others. The main goal for activities aiming at advancing the students interaction with techs is fomenting the students' autonomy in exploring the tech.

Table 4.5 exhibits a list of computational thinking abilities to be practiced in activities focusing on advancing the students experience in interacting with a tech. At this point of the initiative, students are more familiar with the tech, which can set more fluid experiences in which they explore and conduct the activities more freely. However, new students may arrive at this moment, and it is recommended to always have an idea of how to include that student in the current activity so everyone can practice and learn together, respecting their own experience.

The goal of workshops fostering students' autonomy in technology use is to support them to feel confident in adopting technologies in their lives, thereby expanding their digital experience and contributing to their digital culture development.

Table 4.5: CT abilities to practice in workshops to advance the use of techs

Algorithm	Create algorithms Order steps of an algorithm Adapt an algorithm Adapt the order of steps of an algorithm Interpret an algorithm Execute an algorithm
Abstraction	Abstract differences between the prototype and the real device Abstract differences among different brands of devices
Simulation	Simulate the use of the ICT Mentally simulate the behavior of the ICTs Simulate an algorithm to check its correctness (mentally or not)
Data Analysis	Analyze the interaction with the ICT Analyze different information to understand what is a goal to achieve Analyze if the achieved outcome in the device matches the desired outcome Analyze information and combine it in different ways Analyze information to turn a good solution in a better one
Problem Decomposition	Combine multiple algorithms to achieve bigger tasks Combine tasks to achieve a complex task
Pattern Recognition	Recognize similarities from algorithms to algorithms, from performing similar actions in the device
Automation	Use a device to operate part of the process they want to do

4.5 The steps to design each workshop

So far, we have explained our understanding of a socially aware initiative with the YAE audience, presented the principles supporting its practical implementation (Section 5.1), and detailed how the initiative's focus progresses (Section 5.2). This section now details the design process for the first workshop (steps 0 to 3) and explains how the continuous cycle of steps (1 to 3) will lead to the design of the following workshops until the end of the initiative. Figure 4.3 presents the steps and the cycle of designing workshops.

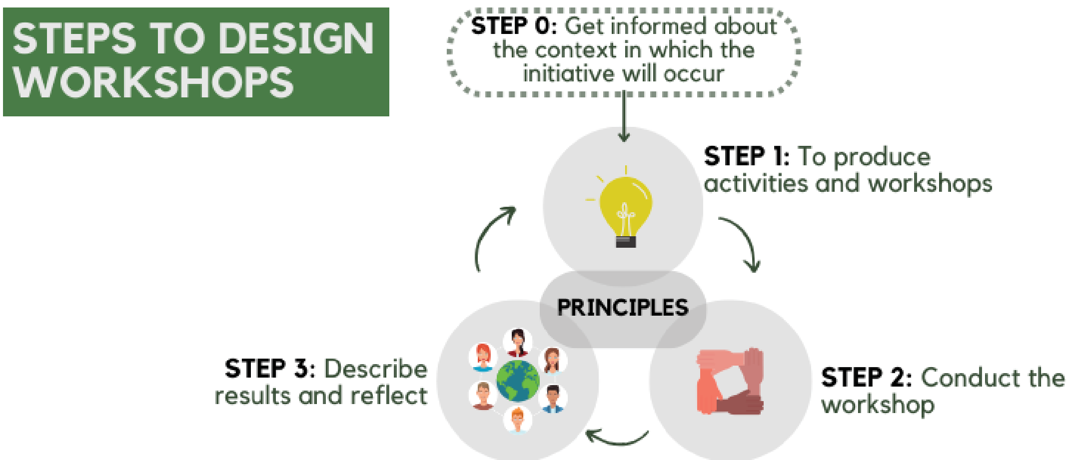

Figure 4.3: Steps to design the workshops

0. Get informed about the context in which the initiative will be conducted

This step is dedicated to initiating the understanding of the students and the school where the initiative will occur. We strongly suggest visiting the school and having a conversation with the YAE teachers and principal. They can provide helpful information about the students, such as the games and activities they enjoy, the abilities they have or are developing (e.g., literacy), places they usually visit, the general profile of the group (age, profession, gender, etc.) and special needs students may require to accomplish specific activities. This first data is essential to designing accessible and suitable activities before meeting the students in the first workshop. This step provides an initial comprehension of the students' context, which will be continually deepened and refined as the initiative progresses.

1. Produce Activities and Workshops

This step is dedicated to producing activities for upcoming workshops and encompasses the following tasks: specifying the workshop's goal and desired outcome; determining what needs to be tracked with students; elaborating activities tailored to the specified goal; verifying the activities' complexity level; testing them for accessibility; elaborating supporting materials; and describing the full workshop program. For ongoing initiatives, information collected in previous workshops can inform the design of subsequent ones.

1.1. Specify the workshop's goal and desired outcomes: specify the goal and desired outcomes of the workshop, according to what is suitable for the moment of the initiative, and according to the focus of interaction with techs. When designing the first workshop to be conducted, suitable goals could be to get to know the students current level of interaction with technologies, what technologies they have at home, and what they would like to learn more about. As the initiative progresses, the goal and the desired outcomes will progress accordingly.

1.2. Determine what needs to be tracked with the students: think about the important data that helps understanding whether the specified outcome was achieved, and that can inform further workshops. Aspects that should be considered are the time students took to complete the activities, the sentences/expressions they have said during the activity, what difficulties the students had, what technologies they were more interested in, if they needed help to perform the activity, among others. This moment is also to consider how the activities should be designed to allow the easy obtainment of this information. For instance, is there any information that can be obtained through pictures? A picture is faster to be taken than taking notes. Is there a possibility to record audio/video of the workshops? All these material are easy and fast to obtain, and once registered, can be processed later. Specific about photos, they can be a good material to make comparisons and publish later.

1.3. Elaborate activities to the specified goal: this task encompasses the production of the activity that will be utilized, being a whole new activity, or inspired by existent activities or games. Activities should be in accordance with the workshop's goal. To each activity designed, consider: if it matches the desired outcome; if it can follow the logistic of some existent activity students like; if it can be a game; if the activity is fun; if the activity should be conducted in parallel with the whole group, in small groups, or individualized, student by student; how long does the activity will take to be completed; how many facilitators/supporters it will require, among others. One workshop can accommodate more than one activity.

1.4. Verify the activities' complexity level: check the activities complexity in terms of language, logistic, vision, knowledge, among others. Verify aspects as: is the activities easy to follow?, is it easy to explain?; does the explanation involve words not commonly used by the students?; words they will likely know?; do the students have the ground knowledge to understand

and accomplish the activities' goal?; does the activity resemble to some activity the students are already familiar with?; among others.

1.5. Test it for accessibility: given the varied profile of YAE students, they often have diverse needs. As many are older, support for sight and hearing, and non-textual representations are often crucial. Additionally, resources like the META model (Menezes and Pereira, 2022) can support the verification of other accessibility aspects.

1.6. Elaborate supporting materials: develop materials for the activity, as prints, papers, boxes, prototypes, etc. Observation materials should also be prepared in this step. Considering the information that needs to be collected during the workshop, think of an easy way to collect it to later process it: using a rubric, a form, or recording the audio from the workshop, etc.

1.7. Describe the full workshop program: elaborate a document and describe the full itinerary of the workshop. The level of detail should allow facilitators and tutors that will accompany the workshop to fully understand what is going to happen and allow them to conduct the workshop as well.

2. Conduct the workshops

This step is focused on going to the school, meet with the students, and conduct the workshop as previously planned. Tasks of this step are: conduct the activities, support and track the students' progress, fill the observation form, and observe activities' accessibility.

2.1. Conduct activities: conduct the activity as much as planned as possible (on time adaptations may occur). Support facilitators in conducting activities and support the students in pursuing the activity.

2.2. Track student's participation: pay close attention to students' development. Even small, seemingly unimportant information or saying by the students should be registered (preferably the quote and who said it), as it may be useful in further moments. Commentaries that students make about the theme, their life, their interests, etc., should also be registered to support decisions in the design of further workshops.

2.3. Observe activities' accessibility: observe if the students have any difficulty in participating of the activity, and if some adjustment can support them in the activity. Observe this elements to implement it in future activities.

2.4. Fill the observation form: register all data collected in the observation form. Preferably, as quickly as possible, during the workshop, or right after it finishes. The thought that some information will not be forgotten can lead facilitators to fill the form *later*, but this is not recommended. On the contrary, observation form should be filled as soon as possible, so nothing gets missed. In addition, information registration should not be limited by the form questions, if something else happened that caught the facilitators attention, it should also be registered, preferably, not resumed, but with all available information possible.

*Note: Do not get frustrated if the workshops do not unfold exactly as planned. This is live adjustments, intrinsic part of teaching and the self-regulated principle. Instead, know what are the more relevant activities of the workshop and, if some live adjustment is necessary, focus on completing the relevant activities.

3. Describe Results and Reflect

This step is focused on describing the results and data collected in the workshop, and reflecting on it. The main idea here is to organize data to support the production of another workshop. The step encompasses the tasks: summarize the workshop outcomes and reflect on the data collected.

3.1. Summarize the workshop outcomes: describe how the workshop took place, paying close attention to rigor, reproducibility and responsibility. Create an specific document for each workshop, and describe information as listed below. In cases where multiple facilitators participated in the workshop, the document should be written collaboratively. However, it is important to be able to easily retrieve the author of each section in the document, in case doubts and important opportunities arise in the future.

Describe technical details of the workshop, as: time workshop has started and finished, list of attendees, in which room the workshop took place, which were the activities involved, how long each activity took, which materials were involved, among other features.

The second part is describing the micro information, as: what was the students posture during the activities; whether they asked for help, in which moment; if all students could complete the activities; if varying levels of success were observed, how to characterize them; if students mentioned personal statements related to the activity or with the tech; if students mentioned another techs; if students mentioned personal statements about problems with technology that they need help to overcome, among others. Combine this information with other possible sources of data, such as student voting, teacher and other participants' feedback, observation protocol, among others.

3.2. Reflect on the data collected: analyze the information collected focusing on identifying patterns, new trends, to follow the student's development, what difficulties they had, if there was any change in their abilities, and what ideas can be suitable to work with in the following workshops.

After this cycle is finished, a new workshop can be designed with the restart of the cycle from step 1, and keep following the next ones as described. The facilitators' experience in the conduction of every cycle of steps will also serve as experience and knowledge for the next ones, being themselves also in an iterative and incremental cycle.

4.6 The author's reflection on the understanding

This understanding, developed over 10 years of iterative and incremental research, was not produced overnight. It was developed over continuous experiences in the classroom, collaborative meetings, analysis of workshop results, and ongoing engagement with academic literature. The creation of this understanding itself was self-regulated, socially aware, and an experiential learning process for the team, as we frequently reflected on outcomes, refined hypotheses, considered the applications and implications of each model principle, and adapted workshop designs accordingly.

Hence, the originality of this research lies not only in the methodological theory it presents but in the cohesive combination of these theories applied in initiatives to teach about technology. All principles, purposes, and steps developed in this research reflect a unique union of Freire, Dewey, and Baranauskas's theories with our accumulated practical experience. Additionally, this research's originality extends to its proposition to use computational thinking abilities as a tool to develop digital culture with YAE students.

In our research, we do not focus on teaching computational thinking abilities themselves because we understand these abilities arise from logical thinking and are grounded in how people do their day-to-day tasks. We use computational thinking abilities to transform high-level tasks, e.g., making a video call, into a set of low-level tasks, e.g., opening the app, clicking on a contact, etc. This process is analogous to providing instructions to others when we want them to do something our way (such as cooking beans, baking bread, and washing the dishes). Students from the YAE are very used to giving others instructions on how to do things, so the practice of computational thinking ability comes as these small portions of practice and create in the students the idea of "I am following instructions, and this is exactly what I ask others to do." Moreover, by learning how to receive, interpret, and execute instructions, they are advancing in understanding how technological devices function, further fostering more and more interaction with techs.

It is important to emphasize that recognizing teachers as facilitators does not intend to diminish their role or importance in the classroom. On the contrary, only a sensitive, humble, and well-developed teacher can guide students, empowering them to take more control over their learning. This approach is particularly relevant for YAE students, as they are adults with extensive life experience, often surpassing that of the facilitators.

We argue that, the understanding produced in this research, translated into a model for designing initiatives aiming to promote digital culture, would be suitable to produce positive outcomes in the related research we have investigated in Chapter 3.

The research from Cunha and Gurgel (2016) could have been impacted by the Socially and Culturally Aware, and Useful principles of the model, as the paper does not mention if the content (Computer start-up, introduction to Windows operational system, Word and PowerPoint, and the Internet) came from the students' needs, or of what they were curious about, or had the need and interest to learn, and the by the Progressive principle, as it could provide the students with practices and activities from the early beginning with technology, and it could evolve in the students pace of development, as strategies to ease the fear of breaking the computer, and low self-esteem.

The research from Silva et al. (2019) could have been impacted by the step 0 of the model "0. Get informed about the context in which the initiative will be conducted". This way, the researchers would not have to redesign the activities, it would be built informed by the students' context, grounded in their needs, abilities, necessities, among others.

The research from Martins et al. (2023) could be impacted by the model because it would inform the researchers to be aware of the students' context and abilities before the classes began, and be informed on how to deal with that. Also, this research would have been impacted by the workshops' progression of purposes, in which the computational thinking abilities would be practiced embedded in the technology activities, not focusing on the abilities itself.

The research from Atkinson et al. (2016) would have been impacted by the universal principle, especially because the activities are tailored according to the students demands, and probably many activities could be reused, since students might have similar interests. Inspired by this principle, the produced activities would be designed to be suitable students with abilities in different levels.

The research from Ngiam et al. (2022) could be impacted by the useful, socially and culturally aware and participatory principles to promote the students engagement in the initiative. Also, the model and its principles could inform the undergrad students on how to conduct the initiative, since the facilitators' posture inspired by the autonomy and participative principles are helpful to provide effective learning experiences.

In addition, the self-regulated principle, and the step 3. Describe Results and Reflect would be beneficial for all research, since any of them have described this characteristic of reflecting on the students' outcomes to inform the next practical session. Therefore, we argue that the consolidated understanding developed in this research fills a clear gap in the literature, offering a practical and theoretical framework designed to produce more significant benefits in initiatives like those analyzed.

4.7 Highlights of the Chapter

- The years of practice with the YAE has revealed that these students face barriers to digital culture development that are earlier than the technical ones, such as psychological and social ones. In our understanding, initiatives must start by identifying and addressing these barriers.

- Our understanding is based on the primary idea that the YAE audience needs to be addressed through a socially aware initiative, with the primary goal of promoting familiarity with technology through the practice of computational thinking abilities. Based on the experiences and outcomes of a workshop, the next ones are built.

- The original productions of this research for the model: 2 principles, 3 categories, 4 purposes, 1 step to design workshops and 13 tasks. In addition, the pre-existent material for the model was updated.

- A set of 11 principles, validated by practice and grounded in theory, is offered to guide the design and execution of these initiatives. The principles are organized into three categories to inform different moments of the process, from guiding the facilitator's posture to designing specific activities and workshops.

- We understand that the initiative will unfold to four different purposes. Knowing the purpose of each workshop facilitates to set activities' goal accordingly, suitable for the moment students are. In addition, always start a set of activities with a technology by introducing them to the students, considering that their knowledge about it is minimum. Then, according to the students' progression, keep progressing the complexity of activities.

- Computational Thinking is not the content to be taught, but a powerful tool used to organize the progression of activities. By structuring experiences with technology through computational thinking abilities, a virtuous cycle of learning is created, fostering the development of digital culture.

- The proposed model includes a practical, iterative 4-step cycle for designing workshops (Get informed, Produce, Conduct, Reflect), ensuring that each learning experience is systematically planned, executed, and used to inform the next, ensuring the initiative remains adaptive and grounded in the students' ongoing journey.

5 The Practice with Youth and Adult Education

This chapter describes the practical work carried out with the YAE audience, from my under-graduation, finished in 2015, until the ones conducted under this doctoral research, in 2019 and 2023. Table 5.1 shows technical details of the four initiatives conducted.

Table 5.1: Technical details of all initiatives

Education	Under-graduation	Master's Degree	Doctorate	Doctorate	Total
Year	2015	2018	2019	2023	-
Title	It's possible. Let's think of a better way	Experimenting the socially aware perspective	Experimenting computational thinking abilities differently	Reflecting on how we understand things	-
Where	*Centro Educacional de Jovens e Adultos – CEJA*, a public school in Itajaí/SC, Brazil	Rachel Mader Gonçalves school in Curitiba/PR, Brazil	Rachel Mader Gonçalves school in Curitiba/PR, Brazil	Rachel Mader Gonçalves school in Curitiba/PR, Brazil	-
Team of researchers conducting the workshops	1	4	3	5	-
YAE teachers participating in the workshops	-	2	2	2	-
Number of workshops conducted	12	8	8	5	33
Quantity of students reached by the initiative	21	17	21	15	74*
Focus of the results discussion	The discovers from the first time working with the YAE	The results achieved after focusing on the students context and their perception of learning	To show the computational thinking contribution to achieving an autonomous use of a device	The barriers and results four students have achieved in the initiative	-

***Note: The total of 74 students does not exclude students who may have participated in multiple initiatives.**

The understanding we proposed in this research is built upon all these experiences, and this is why we present them all here, in different levels of abstraction. We present an overview of the results and the discussion of the first two initiatives in the corpus of this document (Section 5.1 and Section 5.2), and its workshops are presented in Appendix A. The other 2 initiatives – 2019 and 2023, originally planned and conducted within the time frame of this research are described in detail in this chapter (Section 5.3 and Section 5.5).

The first initiative occurred in 2015 and was carried out during my under-graduation in computer science. It encompassed six workshops with two different groups of students, totalizing 12 moments of interaction. The goal was to teach students about computational thinking abilities through the mathematics classes. The most significant learnings from this initiative to me were:

- "*With children aged 6 to 7, it is expected that they are in the literacy stage, but with adults, it is imagined that all of them know how to read and write. However, this was an observed difficulty. In one of the classes, most of the students could not read, so the activities had to be adapted.*"[1]
- "*In addition, we need to be aware that adults are at school of their own will, no one requires them to attend, and if they do not like the lessons or have difficulty with some of the activities, they get up and leave without hesitation*"[2] (which unfortunately happened in real life).
- From the computational thinking view, we saw positive results: students could grasp what the abilities are and what could be their application in daily lives. However, activities were far from the students' context, not being created to be connected to their lives, which weakens further comprehension of usefulness.

In the description of the 2015's classes (Section 5.1), we focused on what we have designed and conducted with the students, and what was discovered from the first time working with the YAE. After finishing this initiative, we understood that it was possible and beneficial to teach computational thinking to the YAE, but paying more attention to the students lives could help them understand the content as relevant to learn and use in their lives.

The second initiative occurred in 2018, with eight workshops under the Master's degree studies. This time, we began to design activities explicitly relating the content with the students' context. This meant that the planning and conduction of activities were not pre-defined: activities were planned, designed, tested, and created in the interval between workshops, so the outcomes from the former workshops informed the next ones. Back then, this new way to create the workshops caused me tension because I did not know how it would work, which techs we would address, or which way we would go. The most significant learning during the 2018 initiative was that it was possible to use data from the former workshops to inform the next ones (in this research identified as the Self-Regulated principle), and conducting the initiative this way brought many benefits. It has facilitated students to build a relationship between what they were learning and practicing at school with their personal activities outside school. We had the opportunity to take advantage of things students *wanted to* learn and *wanted to* use in their daily routines to create activities that students naturally engaged (As Dewey defends). Activities, then, were: closer to the students' context, involved multiple techs they already had some familiarity with (such as the tech name and the purpose), they were interested in learning more about, and the knowledge was applicable/useful in their daily lives.

[1] From the paper Ortiz and Raabe (2016).
[2] From the paper Ortiz and Raabe (2016).

One student's result from the 2018's initiative was that after a workshop of practicing taking pictures, she started to take pictures of her garden on her own, and every change she made on it, she would photograph and bring it to show to her colleagues, which demonstrate how taking pictures was a topic that both came from the students' interest and was highly applicable in their lives. The practice of taking pictures was structured through computational thinking abilities. Students were practicing the abilities, and using personal concepts to represent and better assimilate them (such as recipe or list of steps). The description of the 2018's workshops is in Appendix A.

In the discussions of the 2018's initiative results (Section 5.2), our focus is on the results of focusing on the students context and their perception of learning in the workshops (in contrast to what was observed in the former initiative, in which they would leave if the class was not meeting their expectations). Derived from this experience, we proposed the Socially Aware Model for Computational Thinking initiatives with the YAE audience (presented in Section 2). This initiative has shown us that the social approach was beneficial for students noticing purpose in learning about the computational abilities. Students started asking teachers to create a "list of steps" to complete their regular classes' activities as well, and the technologies approached were closer to their lives, so learning how to use them was rapidly perceived as useful. However, the computational thinking abilities were addressed as the focus of the activities. So, for the next initiative, we thought about proposing a way for the abilities to be practiced as part of the progression of the interaction, and not as the main topic of activities.

In the final two initiatives of this doctoral research, we expanded and refined our understanding of the practice with the YAE and the computational thinking role in the initiative. The third initiative occurred in 2019 with eight workshops. In this initiative, we understood how we could advance the approach to computational thinking abilities, thinking of the practice of the abilities as milestones to progress the activities' complexity. In addition, in 2019, we mainly involved the ATM, which was also a new experience, as in the last initiative we approached different technologies from workshop to workshop. This time, a sequence of activities was conducted, respecting the self-contained principle – in which each workshop has to have a purpose, an activity to be conducted, and knowledge to be developed with minimum dependency from other workshops – but also proposing that the sequence of workshops create a bigger story, in this case, builds a more extensive knowledge.

In this initiative, we tested using computational thinking abilities embedded in the practical activities with the technology, and not as the main focus of the activities. We saw potential to organize the progression of the activities according to the practice of computational thinking abilities. As results, we observed that, some students who had never used the ATM before, after some workshops, have used a functional prototype for the first time, on their own, with the support of an algorithm they have created, which we considered positive outcomes of this approach, demonstrating the value of using computational thinking to support interaction with devices. We argue that this practice has the potential to foster the comprehension of how ICTs can be used, which in turn fosters new experiences with technologies. In the 2019 initiative description (Section 5.3), our focus of discussion is to show how the practice with the computational thinking abilities contributed to an autonomous use of a functional prototype of a device. For a new initiative, we decided to focus on the early stages of promoting familiarity with technology, especially on the multiple barriers YAE students face when starting to learn and use technology.

Due to the COVID-19 pandemic in Brazil, quarantine started in March 2020, and classes at school were suspended. As the YAE students usually have many characteristics of the risk group for the disease, the classes for this audience remained suspended for a long time. During this period, we tried different strategies to remain in touch with the students, such as online classes, but these yielded few positive outcomes in terms of interaction. After the restriction ceased and we obtained the authorization, the initiative continued.

The fourth initiative occurred in 2023, with five workshops, and we focused on the early beginning of interaction with technology, especially considering what barriers students could have to start accessing techs and whether our understanding would be useful to reduce some of these barriers. In this initiative, we have considered how our understanding from experience and theoretical background was combined, how it works together, and how the movement toward digital experiences can be encouraged. Once again, computational thinking was used to organize the progression of activities. In the description of this initiative (Section 5.5), our focus of discussion is based on the barriers and results achieved by the students. Later in the chapter, we present a summary of the experience of four students regarding the barriers they had and the results they have achieved in all initiatives they had taken part (Section 5.6). After this discussion, we present a section with challenges and opportunities we encountered when working with the YAE audience (Section 5.7). The chapter ends with the perspective of the researchers who were part of the team of this research (Section 5.8).

