Conceptual Elaboration Through the Collaborative and Collective Creation of Digital Games in the Perspective of Inclusive Education[1]

Elaboração Conceitual por meio da Criação Colaborativa e Coletiva de Jogos Digitais na Perspectiva da Educação Inclusiva

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ABSTRACT: This paper examines the development of concepts in children with and without disabilities through digital game creation activities. The study presents the use of technology in a pedagogical approach based on Vygotsky's theories related to conceptual elaboration, imagination, and creativity in childhood and on advanced studies in game design with children. The qualitative research adopted the Design-Based Research (DBR) as a methodological approach, which made the collaborative and collective performance of students in games creation activities possible. The interdisciplinary team was composed by researchers and undergraduate students in the areas of computing, education, and design and by four children from the third year of Elementary Education at a school in Itajaí, Santa Catarina, including two with intellectual disabilities. Data analysis revealed the children's appropriation of concepts about digital games and their components, the perception of the game creation process, the complexity inherent in the construction of technologies, and the critical view of children regarding games and their use. Intellectual differences among children were overcome through approaches that favored their different competencies, which afforded admiration among peers, mutual respect, and school inclusion.

KEYWORDS: Special Education. Intellectual disability. Technology creation. Cooperative learning.

RESUMO: Este artigo examina a elaboração de conceitos em crianças com e sem deficiências em atividades de criação de jogos digitais. O estudo apresenta o uso da tecnologia em uma abordagem pedagógica sustentada nas teorias de Vigotski relacionadas à elaboração conceitual, à imaginação e à criatividade na infância e nos estudos em *design* de jogos com crianças. A pesquisa qualitativa adotou o *Design-Based Research* (DBR) como abordagem metodológica, que possibilitou a atuação colaborativa e coletiva de estudantes em atividades de criação de jogos. A equipe interdisciplinar foi composta por pesquisadores e acadêmicos das áreas de computação, de educação e de *design* e de quatro crianças do terceiro ano do Ensino Fundamental de uma escola municipal de Itajaí, Santa Catarina, dentre as quais duas com deficiência intelectual. A análise dos dados revelou a apropriação das crianças sobre conceitos acerca de jogos digitais e seus componentes, a percepção do processo de criação de jogos, a complexidade inerente à construção de tecnologias e o olhar crítico das crianças relativos aos jogos e seu uso. As diferenças intelectuais entre as crianças foram superadas por meio de abordagens que favoreceram suas diferentes competências, o que proporcionou a admiração entre os pares, o respeito mútuo e a inclusão escolar.

PALAVRAS-CHAVE: Educação Especial. Deficiência intelectual. Criação de tecnologia. Aprendizagem cooperativa.

1 Introduction

There is a notion that those born in the 1980s, labeled "digital natives" by Mark Prensky, are safe users and experts in the use of technology. Prensky (2001) argues that digital natives are used to receiving information quickly, enjoy parallel activities and multitasking, prefer graphics over text and random access to information through hypertext. They work

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best in networks and prefer instant rewards. According to the author: "They prefer games to 'serious' work" (Prensky, 2001, p. 2).

These often positively presented and celebrated digital native empowerment capacities have been opposed to the fact that the increased autonomy, resulting from the use of digital technology, can also lead to the disadvantage and powerlessness of children and youth through a set of "risks" and "dangers" of technology use (Selwyn, 2009, p. 368). In addition to the emotional, physical and sexual risks associated with the use of technology, researchers argue that children are having their intellectual abilities impaired by the use of internet information in an uncritical manner.

From an adult's point of view, Prensky's definition of "digital immigrants" as those who "were forced to adapt to the world of digital media" (Selwyn, 2009, p. 369) implies that adults lack knowledge of youth-dominated technologies and feel like foreigners in this digital world. This intergenerational discourse has implications for traditional education policies and structures, generating tensions about how these young people deal with technology and the emergence of revising educational practices. However, Selwyn (2009) warns us that: "Whilst often compelling and persuasive, the overall tenor of these discursive constructions of young people and technology tends towards exaggeration and inconsistency" (p. 370). The idea that digital natives have innate skills and abilities is rarely substantiated by rigorous, empirical studies and conducted by representative examples. Indeed, studies of this nature show that children's use of digital technologies is a more complex debate than Prensky's deterministic discourse. Economic factors that define access to technology, as well as cognitive, social and cultural factors, affect technology skills. Moreover, studies on the use of technology by young people demonstrate a somewhat passive and merely consumerist relationship with the technological universe.

Fajardo (2015) analyzes the relationship between youth/technology and adult technophobes with care. Regarding digital games, the fact that teachers do not play frequently does not mean that they have an aversion to technology, and many have revealed that they use games during moments of leisure. With regard to students, they reveal to enjoy playing due to the strong interaction component with friends. "In short, for many children and young people, technology use at home or at school remains rather less expansive and empowering than the rhetoric of the digital native would lead us to believe" (Selwyn, 2009, p. 372).