5.1 The Initiative of 2015: "It is possible. Should we be closer to the students' context?"

The first initiative of workshops was held in the Youth and Adult Education Center[3], a public school in Itajaí/SC, during my capstone project in Computer Science. Table 5.2 presents more details about this initiative. The main results from this initiative were reported in a paper called "Computational Thinking in Adult Education: Lessons Learned"[4], published in the Workshops of the V Brazilian Congress of Informatics in Education - CBIE 2016 (Ortiz and Raabe, 2016).

Table 5.2: 2015 - Technical details of the initiative

Where?	In the *Centro Educacional de Jovens e Adultos – CEJA*, a public school in Itajaí/SC, Brazil
My connection to the school	I conducted the research as a volunteer
How many workshops?	a total of 12 workshops, 6 with each group of students
How often?	2 workshop per week
When it happened?	2015
Workshops duration	approximately 1h30min each
How many students	21 students total
Average attendance per workshop	Class L: 6,5 students Class E: 9 students
What was the students age range?	students unknown age: 13 up to 20 years old: 2 20 to 29: 1 30 to 39: 1 40 to 49: 3 up to 60: 1
How many researchers took part on the initiative?	the author, who acted as the main facilitator
Evaluation methods used	structured interviews with YAE students
Focus of the results discussion	the discovers from the first time working with the YAE

Six activities were created, unplugged and plugged, and two classes of YAE students were invited to participate in the initiative: the "L" class, from the name *Leveling*, and the "E" class from *Elementary School*, both following the characterization the school utilized. Table 5.3 shows details about the workshops. The initiative's main goal was to teach computational thinking abilities through mathematics, not specifically related to technology. Six meetings were held with each class, two per week. Each meeting lasted approximately 1h30min and was used exclusively to apply the program's activities. All the students in the class took part in the workshops; no selection was made.

In class L, a total of 8 students took part in the workshops (6,5 students average), and only 2 participated in all the workshops. The lowest age recorded was 17, and the highest was 50. In class E, 13 students participated in workshops (an average of 9 students per workshop), with only 4 students attending all the activities. The lowest age recorded was 15, and the highest was 57. The audience from both classes varied greatly, as there was a 15-year-old student who was literate and other students in their forties who were still in the process. There was also a student who had a stroke and presented motor and cognitive difficulties, having to start the literacy

[3]From the Portuguese: *Centro Educacional de Jovens e Adultos – CEJA*
[4]From the Portuguese: *Pensamento Computacional na Educação de Jovens e Adultos: Lições Aprendidas*

process again. The students' professions varied too, as fishermen, musicians, manicurists, and some students were already retired. One student with Down's syndrome and one student with evident motor difficulties took part in class E. She was unable to speak or move in a coordinated way on her own, but she was able to understand vital communication.

Table 5.3: 2015 - Overview of the workshops conducted

Workshop goal and activities involved	**Main results**
1 E - Starting the workshop series, discuss about algorithms and create an algorithm together. *Activity: Donkey Robot*	Students began to understand the importance of specifying instructions correctly and paying attention if the language is understood by the instructions' receiver
1 L - same as class E	same as class E
2 E - Keep on describing algorithms in a matrix context. *Activity: Matrix mat*	Students were engaged in participating in the practice. They tested describing and executing algorithms to pursue a path on the mat
2 L - same as class E	same as class E
3 E - Practicing the description of algorithms in the computer. *Activity: Hour of Code lesson*	Students got to practice interacting with the computer and its devices, and got to know a programming language based on blocks of command
3 L - Practiced again the unplugged description of an algorithm to visit apartments. *Activity: Apartment building*	Students could complete the activity more easily because they have already practiced the commands before
4 E - Create algorithms to draw geometric shapes. *Activity: Hour of Code lesson*	Students could practice the concepts of repetition and condition blocks and had the opportunity to practice interaction with the computer again
4 L - Practicing the description of algorithms in the computer. *Activity: Hour of Code lesson*	The list of available commands was shorter, but students had practiced it in the former activities.
5 E - Exploring a more robust environment to describe algorithms. *Activity: Scratch*	Students freely explored the platform
5 L - Debugging codes to achieve a known final destination. *Activity: Hour of Code lesson*	Students were more familiar with the computer
6 E - Programming an actor to move using the arrow keys. *Activity: Scratch*	Students could assimilate how games are programmed
6 L - Describing and testing an algorithm to complete a maze on the right path. *Activity: maze drawn on the board*	Observation that students who had participated in the former workshops were more familiarized with abstract thinking

The evaluation method selected for this initiative was interviews with the students. An interview with open and closed questions was created to be conducted with the students after the conclusion of the set of workshops. The focus was on capturing transformations in the students and identifying difficulties and barriers they had encountered so that these challenges could be considered when designing future projects and getting to know the selected audience better.

Results and Discussion

Interviews were carried out with 5 students from class E, and 3 from class L – the students that attended the last workshop and who had participated in at least two of the six workshops held with each class. Each student, one at a time, was invited to accompany me to a different room, and was then interviewed. The interview was not recorded in either video or audio; instead, responses were transcribed onto a data sheet.

I observed an apparent difference in digital fluency between the adult and young students. The adults had more difficulty assimilating the tasks and performing them. A possible explanation for this difference is that the adults did not have contact with technology since their childhood, like young people today usually have. So, if this difference already exists naturally, it is even greater with these students, who did not have access to education at a regular age, for various reasons, and are now learning to read, write, add, subtract, etc. For all of them, talking about computers was often unattainable. Some students could not even use the mouse at the start of the activities, others were able to use the computer, but they did not like to be assisted during this process, probably feeling embarrassed, and they did not like to try anything new so they would not feel exposed and discomforted by not knowing how to do it. In some cases, I observed that for the students, it was easier to say that they did not want to do the activity as an attempt to hide the fact that they were struggling in it.

When it comes to using the computer at home, the reports heard showed changes, such as: "*Now I know I can search the Internet for recipes whenever I want, which I could not do before*", and "*in the 2000s, access to these resources was not so easy and since I did not have any practice, I was always angry because I could not use them. Today it is different*". These reports, recorded in individual interviews, show the students' understanding that the computer and its resources are available for use whenever they want to use it. They understood that they can choose to use it or not, and that the computer makes it easier to carry out some tasks, such as searching for a recipe.

Autonomy, (a principle we have formalized in our understanding in this research), according to Horochovski and Meirelles (2007), refers to the ability of individuals and groups to decide on issues that concern them, and I claim that it was stimulated in students, since it was possible to observe it through individual reports such as "*I liked using the computer. When I could not do the activity, I felt scared, but I tried again, and when I succeeded I got happy. Before [the workshops], I always called my boyfriend or brother to help me, now I can try on my own, and I even help my mother to use the computer too*", or "*I only did the basics, today I have seen that I can do more. When I couldn't use the computer, I thought it was a little monster, now I know that if I make a mistake, I can just try again*".

Still according to Horochovski and Meirelles (2007), empowerment occurs whenever "people feel that they are competent in a given situation, that their presence is relevant, that they have more opportunities and resources to act, rather than constraints and limitations", and this characteristic was also observed in the students. One example of this is the testimony "*Before the classes, I only saw others using the computer, I did not think I could do it, I felt scared. It was a great opportunity to get started. I am still facing some difficulties, but I am not afraid anymore*".

Some of the students said that at first, they thought they would not participate in the workshops because they had no *familiarity* (what we focused on in the 2023 initiative) with the computer. The YAE teachers also reported that this was likely to be the case. As the students come to class of their own free will, no one requires them to be present, it was therefore possible that when the computer activities began, the students' attendance would drop. However, their attendance was maintained and the reports after the classes were "*I have always had difficulties, I thought about giving up, but when I completed something, I wanted to use it more. Today I feel more confident about trying*", and "*In the beginning I was not afraid, but I found it difficult. After the classes I found it easier, I lost my resistance and it was very interesting to use the computer*".

This initiative taught me that teaching computational thinking to the YAE audience was possible and beneficial for them. Students' feedback demonstrated they have assimilated the knowledge and the abilities. Their testimonies showed that after discussions, they could establish a relationship between the content in class and the situations in life – such as the loop in music. Hence, the activities had similarities to the students' life situations, but were not intentionally designed to encompass that. In future initiatives, if we relate the content of the activities with the students' concrete life situations, this relationship between what they are learning at school and how they can use the knowledge in life may be enhanced. This is what drove the pursuit for a theoretical background to inform the initiative. So far, the only concept I was using at this time was computational thinking. Conceiving activities this way might reinforce the students' willingness to participate. To me, it was very special to observe how a few moments with technology and a few simple activities could represent such a difference in their perspective on using technology. I only realized this when new students joined the last workshop and were lost even with our explanation (not only mine but also from the other students).

5.2 The Initiative of 2018: "Towards a socially aware perspective"

This initiative was part of a service project approved by the University and the Rachel Mader Gonçalves School, a public school in a low-income neighborhood of Curitiba. All students were invited to attend the workshops, and their participation was voluntary, i.e., they decided whether they wanted to participate or not. The informed consent form was orally obtained as students were in the literacy process. The initiative's main goal with the students was to promote students' familiarity with contemporary technology, reducing barriers to its usage. This goal was adequate, as it was discussed with the YAE teachers that their students had strong barriers to contact with technology, especially personal barriers involving their feelings, self-esteem, and perception of their own capability and autonomy (which is discussed in Chapter 2, and it was the focus of the 2023's initiative). Table 5.4 presents details about this initiative.

Table 5.4: 2018 - Technical details of the initiative

Where?	Rachel Mader Gonçalves school, a public school in a low-income neighborhood of Curitiba, Brazil
Our connection to the school	We conducted the research as volunteers
How many workshops?	8 workshops
How often?	1 workshop per week
When it happened?	second semester of 2018
Workshops duration	approximately 2 hours each
How many students?	17 students total; 14 women and 3 men
What was the workshops attendance?	13, 10, 10, 11, 12, 13, 12, and 13 students, respectively
What was the students age range?	unknown age: 5 up to 16 years old: 1 20 to 29: 1 40 to 49: 2 50 to 59: 4 60 to 69: 3 70 to 79: 1
How many researchers took part on the initiative?	4 researchers: the author, the research advisor, and two researchers from the IHC-UFPR research laboratory
How many YAE teachers participated?	2 YAE teachers
Evaluation methods used	voting and feedback from students, structured observation from researchers, and unstructured interviews with YAE teachers
Focus of the results discussion	the results achieved after focusing on the students context and their perception of learning

This initiative had different settings from the 2015 one, such as the participation of the YAE teachers and a team of researchers together with me in the project; the idea of bringing the content intentionally closer to the students' context, which means, from their context we select topics to work with; and from having adopted a virtuous cycle to get the initiative informed by the results obtained in the last workshop, so the workshops were built along the way. These differences paved a path toward socially aware perspective.

The YAE teachers are part of the student and the school's context, so their participation in our initiative was highly encouraged. However, it was limited by the teachers' availability to dedicate time for the initiative and our availability to be at school beyond the workshop moments. Still, the teachers' participation provided valuable insights about the students' abilities and ideas for topics to address with the students.

This initiative was planned as a season of 4 workshops. If students and teachers wanted more, we would extend the initiative by adding extra workshops. Due to positive feedback and requests from both students and teachers, the set was extended from 4 to 8 workshops. We consider this extension as positive evidence that our workshops were well accepted and positive for them. Table 5.5 presents an overview of the 8 workshops, with its title, goals, CT abilities involved, and a summary of its outputs.

A TV Show's metaphor was adopted following the idea that a story is composed of small pieces of stories – accomplishments by each student – how their familiarity with technology is expected to happen. Even if two workshops (episodes) are similar, in the major story they would never rewrite one another. Even if we use the same activity in two different workshops, they will never have the same results because the timing would be different, the student's abilities, experiences, and knowledge level would be different. Continuing the story is determined by our audience: if students are engaged in practicing and want to keep learning about technology, new workshops can be designed (as they were), and new seasons can be produced (thinking of more initiatives). For this initiative, a set of 12 activities was created, and the Socially Aware Model(presented in Chapter 2) was derived from this initiative.

Because this initiative's main goal involved students' perceptions about themselves (their capacity and self-esteem), their opinion about their own progress and their interest in the activities would give us the most trustworthy evidence of achieving our goal. More important than reaching a specific performance or grade is whether students felt they were learning from the experiences and activities, and wanted to keep learning. Observations from researchers and interviews with teachers would provide additional evidence about whether the initiative was succeeding in reaching students' context and becoming part of it. Therefore, free feedback from students, unstructured interview with teachers, and natural observation by researchers were adopted as evaluation methods.

At the end of each workshop, students were asked to answer 2 questions using colored cards and cards with *emojis* and placing them into a ballot box. For identifying students' engagement, the first question was: "*Do I want to keep learning about technology?*", and for identifying their learning self-perception, the second question was: "*How much do I think I have learned from this workshop?*". Figure 5.1 presents details about the possible answers for these questions. Voting was optional and anonymous, as the ballot box was placed outside the classroom. Teachers and researchers also registered explicit feedback from the participants.

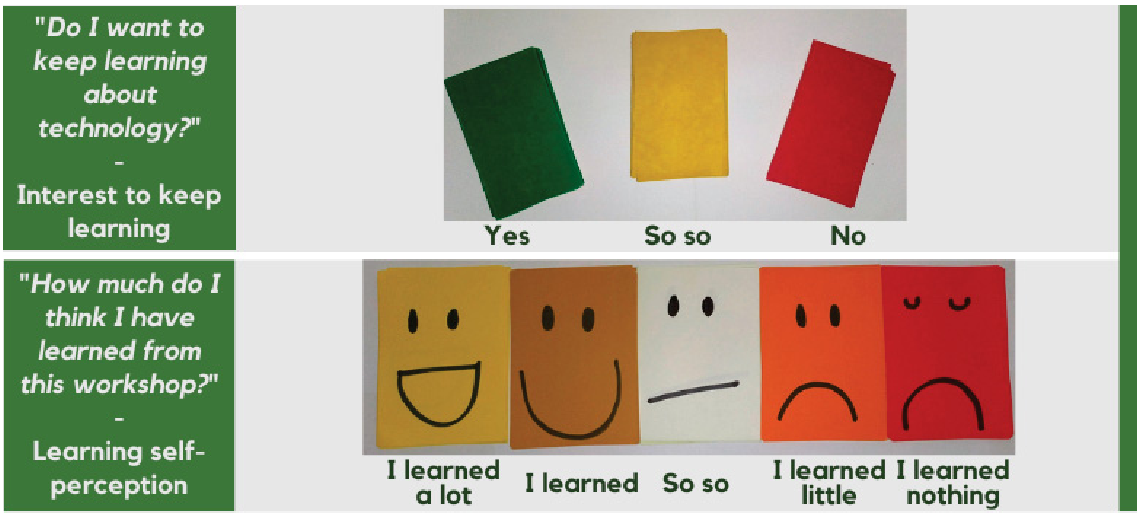

Figure 5.1: Questions asked to students and the possible answers

Table 5.5: 2018 - Overview of the workshops conducted

Title and Goal	CT abilities involved and examples	Outcomes
1: The icebreaker. Introduce the study and its goals, get to know the students, understand their context and discuss about technologies in a StoryTelling style.	Pattern recognition and abstraction. *Pattern recognition*: to distinguish electrical and technological devices.	Informed the following workshops and promoted the feeling of belonging to a group that everyone had possibilities and limitations, and what to learn and teach. Students' were interest in the following technologies: smartphones, music, making calls, taking pictures and using ATMs.
2: Training family photographers. Discuss about photos, describe and perform a sequence of steps to take pictures using different devices.	Algorithms, pattern recognition and automation. *Algorithm*: when creating a sequence of steps to achieve a goal (i.e., taking a nice picture considering its framing and lighting).	Explored the connection between home, personal life and school, creating opportunities for them to show and practice at home what they were exploring in the classroom.
3: Let's talk about voting. Discuss about the voting terminal, describe and execute a sequence of steps to vote.	Problem-decomposition, algorithms, simulation and pattern recognition. *Algorithm*: voting for different candidates until the process was finished, and deciding whether the correct candidate was selected according to the entered number.	Aligned with the 2018 election scenario, the exercise of citizenship was discussed by involving the voting terminal, an important device that still caused anxiety and was challenging for them.
4: Searching on YouTube. Introduce YouTube and the voice-based interaction. Perform a sequence of steps to search.	Algorithms, automation, pattern recognition and simulation. *Automation*: share a sequence of steps and process it on multiple devices.	Involved them in using voice-based commands, exploring new forms of interaction and new applications through positive and valuable experiences for their lives, searching for recipes and songs they liked.
5: Game night! Play a game and remember what have been seen regarding technology so far.	Algorithms, problem decomposition, data analysis and pattern recognition. *Problem decomposition*: in splitting the 'winning the game' goal into smaller achievements.	Fully integration with the literacy content that teachers practiced with them, in which they could see more clearly their progress while enjoying a YouTube soundtrack they had created in the previous workshop.
6: Lady Miroca: movie and popcorn. Watch a movie that presents an algorithm created and executed by someone with similar characteristics to the students, and discuss it.	Algorithms, simulation, data analysis and pattern recognition. *Data analysis*: in analyzing words that rhyme (the main character of the movie used to speak only through rhymes).	Film session, part of school's official program, indicating workshops were connected with other events in school life. Also showed a connection with what they had been learning and producing in the previous workshops.
7: Hello? Who is this? Introduce WhatsApp audio and video calls. Build and perform a sequence of steps to make a call.	Algorithms, pattern recognition, data analysis, automation and simulation. *Simulation*: in practicing with low fidelity materials before practicing in a real device.	They have put all their skills into practice, both in terms of contact with technology and in terms of didactic content worked, showing confidence and familiarity with the activities.
8: The Grand Finale. Remember all workshops, talk about the initiative and get feedback from students about the classes for a further season with more workshops.	—	The socialization and the remembrance of all the way through the season brought the feedback on what was worked and what could be even better, resulting in the renewal of the partnership for a new season.

Results and Discussion

After the 8 workshops involving many activities and technologies (Figure 5.2), observation from both teachers and researchers suggested a reduction in students' resistance to contact with technological devices, as well as an increase in the interest to learn more about technology. In the early workshops, only talking about technology seemed to make the students feel uncomfortable. Back then it was common to hear sentences like: "*I will not be able to learn about it*", and "*my grandchild knows how to do all this, he is the one who should be here*", suggesting a feeling of incapacity. When using a smartphone, students were usually uncomfortable and could hardly hold it with full hands. Instead, they tried to hold it with their fingertips, which can be interpreted as resistance or insecurity about the device. As the workshops were taking place, commentaries of insecurity disappeared, and instead, students were getting engaged in the activities and having fun, elaborating, and testing their solutions.

The participation on the workshops was voluntary, and all the present students decided to participate with us, and were always excited for the workshops. We consider that students' attendance is a strong evidence of the reduction of internal barriers for their contact and use of technology and our success in making activities relevant for their life context, as they knew the days we had workshops there, were free to skip or leave the workshop if they wanted to (as happened in 2015), but they kept accepting to participate.

Figure 5.2: Pictures of workshops and activities during the initiative

The participants' votes in each workshops corroborate our perception of their engagement and positive learning perception. As Figure 5.3 - A shows, for their interest in learning more about technology we received a total of 68 votes, and the 68 were "*Yes*". Regarding their learning self-perception (Figure 5.3 - B), only asked in workshops that involved practical activities and content (from 2nd to 7th), from 64 votes, 57 were "*I learned a lot*", 6 were "*I learned*", 1 was "*So so*", and none was "*I learned a little*" or "*I learned nothing*". Based on these results, we consider students were motivated and had an excellent perception of their learning progression.

During the workshops, students always had many experiences and personal stories to share about the addressed topics, indicating that activities involved subjects that were meaningful to their lives. Teachers reported that students were using at home the knowledge they have created during the workshops, sharing their experiences with their colleagues. Taking pictures of their family's Sunday lunch or voting are a few examples of knowledge they have practiced in their own context. This feedback indicate that the activities designed for the workshops was successful in addressing contents from students' contexts and contributed to them.

Regarding computational thinking and digital inclusion, the more the students could complete the activities with technological devices, the more they seemed to feel part of a group, working together and the more they felt confident to share their – temporary – lack of ability for some tasks, not mattering to feel exposed, and just focusing on learning.

In the third workshop, with a voting terminal prototype, we identified students around their sixties who had never voted via the voting terminal before because they could not have help while operating it. Many of them even described the act of voting as something bad or painful, based on their previous experiences with this technology. Together, we created an algorithm for the whole voting process, and as the discussion was going on, students realized they only did not know a few steps of the process and how to perform them on the voting terminal. The practice of computational thinking abilities, such as problem decomposition, simulation, and algorithm, helped students perform a complete algorithm to vote in the voting terminal prototype. After this workshop, in October 2018, one student reported having voted for the very first time, offering evidence that fear of using technology was reduced in some extent.

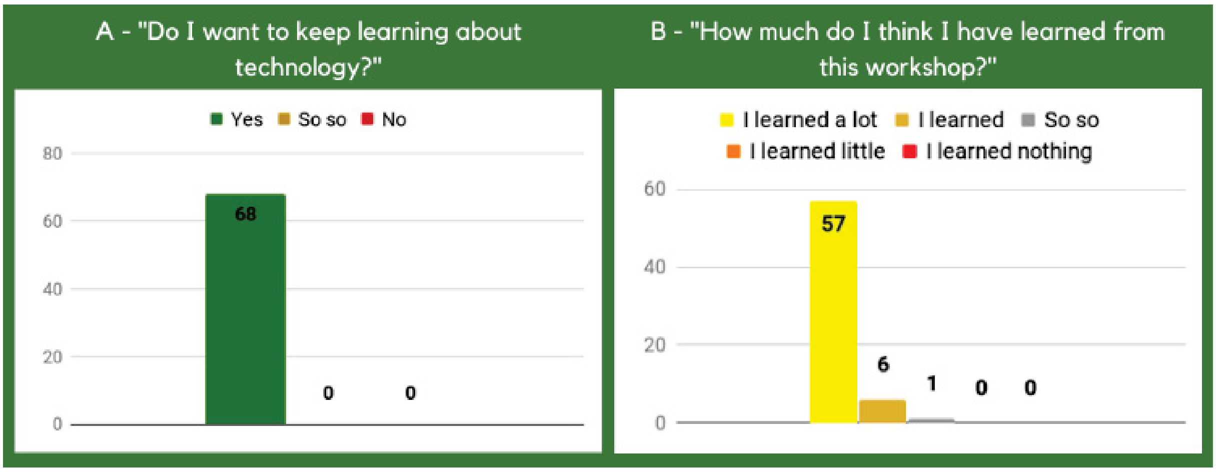

Figure 5.3: A - Results from students interest in learn more about technology, B - Results from students learning self-perception

As another evidence of a reduction in fear of technology, the ability to hold (and use) the smartphone was surprisingly improved. In the last activity that involved the smartphone, the students were asked to interpret and execute an algorithm based on the experiences the have had throughout the workshops. Five of the twelve students present were able to hold the smartphone and complete the activity *autonomously*, without any help, only with the material and explanations provided at the beginning of the workshop, which indicates the experiences in the workshops were useful for their learning and autonomy development (in this research, a principle in our understanding). The other students completed the activity as well, with some help during the process – as was expected, and showed no concern or fear of doing something wrong.

According to the teachers' feedback, after the workshops, students started asking them for a "list of instructions" (algorithm) of what was expected to be done in the regular activities, claiming that when writing down, they would not forget anything and could consult if they needed to. We understand this as evidence that students have assimilated the idea of algorithms, and comprehended one of the computational thinking abilities' benefits, applying it in their contexts.

Regarding barrier reductions in contact and use of technology, a student said that when we invited her to the activities, she felt that she would not be able to participate and carry out any of the activities. However, when she took the first picture in the second workshop, she decided to keep learning about technology as long as she had the opportunity to do so. Later this student told us she took several pictures of Christmas to show her teachers, and each change she makes in her garden, she photographs to show to her colleagues. Another student commented that she was able to talk to her grandson through a video call on WhatsApp, and she also took pictures of her family over the weekend: her relatives thought she would not be able to, but she took the picture and told us proudly: *"They asked me where have I learned how to do it, and I told them I had learned at school!"*. So our perception of their engagement, initially observed by us, was quantitatively corroborated by the positive votes and qualitatively validated by the students' spontaneous reports on the use of technology at home.

A few months after this initiative finished, teachers reported that students commented they now have or want to have a smartphone, and are looking forward to a new season of activities for using their own devices. As another positive evidence, in the following term after the workshops, students who had taken part in them were telling new students about what they had learned together, and have invited them to participate too. Indeed, when we got there for the next initiative in 2019, they were already waiting for us, and with many new doubts and topics they wanted to discuss.

These observations, together with the results students have achieved, corroborate that the practice of computational thinking abilities helped to reduce the rejection and fear of technology and supported them in using technological devices. It also shows that contextualizing the activities engaged students to participate and favored the perception of usefulness of the learned knowledge in their lives. Hence, we understand that practicing computational thinking as a natural part of positive experiences and contextualized activities helps students to be curious and willing to explore new technology. This naturally helps them understand how technology works, the possibilities and restrictions on its use, how it should be used, and in what contexts it could be used. The more the students comprehended these aspects, the more favored their interaction with technological devices tends to be. For people who are not used to use computing technology as part of their daily lives, practicing computational thinking abilities can provide fundamental structures (i.e., mental models) to experience digital environments.

Our thoughts for a new initiative were on exploring the computational thinking abilities in a progression of knowledge. This would be a challenge in an audience with an unsteady attendance as the YAE, but our thought was that it would be beneficial for them to create a more solid understanding on how the techs work and can be used, as they would practice more, and this would favor them to expand their digital experiences more easily. So, this is what we have proposed for the next initiative.

5.3 The Initiative of 2019: "Practicing a socially aware perspective"

This project was authorized by the Ethics in Research committee, from both the author's university (#46557121.1.0000.0102) and the city's education council (#46557121.1.3001.0101). The informed consent form was obtained orally as the students were in the literacy process. All classes were held in the same public school as the previous initiative, Rachel Mader Gonçalves School in Curitiba. All of us, researchers, worked as volunteers in the school.

The initiative's goal was to promote opportunities to learn about technology through the practice of computational thinking activities. Our understanding (presented in Chapter 4) supported the design of the workshops, and the results of the workshop also shaped our understanding, in a virtuous cycle. When adequate, references to the understanding elements will be highlighted to illustrate this mutual influence. Table 5.6 presents details about the 2019 initiative conducted.

Table 5.6: 2019 - Technical details of the initiative

How many workshops?	8 workshops
How often?	One workshop every two weeks
When it happened?	From August 27th to December 3rd, 2019
Workshops duration	Approximately 2 hours each
How many students?	21 students; 18 women and 3 men
What was the workshops attendance?	14, 15, 15, 10, 11, 10, 10, and 10 students, respectively
What was the students age range?	unknown age: 2 up to 25 years old: 2 30 to 39: 1 40 to 49: 5 50 to 59: 4 60 to 69: 5 70 to 79: 2
What was the initiative's team?	6 researchers: the author, who acted as the main facilitator, and other five researchers from the IHC-UFPR research laboratory, who acted as observers and participants.
How many YAE teachers participated?	2 YAE teachers, who acted as participants and partners.
Evaluation methods used	Voting and feedback from students, structured observation from researchers, and unstructured interviews with YAE teachers
Focus of the results discussion	To show the computational thinking contribution to achieving an autonomous use of a device

Our activities usually took place in the school library (principle Differentiated & Attractive). Students age range varied greatly, and we suspect that this occurs in the YAE modality because the students are grouped according to their abilities (i.e., reading and writing skill levels) and not by their age. The students' participation was voluntary, and every student present in class on the days we conducted the workshops was invited to participate. Students gave their consent orally as they were in the literacy process (oriented by the principles Universal and Autonomy). Table 5.7 presents an overview of each workshop.

As evaluation methods, we adopted student feedback, unstructured interviews with teachers, and natural observation by researchers. During each workshop, at least one researcher was in charge of taking notes of the students' progression, feedback, performance, etc. The team then shared, discussed, and documented the observations and used this to plan the following activities. Therefore, workshops were conducted dynamically, supported by previous results and achievements, instead of being predefined and restricted (principle Self-Regulated).

Table 5.7: 2019 - Overview of the workshops conducted

Workshop goal, purpose and activities involved	**Main results**
1- Starting the workshop series, discuss about everyday technologies and learn about the students' interest. *Activity: Storytelling. Purpose: 1. Establish foundation and contextual understanding.*	The technology of greatest interest was the ATM, and the purpose of cash withdrawing.
2- Practicing reading words from the ATM context, such as: balance, payment, and cash. *Activity: Hangman game. Purpose: 2. Promote technology familiarity.*	Students were motivated to practice reading because it was a fun activity and because the words were related to the equipment that interests them.
3- Reading words from the ATM context and making withdrawals in a low-fidelity (non-functional) prototype. *Activity: Bingo-type game and low-fidelity prototype. Purpose: 2. Promote technology familiarity.*	All the students were able to have a withdrawal experience, giving them a start on understanding how the process occurs.
4- Perform a withdrawal at the ATM low-fidelity prototype and describe a list of steps of how to perform this task. *Activity: operating the low-fidelity prototype. Purpose: 3. Promote learning on how to use the technology.*	All the students were able to have a new experience with withdrawal, now understanding that it is possible to describe the steps performed for future execution of the procedure.
5- Interpreting, ordering and executing a cash withdrawal algorithm in a functional prototype. *Activity: ordering a pictorial algorithm to withdraw and operate a high-fidelity (functional) prototype. Purpose: 4. Advancing the interaction with the technology.*	Students were able to perform the withdrawal process at the functional terminal with little or no assistance.
6- Practicing paying bills and checking the cash change. *Activity: Elaborate and practice an algorithm to check the cash change after paying bills. Purpose: 2. Promote technology familiarity.*	Students practiced a task they usually have difficulties with, and were engaged in learning ways to make it easier.
7- Practicing calculations on the calculator. *Activity: Practice the usage of the calculator to check cash change. Purpose: 2. Promote technology familiarity and 3. Promote learning on how to use the tech.*	Students realized another usage for smartphones, and practiced with the calculator.
8- Remember all the topics and subjects that were discussed during the previous workshops.	Students remembered all the topics discussed along the initiative, and gave us qualitative feedback about the things they have liked and things that could be better. Students invited us for another set of workshops.

As in the 2018 initiative, we continued to use the anonymous voting system to track the students perception. At the end of each workshop, students were asked to answer questions by using colored cards and cards with *emojis* and put them into a ballot box. For identifying students' engagement, the first question was: "*Do I want to keep learning about technology?*", and for identifying their learning self-perception, the second question was: "*How much do I think*

I have learned from this workshop?". Voting was optional and anonymous as the ballot box was placed outside the classroom. Teachers and researchers also registered explicit feedback from the participants.

Workshop 1

The first workshop was dedicated to introducing students, researchers, and teachers and to integrate the group, corresponding to Purpose #1: Establish foundation and contextual understanding. Our goal was to know the students and get known by them, talk about the technologies they know and see a purpose for using them in their day-to-day lives. About the computational thinking abilities, in this introductory workshop, the practices focus on understanding the dynamics and distinguishing the several kinds of technology. Table 5.8 presents technical details about this workshop.

A storytelling session was conducted to inspire participants to share, among personal information, what technologies they use and the ones they would like to learn about. The order to select the next student to talk was the game Hot Potato, in which a song is playing while students are passing a ball from hand to hand. When the song stops, the student holding the ball is the next one to speak. Among all the mentioned technologies, most students said they spent a long time waiting at the bank, and if they knew how to withdraw cash from the ATM, they could save much time.

Table 5.8: Technical details of Workshop 1

Participants	14 students, 3 researchers, and 2 YAE teachers
Workshop Purpose	1. Establish foundation and contextual understanding
Voting for "Do I want to keep learning about technology?"	87% positive votes, and 13% neutral votes
Practice of Computational Thinking Abilities	
Algorithms	Comprehending the logic in action to organize the Storytelling dynamic.

Analyzing the results to prepare a new workshop, we would likely choose many other technologies to address before the ATM. I thought it interesting that the students commented about this technology; it may indicate that now they are "more aware" of the day-by-day technologies that could help them get their things done. Based on the principles Socially and Culturally Contextualized, Useful, Relevant & Appropriate, and many others, we planned to work with the ATM in the following workshops. We applied the transdisciplinarity principle in the ATM context by addressing reading and writing words from the context into the activities, also through computational thinking abilities. Furthermore, this decision was beneficial to support interaction with the tech as the machine does not support other input modalities, such as voice commands.

Workshop 2

This workshop's goal was to practice words from the ATM usage context, to start entering the ATM subject. This goal started the workshops with the Purpose #2: Promote technology familiarity. About computational thinking abilities in this workshop, our goal was that students could perceive that working on a list of steps can facilitate reaching a solution, perform analysis and recognize patters in the possible solutions. Table 5.9 presents technical details about this workshop.

Table 5.9: Technical details of Workshop 2

Participants	15 students, 4 researchers, and 3 YAE teachers
Workshop Purpose	2. Promote technology familiarity
Voting for "Do I want to keep learning about technology?"	93% positive votes, and 7% neutral votes
Voting for "How much do I think I have learned from this workshop?"	100% I learned a lot votes
Practice of Computational Thinking Abilities	
Problem decomposition	Decomposing the task of guessing the whole word into easier tasks as guessing the letters.
Data analysis	Analyzing the letters that were already tested and the still valid letters to try.
Pattern recognition	Analyzing the incomplete word and the sound of the group of letters to recognize and test word valid guesses.
Algorithms	Figuring out a list of steps to solve the puzzle faster.

To achieve these goals, we played the hangman game. For each correct guess of a letter, the participants would win five game-cash bills, and for each correct word, participants would win 20 game-cash bills. After each word was revealed, there was an explanation of that word's meaning, specifically, the meaning in the ATM context.

Students were encouraged to think about strategies to deal with the hangman puzzle. This seems logical to literate people, that can think of the most common letters to try first, but for non-literate students, this was not trivial. During the workshop, one student mentioned the strategy she identified: she wrote the letters already identified in her notebook: _ O I N. In this writing, she analyzed the sound of the letters, and realized that it could be the word COIN because of the sound of OIN, which only required the C for Coin, illustrating her perception of pattern recognition in an algorithm. She then continued to elaborate this strategy for the following words. Therefore, participants were playing, becoming familiar with the words from the context, and collecting game-cash bills they would use later.

Students were happy to play a game that could contribute to their abilities, and they had varying levels of success in the game, according to their reading and writing abilities. About this workshop, a student commented: *"I learned about cards, cash, checks, savings, and I liked it. And now we have to learn how to put [deposit] and withdraw cash"*, demonstrating their willingness to keep learning about ATMs.

Workshop 3

The goal of this workshop was to keep practicing the words from the context and to introduce the ATM. To this end, a non-functional prototype of an ATM was built (Figure 5.4 - A). This workshop still had the Purpose #2: Promote technology familiarity, now offering an experience to be introduced to the tech, even though through a prototype. About the computational thinking abilities, in this workshop our goal was to practice: recognize elements of the physical-world (the machine) into the prototype; decompose the complex task of using an ATM into knowing its elements; assimilating that there are some steps to make the withdrawal operation in the ATM; all of these through the simulation of ATM function. Table 5.10 presents technical details about this workshop.

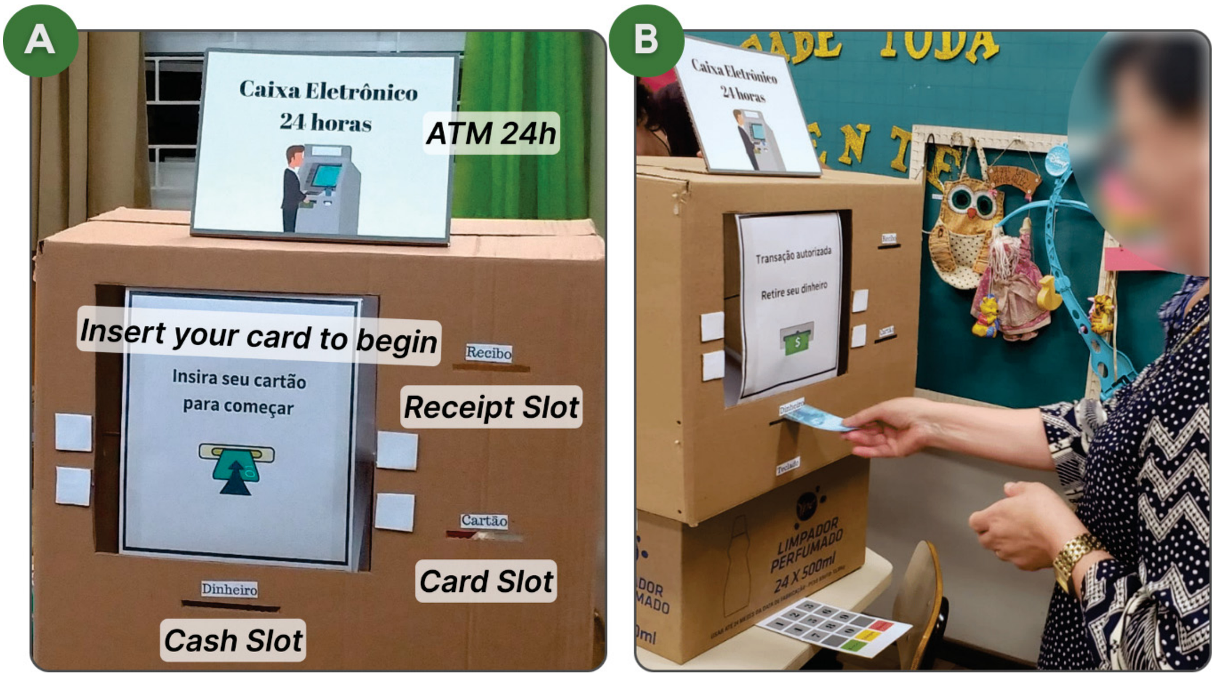

Figure 5.4: A - Non Functional ATM Prototype; B - Student using the non functional ATM prototype

The materials chosen for the prototype were paper and cardboard because students were already familiar and had experience with them and allowed for easy improvement, depending on the complexity of the activities (principles Universal and Progressive). The prototype contained the common elements of an ATM: buttons, slots for inserting the card, withdrawing cash or receipt, numeric keypad, and four different screens printed on paper, referring to the withdrawal.

Cards similar to bank cards in appearance were given to participants, displaying their photo, their name, and the school's name, a strategy to enhance the feeling of participation and the credential for the activity (principle Differentiated $ Attractive). Changes between screens and the delivery of cash through the machine was done manually by a researcher, fostering in the participants the understanding that for each action they performed on the interface, the machine would take time to process and then give them feedback – understanding interaction as dialogue, according to Hornbæk and Oulasvirta (2017).

Showing willingness to integrate the workshops into the school program and life, the school's principal and teachers prepared a bazaar with various items to integrate Workshop 3. This integration reveals benefits from adopting a participatory-based approach. Workshops were planned and discussed with the school as interested parties: they not only provided us with helpful information on students, their interests, and expectations, but also provided us valuable feedback on the results they perceived from the workshops and supported us in extending the reach and scope of each workshop.

A bingo-type game with personalized cards was designed so students could keep practicing their reading ability, enhancing again the transdisciplinarity principle in the initiative. While the participants played bingo in the classroom, students were called individually to withdraw the cash accumulated in Workshop 2. We presented the prototype of the ATM with all its elements, explaining how the withdrawal process occurs step by step, along with basic safety precautions and other relevant information.

Table 5.10: Technical details of Workshop 3

Participants	15 students, 3 researchers, and 2 YAE teachers
Workshop Purpose	2. Promote technology familiarity
Voting for "Do I want to keep learning about technology?"	100% positive votes
Voting for "How much do I think I have learned from this workshop?"	100% I learned a lot votes
Practice of Computational Thinking Abilities	
Algorithms	Assimilating that to execute the withdrawal there is an ordered list of steps to follow.
Problem decomposition	Decomposing the task of using a real functional ATM to withdraw money into using a prototype; and using the prototype was decomposed into knowing the elements of a prototype.
Pattern recognition	In recognizing words of the context in the prototype; in recognizing elements of the real ATM in the prototype.
Simulation	In simulating the interaction in a non-functional prototype.
Abstraction	In understanding that the prototype resembles to a real device.

In this workshop, we tried for the first time conducting two activities in parallel at school, and our group that day was composed of three researchers and two YAE teachers. The team's level of work was significantly higher, as all three researchers were working as facilitators the whole time (one conducting the bingo with the two YAE teachers in the classroom, and the other two researchers in the library: one presenting the ATM, and one acting as the ATM, changing its screens). This first interaction was individual so students could receive personal attention and time according to their level of experience and knowledge (Figure 5.4 - B). This decision was inspired by the Progressive principle, that recognizes and respects the students individual time to perform activities.

Despite the extra work, the results achieved were positive. The time each student took to go through this first introduction varied greatly. As for many of them it was the first time using the ATM (even as a prototype), they were able to ask all their questions without fear of being observed by the other students or having their time compared to others.

Each student performed a complete withdrawal process and started to create their own experiences with the ATMs, although informally and without realizing it. With the cash from the game, students went to the bazaar, where they could use their game-cash bills to buy objects donated by the school, such as bags, frames, candles, and other decorative objects. Student quote about the third workshop: *"We withdrew cash, we had bingo and shopping, I liked it. I want you to come back soon!"*.

Workshop 4

The goal of the fourth workshop was to continue practicing with the ATM low-fidelity prototype. In this workshop, the prototype "was programmed" to deliver chocolates instead of cash, to add a surprise, make the practice different, and to help students realize similarities with other machines, e.g. a vending machine. This decision was inspired in the Differentiated & Attractive principle. This workshop advanced to Purpose #3. Promote learning on how to use the tech, in which the main goal regarding computational thinking was for students to think about the steps they have performed in the ATM, and list/describe these steps, starting to practice describing algorithms in their own way. Also another CT abilities were practiced, as presented in Table 5.11, that also presents technical details about this workshop.

Table 5.11: Technical details of Workshop 4

Participants	10 students, 2 researchers, and 2 YAE teachers
Workshop Purpose	3. Promote learning on how to use the technology
Voting for "Do I want to keep learning about technology?"	92% positive votes, and 8% neutral votes
Voting for "How much do I think I have learned from this workshop?"	100% I learned a lot votes
Practice of Computational Thinking Abilities	
Problem decomposition	Using a non-functional prototype to further use the functional prototype.
Data analysis	Comprehending the interaction with the ICT prototype, understanding when the machine is waiting for a command, or processing a command. In reading the screens (words and images) and inferring what is the next step they should perform in the prototype.
Pattern recognition	In recognizing elements of the prototype, recognizing the screens and again in recognizing the order of steps they should perform.
Simulation	In simulate the interaction with the ATM with the help of a prototype.
Abstraction	In comparing elements of the real ATM with the prototype. Understand that they are practicing a simulation, and that the prototype is not the device, but the interaction with prototype resembles to the interaction with the functional machine.
Algorithms	In describing the steps students have done to perform the withdrawal.

In this workshop, we invited students one by one to withdraw chocolates, and after each student had completed this process, we invited them to specify the steps they have performed to create a list of instructions (Figure 5.5). The list format was free: diagrams, drawings, etc. The level of detail we oriented them to use was such that anyone using their list of instructions (not limited to themselves) would be able to perform the withdrawal in the machine. The goal of this activity was to encourage them to organize and review what they had already explored and experienced, practicing the skill of algorithms. The exercise of translating the informal experience into a formal and organized list allowed them to practice and keep structuring experiences about the equipment.

This time, I noticed students were more confident to do the activity. They seemed to be thinking "I *can* learn to do that". This posture may be related to the individual experience they had in the former workshops, and also because some students had already developed some familiarity with technology in general in the previous initiative (the one from 2018).

Figure 5.5: Students together in the classroom specifying the steps to perform a cash withdrawal

One interesting observation about the steps the students have described was that, some of them, started the list with steps such as "getting the bank card" or "going to the bus station", which demonstrate how effective the activity was in addressing things from the students' context, exactly as the Socially and Culturally Contextualized, Useful and Relevant & Appropriate principles suggest. Student's feedback about this workshop: *"We learned to insert and remove cards to receive our payments. We did not know [how to do it], now we will find out. And it is really interesting that we avoid the queue and the hassle, take our cash and leave. I liked it because we are learning how to put the card and get our cash for the month, our payments and this is very important. I don't need to keep asking anyone. I want to learn a lot!"*.

Workshop 5

This workshop involved two activities to continue the practice of algorithm and interaction with the ATM, now in a functional prototype. This workshop's purpose advanced to Purpose #4. Advancing the interaction with the technology. The computational thinking abilities we mainly wanted to practice with the students in this workshop were: interpreting an algorithm, ordering the steps of the algorithm – which stimulates them to recall their previous experience of interaction, abstract differences between prototypes, as well as recognize the patterns between them, since a new prototype is introduced. Table 5.12 presents technical details about this workshop.

Table 5.12: Technical details of Workshop 5

Participants	11 students, 3 researchers, and 2 YAE teachers
Workshop Purpose	4. Advancing the interaction with the technology
Voting for "Do I want to keep learning about technology?"	100% positive votes
Voting for "How much do I think I have learned from this workshop?"	100% I learned a lot votes
Practice of Computational Thinking Abilities	
Problem decomposition	Breaking the task of using the functional prototype into smaller tasks as interpreting, ordering, and executing a list of steps.
Data analysis	Logically comprehending how the interaction was with the non-functional prototype, and how it is now with the functional prototype. In interpreting the steps to perform the withdrawal.
Pattern recognition	Recognizing the elements of the real ATM in the functional prototype. Comprehending the meaning of the images of the list of steps.
Simulation	Mentally ordering the steps to check its correctness, and simulating the withdrawal in a prototype.
Abstraction	Abstracting differences and similarities between the non-functional prototype, the functional prototype and the real ATM.
Algorithms	Abstracting, ordering and executing the steps to perform the withdrawal.

The first activity used the instructions lists students had created in the previous workshop. We compiled their lists into a single one, with each step illustrated with a picture so that the set of pictures formed a pictorial algorithm of how to perform the withdrawal process. We started the activity by discussing which step each picture represented, along with security issues and safety precautions. Then, random steps were given to the students, and the activities' goal was to order the steps in a meaningful order, recreating the algorithm based on their previous experiences (i.e., in a progressive manner). For the second activity, the low-fidelity prototype was evolved into a high-fidelity and functional ATM prototype by coupling a tablet to simulate the ATM screens.

An ATM simulator software was developed, simulating nine key screens that resemble the actual equipment (4 of which are presented in Figure 5.6 - A). This evolution allowed practicing computational thinking skills and perceptual, motor and cognitive interaction with the digital equipment.

Each student received an alphabetic password and a printed copy of the pictorial algorithm ordered correctly (Figure 5.6 - B), with an additional step (3). This step represented the decision whether the withdrawal should occur from the savings or the checking account. This activity built upon the experiences students had gathered in the previous activities to interpret and perform the algorithm and the withdrawal process in the functional prototype, illustrating the Progressive principle.

Figure 5.6: A- 4 Screens of the ATM simulator; B- Ordered algorithm used in the activity

In this workshop, we noticed students more confident and secure in solving the activities. Many of them even used the ATM on their own, only following the steps of the algorithm they received, and based on their former experiences. This time, the interaction with the ATM was also individual, but we all were in the library, and while one student was practicing with the prototype, the others were discussing the steps of the algorithm. Students' quotes about this workshop were: *"Today we put in and took out the ATM card to withdraw cash. I loved doing this. I ask God that you come back to continue teaching us next year"*, and *"We got cash from the bank. I loved it because I am already learning"*. Figure 5.7 presents a student using the funcional prototype.