The perspective that children and young people will learn on their own through technology has not been confirmed, which highlights the importance of the role of adults in supporting creation and communication, meeting the needs for experience, confidence and motivation involved in processes of design, implementation and evaluation of the constructed content. It is the task of adults in general, and particularly teachers, to establish interactive, critical and collaborative relationships and experiences in the use of technologies. According to Selwyn (2009): "Yet rather than concentrate solely on the technical training of young people, efforts also need to be made to explore the ways in which 'critical digital literacies' can be developed" (p. 374).

Thus, a potential alternative for empowering children and youth in their relationship with the digital universe is the creation of digital technologies through shared and interactive experiences. Using technology design, development and assessment approaches, students

migrate from consumers to digital solution builders (Alves, 2017; De Paula, Valente, & Hildebrand, 2016; Kafai, 2006; Li, 2014; Moser, 2015). To Oliveira (2014), this approach reviews the use of technology as a software for teaching, referring to a new technological paradigm, namely: "the main source of productivity is the action of knowledge about one's own knowledge" (p. 162).

When analyzing the participation of students with disabilities in the technology creation process, Börjesson, Barendregt, Eriksson, & Torgersson (2015) found that there is a growing increase in research that includes children with disabilities in design processes, but still with little active involvement on their part. According to the authors, most research involves students only in product evaluation activities.

In this scenario, we bring to the analysis the research developed in Alves's (2017) Doctoral dissertation that seeks to contribute with a new way of understanding the use of technology to support learning. Particularly, the research sought to involve children with and without disabilities in digital game creation processes as a way of developing creativity, protagonism and school and digital inclusion. The study involved four nine-year-old children, including two with intellectual disabilities, who, through a mediated process, followed a path to build digital game concepts that culminated in the authoring of a game.

In this paper, we discuss this construction of concepts that was favored through collaborative, collective and mediated activities for the creation of digital games. The theoretical-methodological frameworks that anchor the research are based on the assumptions of Vygotsky's historical-cultural approach closely related to the learning of students with intellectual disabilities and their school inclusion: collectivity, collaboration, experience and symbolic mediation (Vygotsky, 1997, 2007, 2010, 2014).

The study was developed at the Research Group on Education Policy Observatory of the Graduate Program in Education of the University of Vale do Itajaí (UNIVALI), Itajaí, Brazil, and the project *The schooling of students with intellectual disabilities: public policies, cognitive processes and learning assessment* (Pletsch, Lunardi-Mendes, & Hostins, 2012). In addition, it received subvention from the Coordination for the Improvement of Higher Education Personnel (CAPES) and from the National Council for Scientific and Technological Development (CNPq) through PhD scholarships and scientific initiation. We present, in the Method section, the methodological approach of the research, based on the Design-based Research (DBR); in the Results and Discussions section, the research results; and, finally, the conclusions of this study.

2 Method

This research is characterized as a qualitative approach based on DBR, which considers a deep collaboration between researchers and participants, combining research in education with the problems experienced in practice. It proposes the construction of knowledge that can be used at school in order to achieve theoretical and practical goals (Baumgartner et al., 2003; Wang & Haffanin, 2005). In this approach, researchers provoke the interactions they desire by assuming the role of designers, not simply observing interactions.

The methodology proposes the implementation of interventions, based on theoretical frameworks, through iterative cycles, providing systematic and permanent analysis and design review (Barab & Squire, 2004). Its application has been relevant in research involving technology in education. As we can see in Figure 1, the process starts with a theoretical concept guide, which is implemented in the field (school). Implementation data is collected and analyzed. The result is the theoretical implications and redesign of the next cycle (Fraefel, 2014).

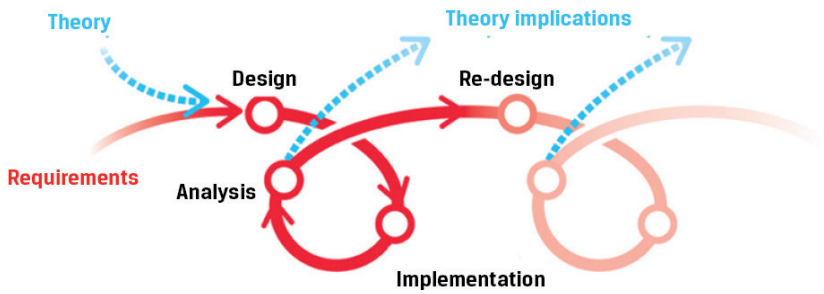


Figure 1. Iterative view of Design-based Research
Source: The authors based on Fraefel (2014).

Associated with the DBR, we used the narrative analysis approach that privileges issues related to the singularities of the lived experience and the subjects who participated in it (Bamberg, 2012). As it is a research oriented to the principles of collaboration, collectivity and experience, it was considered appropriate to work with the narratives as a possibility of registration and analysis of the constructed process in the interaction.