After this practice with the functional ATM, we considered going on a real-context ATM to practice with the students. However, several concerns were raised, especially about safety and logistics. Students would have to feel safe and trusting in the environment, and there would be multiple factors to control to try to achieve this. Personally, I was excited to observe and assist the students using the actual ATM for the first time, but the difficulties and the concerns about safety and logistics were relevant. Also, students would feel more comfortable and secure if a person within their private circle guided them through the process with the machine in the live context. Hence, it was decided not to pursue this goal.

The school teachers raised another topic related to ATMs. They told us students have difficulties in checking the cash change whenever they pay a bill. When we brought the topic to discuss with students, many of them shared that sometimes they think/get worried that someone may be fooling them. So, considering the principles Useful, Relevant & Appropriate, Socially and Culturally Contextualized and Self-Regulated, we considered cash change as the topic of the following workshops.

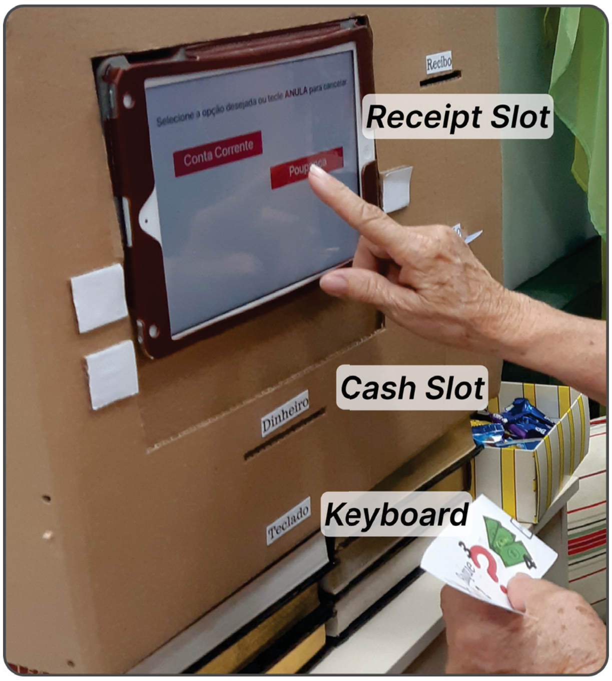

Figure 5.7: Functional prototype being used by a student

Workshop 6

Informed by the students' context and the principles, we decided to continue addressing the financial context, now with the topic of paying bills. This workshop's purpose returned to Purpose #2. Promote technology familiarity. Our goal with computational thinking abilities involved the ability of data analysis, to help students calculate the amount of cash they would need to pay different bills with different denominations and the change they should receive. This activity also encouraged students to reflect on the idea that a list of steps can support them in this calculation, and that knowing this algorithm can facilitate completing the task. Table 5.13 presents technical details about this workshop.

Students were organized into three groups to receive more attention according to their needs. Fake bills similar to those they are used to deal with, such as electricity and water, were created so students could practice. Game-cash was used to help them visualize the amount of cash when paying bills of different amounts, as well as realizing that the same amount of money can be represented with different combinations of notes (e.g., 100 game cash could be two notes of 50, five notes of 20, and 10 notes of 10). In this activity, no device was involved.

Students had experience with bills and cash, and the relation between the amount of money and the correspondent value in different notes was something new for them to practice. Students' quotes from this workshop were: *"We trained to do math... there should be more of it, so we can learn to do more math. I really liked it. I would like to have more math lessons"*, *"We did calculations to pay and get change. We enjoyed the class. I want to practice doing math again, I am learning!"*, and *"We did the math, paid what we owed. I liked it, I want to practice doing math again. Whenever you guys return, you will be received with all affection!"*.

For the first time in the initiative we had a vote "I learned nothing", and is also the only time in which we registered 11 votes with 10 students in class. This informs us that this negative vote could be since only a mistake in taking the wrong card, a change of idea and voting twice, until in manner fact an expression of true "I learned nothing today", that could be based on practicing something that student already knew, or was not interested in, or even because there was no technology involved in this workshop. Unfortunately, we do not have enough data for clarifying the motivation behind this vote. However, it certainly caught our attention to keep following the students perception of learning. Still, the voting confirmed they continued wanting to learn about technology.

Table 5.13: Technical details of Workshop 6

Participants	10 students, 3 researchers, and 2 YAE teachers
Workshop Purpose	2. Promote technology familiarity
Voting for "Do I want to keep learning about technology?"	100% positive votes
Voting for "How much do I think I have learned from this workshop?"	82% I learned a lot votes, 9% So so votes, and 9% I learned nothing votes
Practice of Computational Thinking Abilities	
Problem decomposition	Still in the financial context, practice separating the withdrew money to pay bills.
Abstraction	In distinguishing the information from the practice with the ones they can learn and apply in their lives.
Data analysis	In analyzing different combinations of notes that could represent the same amount of money.
Algorithms	Create an algorithm to accomplish bills payment.
Simulation	Simulating the task of paying bills and checking the exchange.

Workshop 7

In this workshop, we extended the money change activity with a different dynamic. This time, our goal was to help students perform the calculations using a calculator. As it is a simple resource, and students had already practiced algorithms in other contexts, this workshop's purpose started in Purpose #2. Promote technology familiarity, and reached the Purpose #3. Promote learning on how to use the technology. Regarding computational thinking, the practice this time focused on the ability of algorithm, in which students were supposed to interpret, execute, and propose adaptations for the algorithm to use with the calculator, according to what was asked. This adaptation also involved data analysis, pattern recognition, simulation, among others. Table 5.14 presents technical details about this workshop.

Several students had never used a calculator before. This equipment was chosen because it is an inexpensive one that they already knew the name, and they could also find similar apps on smartphones, adding another function to this device. The activity was to calculate the change for a purchase, in which we provided the items to purchase, the price of each item, and how much cash the buyer had. Inspired by the Participative and Differentiated & Attractive principles, the activity was designed as a competition with several rounds, but all students were in the same group. For each round, the first student to achieve the correct answer would win points for the entire group. As the group achieved a certain amount of points, prizes were given to all students.

To continue practicing about algorithms, pictorial algorithms of how to perform the calculations were delivered to students: using the list of items we have provided; they had to interpret and execute the algorithms' steps on the calculator. The repetition concept was practiced as students were asked to perform operations with more than two numbers (prices), and they should analyze which core steps to repeat in their algorithm.

Table 5.14: Technical details of Workshop 7

Participants	10 students, 4 researchers, and 2 YAE teachers
Workshop Purpose	2. Promote technology familiarity and 3. Promote learning on how to use the tech
Voting for "Do I want to keep learning about technology?"	90% positive votes, and 10% neutral votes
Voting for "How much do I think I have learned from this workshop?"	75% I learned a lot votes, and 25% So so votes
Practice of Computational Thinking Abilities	
Abstraction	Abstracting the information from the practice in school with the ones they can learn and apply in their lives.
Data analysis	Processing different information and finding out what the practice is asking them to do.
Algorithms	Interpreting and executing the algorithm to make calculations.
Automation	In using a device to operate part of the process they need to do.

The calculator is a simple application, but it has a great purpose for them. Many students shared concerns about the change they receive when paying bills. Informed by the principles, we were directed to consider the students' interests, doubts, and other aspects to design a workshop that addressed a relevant topic for them. In class, the activity was not about the device itself anymore; it was about the students practicing on their own with the calculator the ability to check whether they were receiving the correct exchange. It was a workshop in which their desire to develop autonomy was higher than learning to use technology. Students testimony about the workshop were: *"I liked the calculator... I did not know how to use it. Now, when I get home, I want to practice. I have a calculator and I never used it because I did not know how to use it!"* and *"We did math using the calculator. I enjoyed today's class, and I want to do math using the calculator more often"*. In the final voting, we observed there was no "I learned nothing" votes, which could either mean the former vote was a mistake, or that the student's issue was resolved. Figure 5.8 shows a moment of this workshop.

Figure 5.8: Student practicing with the calculator

Workshop 8

For the last workshop, a video was prepared with pictures and videos recorded during the initiative. The idea was to review some of the moments we had together. Popcorn and a special room were prepared for this moment. As the last workshop of the initiative, there was no activity planned for practice. Instead, we talked about what topics and activities each participant enjoyed the most, the ones they would like to participate in again, the ones that we could improve, and how we could do it. Table 5.15 presents technical details about this workshop.

Table 5.15: Technical details of Workshop 8

Participants	10 students, 5 researchers, and 2 YAE teachers
Voting for "Do I want to keep learning about technology?"	100% positive votes

A new student joined the initiative for the first time in this workshop. After seeing the video, she expressed excitement upon seeing everything her colleagues had learned together, and if she knew that there were classes about technology, she would have enrolled in school sooner. All students shared their preferences, things they wanted to learn more about, and the ones they liked less. As the main result of this workshop, students and teachers invited us to continue the project in the following year.

Results and Discussion

In this initiative's discussion, qualitative and quantitative data were combined for analysis to extract evidence on the main topics we wanted to discuss. The data we used to draw these discussions were the students voting and feedback, the teachers' feedback, and the researchers' natural observation. Data were analyzed through a qualitative analysis using coding, in which for each topic we wanted to discuss, we analyzed all data we had that could support us in the discussion, and then we summarized what we had found.

The results from the students' voting were very positive, both in their interest in learning more about technology, and for their learning self-perception. This assumption is supported by the quantitative results of students voting. Figure 5.9 - A shows the students accumulated votes for interest in learning more about technology: a total of 92 votes, 87 were "*Yes*", and 5 were "*So so*". Figure 5.3 - B shows the students accumulated votes regarding their learning self-perception, only asked in the workshops that involved practical activities: from the 63 votes, 59 were "*I learned a lot*", 3 were "*So so*", and 1 was "*I learned nothing*". We suggest that these results, combined with the students' results with technology along the workshops are evidence that our understanding (principles, steps, purposes, experience and theoretical background) was helpful for creating an initiative that addressed technologies from the students context, that it has promoted the students' engagement in learning about that technology, and that promoted activities in which the students perceived a positive growth after participating.

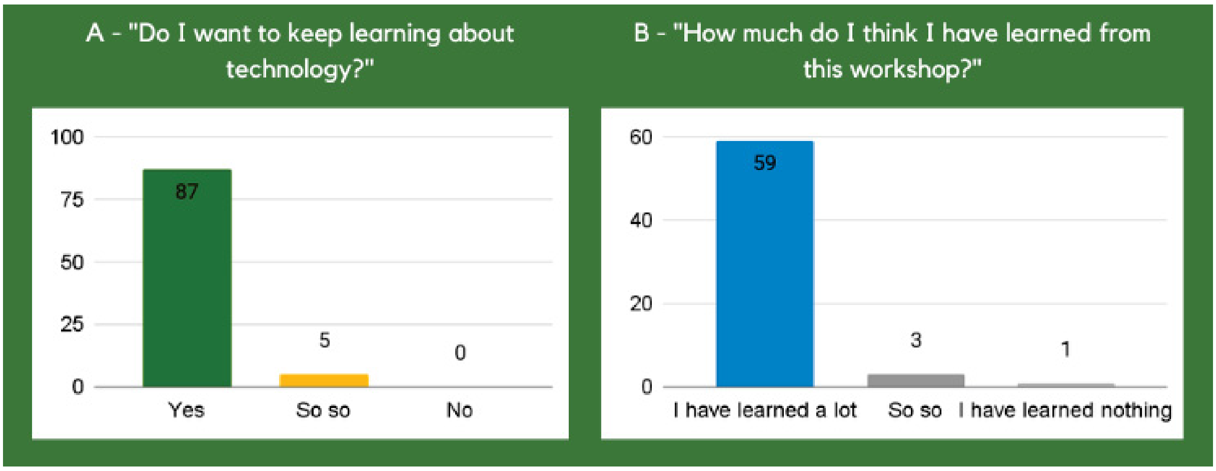

Figure 5.9: A - Results from students interest in learn more about technology, B - Results from students learning self-perception

There are other perspectives we could discuss about this set of workshops, but the main purpose of the initiative within this doctoral research is to evaluate the computational thinking contribution to promoting familiarity with technology, defending its usage as a tool to organize the progression in the activities' and the workshops' complexity, instead of being the content of the activities as in the former initiatives.

Regarding this topic, we observed that throughout the workshops, students gathered experiences that helped them in the following activities, in a constructive learning process. The strongest evidence that demonstrates this is when we moved from the low-fidelity to the high-fidelity prototype. Students quickly comprehended how to explore and use the evolved prototype, and 5 of the 11 students performed the withdrawal process on the functional prototype entirely on their own at their first attempt. When help was needed from the other 6 students, it was mainly related to confirming whether a step was correct or issues about physical interaction with the device. For instance, the touch on the surface sometimes lasted more than it should have, with some dislocation, similar to a *drag* interaction, resulting in no response in the prototype. Another difficulty was with a student that had hand tremors due to a medicine she was taking under prescription. She had to practice more to achieve precise touch, and after practicing for a while, she was able to use the touchscreen with no difficulties. The evidence of students using the functional prototype correctly, on their own, and for the first time confirms our observation that their former experiences sustained a new interaction with a functional prototype. We understand that the practice with the non-functional prototype favored their understanding of interaction with devices, and when using the functional prototype, they knew how the interaction should work, in which they should expect a response from the device, and interpret this response before giving a new command (exactly as they learned with the non-functional prototype). We argue that the practice with the computational thinking abilities during the prototype exploration was responsible for this constructive learning, that fostered new experiences with technology with autonomy.

As these students interact with computing devices infrequently (many only use them during our workshops), we consider that a combination of factors contributed to their confidence: the practice of computational thinking abilities through activities that evolved from basic to more elaborate, the inclusion of the non-functional prototype, and the positive experiences they were gathering along the way. As a result of this process, familiarity with the technology was developed, which further supported them in future activities. Even though the students had not used a functional ATM yet, we understand that the same way the experience with the cardboard equipment helped them transition from the non-functional to the functional prototype. Likewise, we suggest that the experience with the functional prototype will be a basis for using the equipment in a real-world context.

Regarding the students practice of computational thinking, when a new device was introduced - the calculator, along with an algorithm on how to use it, students did not question their capabilities on using the device. Instead, they interpreted the algorithm, demonstrating they were familiar with this concept and the support this list of steps provide, and practiced the activity. Beyond the technology usage, they have perceived the usefulness of this technology for developing their autonomy as citizens. We understand this as evidence of the practice of computational thinking abilities fostering the development of digital culture (by expanding their digital experiences), and culminating in combating digital divide *and* vulnerability and exploitation risk.

We suggest that, as students participate in activities with technology practicing the computational thinking abilities, familiarity with technology will be promoted, and so new interactions with and through techs will be favored, which will deepen their knowledge and experiences with the digital world, and so on. The progress in interacting autonomously with ICTs will allow students to apply and incorporate them into their daily lives, mainly when students become aware of technology's functioning, purposes, and possibilities. Hence, we consider this strategy to organize activities according to computational thinking abilities as positive and incorporated it into our understanding and the model, suggesting this same approach for new initiatives: activities from static prototypes to functional ICTs, from an early introduction of the tech, progressing from one stage to another until describing, interpreting and executing algorithms for using it.

As this initiative was conducted in the same school as the previous one, we understand that YAE students could have had some previous knowledge that could have helped them in this goal of getting familiar with technology, supporting them in exploring new technologies. However, students in the very early levels of contact with technology would be the more probable audience to find in the YAE, and for a new initiative we decided to focus on the early stages of the contact with technology, investigating whether the progression on computational thinking abilities would favor the *start* of this movement towards familiarity.

5.4 In Between Initiatives

Quarantine due to the COVID-19 pandemic in Brazil started in March 2020. Back then, we did not know how long it would last. Students had difficulty following the regular educational content broadcasted on television, a strategy to keep the workshops happening. In WhatsApp groups, there was also little participation. There were days when the students were supposed to visit the school to get new activity sheets, deliver the concluded ones, and pick up food baskets the government assigned to them. On those days, they registered excellent attendance. This occasion occurred monthly at school. In one of these deliveries, we were present delivering the same WhatsApp recipe that we used in the last 2018 workshop with the students on how to make a video and audio call. A student contacted us a few times during isolation asking for tech classes, but we have no record of the other students.

During quarantine, we have organized a donation to raise smartphone devices to give to the students. This attempt was motivated by the desire to help students get through this, be able to communicate with others more easily, and eventually adopt a new way to keep going with our workshops. 2 smartphones were donated to the students. In addition, a crowdfunding initiative was organized, in which some money was raised, but as it was not enough to provide devices for all students, we decided to wait for clearance to return to school for in-person workshops.

After this period, students were already in the classroom, but we were not yet allowed to be with them. We held a virtual meeting via Google Meet, in which the students were all together at school, and the researchers were at home; however, the meeting faced technical issues. The school's internet had limited speed, which caused connection failures. The students were unable to connect/respond to what we were saying, and they commented much more among themselves about what they were seeing: "*What is that orange thing there? I do not know, I think it is a fruit she is eating, and a piece of it is hanging there*" (it was the noise-canceling microphone attachment for the headphones). It was noticeable that they struggled assimilating this form of interaction. Perhaps because they were in a group watching on a screen, they assimilated the interaction more with the "watching television" model than the "video call" model.

Sometime after this attempt, we held another face-to-face class in the classroom to reestablish contact with the students while we awaited approval from the Ethics Committee to carry out the research in person.

5.5 The Initiative of 2023: "Practicing a socially aware perspective again"

The 2023 initiative's purpose for the research was to focus on the initial stages of approximating technology. Our main goal was to observe whether our understanding could guide and inform us in identifying and address the barriers students may face in this contact. Our goal was to create experiences so students could think: "I can be here, I belong to this place if I want to", "I have the right/credential to be here", "this is not a threatening topic", "I could actually learn about it if I want to", and "It would be useful to use these things in my daily life". In this initiative, a total of 5 workshops were conducted and 15 students took part in at least one meeting with us – 11 women and 4 men. The highest registered attendance for a single workshop was 14. Table 5.16 presents details about the initiative conducted.

Table 5.16: 2023 - Technical details of the initiative

How many workshops?	5 workshops
How often?	One workshop every two weeks
When it happened?	From October 31st to December 12th, 2023
Workshops duration	Approximately 2 hours each
How many students?	15 students; 11 women and 4 men
What was the workshops attendance?	13, 11, 14, 9, and 11 students, respectively
What was the students age?	unknown age: 2 20 to 29 years old: 3 30 to 39: 0 40 to 49: 2 50 to 59: 3 60 to 69: 3 70 to 79: 2
What was the initiative's team?	5 researchers: the author, who acted as the main facilitator and other four researchers from the IHC-UFPR research laboratory, who acted as observers, tutors and participants. We all worked as volunteers.
How many YAE teachers participated?	2 YAE teachers, who acted as participants and partners, in which one was the first time participating in our initiative.
Evaluation methods used	Voting and feedback from students, structured observation from researchers, and structured interviews with YAE teachers
Focus of the results discussion	The barriers and results that four students have achieved in the initiative

Because it was the third time addressing the YAE audience of Rachel Mader Gonçalves school, and some students had already taken part on our workshops, we knew that some of them might be more open to technology than others, even though a few years had passed since our last time in school. Following the Step 0 - Get informed about the context in which the initiative will be conducted, and the Purpose #1. Establish foundation and contextual understanding – we decided to disregard our prior knowledge of some of their interests about technology. According to the model, we started the initiative as if the students were distant, in denial, and facing many barriers to access technology, as this is the most probable condition YAE students would be in.

Table 5.17 presents an overview of each workshop. As evaluation methods, we once again adopted student voting, students spontaneous feedback, structured interviews with teachers, and natural observation by researchers. During each workshop, at least one researcher was in charge of taking notes about students' behavior, feedback, performance, etc. Some classes also had the audio recorded, only for the purpose of facilitating data extraction. After each workshop the team shared, discussed, and documented the observations and built the following activities upon that data. Therefore, workshops were conducted in an incremental and iterative manner, supported by previous results and achievements, instead of predefined and restricted, as the Self-Regulated principle suggests.

Table 5.17: 2023 - Overview of the workshops conducted

Workshop goal, purpose and activities involved	**Main results**
1- Get to know the students, explain about the initiative, get students declaration of participation (*TCLE*). *Activity:* Bingo and storytelling. *Purpose:* 1. Establish foundation and contextual understanding.	Activities revealed a heterogeneous group of students. Personal answers revealed some students could be in denial and distant from technology, but also great sings of willingness to talk and learn about technology.
2- Practice taking pictures. *Activity:* 2 scenarios for photos: a dining table and selfie. *Purpose:* 2. Promote technology familiarity and 3. Promote learning on how to use the technology.	Activity encouraged a moment of simple interaction with the smartphone, and a moment of reflection about the results achieved.
3- Leveling the knowledge on WhatsApp. *Activity:* bingo game and sending an audio message on WhatsApp. *Purpose:* 2. Promote technology familiarity.	In such a heterogeneous group, there were students who knew how to send audio messages, and other ones who did not used the app before. Leveling of knowledge through individual moments with the students helped to keep building on the same background.
4- Exploring functions on WhatsApp. *Activity:* Creating a list of steps to WhatsApp several functions. *Purpose:* 3. Promote learning on how to use the technology.	Decentralized activity was helpful to keep students focused on the tasks, and to explore the app according to their will. Students got happy about the outcome, and wanted to practice more.
5- Exploring higher abstraction on algorithms to perform the same WhatsApp functions. *Activity:* Ordering the algorithm for each WhatsApp Function. *Purpose:* 4. Advancing the interaction with the technology.	Activity similar to the former one, but important for students to practice and think about what they were practicing. Many students could practice on their own phones, with their personal contacts.

Once again using the colored cards, a strategy that worked well in the former initiatives, at the end of each workshop students were asked to answer the question "*How was your experience in this workshop?*". The possible answer for this question were: green card - positive experience, yellow card - neutral experience, and red card - negative experience. Voting was optional and anonymous as the ballot box was placed by the exit of the classroom. Teachers and researchers also registered explicit feedback from the participants.

Workshop 1

This first workshop was dedicated to introducing the research, getting to know students, researchers, and teachers, and integrating all the participants into one group. Table 5.18 presents technical details about this workshop.

The workshop's goal was presented as "talking about how technology can help in our daily activities". We explained to the students that their participation was voluntary, they had the right to decide whether they wanted to be part of it or not; the data collected in the workshops would serve only for the purpose of the research and was not going to be openly distributed; their identity will always remain anonymous in every publication; participating in the classes represents no risk to their lives and demands no payment; and if they decided not to participate anymore, at any moment, they could tell the teachers with no risk or disadvantage. After this explanation, we requested the consent form. The acceptance was registered by voice since the students were in the literacy process. A smartphone was passed around to record the oral authorization of the students hand-to-hand, and they said: "I [name] want to participate in the Technology Workshops".

Table 5.18: Technical details of Workshop 1

Participants	13 students, 4 researchers, and 2 YAE teachers
Workshop Purpose	1. Establish foundation and contextual understanding
Voting for "What was your experience in this workshop?"	100% positive experience
Practice of Computational Thinking Abilities	
Algorithms	Comprehending the logic in action to organize the practices (bingo and storytelling).

A personal presentation session was conducted with all the participants at the next moment. In a circle, each one of the people present should introduce itself by sharing their name, if they would rather have tea or coffee, what their favorite food is, if they use/have used technology, and if so, for which purpose. We selected the topics of coffee, tea, and favorite food as a strategy to engage the group in a conversation, with the students willing to share personal aspects of their lives in a respectful and friendly place. From this introduction, we became aware of the students' interest in learning about technologies, mainly regarding photos, WhatsApp, and a health government app[5].