The research was carried out in a school of the Itajaí Municipal Network, Santa Catarina, Brazil, and had the participation of four 9-year-old students of the third grade of Elementary School: Leonardo, Manuela, Raphael and Vitória. Raphael is diagnosed with autism associated with intellectual disability (ID) and Vitória diagnosed with ID. The small number of children and the peer composition (two with and two without a diagnosis of disability) was a research choice, which aimed to observe particularly each student, the mediation with and among them, the collaboration and the establishment of the methodological process. For this purpose, an approval was granted by the ethics committee under Protocol No. 23083.007306/2012-61, an authorization of the Secretariat of Education of the Municipality of Itajaí, Santa Catarina, and a consent of the guardians through the Informed Consent Form (ICF), including use of images. Given the children's authorship of the digital game creation, their names appear on the Google Play game credits, so we preserve their real names in this text.

The interventions provided for in the DBR took place through weekly workshops held at school at regular class time, lasting one to two hours for six months in 2015, and two more workshops in 2016. In the workshops, collaborative, collective, and creative activities about digital games and game design were developed.

The workshops followed the framework named "I created my game", which was the main result of Alves's thesis (2017). The framework, according to Ellis (2008), exists "to

provide structure and direction on a preferred way to do something without being too detailed or rigid. In essence, frameworks provide guidelines". Thus, "I created my game" divides the process into four stages, which, in an articulated manner, lead children to the construction of concepts about digital games, provide opportunities for collective and collaborative work, favor different skills (reading, drawing, theater, writing, imagination). The stages are:

- Involvement: stage that promotes the engagement and integration of the research participants. Researchers and children start a relationship of trust and respect. The playful activities promote the first collaborative and collective works, in the sense of building a synergy among all for the accomplishment of the later stages.
- Experience: stage that promotes the expansion of children's knowledge about concepts related to digital and analog games. This stage considers the need for elaboration of concepts, and even the "leveling" on the subject, because we assume that students have different experiences with digital games and that, in many cases, never reflected on their constituent elements. In this stage, the playful activities involve moments of leisure and reflection with analog and digital games.
- Transposition: At this stage, the goal is to promote the child's understanding of the process of creating a digital game. Through an authoring tool, children create their first games, individually and collectively, realizing the transposition of the project from paper to the digital media.
- Creating digital games: This is the longest stage in the process, consisting of several phases for creating a digital game. Supported by educational or game development industry processes (Li, 2014; Moser, 2015; Novak, 2011; Sommerville, 2011), this stage includes defining the concept of a game, its design, development, and evaluation. Rebuilding the process is a cross-sectional phase through which researchers and children can review and understand the course that is being followed.

Data were collected through photographic records, filming, forms, participant observation in workshops, artifacts constructed by children, software artifacts, among others.

3 Results and discussions

> Leonardo - So, I think you have to put a CD that is for video games ... I only know how you do it for video games, my cousin arranged for me. You have to get a DVD that leaves nothing recorded and put in the computer and put everything in the DVD.
> Researcher - So you recorded the DVD to play in the videogame?
> Leonardo - yep.
> Researcher - How do you make a game? (looking at Vitória).
> Vitória – Lowering?
> Researcher - Downloading? From the Internet?
> Vitória - yep.
> Researcher - And you Rapha, how do you think you make a game? Imagine how you make a digital game, a game on your computer?
> Raphael - (shakes his head).
> Researcher - No idea?
> Raphael - (nods negatively). (Alves, 2017, p. 87)

The excerpt from this dialogue was held at the first meeting between researchers and children. The intention was to find out the children's concept of creating a digital game. What can be observed was the knowledge and prior familiarity of children with the world of digital games – what Vygotsky calls the process of conceptual elaboration. In this case, the previous conceptual elaborations (hypotheses) about "how to create a game" and "how it will end up on the computer" were expressed as follows: "lowering", said Vitória, referring to downloading from the internet; "I think you have to put a CD that is for video games", said Leonardo. The researchers also asked: "How will this become a game?"; to which Leonardo replied: "You have to draw […] then you put it on the computer and there you make it move (he makes gestures with his hands)", and "you have to think", concluded Vitória. These attempts and alternative answers demonstrate what Vygotsky calls the spontaneous concept, which is built on the immediate and practical experience of children with the object of knowledge. What is worth noting, however, is that the answers were refined as the researchers rephrased their questions and urged the children to think and identify the need to find out how to do it. Raphael is not oblivious to what is being discussed. His nods and/or head shaking demonstrate a form of silent interaction, but connected to the moment and the subject discussed. The previous concepts were changing throughout the research.

From this initial investigation, the construction of the concept of the game and the creation of the digital game took place through a long process, in which several activities were developed to promote creativity, the elaboration of concepts and the collaborative and collective environment among the participants. We understand creativity as the indispensable mechanism for cognitive development. As Vygotsky (2014) tells us, the new is created from a complex process that does not arise spontaneously, without any conditions, but on the contrary, it arises from previous experiences, interests, needs and the environment which the individual is part of.

Understanding the mechanism of creative imagination allows us to elaborate paths that lead to the development of creativity and, consequently, to the intellectual development of the child. This mechanism, summarized in the diagram in Figure 2, is divided into three main processes: perception, elaboration and crystallization (Vygotsky, 2014).