The third activity of the workshop was a "bingo-style" game, which the teachers had previously informed us that the students liked to play. A bingo card was prepared with 38 numbers, and 38 sentences were selected, corresponding to five different topics we wanted to know more about: students' context, reluctance, willingness to talk/use technology, desire to learn, and if/how interaction with technology already occurs. The game's dynamic was: I read a sentence, and if they relate to that sentence, then the corresponding number should be marked on the bingo card. The sentences' content was all related to the use of technology, either positive or negative thoughts. Table 5.19 presents examples of these sentences.

For this activity, we inserted sentences that demonstrated reluctance to interaction so we could, after the workshop, have data to draw discussion on the students' results along the initiative. Counting the times each sentence was marked, we could understand that students had a low level of technology reluctance (26% of the sentences marked within the whole group). Still, their willingness to talk about technology was great (97% of the sentences marked), along with their strong desire to learn about technology (81% of the sentences marked). Additionally, in this activity, some of the sentences mentioned a specific ICT, which contributed to accurately identifying the students' interest in what they would like to learn about. This activity confirmed the findings from the personal presentation activity, that the topic of photos was among the students' interests, so the researchers' team agreed to address this topic in the following workshop.

My thoughts on this first workshop were: there were 8 students who were participating in our workshops for the first time, so it would be interesting to follow their progression; also, we had 6 students who had participated with us in the last initiative, so it would also be interesting

[5] *Saúde Já* App.

to see how they relate to technology now, after this period of more than 3 years. Additionally, this bingo activity we designed achieved complementary information – specific on the topics we asked, but students were not afraid of feeling exposed or embarrassed by agreeing with a sentence; they knew that everyone was paying attention to their own card.

Table 5.19: Examples of the bingo game's sentences

Topic	Sentence
Students' context	"I have my own smartphone" "I will like to learn about smartphones at school"
Reluctance	"I'm afraid of using technology because it could *eat* my money" "I'm embarrassed to try to use the smartphone, because I think it will not work" "Technology is bad, it is just to scam us"
Willingness to talk or use technology	"I always see my family using the smartphone" "When I see someone using a smartphone, it makes me want to know how to use it too"
Desire to learn	"I want to learn more about WhatsApp" "I would like to know how to take photos on the smartphone" "I would like to know how to use my cell phone without help"
Interaction	"I use technology on my smartphone. I know how to make calls and take photos" "Whenever I use my smartphone, I like having someone with me to help me"

Workshop 2

The goal of this workshop was to take pictures in two different scenarios: a) taking pictures on a dining table, resembling to what students would face in a "Sunday family lunch" and b) taking selfies, resembling what they could experience in a school external class, visiting some museum or just registering a moment with someone they care about. Table 5.20 presents more details about the workshop.

Table 5.20: Technical details of Workshop 2

Participants	11 students, 5 researchers, and 2 YAE teachers
Workshop Purpose	2. Promote technology familiarity and 3. Promote learning on how to use the technology
Voting for "What was your experience in this workshop?"	100% positive experience
Practice of Computational Thinking Abilities	
Abstraction	Think about aspects of the scenario they have at home to practice in class. Abstract the differences between devices they were practicing on.
Algorithms	Create an algorithm on how to take pictures.
Data analysis	Identify and list aspects that turn a picture into a good picture.
Simulation	Simulate different settings to achieve better pictures (angle, light, etc).

On this day, a student came to see us when we got to school, and with excitement she told us that she had brought her smartphone to class. During the workshop, we learned that three other students had also brought their devices to practice with us. After greetings, we started the workshop by talking about the Camera Icon, which can be slightly different from smartphone to smartphone, and comparing the differences (background color, camera format, icon format, etc). After that, the YAE teachers organized the group into the two scenarios that were already set, and the practice started. Figure 5.10 shows on the left the dining table scenario, and on the right a group of students practicing selfies.

Figure 5.10: On the left, 3 researchers standing close to the dining table scenario prepared for the practice. On the right, a student making a selfie of the group of participants around her.

The goal of the activity was to practice taking pictures on the smartphones, and also to practice analyzing the pictures, encouraging the students to come up with ideas to get the most out of the given scenario, thinking about why one picture looks “better” than others, and what actions could reach an even better result. Students already had an idea of what a “good picture” looks like, and they could choose which was the best between two pictures (bright vivid colors, more light, photo grid, zoom, etc.), but in the activity they practiced taking pictures, and together they came up with ideas and a “checklist" for taking good pictures. All students achieved the purpose of the workshop at varying levels of success. We observed several students happy about practicing taking better pictures.

Workshop 3

Based on the students’ interest in WhatsApp – revealed in the first and second workshops, this moment was dedicated to exploring this app with the function of sending audio messages. Some students already knew how to send audio messages, but others had never used the app before. The model and principles informed us to respect these differences and accommodate the individual time students may need to perform the same activity. In our scenario, one feasible way to accomplish this was to work with the students in individual sessions, and the team agreed to do so. Table 5.21 presents technical details about this workshop.

The workshop organization started by separating the researchers into two different activities: two researchers and the YAE teachers were in the classroom conducting a bingo game that involved words common to the WhatsApp context (for example: audio, video, call, contact, etc.), and the other three researchers were in the school library. In this space, the researchers occupied three separate desks so they could perform the activity with three different students in parallel. Researchers followed a script to conduct the activity so students would have similar experiences. Each student was asked to send an audio message on WhatsApp. The students who knew how to do it performed the task more quickly, and the students who were not proficient with the app had the opportunity to interact with it, getting an explanation about the app as they progressed in the task. Some students were using the app for the first time. As materials to support the practice, printed papers were provided containing images of the screens involved in performing the process so they could take notes during the process and take this material home for practice.

Table 5.21: Technical details of Workshop 3

Participants	14 students, 5 researchers, and 2 YAE teachers
Workshop Purpose	2. Promote technology familiarity
Voting for "What was your experience in this workshop?"	100% positive experience
Practice of Computational Thinking Abilities	
Problem decomposition	Splitting the how to use the WhatsApp knowledge into recognizing its screens and icons.
Pattern Recognition	Recognize elements of the physical-world into the digital context (as the phone in the WhatsApp icon, the camera, etc).
Algorithm	Understand that there is a list of steps to be performed to achieve the goal of sending an audio message.
Simulation	In simulating sending an audio message to some contact.

Of the 14 students we had in class, 10 performed the task with minimum or no help, varying times of accomplishment (from 30 seconds up to 6 minutes), and the other four students needed help, requiring five up to 11 minutes to complete the task. The students who already knew how to send audio messages were asked if they were willing to help teach the colleagues in a future opportunity.

In this workshop, it was clear once again that students were excited to talk about WhatsApp, so the topic remained for the following workshops. In addition, conducting activities in parallel requires more work from the team, but achieves good results with the students, each one having their individual time to explore the tool.

Workshop 4

This workshop was designed to explore other WhatsApp functions beyond audio messages. Table 5.22 presents technical details about this workshop. The students were divided into four teams so that in each team, at least one student had accepted to be a "tutor" (as we asked in the previous workshop). As materials for this workshop, we prepared several screenshots of the steps of different WhatsApp functions (sending a picture, sending an audio message, making a video call, making an audio call, and sending location) and the purpose of the activity was to order the screens and create the "algorithm" to perform each function. Students could use their phones to elaborate and test the algorithms, and researchers would also lend their phones so all students could practice at least once with a physical device.

It was challenging to follow multiple students practicing in parallel and with multiple guidance from multiple sources (including other students), but the workshop's goal was accomplished: each student practiced each function at least once on the smartphone.

Table 5.22: Technical details of Workshop 4

Participants	9 students, 4 researchers, and 2 YAE teachers
Workshop Purpose	3. Promote learning on how to use the technology
Voting for "What was your experience in this workshop?"	100% positive experience
Practice of Computational Thinking Abilities	
Problem decomposition	Decomposing the task of performing the WhatsApp functions into performing the steps.
Abstraction	Abstract the differences between the printed screens and the device they were using to practice. Abstract commands into representations in the paper.
Pattern Recognition	Recognize the screens in the printed papers with the ones in the device.
Data Analysis	Identify and analyze what was wrong when the outcome was not the expected.
Algorithm	Describe in the printed papers the steps to perform the functions.
Simulation	Test the described steps to check its correctness.

Workshop 5

This workshop focused again on the same WhatsApp functions as before. Similarly, students had to order the steps to perform each function (sending a picture, sending an audio message, making a video call, making an audio call, and sending location); the difference this time was in the abstraction level of the material. The printed materials students had practiced with in the last workshop were the whole screen of each step, and this time, it was only the icons they should press/click in each step to perform the function. Table 5.23 presents technical details about this workshop.

Once again, the students were organized into groups and started ordering the steps and testing the algorithms on their phones, i.e., interacting with the smartphone and using the app. Although this activity was similar to the previous workshop (order steps to perform a function), this time, students were more familiar with WhatsApp and the overall process: the idea of algorithms, the steps they had to follow, and the method of ordering and checking. Our perception was that this familiarity made the students more relaxed, comfortable in the activity, learning from it, reflecting on the focus of practicing and putting each step in the correct order. I was very grateful to observe students practicing, and this time, many of them were practicing on their own smartphones. Figure 5.11 shows the students practicing with the different materials.

Figure 5.11: On the left, group of students with the screen printed material, on the right, group of students with the icon printed material.

Table 5.23: Technical details of Workshop 5

Participants	11 students, 4 researchers, and 2 YAE teachers
Workshop Purpose	4. Advancing the interaction with the technology
Voting for "What was your experience in this workshop?"	100% positive experience
Practice of Computational Thinking Abilities	
Problem decomposition	Decomposing the task of performing the WhatsApp functions in executing the algorithms.
Pattern Recognition	Recognize the icons in the algorithm with the ones in the screen.
Abstraction	Abstract the differences between the printed screens and the device they were using.
Data analysis	Analyze the state of the device and the algorithm to determine if the last action was valid.
Algorithm	Order and execute the steps to perform the WhatsApp functions.

Results and Discussion

In this initiative's discussion, we again combined qualitative and quantitative data for analysis to extract evidence on the main topics we wanted to discuss. The data we used to draw these discussions were the students voting and feedback, the teachers' feedback, and the researchers' natural observation. We have invited the YAE teachers to answer our structured interviews about each workshop, nonetheless, we have not received any response. Efficiency measurement would not be helpful to provide us with data, because solely completing the activities 100% right does not directly imply that the students are now less reluctant and more familiar with technology and with the idea of adopting technology. All data we gathered were analyzed through a qualitative analysis using coding, in which for each topic we wanted to discuss, we analyzed all data we had that could support us in the discussion, and then we summarized what we had found.

This initiative focused on the early stages of interaction with technology. Our main goals were to understand which barriers affected students' approximation with technology and whether our understanding and theoretical background would be useful to design initiatives and activities that could identify these barriers without exposing any student and ease some of them throughout the initiative. As results, the main barriers our observation identified were the students' idea that they should not use technology; fear and anxiety of using technology, as if they did not have the capabilities to learn how to use it, or feel vulnerable to try in front of their colleagues; and lack of encouragement, motivation, and support in adopting and using technology. These barriers were confirmed by the students' feedback in class, and their responses in the bingo-style activity. Hence, we conclude that our understanding guided a sensitive initiative to identify the students' barriers, and we argued this is due to its socially aware perspective.

To collect evidence for this discussion, we asked the students how was their experience in the workshops, in which the possible answers were positive, neutral, and negative. Figure 5.12 shows the accumulated votes in all workshops, in which from the total of 60 votes, 60 were "*Positive experience*". Our interpretation of this result is that students have not felt insecure, or exposed, or vulnerable during the workshops. On the contrary, we infer that the principles Socially and Culturally Contextualized, Participative, Relevant & Appropriate, and Progressive were able to inform an initiative in which the students had positive experiences even in sharing their fears and anxieties.

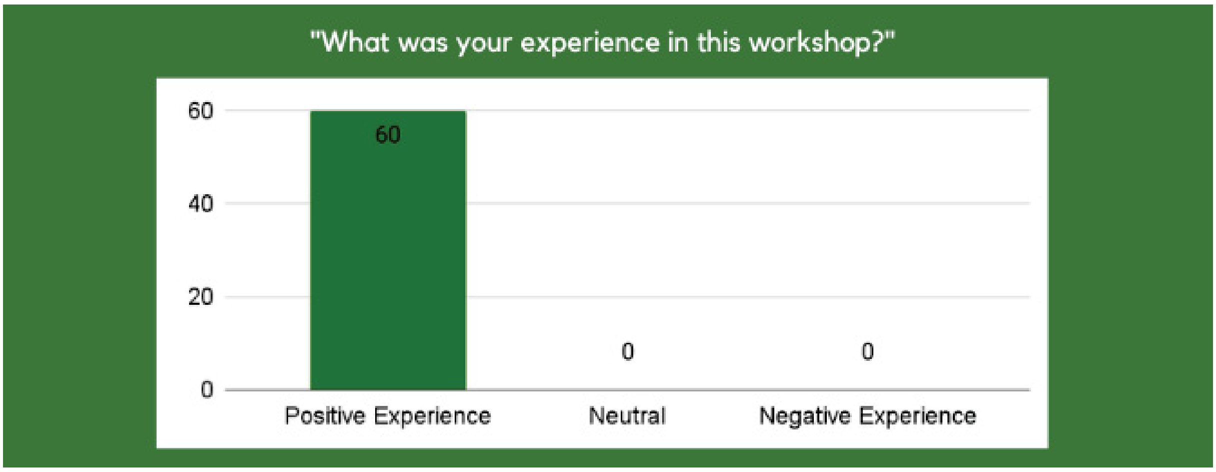

Figure 5.12: Results from the students' experience in the workshops

As the workshops were occurring, our observation confirmed another aspect the bingo-style activity has shown: that students had a great motivation to learn about technology. The students were participating in the activities, bringing their phones to practice with us, installing the app, practicing the activities on their own phones, at school and at home, messaging their personal contacts, and calling siblings, parents, and family. This is evidence students were engaged in the learning activities with technology, and since in the first workshop it was confirmed that they had some barriers to using technology, and now they are practicing even at home, this is evidence that barriers to accessing technology were eased to some extent. To draw the discussion on which barriers students had faced, whether they were eased, and what results the students have obtained, we present a compilation of four students from the school who have participated in our initiatives. This discussion is presented in Section 5.6.

We observed that students were gathering experiences that helped them in completing the following activities, in an iterative and incremental learning process, just like we have observed in the 2019's initiative. The growth in the students' autonomy was demonstrated by their comfort in practicing the activities on their own. Retrieving the empowerment concept by Horochovski and Meirelles (2007), that is when "people feel that they are competent in a given situation, that their presence is relevant, that they have more opportunities and resources to act, rather than constraints and limitations". In addition, Freire says that "*to support the student so* *that he himself can overcome his difficulties in understanding the object and so that his curiosity, compensated and gratified by the success of the understanding achieved, is maintained and, thus, stimulated to continue the permanent search that the process of knowing implies*" (Freire, 1997, pg. 116). This is exactly what we have observed with our students. By the fifth workshop, they were confident in trying to solve the activities by themselves, rarely asking for help to get the activity done, only to check if they had done it right. They actually have changed their perception on themselves to "I trust more that I am capable to try, than in the limitations that prevent me from trying". We argue this change in the students' mindset is the result of an initiative that is inspired by all the theoretical background we have orchestrated: that the YAE audience needs to be addressed through a socially aware initiative, with the primary goal of promoting familiarity with technology through the practice of computational thinking abilities, informed by the principles, designed by the steps and purposes and as a result, digital culture is developed.

Students were motivated because the technology addressed was of their interest; students were practicing at home because the initiative addressed the technologies they said they wanted to learn, and encouraged them to rethink technology in their context; students were practicing with the activities because the material and tools used enabled their usage with accessibility; students were progressing in the experiences because the practice of computational thinking abilities made them assimilate how technologies work and can be used; students were calling their parents because they had already understood the purpose of that technology; and the experience progressed successfully because it was informed by a theoretical background and by our experience and understanding on the topic.

We understand that the positive results we observed in students' approximation with technology were not solely from participation in our workshops, but also influenced by other social, informal, and formal factors. However, we understand our initiative was the starting point of this process, promoting a learning environment and respecting the students knowledge and doubts, easing the barriers that prevented them from perceiving they can use technology if they want to; inviting them to rethink their perspective on their abilities, acknowledging that their abilities are under development, among others. We understand the initiative served as a tool to address these first barriers that prevented them from even considering technology as an option. According to the results students have achieved, we consider the initiative successful in helping students overcome barriers to interacting with technology, and we argue that the understanding developed in this 10 years of research (presented in Chapter 4) was responsible for designing initiatives to promote digital culture with the YAE audience.

5.6 Discussion on the students' perspective

In this section, we present a compilation of four students from the Rachel Mader Gonçalves school who have participated in the last 3 initiatives (2018, 2019, and 2023). This is not an exhaustive description; it gathers what was possible to observe throughout the initiative. Our perspective in presenting these observations is understanding and discussing which barriers to accessing the technology these students have faced and how their process to develop familiarity with technology occurred along the initiative.

We are not claiming that these are the most substantial barriers students would find to access technology; we are just stating that these were the ones we could identify in this group during the activities that were involved. We expect the same activities with a different group of students or the same group of students with different activities may reveal different barriers. These are the ones that we have collected enough data to discuss and compare how the student was in the beginning and what their outcomes were. Table 5.24 present these four students that participated with us.

Table 5.24: Overview of the participation of four students from the Raquel Mader Gonçalves school

-	Student I	Student II	Student III	Student IV
Gender	Female	Male	Female	Female
In 2018	Age: 69 Frequency: 75%	Age: 51 Frequency: 100%	-	Age: 64 Frequency: 100%
In 2019	Age: 70 Frequency: 25%	Age: 52 Frequency: 100%	Age: 67 Frequency: 100%	Age: 65 Frequency: 88%
In 2023	Age: 74 Frequency: 100%	Age: 56 Frequency: 100%	Age: 71 Frequency: 100%	Age: 69 Frequency: 100%

Student I

Female. The oldest student in the group. In 2018, at the age of 69, she participated in 75% of the workshops (6/8). She enjoyed taking pictures and making video calls through the internet. She suggested we propose more activities involving the smartphone. She practiced taking pictures and making phone calls on WhatsApp with us in this initiative; however, she did not say if she continued practicing at home.

In 2019, at the age of 70, she participated in 25% of the workshops (2/8). In the first workshop, she said she wanted to learn to withdraw money from the ATM, take pictures, send messages, and find and listen to songs on the Internet. She commented that she really wanted to learn how to interact with the ATM. However, as she participated in only the two first workshops, we could not observe aspects of her interaction with this technology.

In 2023, at the age of 74, she participated in 100% of the workshops (5/5). In our bingo card, she marked the sentences: "*I am embarrassed to try to use the smartphone because I do not think it will work*", and "*My family has no patience to teach me how to use the smartphone*". Despite that, she was very willing to talk about technology (marked 100% of the sentences) and had a great desire to learn about technology (marked 90% of the sentences).

She actively participated in the first workshop, as she interacted with us, and decided to participate in the initiative. In the second workshop, we noticed signs that she was excited to learn with us when she said, "*Oh, I knew that today the tech teachers are coming, so I brought my smartphone*". The topic of photos was especially interesting for her that day because in that week, the students had an external class (visiting a park), and she told us she was frustrated because she did not have a good picture from that moment. In the only picture she was in, her hair was messy because of the wind, and in the other photos that were taken of her, she appeared only inside the bus and not in the beautiful landscapes and surroundings. She learned to take pictures with us in the 2nd workshop, and we noticed she had slightly shaky hands that day. After taking pictures, which she practiced on her own phone, she asked how to delete a picture in case the wind blows too hard again, or when the focus is not good, etc. In the third workshop, she learned to send audio messages on WhatsApp, completing the task in 9 minutes and 42 seconds. She continued attending the workshops and practicing the other WhatsApp functions with us, and she asked us to take home all the printed materials we had prepared for the practices.

According to the sentences she has marked on her bingo card, we wonder if the embarrassment and the family issue are somehow related. The family's impatience could be her perception that asking for help would bother the family; or that if she asks for help, they will try to do it for her instead of teaching her; or even that she is embarrassed to ask for help because she knows that she will need more time than usual to perform the task, and does not want to look or feel vulnerable by this (unfortunately, we have heard reports from other students of family members who presented a negative attitude toward their request for help with technology).

Indeed, in that second workshop, her completion time was one of the longest among the group, but she successfully completed the task, which was the purpose. In this case, a possible barrier she may have had was "*I'm embarrassed to try because I do not want to look or feel stupid for needing more time to understand digital things than my colleagues*". The Progressive principle informs us to respect the individual time each student needs to perform the practice, with no competition, no comparison, no classification between fast or slow, no speeding them up, among others. Instead, we previously stated that our workshop was a space for learning, that we researchers were there learning too, and that everyone needed their own time to complete tasks. In fact, the individual introduction of the students to the WhatsApp audio message supports this point of view. Each workshop was prepared this way, not "adapted" to fit the students' needs, but built from them. Student I could complete the activities at the end of the initiative; she learned from it, developed autonomy, practiced on her smartphone, on her own time, and even continued practicing at home, which led us to consider the initiative's goal accomplished.

With this student, I have learned that age does not impede learning and using technology. She was great through all the workshops. Always happy, frequently motivated to learn. Once, when she took a picture of her family, she was so proud that she told her family, "*I learned taking pictures in my school*". During the COVID-19 pandemic, she lost her partner and got very sad and discouraged. In 2023, I was so happy to see her there with us, and once again, she was brilliant in being motivated and learning about technology.

Student II

Male. In 2018, at the age of 51, he participated in 100% of the workshops (8/8). In the first introduction, he said that he had gone through brain surgery due to an accident. He said that, despite his recovery being considered a miracle by the doctors, his brain was not the same anymore.

About using technology, he told us he receives calls on his smartphone but does not call anyone; he only answers the calls. He said the kids usually know more about technology than "they" (YAE students). In a workshop where we talked about selfies, he said he did not know what it was and asked if it had something to do with the sky[6], relating *céu* with selfie. He also showed signs of lacking literacy ability when he said that we could remove the letters from the wall to take pictures because no one uses them. Later in the initiative, he said he would buy an smartphone with a camera. In the following weeks, he brought his regular phone, and even though we had practiced taking pictures in the classroom, he said that he had not taken any pictures that week. In the classroom, he got to take a selfie with us. In a workshop on making video calls, he said he had never made a call before. At the end of the initiative, he said that he enjoyed using the smartphone and learning about video calls.

In 2019, at the age of 52, he participated in 100% of the workshops (8/8). He said he wanted to learn more about smartphones. He was disappointed that his five-year-old niece knew how to operate a smartphone better than he did. During this initiative, we noticed that he had some difficulties in abstract thinking, in thinking about things that are not concrete, not in front of him, things that are not "something" he can relate to. In the calculator workshop, he had more difficulties dealing with it than his colleagues. He could mentally calculate the price he would

[6]From the Portuguese: *céu*.

have to pay if he had A, B, and C bills to pay; he knew how to calculate the exchange, but when formalizing these calculations in the notebook or the calculator, it was hard for him to understand that this formal way of making calculations means the same thing as his mental calculations.

In 2023, at the age of 56, he participated in 100% of the workshops (5/5). About reluctance, he marked the highest quantity of sentences, including: "*I do not think I can use technology*", "*I am embarrassed to try to use a smartphone because I do not think it will work*" and "*Whenever I tried to use technology I was told that it was bad, or someone fought with me*". He tried practicing taking pictures in our workshop, and he presented motor and cognitive difficulties. Motor difficulty in holding the phone stably, adjusting the camera to the location he wanted to take the picture, and having precise clicks on the screen button. Cognitive in remembering past actions and instructions, and difficulty focusing on the activity. After the practice, he also asked for help to delete the pictures he had taken, and he was guided and yet assisted in doing that. He was also introduced to audio messages during the third workshop with the help of a researcher, completing the task in 5 minutes. He was assisted through all the activities. In the fourth workshop, we noticed that he was more intimate with technology, but still presented issues in focusing on completing the task without giving up. In the last workshop, he sent a photo and an audio message to his school colleague, asking where he was. He made this on his smartphone and by himself. So he tried to use technology on his own, on his smartphone. It worked, and no one fought with him.

In this case, beyond the cognitive and motor difficulties, a possible barrier to the use of technology he faced was the anxiety and stigma "*I do not think I can*" use technology. Maybe this thought came in transference from other experiences that he could have gotten frustrated for not performing according to the way it was expected by him or others (as the calculator in 2019), so when he thought about technology, he may have thought "I will not be able to do that *either*". We suggest that the experiences in our workshops, designed by an understanding that was based on this audience, with the practice of computational thinking abilities from the scratch, introducing the technologies, and especially informed by the Progressive principle, that proposes a slow and continued progression in complexity, contributed to change his conception to "*I think I can use technology*". Indeed, he used his smartphone for new functions by himself, which we consider a positive result in approximation to technology.

With this student, I have learned how hard the life of the YAE students can be and that age is not always what determines how well a person will learn. Student II was not among the older students in the class, but he was still among the ones with more difficulties in general (not only with technology). The experience of following his progression through all initiatives was so gratifying, especially when we saw him texting and sending audio messages on his own.

Student III

Female. In 2018, she was not enrolled in the school.

In 2019, at the age of 67, she participated in 100% of the workshops (8/8). She said she wanted to learn how to send messages and take pictures. In some activities, her ability to read and make calculations in the notebook was more proficient than the rest of the group. About the ATM topic, she said that the bank employees already recognize her when she gets to the bank because she always asks for their help. She participated in the workshops with the ATM and completed the activities with average performance, but at the end of the initiative, she said the calculator activities were the most enjoyable ones. During this initiative, she told us she got a smartphone as a gift.

In 2023, at the age of 71, she participated in 100% of the workshops (5/5). Sentences she marked about reluctance to use technology were: "*I have never had a great experience with* *technology, so I think it is better not to use it*" and "*I do not think I can use technology*". In our first workshop, she shared that she is still trying to learn about the smartphone. She said: "*I would like to learn to send messages and videos. My sisters send me videos, and I just watch them. And messages. And photos, I want to learn too*". Still, that day, she told us she wanted to learn about a public government health app. She said that her daughter helps her to access and check the messages for doctor's appointments and exams, but when she is trying to learn from her daughter how to use it, for some reason, she cannot, so she specifically said "*if someone else teaches me how to use it, maybe I will learn better*".

In the second workshop, she participated in the practice and took a couple of pictures with the help of a researcher, but pictures just of the researchers, not of the group of students. It was clear that she was not familiar or comfortable with holding the device, which caused the pictures to be slightly blurry (maybe she did not want to take pictures of the colleagues so they would not ask to see it, and so they would not see that she was not taking 'good' pictures). In the following workshop, she said she had practiced at home and took a selfie. That same day, she was introduced to the audio messages for the first time and completed the task in 11 minutes. In the fourth workshop, the researcher who was helping her noticed that she could understand better when practicing on an actual phone instead of just on the printed screenshots. Until that day, she had not taken her phone to class, so she was practicing on the researcher's device.

With her that day, there was a YAE teacher helping the group with the practice. After a couple of times that the teacher noticed that she was signaling she was lost in the activity, the teacher, with a good heart and the best intention, ended up indicating the correct answer, telling her what the next step was. From that moment on, the student became quiet and passive, now only waiting for the teacher to say the next step. The researcher that was with that group noticed what was going on and subtly started encouraging her to keep trying on her own, through sentences like "*now it is your turn, I would like you to try on your own, we can do it together if you want to*". She accepted the advice and started practicing on her own. In that same workshop, when she completed the steps to make a video call, and the researcher's face appeared on the phone she was holding, she got thrilled and said, "*Now I can call my siblings!*".

Passiveness and discomfort could prevent people from action, and this is what we have observed with Student III. When she saw that she could be given the correct answer, she decided to do that instead of pursuing it. Maybe, this was the same situation that happened with her daughter, and many reasons could have led her to this passive posture of waiting for the answer. However, we were informed by her test and commentaries that she wanted to learn. By her actions (how she held the phone and for how long she was practicing before passing it to some other student), we could understand that she was not comfortable around technology yet, not familiarized with it. However, inspired by the Autonomy and Participative principles, we encouraged her to explore the activities in her own space and time. As a result, she completed the activity independently. In the last workshop, she brought her own device, asked the researchers to install WhatsApp on her phone, and started practicing the functions; seeing a purpose for the use of technology for her own demands, she said, "*I can contact my family*". She was right; when someone supported her in using technology, she learned better.

With this student, I learned that words of encouragement can make a huge difference and that students might sometimes need to rely on our confidence in their ability to decide to try and complete the activities. Also, this student taught me not to assume that a lack of questions is a lack of doubts.

Student IV

Female. In 2018, at the age of 64, she participated in 100% of the workshops (8/8). She said that she uses her daughters' smartphones to make calls and receive video calls from her sister. She uses her husband's smartphone to talk, but only for standard calls. She said she knew how to develop photos, as she had worked in a place that offered this service, in a dark room, where the photos (negatives) were submerged in water. She said she does not take pictures because her phone has no camera; she only takes pictures on her daughter's phone. Her phone only receives calls. In one of our classes, she was already interested in taking pictures; she asked if, to learn how to take pictures, it was necessary to "program" the smartphone, and after an explanation, she asked: "*to take a picture, you just have to press here?*" pointing to the screen button. The following week, she brought her grandson's phone and showed the group pictures she had taken from her garden. She also took a selfie at home. The teachers were so proud of her experience that they called the principal to come to class and check the pictures. We were expecting more pictures the next week, but she said she did not take them because her grandson had not visited her again, and she did not have a smartphone. At the end of the initiative, she said that what she liked the most was learning to take pictures.

In 2019, at the age of 65, she participated in 88% of the workshops (7/8). In the first workshop, she told us: "*Yes, I took a lot of pictures after the 2018 workshops, pictures of the beach house, my sister's apartment, the waiting room, on vacation, a lot of photos. I even brought them for you to see, but you didn't show up anymore.*". When sharing what technologies they were interested in, she agreed with the students, saying she wanted to learn to withdraw money at the ATM, and she told the teacher that she already made video calls to her sister via WhatsApp, using her grandson's smartphone. Later in the workshops, she told us she won a smartphone and that she already knew everything about it and how to use it. She also said she wanted to learn to read and write so she could use the computer.

Furthermore, in the last workshop of 2019, she shared that the activities she enjoyed the most were the calculation ones. This student also said she likes to use WhatsApp and make video calls and that now she knows how to take pictures, and as she has a smartphone now, her device is full of them. She completed her testimony by saying: "*it takes time to use everything on the smartphone, there are many things, but I do not use everything, only what is necessary*".

In 2023, at the age of 69, she participated in 100% of the workshops (5/5). The only sentence she marked about reluctance was: "*I am afraid of using technology because it could eat my money*". We believe that she only marked this and some other sentences by the pressure of her colleagues. A researcher noticed that when they were marking the sentences, this student was confident that she knew how to use the smartphone, but her colleague convinced her to mark the sentence anyway so they could learn more about it. Also, she said she was not afraid of scams (through the smartphone), but again, her colleague told her to mark the sentence so the group could learn more about it. Her card also showed that she had a great willingness to talk about technology and desire to learn more about technology.

In the first workshop, she already said she knew how to take pictures, record videos of her flowers, send audio messages, and make WhatsApp video and audio calls. In the second workshop, she offered to be the first one to take a selfie in the activity. After this workshop, she told the teachers she was happy to learn how to take better selfies at a better angle, which hides her double chin and neck. In the following ones, she continued to share things she already does on her smartphone: taking pictures of the birds on the television and calling her sisters and friends, among others. She also said that she does not like letters (textual messages) because she does not understand them very well (she was in the process of becoming literate); she would rather send audio messages. She also shared with us that her son taught her to send pictures on WhatsApp, and then she described the steps to complete this task. When asked about what she would like to learn about technology, she said she would like to learn to send emojis on WhatsApp, make group video calls, and post stories on Instagram. She was not interested in practicing with the printed papers in the workshops to create and order the algorithms to make calls, because she already knew how to do it, but she got interested in sharing contacts and locations on WhatsApp. She also asked about the GPS, that sometimes her family visits someone and uses the GPS to get to the right place.

According to the sentences she marked on her bingo card and her sayings, she demonstrated having great confidence in dealing with technology. Looking at her participation with us since 2018, we can see how much she has learned since the day the technology workshops started. She learned not only at school but also with her son and maybe with her grandson and daughters too, as she used their smartphones for a while. However, our initiative was the starting point for her, where she started to learn how to take pictures, and ever since, she gathered a piece of knowledge from every workshop, such as taking selfies at a better angle to hide double chins. In this scenario, a barrier preventing her development is the lack of literacy, which could be a barrier for achieving new possibilities in the digital world.

This student was a joy in our classes, always with an opinion, always curious about things, and determined to learn. Throughout all the initiatives, she always had the greatest willingness to learn and to adopt technology in her life as well. Even though she was still in the literacy process, technology was never too much for her. Many times in these years of research, my willingness to keep the initiative going was strengthened by her testimony about her learning.

Remarks

These four longitudinal perspectives show how many multifaceted is the YAE audience. This is why we defend this audience requires a conceptual and practical framework that is built from and for them, and not adapted to meet their needs. The journey of each of the four students through the same group of experiences is unique, and has enhanced different aspects of the Socially Aware Perspective. From all of them, the main starting point was identifying their barriers to accessing technology, and focusing on the first purpose of promoting familiarization with technology, essential to create the perspective of technology as a *possibility*.

Regarding the barriers these four students faced, we understand they are multiple, from different natures, and interconnected. They weave together emotional barriers, such as the embarrassment and fear of looking "stupid" (Student I, Student II); social barriers, like the lack of patient support from family (Student I) or even well-intentioned help that fosters passivity (Student III); cognitive barriers, such as the difficulty in moving from concrete mental calculations to abstract tools (Student II); and structural barriers, like the lack of access to a device or the limitations imposed by literacy levels (Student IV). We argue our understanding was helpful to identify and address there barriers because they were not presumed, they were investigated with the students and from the students socially aware context. Probably, a different group of YAE students could reveal different barriers to the access of technology.

Before evaluating and discussing any other data about the students' success rate in completing the activities, what we want to enhance as the most significant outcome achieved with the students was the shift in their mindset. The change in the ideas "I can't", "It is not going to work", "Others should be learning it, not me", "I do not want to try", "I do not have enough capabilities to use technology" to "Let's see if I can" already demonstrate a great shift in their

Students were able to diminish their limiting beliefs about their capabilities and decide to practice and create experiences with technology. As the initiatives were happening, students could decide whether they wanted to keep learning and creating more knowledge based on what they knew. An important outcome our research has achieved is students understanding that they can use technology if they want to. Deciding to use and adopt technology in their lives comes *after* the understanding that they *can*.

Hence, we defend that the practice within the YAE students has to be informed by material capable of dealing with the audiences' characteristics, elaborated specifically for this audience. We claim initiatives must be from a socially aware perspective so the initiative gets informed by the students' social context. Researchers do not need to preview all the possibilities; instead, the initiative is designed to be informed by the students' perspectives. All our students had positive outcomes in their time and their way, making sense of technology in their context and purpose, and especially, could choose to keep learning from technology now that they know they can.

5.7 Challenges and Opportunities in working with the YAE

Working with the YAE audience has been an inspiring and transformative experience for me. To share insights from this journey, this section summarizes the main challenges and opportunities we have faced. The YAE audience is characterized by a diverse combination of characteristics, which makes this audience very specific and unique. To achieve great results, it is mandatory to be aware of this and *build the initiative from the students' background*, and not merely *adapt* it to fit into this scenario. While this summary is not exhaustive, we hope it can enlighten the rich singularities and opportunities in working with the YAE students. Finally, we hope this summary can support and encourage more researchers to address this audience.

Heterogeneous group of students

In our classroom, students had different ages (from 20 to 74 years old), different preferences, different abilities, and varying levels of development, all participating together in the same classroom, almost as several small groups. Design experiences to accommodate such diverse knowledge levels can be challenging because the same activity has to be suitable for the students who have never seen that topic before but also be exciting and somehow challenging/engaging for those who already have some knowledge on the topic.

One opportunity we took advantage of was inviting students to become class tutors. When the experienced students needed to teach something, we noticed they rethought and analyzed the best/most straightforward way to explain, and this exercise can be perceived as part of a learning process too. Hence, the advanced students are involved in the same experience as the beginner students, but in different roles, and everyone learns and practices at the same time.

Some of the benefits of this approach was: for students learning something for the first time, having their colleagues tutoring them could bring comfort, safety and motivation to be part of the initiative, as seeing their colleagues as tutors may increase their will to become tutors in other topics too.

Additionally, Vroman et al. (2015) indicates that lonely older adults are less likely to self-initiate exploration of technologies, whereas the participation of someone close to them can inform and encourage the adoption and sustained use of ICT. Unfortunately, as mentioned earlier, many students reported not being encouraged by their families in using or buying smartphones, which could build up to the already existing barriers students have to begin to learn about this topic. Having the encouragement of their colleagues in the usage of technology can be a great stimulus to start and keep learning about technology.

As an outcome to be aware of, adopting this strategy made our workshops more dynamic, flexible, and enjoyable, although it made it more complex for the researcher to track the students' progression, and collect their individual data.

Materials' design

A heterogeneous group of students is expected to have different abilities and limitations at different levels, so the same material needs to be suitable for the most diverse combination of abilities. As it is hard to predict what kinds of limitations students have, because new students could come up in any workshop, new medicines can manifest different needs, and aging can manifest different limitations in different people, materials should allow easy adaptation.

In our group, we had students with different difficulties in motor coordination and myopia. However, we had no students presenting low vision. Either way, all of our materials were made of paper and cardboard, allowing braille inscriptions in case students who needed this resource started participating in the workshops, or, not representing a huge cost to throw away in case a new one becomes needed.

A method that was helpful for informing us of the aspects to consider when projecting materials for the YAE is the MeTA, designed by Menezes and Pereira (2022) - A Method for Evaluating Accessible Educational Technologies from the perspective of the Universal Design.

Aging process

The aging process occurs depending on different aspects – such as genetics, life experiences, age, among others – and manifests in different ways. Among our students, we perceive differences in memory, vision, hearing, language, cognition, and motor coordination. Sometimes, even some remedies the students take could affect their mood or cause physical changes, such as hand tremors. This variance shows the richness of human diversity and represents an important aspect to consider when addressing the YAE students.

However, aging can also be an opportunity to explore technologies and resources that could be extra helpful for overcoming these effects. Taking pictures, for instance, could be facilitated with the help of smartphone support (as some students had hand tremors), and it also could help in the memory, immortalizing their moments, facilitating the celebration of memories, and sharing their life stories with colleagues or people they love. The concept of algorithms, or list of steps as we described for them, beyond facilitating the completion of the task, can also be beneficial for memory, being a support material to inform how to perform that action after a while (days, weeks).

While the presence of aging students presents unique challenges, it also offers an opportunity to tap into their wealth of wisdom and life experiences. The privilege of assisting them in their pursuit of knowledge at this moment of life is truly rewarding and inspiring.

Students' resistance

When experiences are designed for students' experimentation in their own time, it fosters a feeling of a safe learning environment, one that is not perceived as scary. Offering a fail-safe environment for making mistakes helps students understand the workshops as a safe place to experience technology and overcome fears. However, even in a workshop designed with this goal, sometimes students could demonstrate resistance to accomplishing the activities. They want to be there because there is where their friends are, and the topic is interesting for them, but for several reasons – such as “I’m tired today”, or a fear of incapability to finish the task – students could adopt a passive posture, just waiting for the workshops’ conclusion and listening to what other students have learned that day.

In these cases, it is even more important to encourage the students, offering extra doses of support and assistance for them to try on their own. In our initiative, having multiple facilitators (such as our group of researchers) to support the workshops was imperative to allow us to identify and dedicate time to students in this condition.

Life changing for all

The results of a workshop are sometimes not logically predictable. The experiences our students have are infinite; it is nearly impossible anticipate if a topic is sensitive due to some bad experience they have had before. It is just unpredictable.

Sometimes, we think that because one student is younger than another, they will have faster development in technology. This is not the case. We had a student who was the oldest in class, and still, she was eager to learn more, whereas some younger students were not. Students with less than 25 years old could not understand the purpose of a list of steps as greatly as others did. Students participating in more classes will likely develop better and learn more about technology than those who attend intermittently, but that is not a rule. Students practicing with the device in their hands would learn more than others just looking, but that is not a rule, either.

In summary, predicting how things with the YAE audience will happen in all its variances is nearly impossible. Researchers and teachers need to know that staying motivated to pursue the initiative based on the expected result students will present in a single workshop is draining. Here, we have the opportunity to do our best, plan, and consider a great possible combination of activities. This requires serving students with a pure willingness to give, being fully present, and expecting nothing in return—even if it means sometimes going home only with ideas for future improvements.

On the other hand, even the smallest thing the students learn can change their day and their lives. For literate adults, imagining getting day-to-day chores done without the ability to read is nearly impossible. Most of the time, this ability is taken for granted without even considering how life would be without reading, writing, and nowadays, without technology. However, being around YAE students raises the awareness that we must still consider how to address this gap, and any contribution technologies can make to their lives can represent a huge impact.

We had a 28-year-old student who told us in class that in that very morning, he had received a text message from his boss telling him that he did not need to go to work that day and, because he could not read, he was unable to understand the message and went to work anyway. When he arrived, the boss’s son asked him, “*Haven’t you seen my father’s message?*” and the student, too embarrassed to admit he did not know how to read, said, “ *I was already on my way here when I saw the message*”. Then, he had to return home with the public bus, on a rainy day.

Stories like that inspire compassion and sympathy, and continuing the research is an opportunity to create more and more ways to keep teaching about technology, so students can create new meanings and actions around it to keep changing their lives.

5.8 The Researchers' Perspective

In this section, the researchers who participated with me in the initiatives were invited to express their experience of participating in the workshops with the YAE audience.

Deógenes Junior

My involvement in the project began at the beginning of my Master's degree and continued throughout my PhD. With Júlia's openness, kindness, and generosity, around nine researchers contributed to the project over the years. These different people shared an open and collaborative space that was an invaluable opportunity for me to mature and learn as a researcher and as a human being. Through the project, I was able to put into practice what it means to be socially aware in education, as the activities were planned carefully, with emotional engagement and involving the people in a participatory way. Socially aware does not only involve taking accessibility criteria into account, or completing empathy activities as if completing a checklist. The socially aware approach that we apply involves engaging with people in a participatory manner in their entirety (their history, their embodiment, their family, their desires, emotions, and values), being reflective and critical regarding the broader socioeconomic and cultural context in which they are inserted.

On the one hand, people in YAE suffer from a lack of social and digital inclusion, from experiences in social spaces that did not listen to them, did not give them confidence, and were surrounded by various forms of violence. On the other hand, these same people had several skills, learning experiences, and stories of triumph. Thus, at the Rachel Mader Gonçalves School, at the same time that I heard stories of deprivation, fear, discouragement, and lack of support about technology, I met people of inestimable value and realized the nobility of education and its liberating potential: it was at school that people who studied in YAE found an additional space where they could speak, express themselves and exist in their dignity safely, with technology and in their lived lives. In any case, research with YAE allowed us to find real people with whole bodies, unique stories, and life horizons and to appreciate how people transform their realities to create new relationships, senses, and meanings. At this point, education is not the transmission of facts or skills. Education is the relationship created between people that opens everyone to the broader horizon of becoming human and dignified with autonomy.

My participation also helped to transform my vision of research. Whenever possible, research should be allied with the community outside the university and not be dissociated from the broader context in which we operate. Through this project, I was able to get in touch with which values I, as a researcher, want to defend or communicate. Júlia Ortiz's research began in a context where almost no Computational Thinking research was taking place with YAE. Through my work on this and other projects, I could also perceive areas with challenging social contexts with few people conducting research, both in the global context and especially in Brazil. The Brazilian reality is and will always be our background in a public university in Brazil. With the YAE project, I learned that ignoring or paying attention to this social background is a choice, very much informed by the values we choose to defend. Therefore, the value that I assume from this project as a researcher is never to be far away, disassociated, or oblivious to our country's problems and challenging socioeconomic contexts. While at the university, I will seek to work with extension and projects that involve local communities, as a way of respecting the dignity and human potential that we find in vulnerable spaces of existence.

Caio Carvalho[7]

Taking part in the YAE workshops was a transformative experience. In our research group, we often discuss the social impacts of technology, but we do not always have the opportunity to experience them in practice. During the YAE classes, I was able to closely observe how activities that I consider simple, such as making a phone call or accessing a banking application, can represent significant challenges for people unfamiliar with technology. I also realized how these difficulties generate feelings of exclusion, stigmatization, and suffering, often making them dependent on others. In class, I had the chance to contribute a little to increasing these students' confidence in using technological resources and promoting greater autonomy in their routines.

Krissia Menezes[8]

Paulo Freire states that "those who teach, learn by teaching. And those who learn, teach by learning", and that was exactly what I experienced when I participated in the planning, execution, and analysis of the workshops with YAE. I not only taught, but I also learned — and I learned a lot — by dealing with the diverse needs, skills, and literacy levels of people.

I consider that working on the YAE project was an opportunity for professional development but, above all, for human development. In this project, there is an opportunity to live in a different social context, in which people have limited access and the exercise of citizenship due to limitations not only in medical accessibility, as we often see in our research, but also in social accessibility. Especially when we consider that the YAE audience is made up of people who have historically been marginalized and deprived of access to basic human rights, such as voting and even making money transfers through an ATM. During my participation in the workshops, I was able to experience the transformative power of education by observing

[7]Translated from the original: Participar da EJA foi uma experiência transformadora. Em nosso grupo de pesquisa, frequentemente discutimos os impactos sociais da tecnologia, mas nem sempre temos a oportunidade de vivenciá-los na prática. Durante as aulas da EJA, pude observar de perto como atividades que considero simples, como fazer uma ligação telefônica ou acessar um aplicativo bancário, podem representar desafios significativos para pessoas sem familiaridade com a tecnologia. Percebi também o quanto essas dificuldades geram sentimentos de exclusão, estigmatização e sofrimento, tornando-as frequentemente dependentes de outros. Nas aulas, tive a chance de contribuir um pouco para aumentar a confiança dessas pessoas no uso de recursos tecnológicos e promover maior autonomia em suas rotinas.