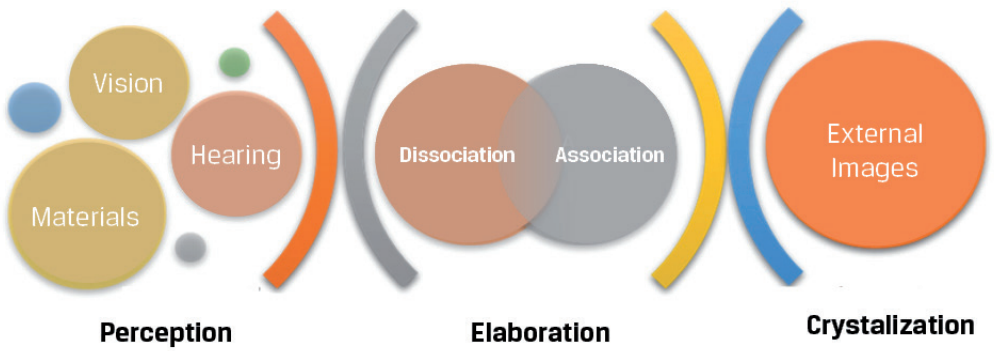


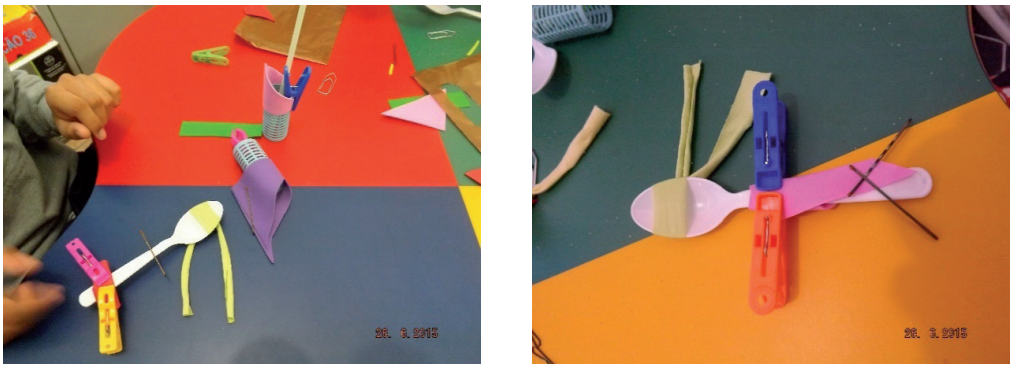
Figure 2. Mechanism of creative imagination.
Source: The authors based on Vygotsky (2014).

a) Perception is the foundation of the experiences, acquired by our senses, which allow the accumulation of materials necessary for the imaginative processes.

b) The elaboration is divided into two processes, the first being the dissociation process in which the subject fragments the materials, divides them into smaller parts, compares, selects and modifies. This process is fundamental to the development of abstract thinking and conceptualization. In the second process, called association, there is the joining of dissociated and modified elements, and may adopt different forms and bases from the original materials perceived at the beginning of the process.

c) Crystallization is the conversion of imagination into external images, completing and effecting creative activity. These external images are the result of the creative process: a product, a concept, a text, a drawing.

With the intention of provoking this creative process, we proposed an activity with scrap materials and the creation of a story involving the constructed objects. We offered each child a gift bag with unrelated objects: clothes pegs, hair rollers, foam paper, straw, strips of fabric, and we asked them to create something and name their creations. The children took the objects and explored them, manipulated them, put them together in an attempt to create something. Leonardo announced that he would make a weapon; Manuela gathered a spoon, clothes pegs, foam paper and clips and said it was a doll; Vitória gathered a straw with a tape and drew our attention to look, unable to define what it was; Raphael watched his classmates struggling to create something. The researchers asked the others to help Raphael, who expressed his desire to create a boy doll, similar to Manuela's. In this process, the elaboration of concepts was extremely mediated and all together sought to select the most coherent objects with the characteristics of a boy (arms made with a hair pin, hair made with strips of fabric, and a spoon to make a body). Figure 3 shows the boy dolls created by Manuela and Raphael.



(a) Boy doll, rocket and house, created by Raphael (b) Boy doll created by Manuela

Figure 3. Objects created by the children made with unrelated objects.
Source: Personal Archive.

Although the activity requires the children to individually create something, it was shared in the attribution of meanings[4] of the created objects. Vitória assembled her objects and threw questions to the classmates and researchers in an attempt to find meanings for her creations. She did not previously define for herself which object to create. Raphael watched his classmates, made attempts, but unmade, tried again and unmade; Leo defined even before handling his objects: "I will make a sword", or a weapon. Manuela put the pieces together and created a doll. The purpose of this experiment with differentiated and apparently meaningless objects was to enable the make-believe, the imagination, the transformation of meanings. This transformation comes when there is one's need to adapt to the environment. According to Vygotsky (2014), if life around you did not challenge you, if your inherited, natural reactions kept you in balance with the world around you, then there would be no foundation for the emergence of creative action (p. 30).

Apparently unrelated to the creation of digital games, the creation of characters, scenarios and scripts are essential in the construction of a narrative that supports the proposed gameplay. Schuytema (2013) elucidates that games and stories have always been intertwined because, just like a story, a game deals with conflict resolution and the attempt to overcome challenges in order to win in the end. Thus, in continuity, we worked on creating a story that involved objects. This time, it was intentional to create a single story because we wanted to provide collective and collaborative work.

For the creation of the story, many ideas were presented, but it was not possible to elaborate a story, with a beginning, middle and end. Manuela proposed a complete story, but we emphasized that the story should be collective, therefore it should contain input from everyone. We realized the difficulty in constructing a narrative from the children's creations, so we tried to start the dissertation from the children's own experience in creating the toys. Vygotsky (2014, p. 45) states that "creating is difficult" and the impulses to create do not always coincide with the subject's capacity for the task, which generates a feeling of torture and suffering, which he called "The torments of creation". These feelings constitute the most important characteristic of creation, as they signify the desire of the imagination for creation. "Any construction of imagination, starting from reality, tends to describe a complete cycle and reincarnate reality" (Vygotsky, 2014, p. 47).

Studies show that children learn better when working in groups rather than individually. However, the search for a common goal is necessary to bring meaning and motivation to cooperative activities (Moll, 1996). We evidenced through this experience the collaborative work in building something new, as a group. Conflicts were revealed: "Teacher, I don't think this idea is very good", says Leonardo; Vitória replies: "I think it's good"; solidarity: "so, I will help her, this is Vitória's idea…", says Manuela; cooperation: "Here, make the tie here", says Leonardo, taking Raphael's hand to help him draw. An important fact was Raphael's participation through his drawings: not very talkative, the boy aggregated his classmates around the whiteboard, where he drew a sequence of images and helped everyone in the outcome of

[4]The meaning of a word is "a generalization or a Concept" (Vygotsky, 2008), without which the word is an empty sound. It is, to Vygotsky, a phenomenon of thought.

the story. Despite the need for continuous negotiations of meanings[5] and consensus and some difficulties faced, the group was able to finish the story, constantly relying on the researchers' mediation. Here begins the collective and collaborative work of the participants.

In the process of intellectual development, the experience of the individual in the environment in which they are inserted is essential, and this changes, as well as the child, throughout his/her existence. In this process, new meanings are constructed, as Vygotsky elucidates, and for this, it is necessary that the child has in his/her social relations ideal or superior forms of development that influence him/her in the sense of developing from his/her primary or initial forms. The author uses the development of speech as an example: if the child does not live in an environment where the ideal speech is adopted, the one used by the adults, which is the expected final result of his/her development, it is unlikely that this child will be able to develop his/her own speech. According to Vygotsky (2010), there is something that must be built at the very end of the development, and that somehow influences in the early stage of this development (p. 693). When for any reason the relationship between the ideal and the initial form is broken, development becomes limited and the consequence is the underdevelopment of this or that intellectual property.

> Developed ideal forms exist in the environment. They have been worked out by mankind. They should arise at the end of development. Ideal forms affect children from the first steps towards the domination of the primary form. Throughout their development, children appropriate and transform into their interior acquisitions that which, at the beginning, was its way of external interaction with the environment. (Vygotsky, 2010, p. 698).

Thus, it is understood that experiences with intellectually developed adults or children, through collective and collaborative actions, help those with greater difficulty. To Vygotsky (1997), the incomplete development of the superior functions of the disabled child is a superstructure secondary to the defect:

> Underdevelopment springs from what we might call the isolation of an abnormal child from his collective. This process proceeds in approximately the following manner. Any given defect in a child produces a series of characteristics which impedes the normal development of his collective relations, cooperation, and interaction with others. Isolation from the collective or difficulty in social development, in its turn, conditions underdevelopment of higher mental functions, which would otherwise arise naturally, in the course of normal affairs, linked to the development of the child's collective activities. (Vygotsky, 1997, p. 223)

Beyond the adult/child relationship, the study of peer collaboration, that is, between children with different competence levels, also proves to be beneficial to cognitive development, but, in Moll's (1996) view, it does not guarantee that the more competent partner influences the less competent. To encourage everyone's learning, it is recommended to assign shared meaning and work towards a common goal. In this sense, the author guides us to pay more attention to the process of interaction itself than to consider the association between children in a casual way (Moll, 1996).

[5] From Vygotsky's perspective, the sense of a word predominates over its meaning and is associated with the context in which it is used, refers to the psychological events it arouses in our consciousness (Vygotsky, 2008).

In the conceptual elaboration about digital games and their creation, we seek to develop diversified strategies: we carry out analog and digital games workshops and authoring games creation workshops. In the former, through playful activities of individual and collective games, analog and digital, we seek to reflect on the elements that make up the games, which are listed by Prensky (2012) as: rules, goals or objectives, results and feedback, conflict, interaction, representation or plot. By playing the same game in its digital and analog versions – Base Game 3 and Dinobase (Alves, Cathcart, & Hostins, 2014), children's perception of the rules embedded in both games was highlighted. From the girls' words – "they are the same game" and "the same meaning" - we realize the understanding they have been able to derive from gaming activities. The signs used in the different versions of the game - geometric figures and dinosaurs - although different, represent the same thing, have the same "meaning". Through this mediated activity, one can perceive the formation of the concept of what is a game.