[8]Traduced from the original: Paulo Freire afirma que "quem ensina, aprende ao ensinar. E quem aprende, ensina ao aprender", e foi exatamente isso que experimentei ao participar do planejamento, execução e análise das oficinas com a EJA. Não apenas ensinei, mas também aprendi — e aprendi muito — ao lidar com as diversas necessidades, habilidades e literacias das pessoas. Considero que trabalhar no projeto da EJA foi uma oportunidade de evolução profissional, mas, acima de tudo, de evolução humana. Neste projeto tive a oportunidade de conviver com um contexto social diferente, em que pessoas têm limitação de acesso e ao exercício de cidadania devido a limitações não só de acessibilidade médica, como é comum olharmos em nossas pesquisas, mas de acessibilidade social. Principalmente quando consideramos que o público da EJA é formado por pessoas que são historicamente marginalizadas e tolhidas do acesso à direitos humanos básicos, como o voto e até mesmo movimentação financeira em caixa eletrônico. Durante minha participação nas oficinas, pude vivenciar o poder transformador da educação ao observar pessoas que, inicialmente, tinham receio — ou até medo — de utilizar tecnologias, por considerá-las distantes e inacessíveis à sua realidade. Com o tempo, essas pessoas começaram a utilizá-las e até mesmo encorajar outros colegas a utilizarem tecnologias e executarem atividades de leitura e habilidades matemáticas do dia a dia, como calcular o troco de compras. O trabalho com a equipe de pesquisadores, com diferentes habilidades e visão de mundo, foi uma experiência enriquecedora. Nessa troca, também aprendemos uns com os outros. Não evoluímos só cientificamente, mas também como grupo, cultivando relações pautadas no respeito e afeto. Tenho esperança de que o nosso trabalho tenha impactado na "vida real" dos alunos tanto quanto vimos impactar na sala de aula. Também o desejo de que possamos evoluir e caminhar em direção a uma sociedade cada vez mais justa e igualitária, com fé no futuro e no poder transformador da educação!

people who, initially, had been reluctant to use technology, or even afraid to use it, because they considered it distant and inaccessible to their reality. Over time, these people discovered how to use it and even encouraged other colleagues to use technology and perform reading activities and everyday math skills, such as calculating change for groceries.

Working with a team of researchers with different skills and worldviews was an enriching experience. In this exchange, we also learned from each other. We evolved scientifically and as a group, cultivating relationships based on respect and affection.

I hope that our work has impacted the "real lives" of students as much as we saw it impacting in the classroom. I also wish that we can evolve and move towards an increasingly fair and egalitarian society, with faith in the future and in the transformative power of education!

Patricia Carstens Castellano[9]

Participating in the EJA experience through Julia Ortiz's doctoral project was a privilege and an awakening to humanizing perceptions. The YAE environment proved to be fertile ground for working on education, and there, we found humble, welcoming people who were open to the proposals presented and eager to experience each opportunity for encounter and learning.

Every proposal was received with seriousness and dedication by everyone: researchers, students, and teachers at the school. The entire process was built with active listening from the parties involved, and the students were able to choose topics they wanted to learn, becoming protagonists in the experience. The students awaited the project's class days with enthusiasm,

[9]Participar da experiência da EJA através do projeto de doutorado da Julia Ortiz foi um privilégio e um despertar para percepções humanizadoras. O ambiente da EJA mostrou-se terra fértil para trabalhar a educação e lá encontramos pessoas humildes, acolhedoras, abertas às propostas apresentadas e sedentas por vivenciar cada oportunidade de encontro e aprendizado. Toda proposta lançada foi acolhida com seriedade e dedicação por parte de todos, pesquisadores, alunos e professoras da escola. Todo o processo foi construído com escuta ativa das partes envolvidas e os alunos puderam escolher temas que desejavam aprender, se tornando protagonistas na experiência. Os dias de aula do projeto eram esperados pelos alunos com ânimo, generosidade e assiduidade, e eles se influenciavam positivamente para aderir à experiência. As avaliações dos encontros eram realizadas ao final e eram sempre muito positivas. Os conteúdos faziam sentido para as vidas dos alunos diante de suas demandas de viver no mundo cada vez mais permeado pela tecnologia. Havia neles muito medo e evitação para navegar no universo digital diante de golpes bancários e de toda ordem, suas limitações de letramento (visto que muitos não sabem ler), até simplesmente o medo do desconhecido mundo digital. Desta forma, os alunos mergulhavam nas experiências de aprendizado com desejo, e os trabalhos realizados se traduziram em conhecimentos que os encorajaram a acreditar que são capazes de ousar e se comunicar no mundo digital da sociedade contemporânea, mesmo com as suas limitações. Inclusive puderam perceber que o mundo digital oferece recursos capazes de ajudá-los a superar bloqueios provocados pelo analfabetismo, tais como recursos de comunicação por voz e de leitura de textos. Vejo na experiência do projeto de doutorado da Júlia que o formato de educação, no qual os conteúdos ensinados foram construídos a partir de dinâmicas de proposições e diálogos com os alunos, mostrou-se exitoso a partir da escuta empática da necessidade do outro. O cuidado com a realidade "desse outro", que é vulnerabilizado por uma sociedade desigual mas foi olhado com respeito em sua dignidade, despertou nele o que podemos dizer ser apenas a "ponta do iceberg" para o aprendizado digital. Essa experiência desbloqueou medos, despertou desejo e coragem, de forma a render frutos intangíveis para a vida desses alunos, pois os conhecimentos adquiridos são impulso para seguirem experimentando e aprendendo autonomamente e uns com os outros. A partir dessa experiência de serviço da equipe de pesquisadores, vivenciei trocas importantes permeadas por um clima de brincar alegre, em que cada experiência era acompanhada de um mimo saboroso e cuidadosamente preparada nos mínimos detalhes. As atividades eram permeadas por brincadeiras como bingo alternado com atendimentos individualizados. Os alunos se divertiam, eram estimulados em seu desenvolvimento e também eram acompanhados individualmente, podendo trazer suas vulnerabilidades e insegurança com privacidade e aprender em seu ritmo próprio. Nessa oportunidade, pude saborear a igualdade humana em que o sagrado que habita o interno de um se encontra com o sagrado do outro e ambos aprendemos juntos e nos humanizamos. Obrigada Julia, por sua missão neste mundo, por apresentar ciência a essas pessoas de forma tão simples e cuidadosa, que eles nem tiveram medo de se entregar e, ao mesmo tempo, tiveram seus olhares transformados em algum aspecto particular de suas vidas. Foi um presente realizar esse percurso com você, ficou com gosto de pouco! Muito amor por tua vida e missão!! Parabéns!!!

generosity, and assiduity, and they were positively influenced to join the experience. The evaluations of the meetings were carried out at the end and were always very positive.

The content made sense to the students' lives, given their demands of living in a world increasingly permeated by technology. They were very afraid and reluctant to navigate the digital world due to bank scams and other types of scams, their literacy limitations (since many of them cannot read), and even simply the fear of the unknown digital world. In this way, the students immersed themselves in the learning experiences with desire, and the work they did translated into knowledge that encouraged them to believe that they are capable of daring and communicating in the digital world of contemporary society, even with their limitations. They were even able to realize that the digital world offers resources capable of helping them overcome obstacles caused by illiteracy, such as voice communication and text reading resources.

I see in the experience of Júlia's Ph.D. project that the educational format, in which the content taught was constructed from dynamics of propositions and dialogues with the students, proved to be successful based on empathetic listening to the needs of others. The care for the reality of "this other person," who is vulnerable due to an unequal society but was looked at with respect for his or her dignity, awakened in him or her what we can say is just the "tip of the iceberg" for digital learning. This experience unlocked fears and awakened desire and courage in a way that yielded intangible fruits for the lives of these students since the knowledge acquired is an impulse to continue experimenting and learning independently and with each other.

From this experience of service by the research team, I experienced important exchanges permeated by an atmosphere of joyful play, in which each experience was accompanied by a tasty treat and carefully prepared down to the smallest detail. The activities were permeated by games such as bingo alternating with individualized care. The students had fun, were stimulated in their development, and were also monitored individually, being able to bring their vulnerabilities and insecurities in privacy and learn at their own pace. On this occasion, I was able to savor human equality in which the sacred that lives within one person meets the sacred of the other, and we both learn together and become more human.

Thank you, Júlia, for your mission in this world, for presenting science to these people in such a simple and careful way that they were not even afraid to give in and, at the same time, had their perspectives transformed in some particular aspect of their lives. It was a gift to go on this journey with you; it was a little bit of a treat! Much love for your life and mission!! Congratulations!!!

5.9 Highlights of the Chapter

- The 2015 initiative primarily informed the YAE audience's diverse profile – wide age range, varied cultural backgrounds, abilities, and interests inside the same classroom. This initial experience also revealed two key insights: student attendance and intent to stay served as crucial feedback on engagement, and students demonstrated early assimilation of computational thinking concepts, using it for understanding their everyday situations.

- The 2018 initiative marked our first experience conducting a self-regulated initiative (later formalized as a principle in this doctoral research). This socially aware and self-regulated approach yielded positive results in students' technology use and learning, fostering significant engagement in the workshops.

- The 2019 initiative, the first one conducted under this doctoral research, focused on the computational thinking approach. The activities' goal was to foster technology interaction, with the practice being informed and facilitated by the practice of computational thinking abilities.
- The 2023 initiative was focused on the early stages of technology adoption, in which it was confirmed that YAE students face multifaceted barriers to digital culture development, encompassing technical, emotional (fear, embarrassment), social (lack of family support), cognitive (difficulty with abstraction), and structural (device access, literacy levels) aspects.
- The longitudinal analysis of four students illustrated diverse barriers they had faced (e.g., embarrassment, lack of family support, fear of feeling vulnerable and incapable). Their individual experiences demonstrated how these barriers were overcome and how the learning occurred. We argue that the model and its principles were responsible for identifying and guiding the initiative, facilitators and students through this process.
- An original finding of this research is that starting by addressing early barriers to the students learning about technology fostered the shift from a limiting belief of "technology is not for me" to an empowering understanding of "I can learn about this if I want to". Hence, we argue that initiatives to promote technology adoption and learning with the YAE audience must be grounded in the students' context and start by addressing the social, cultural, and emotional barriers to technology access.
- The learning process for the YAE audience is constructive and incremental. As students gain confidence, the initial barriers are eased, and the following challenges must be addressed. This movement requires the initiative to be continuously adaptive and responsive to the students' changing needs. This aspect is covered by both the Socially and Culturally Aware principle and the Self-Regulated principle.
- The quality of pedagogical mediation is crucial in determining students' autonomous experiences. The research shows that well-intentioned help that provides direct answers can foster passivity, while an approach guided by both the Autonomy and Participative principles – which encourages trying, acknowledge students capabilities, respects individual pace, and values the process of achieving the correct answer —- is what offers the student a genuine opportunity for development to lasting confidence and true autonomy.
- The theoretical background and the knowledge that informed the conduction of the two original doctoral initiatives were built iteratively upon the prior initiatives with the YAE audience. This emphasizes that the understanding synthesized in this research results from a continuous, iterative, incremental, and self-regulated learning process initiated in 2015, extending beyond the scope of this single doctoral project.
- This research demonstrated that initiatives for the YAE must be "built from" the students' context, interests, and emergent outcomes. This understanding validates the necessity of our socially aware perspective, which was built explicitly for the YAE context.

6 Scientific Publications and Supplementary Materials

This chapter presents a summary of the scientific production published over the years of research. Each paper discuss some of the findings of this research. Table 6.1 presents the material published under the time frame of this doctoral research [2019 - 2024].

Table 6.1: Summary of the scientific production during the research

Venue	Title	Main Contributions
Digital Educational Resource	*Collection of activities for YAE (MEC Digital Educational Resources Platform)*	• Provides a collection of activities developed during the research.
BookChapter	*Pensamento Computational na Educação de Jovens e Adultos: Princípios e Desafios de uma prática socialmente consciente* (Ortiz et al., 2024)	• Describes the 2018 initiative. • Details the conduction of each workshop. • Presents lessons learned.
Journal paper	Computational Thinking and Mental Models: Promoting Digital Culture in the Youth and Adult Education (Ortiz et al., 2023)	• Presents the 2019 initiative. • Discusses how CT and mental models foster digital culture.
Conference paper	Computational Thinking for Digital Culture Development: discussions based on a practical experience (Ortiz et al., 2021)	• Describes the 2019 initiative. • Shows the progression of activity complexity. • Discusses the development of autonomy and familiarity with devices.
Journal paper	Computational Thinking for Youth and Adults Education: model, principles, activities and lessons learned (Ortiz and Pereira, 2021)	• Presents the first version of the theoretical model. • Details principles, activities, and lessons from the 2018 initiative.
Conference paper	Computational Thinking for Youth and Adults Education: Towards a Socially Aware Model (Ortiz and Pereira, 2020)	• Summarizes the first version of the model from the dissertation.
Conference paper	*Atuando na Educação de Jovens e Adultos: nove princípios para guiar a prática* (Ortiz and Pereira, 2019a)	• Focuses on the 9 guiding principles from the master's dissertation model.
Conference paper	*Pensamento Computacional e Cultura Digital: discussões sobre uma prática para o letramento digital* (Ortiz et al., 2019a)	• Discusses a specific workshop from the 2018 initiative. • Presents materials, activities, and the students' outcomes.

Table 6.2 presents a summary of the other scientific papers produced during the decade of research with the YAE audience.

Table 6.2: Summary of the scientific papers published previously from this doctoral research.

Venue	Title	Main Contributions
Journal paper	Teaching Computational Thinking: are we considering students' socio-cultural context? (Ortiz et al., 2019b)	• Deepens the discussion on a prior systematic review, focusing on social aspects of CT initiatives. • Analyzes difficulties found in studies and the contexts of application.
Journal paper	Ten years of initiatives to promote computational thinking: A systematic mapping of literature (Ortiz and Pereira, 2019b)	• Presents a 10-year systematic mapping of CT initiatives. • Discusses settings, content, tools, and duration of the initiatives.
Conference paper	*Aspectos do Contexto Sociocultural dos Alunos estão Presentes nas Pesquisas para Ensinar Pensamento Computacional?* (Ortiz et al., 2018)	• Systematic review analyzing the inclusion of students' sociocultural context in research. • Found that only 5 of 46 studies addressed these aspects.
Conference paper	*Um Mapeamento Sistemático Sobre as Iniciativas para Promover o Pensamento Computacional* (Ortiz and Pereira, 2018)	• Systematic mapping of CT initiatives published from 2007 to 2017. • Highlights the first Brazilian paper to address the YAE audience.
Conference paper	*Pensamento Computacional na Educação de Jovens e Adultos: desafios e oportunidades* (Ortiz and Pereira, 2017)	• Literature review on CT initiatives in Brazil. • Discusses challenges and opportunities of working with the YAE audience.
Conference paper	*Pensamento Computacional na Educação de Jovens e Adultos: Lições Aprendidas* (Ortiz and Raabe, 2016)	• Presents the 2015 initiative, the first practical experience with this audience. • Details activities, results, and lessons learned.

7 Final Considerations

A literature analysis on the Youth and Adult Education has shown that this audience had been systematically excluded from educational initiatives for years, and that still today, efforts are still necessary to provide lifelong quality education regarding technology learning in Brazil. This topic has also been a focus worldwide through the UN global goals. The literature still shows that several of the learning initiatives that had focused on the YAE audience failed to be informed by a theoretical background specifically designed to this audience, that is capable of addressing the particularities of this audience. Hence, the main goal of this research was to provide practical and theoretical knowledge to design YAE initiatives aiming at promoting technology familiarity through interaction with technology and the practice of computational thinking abilities.

As main findings of this research, we highlight that the practical initiatives has confirmed that YAE students face barriers from multiple natures to access technology, such as emotional, social, cognitive, among others. Hence, we argue that there are things to be addressed *before* proposing activities for students to practice and learn about technology, so the starting point of initiatives should be identifying and easing these barriers, to promote the shift in the students' mentality from "technology is not for me", to "I can learn about technology if I want to". Then, the learning journey starts, characterized by being an incremental, constructive and adaptive process. In each workshop, the students' individual pace must be respected, their autonomy must be encouraged, useful topics must be addressed, and the students' outcomes must be collected and analyzed to inform the next workshop. All this characteristics demand for a conceptual knowledge to support the design of the initiative. Therefore, the thesis this research defends is that the YAE audience needs to be addressed through a socially aware initiative, with the primary goal of promoting familiarity with technology through the practice of computational thinking abilities, and as a result, digital culture is developed.

The research question this doctoral research seek to answer is *how should we understand and approach the YAE audience to offer experiences that promote/favor technology familiarity?* This question was answered after a theoretical background research (SG1 and SG2), synthesizing practical guidelines on how to conduct initiatives (SG3), conducting two practical initiative with the students (SG4), culminating in the production of a theoretical and conceptual material to inform initiatives (SG5). To attend SG1, this research started with a systematization and consolidation of the theoretical bases on youth and adult education, computational thinking, digital culture and the key authors Paulo Freire, John Dewey and Cecilia Baranauskas. As a result, an articulated theoretical background for the research was produced, completing the specific goal. Following this step, the SG2 was fulfilled by a literature review searching that looked for initiatives aiming at promoting technology adoption, learning and usage with the YAE audience. As outcomes, we identify that research both in the national and international scenario lacks mentioning a theoretical background that inspired the research, specifically, a background designed for the YAE audience. The remaining specific goals – SG3, SG4 and SG5 – were iterative and incrementally conducted. Two initiatives with the YAE audience were designed, conducted and analyzed, resulting in the design of the new workshops, with more practical guidelines to conduct the initiatives, that were synthesized in a conceptual model for designing technology initiatives with the YAE audience. Hence, the completion of the specific goals provided the answer to the research question: we understand that initiatives with the YAE audience must be of a socially aware perspective, e.g., that look beyond a group of students inside a classroom but see them as people and citizens. To support the design of workshops that have this characteristic, we propose the Socially Aware Model for CT initiatives with the YAE, which was first proposed during my Master's Degree but was updated during this research by the theoretical background and practical initiatives. By providing this conceptual material, the research's main goal was completed.

In achieving the main goal, this research offers original and significant contributions in four interconnected dimensions: conceptual, methodological, constructive, and social.

Conceptual: The articulation of the theoretical background about the topics of youth and adult education, computational thinking, digital exclusion, digital culture and the key authors Paulo Freire, John Dewey and Cecilia Baranauskas. This background was fundamental for answering our research question, and articulating the solid, social, practical, experimental, critical, participatory, self-regulated character of this research. The original conceptual contributions this research presents is the cohesive combination of these theories applied in initiatives to teach about technology, and in the proposition of addressing computational thinking not as the content to be taught in the activities, but as a powerful tool used to organize the progression of activities. Computational thinking has the potential to reduce people's rejection and fear of technology and potentially foster digital culture, and activities informed by the computational thinking activities can lead to understanding how technology work and can be used. This knowledge supports the exploration of different devices, leading to an expansion of digital experiences. These are important skills to work on for singular audiences, such as the YAE, with students who desire to adopt technology and explore all its benefits.

Methodological: The theoretical background, in union with our practical knowledge was translated and synthesized into the socially aware perspective to initiatives with the YAE audience. Initiatives to promote experiences to favor technology familiarity and appropriation within this audience must be of a socially aware perspective: be contextualized in the students' context, support the students' autonomy and development, propose experiences that explicitly relate to the students' context, make sense of things, practice and learn together, and keep evolving the initiative according to the reached outcomes. As material to support the conduction of initiatives inspired by this socially aware vision, we have proposed 11 principles to guide the initiatives, 4 purposes for the workshops, 4 steps and 13 tasks to design workshops, and several instances of the practice of computational thinking abilities according to the workshops purpose. As the model was updated from the Master's degree version, we highlight as original contribution from this research the addition of 2 principles, 3 categories, 4 purposes, 1 step to design workshops and 13 tasks. This material presents characteristics that can fill the gaps found in the scenario of the YAE research regarding digital culture development.

Constructive: This research also provides a compilation of 10 years of practical experience with the YAE modality, with a description of the activities and materials used, that can server as both material to be used and ideas to inspire the production of more materials and activities to work with the YAE audience.

Social: The report of these initiatives serves not only to inform the research community, but, fundamentally, to promote a path towards digital citizenship and empowerment for a historically excluded audience, reducing their social vulnerabilities and fostering genuine autonomy.

The results of this study have direct implications for educators, the research community, and policymakers.

For educator and pedagogical practice, this research represents important contributions due to the shortage of resources destined to investigate technology with this audience in the past years. Back then, when this research started, there was little theoretical ground about designing initiatives for YAE students to learn about technology and computational thinking, leading to easier adoption of technology in their lives. There may be many other teachers working on the topic inside their classrooms with the YAE audience. This work can prevent passionate technology educators – that want to find more material to inform their initiatives, from having to go to school without theoretical support and recommendations on the audience, as I was 10 years ago. With this research, we provide specific material for educators, researchers, and principals to be inspired to look to the YAE audience from a different perspective, and design initiatives for promoting technology learning, from their students context, not a pre-defined set of activities.

For the research community, this research represents a different approach on the research about computing education, informatics in education and human-computer interaction, by proposing a 10-years analysis and compiling the results in a longitudinal qualitative analysis, which represents two differentiators of this research. Hence, this project serves to inspire more studies to be conducted exploring different perspectives on the usual problems. This research is an example of qualitative constructive data resulting in powerful results.

For policymakers, the findings of this research suggests looking to the YAE audience from a different perspective. This research recommends that policies to promote quality, suitable, accommodating learning opportunities for these students, who have the same right to basic education as every citizen, and who had also contributed for our society in their own way.

This research is qualitatively scoped, focusing on the specific context of YAE schools in Southern Brazil. While the findings are deeply situated, the resulting theoretical model and principles are proposed as a framework applicable to other contexts. The study delimits its practical investigation to the initial stages of technology familiarization, addressing early barriers, rather than aiming to measure advanced technical proficiency. Furthermore, the technological artifacts used (such as ATMs and smartphones) serve as case studies for a pedagogical approach, and the findings are not intended to be an evaluation of these specific technologies themselves. Limitations of this research are: we wanted to have followed the students' progression more closely during these years, with more initiatives conducted, but unfortunately it was not possible due to several factors (the COVID-19 pandemic is among them). We have selected the theoretical background according to our understanding of education from a social perspective, and the YAE audience. Different theoretical bases were not addressed. The initiatives of 2019 and 2023 were held in one school only, which was positive because it allowed us to track the students' progression through the years, but limited us in experiencing barriers and outcomes from a different group of YAE students. In addition, the updated model, principles, and other materials have not been used in initiatives conducted outside of our research group. We plan on publishing this material in Portuguese and assist the conduction of initiatives involving this material in the following years, if we have the opportunity.

This doctoral research opens several venues for more research to be conducted. We suggest sharing the material consolidated in our experiences with other YAE schools and in other regions of Brazil, spreading this material to other YAE teachers, conducting long-term studies in other schools, following the development of YAE students in the adoption of technologies over the years, to closely track what the impact was, what barriers they experienced, and how was the process of overcoming it, among others.

From the bottom of my heart, I want to encourage that more adequate and suitable educational opportunities for adults should be offered, not only about technology but for every subject of the whole social, intellectual, and moral development of the individual.

I want this research to spread a seed to YAE students that, if they want, they can take advantage of technology, too. The ground and the experiences we offer have the potential to make this seed germinate and grow after being planted. Nonetheless, students are not obligated to plant the seed if they do not want to. However, the new point of view here is that they can make this decision by themselves.

I plan on dedicating the knowledge I have gathered to thinking about how technology can be designed in a more friendly but not discriminative way to the YAE audience and newcomers in technology in general. To ensure this, I plan on sharing this research in online places and formats to make it accessible to varied audiences, such as through videos, educational infographics, and interactive websites.

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Appendix A: Initiatives

A.1 The Initiative of 2015 - Workshops description

Workshop 1

The first moment of the workshop consisted of asking a student to share their way of changing a tire, baking a cake or cooking beans. After listening to them, it was asked to the others if anyone does it exactly as the colleague described. The other students' versions were heard and compared. Then, the students were asked if there was a way to be sure that everyone would do the process in the same way. In the same discussion it was asked if they have understood completely each step of the process mentioned by the colleague, if no specifications was missing, if only by the explanation, they would be able to accurately reproduce the instruction.

Still in the discussion, students were asked: "What is necessary for everyone to understand and perform exactly the same process?", this was followed by the activity named Donkey Robot, in which the objective was for the students to create a list of instructions to achieve a common goal (algorithm) to guide the robot to the door. This unplugged activity was conducted in both classes, and I played the robot role. At the beginning of the activity, nothing was said about the commands the robot would accept, only that the robot might not understand them, resulting in no action.