> The development of concepts, or word meanings, presupposes the development of many intellectual functions: deliberate attention, logical memory, abstraction, the ability to compare and differentiate. These complex psychological processes cannot be mastered through the initial learning alone. (Vygotsky, 2008, p. 104).

Leonardo described the similarities between the games: raffle a number, make the exchanges. They were asked if they could play if only the Base 3 chips had been presented to them; they said no, that the explanation would be missing. We call that the "rules", that is, how the game works. It was explained to the group that Dinobase was made by boys and girls from college who made the dinosaur designs and the program to implement the same rules of the game with the chips. After all the explanation, the researcher questioned:

> Researcher - So what do we need to make a computer game?
> Vitória - (raises her finger and responds immediately) lowering!
> Leonardo and I say no, while Manuela covers her face with her hand.
> Researcher - no, they created it, they did not download it. Leo said he searched the internet and did not find it because it is not possible to download the game from the internet[6]. It is not downloading that makes the game.
> Leonardo - first we have an idea, then you have to put it on paper and then turn it into a computer game.
> Manuela - Yeah, but you have to take a course to do that. (Alves, 2017, p. 116).

To Victoria, creating a game is still "lowering", her immediate and thoughtless response demonstrates that she still did not make the connection between the game itself and its creation. Fajardo (2015) analyzes the student's difficulty in the creation process of a game by a design team and concludes:

> digital games are perceived in isolation from the author's figure, as finished products that must be analyzed in terms of their technical, aesthetic and content qualities, and not as a cultural production with a meaning and intent to involve the figure of an "author". This almost invisible author is a constant of popular culture. (Fajardo, 2015, p. 112).

[6] At the time of this workshop the game was not on the internet but it can now be downloaded at https://univalildi.wixsite.com/univalildi

On the other hand, in Leonardo's speech – "first we have an idea, then we put it on paper and then turn it into a computer game" - we observe the construction of the concept of the game development process, a hypothesis already presented by him on the first day of the intervention. And in Manuela's argument, "Yeah, but you have to take a course to do that", the ratification of Leonardo's words, plus the perception of the complexity of the task.

> Scientific concepts, with their hierarchical system of interrelationships, seem to be the medium within which awareness and mastery first develop, to be transferred later to other concepts and other areas of thinking. Reflective consciousness comes to the child through the portals of scientific concepts. (Vygotsky, 2008, p. 115).

On the way to building the concept of creating games, workshops with the authoring tool involved skills of imagination, creativity, collaboration and motor coordination. We used the *Inventame app*, which is an app for Android portable devices - tablets, smartphones - that allows the implementation of games based on the interaction between the real world and the virtual world (Ibáñez, 2015). One of the app's[7] appealing features is that it does not require any programming skills for game creation, featuring a high level of abstraction[8] for game creation. The children interacted with physical objects - shoelaces, Legos, drawings - and converted them into digital images that one could interact with through *Inventame*. For the first time, children created something digital, a game. The process of creation involved the discussion of ideas, negotiations, hypothesis raising, testing, which favored a small-scale understanding of what it is like to create a game.

The collective creation of a game with *Inventame* was possible through the researchers' mediation, proposing a reflection on the game to be created, the project of its scenario on paper, the discussion of the objectives and rules and the anticipation of what would be the behavior of interactive objects in the *Inventame app*. The group agreed to create a maze game and drew the scenario on paper (Figure 4). They decided that the interactive object should be led from the girl to the rabbit, and that it could not pass by the monster. Manuela noticed that the lines intersected, preventing the passage of the object; then she suggested painting it green and programming the app to allow it to pass by that color. In this activity, the children understood the operation of the software and anticipated the behavior of the game to be transposed to the digital media. They photographed, programmed the game and tried it on the tablet. Raphael, who was oblivious to the project, was interested when the game was converted to digital.

[7] App is short for application and refers to typically small mobile applications developed for mobile devices.

[8] In computing, it is considered the highest level of abstraction for software development, the one that is closer to human language and distant from machine language.

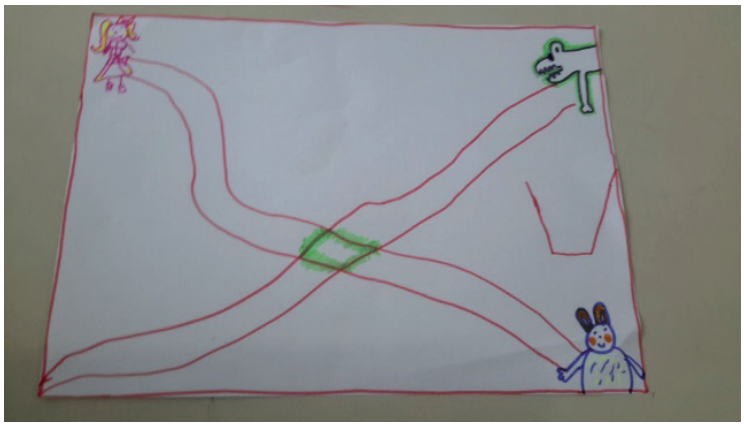


Figure 4. Game scenario created with the *Inventame app*.
Source: Personal Archive.

The accumulation of similar and shared experiences will make the child's brain perform combinatorial activities generating necessary cognitive skills, in this case, for the programming of a new game: planning, anticipation, imagination, distinction between fantasy and reality. When Manuela says, "Yeah, it won't pass through here ..", or when she suggested painting the path green allowing the ball to pass over it, she demonstrated the anticipatory, imaginative activity and problem solving that will occur once the game is concluded. We understand, here, according to Vygotsky (2014), that the products of imagination are built from these elaborated and transformed elements from reality, requiring a large amount of experience.

Vygotsky warns us that "the basic law of child creativity is that his/her value lies not in the outcome, the product of creation, but in the process itself" (Vygotsky, 2014, p. 90). Thus, when adopting the development of digital games by and with children, we need to engender the process in such a way that it is associated with the creative process described by Vygotsky and that fosters the development of children's creativity, regardless of the products - games - to be developed.

The role of pedagogical intervention, in this case, is through mediation in the sense of constantly questioning, provoking, giving clues, guiding and challenging children in their creative processes. This is in line with the relationship between development and learning, especially the conception of the Imminent Development Zone (IDZ), as translated by Zoia Ribeiro Prestes (2010) from Vygotsky's works. In this conception, Vygotsky emphasizes the role of instruction as an action that creates possibilities for development, provided that it is carried out in "a collaborative action, either of the adult or among peers", highlighting, in this process, the creative participation of the child (Prestes, 2010, p. 168).

It is precisely in IDZ that "interference with other individuals is more transformative", as Oliveira (1995, p. 61) points out. Therefore, from what the child already knows, we can interfere through interventions that promote advances in student learning, something that he/she could not achieve alone. The educator, or even a more knowledgeable classmate, as a

mediator of learning, makes the link to unleash skills that the child can already develop. This is a fundamental condition for the intellectual development of every child.

In this sense, creating a digital game is essentially a collective construction activity that requires team involvement, rulemaking, and everyone's collaboration. Around a common goal, children find meaning in their activities, they seek to solve problems, build relationships of admiration and respect. Vygotsky (2008) states that whenever there is an imaginary situation in play, there is a rule. These are rules that derive from the imagined situation and are built throughout the game.

The early stages of the research set the field - that is, the concepts - on which children could take part in diverse activities to create the digital game "*Os brinquedos que criam vida*" [9] (The toys that create life). The children's perception of the path to digital game creation was triggered by the process reconstitution, visually exposed in the timeline (Figure 5), and resumed at various times during the project. We can observe the words "CONCEPT", "DESIGN", "PRODUCTION" - terms used in the area of digital game creation - along with images of artifacts produced by children and photographs of moments they experienced. In the process, reconstitution, the children realized that choosing a game genre, evaluating similar games, writing a script were activities to define the concept of the game, or what it should be. Design was understood as the stage of refining the game, creating characters by drawing or using scraps, simulating their operation through a "theater", drawing the level design (stages of the game). The production consisted of the programming of the game and its digital creation. The evaluation of the game allowed the testing of successive prototypes and their comparison with what had been idealized.

Figure 5. Timeline.
Source: Personal Archive.

[9] Available at Google Play Store.

Understanding the technologies was observed under different aspects during game creation activities. The "Experimental Prototype" technique is an alternative that allows children to validate game ideas through physical simulation, such as a theater play or play (Buchenau & Suri, 2000 as cited in Moser, 2015, p. 30-31). When interpreting the characters or acting as if they were the "game", the children checked whether what was envisioned would work in practice, identified difficulties or problems, and proposed improvements. In the simulation, we observed the much-needed "make-believe" to the process of individual and collective imagination, the elaboration and re-elaboration of concepts by language, the bodily experience of the constructed story, the incorporation of different roles in the game, the anticipation of the facts thinking about the construction of the story of the game, the search for solutions to eventual problems, the communion in the creation of signs. Vygotsky states that the play creates the imminent development zone. According to Vygotsky (2008), action in an imaginary field, in an imaginary situation, the creation of a voluntary situation, the formation of a life plan, of volitional motives - all this comes into play by placing it at a higher level of development (as cited in Prestes, 2010, p. 160).

The game's programming, developed by a computing university student, was accompanied by the children. We discussed languages, and they drew a parallel with the English or German language, and expressed their concerns about why people speak differently from us (Portuguese). This concept allowed us to explain that the computer also speaks a different programming language, and that it only executes what we write. The university student explained an excerpt from the code, in which Leonardo noted: "oh, you wrote here and it said that". Then they tried changing the value of a variable that defined the strength of the character's jump. Vitória suggested 15, and the character did not even get off the ground. Manuela suggested 200 ... 1000 ... children played and had fun observing the results.