The first algorithm read was "*walk to the door*", then it was said that the robot did not understand this command. The second was "*walk, turn, walk*", and in the first command, the robot walked in a straight line, got to the wall, and kept *trying* to walk, so the students realized that there were still missing details. Third attempt: "*walk... STOP!*" and the same result happened, until one of the students started the algorithm as: "*walk three steps*", then the robot did it correctly. At this point, the students got excited, and the algorithm continued: "turn", and the robot kept turning around its axis nonstop. With many laughs and a few algorithms later, the goal was achieved. In the robot's perspective, it was interesting to observe students excited in being "in control" of the activity, being able to determine what the robot would do.

After this practice, we discussed the advantages of composing an algorithm, and one of the students shared an experience when someone close to him asked him to make a soup. He said he did not know how to make it and asked for instructions. He then went home and prepared the soup, but when he returned to the person with the soup ready, the person told him it was not quite what she had asked for but that it was good. Then the student said: "*If she had given me the correct instructions with all the details, I would not have made a mistake*". Everyone in the class agreed, and the students seemed to feel relieved. This commentary indicates that the student could assemble a relationship between the list of steps in the activity and a situation in his personal life.

Computational thinking also encompasses the ability to apply learned computational knowledge in different situations, making an association between the two realities. This ability was observed in this student's experience mentioned above and also at the end of the workshops, when during the interview, another student shared that her mother asked her father to go to the market to buy garlic. When her father came home, her mother got mad because she wanted a garlic bulb, not chopped, but as she had not specified correctly, he did not know it. This is another indication that students could relate the content from activities with their personal life experiences.

Workshop 2

The second workshop's activity was inspired by the Hour of Code program and used a 10x5 matrix drawn on a brown paper mat measuring 60 cm X 200 cm (Figure A.1). Each student received a mission: Go from point (1,1) to point (2,4), only being able to use 3 types of commands: turn right, turn left, and move forward 1 square. Everyone had 10 minutes to create their algorithm with the commands to complete the mission. At this point, the students created the algorithms on their own and were also introduced to a new command language. The same activity was involved in both classes.

Figure A.1: The 10x5 matrix drawn on a brown paper mat

The activity was seen as a competition, with one wanting to complete it faster than the other; everyone worried about getting it right and naturally used the debugging technique to create their algorithms. We agreed on not getting on top of the mat while students were working, so, from the outside, they kept mentally tracing the path of the variable (which would be themselves in the future), point by point, in order to validate that they were on the right path to their goal.

When the execution phase started, many students struggled to understand that the "turn" command only changed their direction and that they had to stay where they were. This behavior was observed multiple times. When the students did not reach the goal after executing their algorithms, they were asked to remain on the mat, and the students helped them continue the algorithm to reach the goal together. We decided to have this time of "recalculation" together with the group to encourage the understanding that what they had written was not wrong; it was only not the best way to reach the final goal, as they still needed more commands. In this activity, as well as having understood that there are rules for using commands, students started to use a different command syntax; they understood that there can be several different algorithms for achieving the same objective and that it could be better to achieve the goal with the least amount of commands. My impression of conducting the workshop was that students were engaged and felt challenged by the activity, wanting to practice and achieve the goal correctly.

Workshop 3

Class E: the third workshop took place in the laboratory, using the Hour of Code tool, a block command programming environment. An activity composed of 20 tasks was chosen, and the goal was to create an algorithm to guide one object to another. For this activity, new concepts were introduced beyond the turn and walk commands, such as conditional deviation and repetition loop. In the final tasks, the repetition and condition blocks were already fixed to the work area, forcing students to use them. In the interview, a student reflected: "*I understood that the repetition loop is similar to the loop in music, to keep doing that for a while without stopping*".

The students were very involved with the activity and completed almost all of the 20 tasks in this workshop. With each appearance of a new block, doubts arose, but soon the new block was being applied correctly. Two older students progressed slowly compared to others, but they understood the aim of the activity and the purpose of each block and could complete the tasks. I observed that students who had never used a computer before had great difficulty handling the mouse, and there was a certain tension among older students, maybe because they were not used to the idea of personally using it or fear not being able to do so.

Class L: the third workshop continued with an unplugged activity with the same commands as the 10x5 matrix activity. The goal this time was that students had to compose algorithms to visit each apartment in a given building (Figure A.2), and the difference was that the commands "turn left/right" now turn and move forward one square. This activity was easily understood because the concepts of the commands were already known. I observed that students seemed at ease with an activity closer to their domain.

Workshop 4

Class E: the fourth workshop involved another activity on the Hour of Code tool, with a set of tasks aimed at drawing geometric shapes. As the students were already familiar with the repetition and condition blocks, adding geometry and angle blocks allowed them to create more complex drawings. The students were very challenged by the tasks and were focused on completing the algorithms to check the new resulting drawing. I observed that students could better grasp the concepts of conditional loops, repetition loops and advanced their understanding of angles. Also, students were more comfortable in front of the computer and used the mouse more easily.

Class L: the forth workshop with class L happened in the laboratory, with the Hour of Code tool. Considering class L was in the literacy process, it was necessary to find an activity in which the command blocks were represented by symbols, and not words. As a result, an activity with 15 tasks to guide a bird to a pig was selected. In this case, the number of command blocks available was smaller. Students could complete almost half of the activity's tasks. My

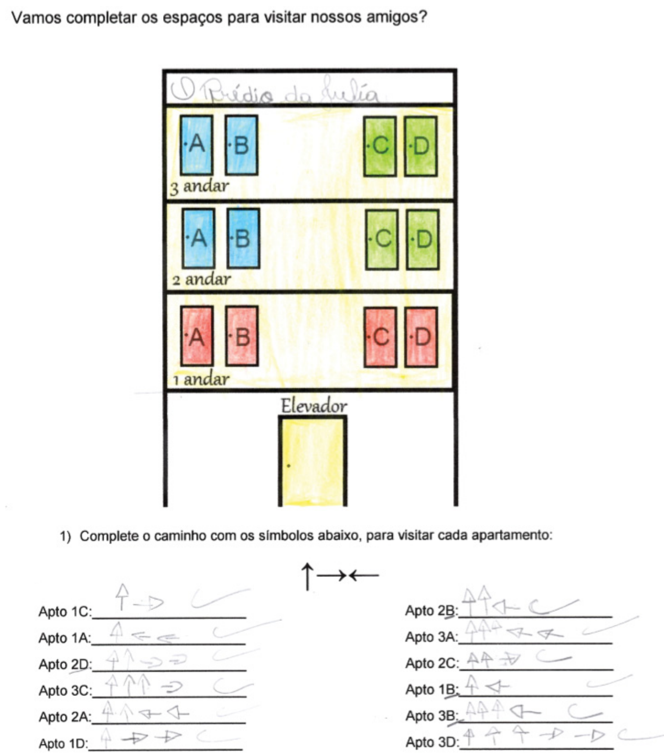

Figure A.2: Activity to create the algorithm to visit each apartment

observation about this workshop was that students felt some insecurity in dealing with the computer, but as this activity remained in a closer context than the building one from the last workshop, with arrows representing the commands, it may have facilitated switching from the paper to the computer.

Workshop 5

Class E: in this workshop, the Scratch tool was introduced, and the goal was to explore it, as it has many resources and commands that make it possible to create different algorithms. Students got curious to check the many actors, scenarios, and objects the platform provides, and they could also explore some games designed on the platform.

Class L: the fifth workshop followed the previous lesson, intending to guide the bird to the pig. In this new set of tasks, the aim was to debug the algorithm already provided by the tool. The students had to analyze the code provided and the position of the bird and the pig to check if the algorithm was correct. If the algorithm was wrong, they had to correct the code until it got right in order to move on to the next task. I observed how, in this workshop, the students were more familiar with using the computer and the tool; students who had constantly given excuses for not doing the activities now wanted to take part in it, maybe because they felt more at ease or not vulnerable in front of the computer. Students could also relate the activity content with other activities in their lives, as a student who compared the bird going to the pig and the fishing activity he used to do.

Workshop 6

Class E: in the last workshop, since the students were already familiar with the Scratch tool, the activity's goal was to create a code to control the main actor/cursor using the up, down, right, and left keys. In this activity, the aim was for the students to grasp concepts of the Cartesian plane: that to move the actor up, a positive number should be added to the value of Y; that to move the author down, a negative value should be added to the value of Y; that to move the actor to the right, it should be added a positive number to the value of X; and to move the actor to the left, it should be added a negative number to the value of X.

Some students had difficulty completing this activity because they were overwriting the value of X and Y instead of adding a value, for example, using the block “When the up arrow key is pressed, change Y to 10", so it worked the first time, but the other times, as the Y axis was already set to 10, nothing happened. It took some time for the students to realize this detail. In this workshop, the younger students seemed concentrated on the platform, as if that simple activity had unraveled the game programming world. Students mentioned that they liked being able to "control" the actor from the keyboard, that they got some idea of how games are created, that everything needs to be programmed.

Class L: due to a problem with the laboratory schedule that day, the workshop had to be improvised in the classroom. To adapt the activity, I drew a maze on the board with various levels and blocks, and students had to work on an algorithm as a trial and error technique to reach the goal. Students were asked to come to the board and unravel the correct path. Before deciding to turn left or right, I observed that some students would analyze whether there was any blockage ahead that would make that path the wrong way, which could indicate mental processing to complete the activity correctly. In this class, 3 new students also participated in the activity, and probably because they had not participated in the former workshops, they had difficulty understanding the objective and how to complete the activities, compared to the students who had already taken part in the other workshops. This observation might indicate that participating in the former activities helped students practice abstract and algorithm abilities.

A.2 The Initiative of 2018 - Workshops description

Workshop 1: The icebreaker

The purpose of this workshop was to get to know the students and prepare the physical and social space so that the next workshops could be prepared and conducted in the best possible way, both in terms of content and in terms of dynamics and social contact between the participants. Even more important than the content to be worked on was the way of establishing contact, creating a relationship of trust between the people involved, and allowing people to participate freely and collaboratively. Table A.1 presents technical details about this workshop.

We noticed that all the students participated in the lesson, sharing their perceptions of the topics covered. All the students were involved both with the dynamics and with us. Using the ball to establish the order of who was speaking was also attractive for breaking the ice, as no one wanted to start. Strategically, one of the researchers taking part in the activity began to speak and expose his difficulties, promoting empathy with the other participants and exemplifying the dynamic. As time passed, all the students wanted to speak, often speaking in parallel (with each teacher). The card voting method was positive because it did not require complex interpretation and was a quick and anonymous feedback process.

This was the first workshop after almost 3 from the last time in a YAE class. It was good to be back in class, but at the same time, being in class again reminded me of how enhanced the differences and challenges found in the YAE audience are. For instance, we wanted students to feel comfortable and safe among us, and a storytelling activity would be perfect for this end. The goal was for the students to talk, but YAE students usually enjoy talking a lot (often, this is their social moment of the day). Parallel talking was often observed, and it took much work to follow what all the students were talking about, and the activity lasted longer than we had previewed.

Table A.1: Technical details of Workshop 1

Participants	13 students, 3 researchers, and 2 YAE teachers
Voting for "Do I want to keep learning about technology"	100% positive votes

Workshop 2: Training family photographers

The purpose of this workshop was to promote the bond between us and the participants, to broaden the students' contact with technology through cell phones, to promote the development of the notion of algorithms as a recipe or sequence of steps to reach a desired result, to create together a sequence of steps to take a good photograph, and to help the students practice this process on their cell phones. This topic was chosen because at the last meeting several students mentioned that they use their cell phones, even in a basic way, and that they like to take photographs. From this meeting forward, we will use a new form of assessment in conjunction with the previous one, following the same method of colored cards, but now also with faces, a representation inspired by the *emojis*. This representation was chosen so that the students could familiarize themselves with this language, which is very common on the internet and in mobile text communication. Table A.2 presents technical details about this workshop.

As previously mentioned, the students' participation was voluntary; they were free to decide whether or not to participate. All the students took part in this workshop; they all took photos, even those who were quieter at the beginning. As their first practical activity with a technological device, we initially noticed some discomfort, even with holding the smartphones – at their fingertips – but as time went by, students got used to holding it confidently. We interpreted this lack of familiarity in holding the device as a lack of familiarity in using and manipulating it. However, in general, students allowed themselves to participate in the **experience** and got happy when they saw the pictures they had taken.

Table A.2: Technical details of Workshop 2

Participants	10 students, 4 researchers, and 2 YAE teachers
Voting for "Do I want to keep learning about technology"	100% positive votes
Voting for "How much do I thing I have learned from this workshop?"	92% I learned a lot votes and 8% I learned votes

Workshop 3: Let's talk about voting

Taking advantage of the fact that the following Sunday (October 28) would be the second round of the elections for President 2018, we used this theme to contextualize this workshop. The voting process takes place approximately twice every two years, making it possible to forget the steps of the voting process. The goal of this workshop was to strengthen the bond with the students, broaden their contact with technology, reinforce the notions of sequence of steps from the last workshop, now in a new context, voting, create together a sequence of steps for the voting process, and help the students practice this process on their smartphones or tablets, simulating the electronic ballot box. Table A.3 presents technical details about this workshop.

At each workshop it was possible to observe the students' plurality of characteristics, some of whom are more comfortable or interested with some things, while others with others, an observation that reinforces the importance of involving different aspects of the students' contexts at each meeting, so that, in general, everyone can have their questions addressed. We also noticed that the students were not used to recording videos, but that they were used to receiving videos, they just did not know how to send them. These topics could be explored in future practices.

In a moment that we mentioned taking photos, we noticed that some students already stood up and said they wanted to take a photo first, a possible indication that they were comfortable and engaged in learning how to use a smartphone. All the students took part in the practice by taking photographs and voting.

During the voting, the students who were more familiar with the process helped their classmates during the creation of the sequence of steps, ordering the actions, answering questions, and sometimes even asking their classmates why they did not go and vote, among other things. With only two researchers present in class that day, it took more work to conduct the activity, as we had fewer people available to help organize the room, talk to the students, answer their questions, record the information, and so on. The students also missed their colleagues (Roberto and Deógenes) who were not there, indicating they were already waiting for us and wanted us to be there. In this workshop, we heard from some students that they had never voted in the ballot box before. They said that when the voting process was on paper, it was easier to mark the 'X' in the chosen option (even though they were unsure who they were voting for because they could not read the names). Now technology facilitated that by showing the candidate's picture, however, the process to vote in the digital ballot box was harder.

Table A.3: Technical details of Workshop 3

Participants	10 students, 2 researchers, and 2 YAE teachers
Voting for "Do I want to keep learning about technology"	100% positive votes
Voting for "How much do I thing I have learned from this workshop?"	90% I learned a lot votes and 10% So so votes

Workshop 4: Searching on YouTube

This workshop's goal was to teach students how voice search works, mainly by helping them to search for videos according to their interests. In this case, the ordered sequence of steps will not be created together, but made available to them, now involving the skill of automation, because they need to interpret and execute a sequence of ordered steps to solve a problem. The skill of pattern recognition was also involved, in order to analyze and make sense of data and recognize patterns and symbols presented on different cell phones. Table A.4 presents technical details about this workshop.

We noticed that students were excited about the possibility of searching for music and videos of their own. Until then, they only listened to music when they received it from a relative or when it was played on the radio. Until then, they had no idea what to do to listen to their music whenever they wanted. We also noticed that they were pleased that they could search correctly on the app even though they had not yet mastered writing. This workshop marked and made me so happy to be there conducting the workshops. It is so easy and natural for us to open an application and choose the song we want to hear that sometimes we take it for granted and forget what it may represent in our daily routine.

Their perception of their ability to use the smartphone in this meeting was positive, compared to the second meeting. When we mentioned using the cell phone again in this meeting, there were no comments like "*ah, I won't be able to do it*", or "*that's not for me, I won't even try*". On the contrary, their attitude was of curiosity rather than resistance.

Again, when the students commented on taking photographs, they already offered to take photographs of their colleagues and the group, reinforcing the understanding that they were happy to have learned and how this is now even more part of their context (because they do not just receive, but they take photographs too).

Table A.4: Technical details of Workshop 4

Participants	11 students, 4 researchers, and 2 YAE teachers
Voting for "Do I want to keep learning about technology"	100% positive votes
Voting for "How much do I thing I have learned from this workshop?"	100% I learned a lot votes

Workshop 5: Game night!

The goal of this workshop was to practice algorithm and pattern recognition skills, to see whether the students remembered what they had been taught about technology in previous workshops, and to address literacy through writing and reading. Table A.5 presents technical details about this workshop.

We also saw that the students enjoyed participating in a game, as the teachers described. At first, they struggled to follow the game's dynamic because we inserted many components into it: cards about the technologies we had seen in former workshops, cards to get some action done, such as taking pictures, and cards to answer questions. Eventually, students understood the dynamic and enjoyed playing together. All the questions about the technologies we have addressed so far were answered correctly, and students helped each other to answer these questions when necessary.

As background sound, we played a playlist with the songs the students had searched on YouTube during the last workshop, and it was very inspiring to see how happy they got about hearing the songs. Students were singing their songs, and making comments like "*this is my song, I asked for it*", "*look colleague, isn't this your song?*".

Table A.5: Technical details of Workshop 5

Participants	12 students, 4 researchers, and 2 YAE teachers
Voting for "Do I want to keep learning about technology"	100% positive votes
Voting for "How much do I thing I have learned from this workshop?"	64% I learned a lot votes and 36% I learned votes

Workshop 6: Lady Miroca: movie and popcorn

The goal of this workshop was to give the students a moment to reflect on life issues and the use of technology, to work on algorithm skills by showing an example of a sequence of steps that has been useful in some context, and to create with the students a sequence of steps to identify rhyming words, data analysis and pattern recognition to actually operationalize the identification of rhyming words. Table A.6 presents technical details about this workshop.

In this workshop, we filled a special request from the school. At the end of the previous workshop, the vice-principal asked us to include a video next week, which could be scenes from a movie, short film, etc., as it was the 6th Youth and Adult Education Week, an event at municipal level. With this gesture, we noticed the school including our initiative in their context of activities, being naturally incorporated into its programming.

We chose the short film called Miroca and her Crazy Cuckoo[1]. In this video, the main character is Mrs. Miroca. She lives alone and does not work, and has a cuckoo clock that she uses as a reminder of the things she needs to do: have lunch, watch the soap opera, among other things. One day the cuckoo clock had a problem and stopped working. Mrs. Miroca took it to the repair shop, but the professional asked for a month to fix it. Mrs. Miroca didn't like this, because she didn't know what she was going to do without the clock telling the time, as she had the right time for everything. A few days passed and Mrs. Miroca saw on television an orderly sequence of steps to make a sundial. Mrs. Miroca decided to do it, and thanks to the precise instructions, she managed to finish the clock and it worked very well. However, some time later it rained and a thunderstorm destroyed it, and she was once again left with nothing to mark the hours. In this situation, Mrs. Miroca managed to find time to do different things, such as meeting Mrs. Cotinha, her friend from childhood, whom she had not seen for a long time.

This short film was chosen for several reasons: it dealt with a character close to them (many students no longer work, and some of them live alone), because it presented a sequence of steps on how to create something, and because it presented interesting reflections on the theme of having time to do what one loves. We noticed that in the short film the protagonist, Mrs. Miroca, always speaks in rhymes and, with the teachers we selected rhymes as the subject to work with students at this stage of literacy. So we proposed an activity involving rhymes and emojis, to bring the students closer to this language that is widely used on smartphones.

When we asked what could help Mrs. Miroca in the situation, especially about something we had already talked about in our workshops, the students answered several alternatives involving the smartphone, such as: calling their friend, taking a picture with their friend, filming the production of the sundial, looking up how to repair the clock, among other things, which indicates that the students were able to find other applications for the functionalities they had learned in previous workshops. Particularly in the situation about talking and seeing Mrs. Cotinha, suggestions raised by the students included audio and video calls, which we understood as possibilities to explore in future workshops.

The activity consisted in, giving a word, the students who were standing and representing the group should say another word that rhymes with the giving one. If the word rhymed, then the group would get points. We noticed that all the students thought about rhymes and participated by saying a few words. Sometimes, students were more intended to say words that relate to the content of the giving word, instead of a word that rhymes with that word (as for instance: wall, they would say floor, instead of fall). Other thing we noticed was that some students felt uncomfortable in standing before others in the competitions, perhaps because they had felt 'exposed' and maybe afraid of not knowing a word that rhymes with the given one. Then, we

[1]Available at: https://www.youtube.com/watch?v=naQz7FIZm0M

changed the format back to group competitions, in which only one student from each group would provide the answer, but the groups were still sitting together, we observed they felt more at ease. Both teachers and researchers were also part of the groups with the students, practicing together. Due to a lack of time, there was only one voting in this workshop.

Regarding the activity, this was the second workshop involving games, and once again, the students enjoyed it so much that we ran over time. Even though it was a different game from the previous one, we saw this dynamic as a promising approach with this audience, as long as the content relate to aspects of the students' context.

We noticed that some students had difficulty reading the words on the cards, so we decided to make the following printed materials larger. In this workshop, it was interesting to see students reflecting on the topics discussed in the video, as if being focused on track of time, being involved in everyday chores, and seldom talking to their friends was something they were used to doing without noticing.

Table A.6: Technical details of Workshop 6

Participants	13 students, 4 researchers, and 2 YAE teachers
Voting for "How much do I thing I have learned from this workshop?"	86% I learned a lot votes, 7% I learned votes, and 7% of So so votes

Workshop 7: Hello? Who is this?

In previous workshops, the students mentioned that they have relatives living far away and talk to them on the phone, but only when someone else dials or picks up the phone and passes it on to them. On the same subject, in the last activity we talked about audio and video calls as a way for Mrs. Miroca to keep in touch with her friend. To keep engaged in the same technology – the smartphone and the Internet – and to take advantage of the topic of phone calls, we designed this workshop to talk about the WhatsApp application. The goal was to present a sequence of steps to make audio and video calls using the application and accompany the students in executing and debugging the steps. Table A.7 presents technical details about this workshop.

We noticed that through this activity, we could once again address issues in the students' context. The use of cell phones and calls was already part of their daily lives; they just did not know how to make the calls themselves. Students were committed to carrying out the activities. They all wanted to complete the activity and asked questions, probably about situations they had already experienced. For this class, we prepared several printed phone screens for the students to practice. We considered this approach useful, as all the students had material in their hands to analyze the similarities and differences with the physical device, draw on, make sense of, practice, and later perform the action directly on the smartphones. In addition, because the size of the screens was very close to the actual device and because we had increased the font size on the printings, all the students could see more easily.

From my point of view, the most significant observation in this workshop was how the students' attitudes towards technology have changed over the initiative. Our perception of their progress in using and understanding the smartphone was very positive. At the beginning of the workshops, there were several comments such as "*I will not know how to do it*", "*you have to learn these things as a child*", and the observation that several students had difficulties holding the phone. At this workshop, their attitude was again curiosity and expectation as they tried to make the calls. Some students tried to carry out the steps of the sequence on their own, relying solely on the printed screens.

Table A.7: Technical details of Workshop 7

Participants	12 students, 3 researchers, and 2 YAE teachers
Voting for "How much do I thing I have learned from this workshop?"	100% I learned a lot votes

Workshop 8: The Grand Finale

This last workshop of the initiative aimed to socialize with the students, review everything seen since the first workshop, receive *feedback* on the students' perceptions of the initiative, and check their interest in a new season. Table A.8 presents technical details about this workshop.

Table A.8: Technical details of Workshop 8

Participants	13 students, 4 researchers, and 2 YAE teachers
Voting for "Do I want to keep learning about technology"	100% positive votes

As a gift, we printed some pictures the students had taken during our former classes and prepared chocolates. Students were very happy to participate in the workshop and with the gifts, and every student had a preferred workshop. In this retrospective, I understood how important every workshop was, and how special it was to consider the students' interests, wishes, and curiosities as input to plan the following workshops. I think we would not have approached this content specifically if we had not been informed by the students.