The evaluation of the game prototypes made it possible to create associations between the implemented software and the definitions made in the concept and design stages. Raphael was talkative when asked about the game, he informed that the "path" of the game ended earlier, that there was a "flag" for the character to catch at the end, he recalled the characters that still needed to appear: "Teacher, we could make a boy with cans, like this", remembering the character created by Leonardo in the prototyping activities. He demonstrated the memorization of previous activities and was able to associate them with what had been implemented. Leonardo evidenced the understanding of the concept of testing, when he questioned about games that did not work correctly: "I've already downloaded a lot of games that have the photos like this, it looks like a really good game we go there it's a lie.. we enter, the game is no good at all ...", and concluded, with the researcher's mediation, that "testing" was missing. Figure 6 presents the children in one of the game evaluation activities.

Figure 6. Children in the game evaluation activity.
Source: Personal Archive.

The game evaluations were reflection points on the process, a thought about what we did and why we did it. The children were critically positioned about elements of the game that were not happy about, brought new suggestions and analyzed the elements of the present games. They were prompted to do so when asked about the rules of the game they created:

> Leonardo - What do you mean, teacher?
> Researcher - What rules did you have in the game?
> Leonardo - None.
> Vitória - Jump, jump obstacles, ride, pass by the dumpster, and pick up the coins and […] assemble the animals so that you get an extra life. (Alves, 2017).

Here we observe that even understanding the game, Leonardo did not realize that its elements constituted its rules, Vitória, in turn, managed to make the association with this concept, demonstrating her capacity for conceptual elaboration.

> The child becomes conscious of his spontaneous concepts relatively late; the ability to define them in words, to operate with them at will, appears long after he has acquired the concepts. He has the concept (i.e. knows the object to which the concept refers), but is not conscious of his own act of thought. The development of a scientific concept, on the other hand, usually begins with its verbal definition and its use in non-spontaneous operations with working on the concept itself. It starts its life in the child's mind at the level that his spontaneous concepts reach only later. (Vygotsky, 2008, p. 134-135).

The finished game closed the cycle of the creative process defined by Vygotsky, namely crystallization. The children understood that their ideas were reflected in the game and that they were the authors together with the research team. When asked again how to create a game, they concluded that it was very "cool", but very difficult. The concept of creating a game throughout the project changed. Before, to Vitória, it consisted of "lowering" from the internet; to Leonardo "copying on a CD". As they were experiencing the different stages of the

process and creation of the game, the children came to understand what was needed: "we have to draw, create the scenery, dolls".

The heterogeneity of the group gave rise to new aspects of the children's personality and intellectual differences were replaced by other potentialities. While, on the one hand, Manuela and Leonardo learned something new more easily; on the other hand, Raphael and Vitória's persistence allowed them to perform complex activities. Vitória was favored by her communicability, being very active and participative in practically all workshops. Raphael expressed his ideas through his drawings. Leonardo collaborated with many ideas and Manuela was always very reflective. Researchers valued these characteristics, taking into account the opinions and ideas of each student, even though it sometimes seemed out of context - like the bird of the Angry Birds that popped up all the time in Raphael's drawings. This directly reflects on children's creative ability and is critical to their conceptual elaboration process and mental development (Prestes, 2010). This practice allowed everyone to have their ideas present in the game creation, giving them a sense of protagonism throughout the process.

4 Conclusions

Aiming to adopt digital technology in education as content or teaching object, as opposed to its use only, this research investigated the children's conceptual elaboration provided by the creation of digital games. Through activities proposed in the framework "I created my game", four Elementary School children, mediated by an interdisciplinary team, went through a process that culminated in the creation of a game called "*Os brinquedos que criam vida*" (The toys that create life).

The creativity development process advocated by Vygotsky is the conceptual basis of the research. The constructed product is the result of the crystallization of imagination and the realization of the intellectual processes necessary to close a creative cycle. However, the process is the most important factor for children's cognitive development. In this, we could observe the crystallization of the concepts about digital games, notably its construction. From the initial assumption that making a game was "downloading from the internet" or "putting everything on a CD", children come up with the concept that many activities are needed, such as drawing, programming, testing.

Digital games alone are attractive to children, which favors their interest in participating in the activities. However, it is noticeable that the concepts of games and their creation were unknown to children who, until then, only acted as users of these technologies. The construction of knowledge was a gradual and particular process for each child, who in his/her own way understood each stage and element necessary to complete the game.

Creating digital games with a focus on design processes provides the collaboration and collective spirit needed for cognitive development, particularly of those with intellectual disabilities. In the shared experience, it was possible to observe the peculiar qualities of each child, such as Vitória's active participation, with her comments and ideas; Leonardo's proactivity, always lively and questioning; Raphael's expression through his drawings; and Manuela's seriousness, seeking ways of problem solving.

The way of using technology from the point of view of its development rather than its use was the great challenge of this research. We verified this to be a tendency that has been established in education in relation to the use of informatics in education. This paradigm aims to enable students to make use of complex technology development processes and use these skills in other contexts of their lives. In the case of this research, the focus was on the creative process, necessary to every individual's mental process.

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