Development of Imagination and Creativity Through the Game Design by Children in Inclusive School[1]

Desenvolvimento da Imaginação e da Criatividade por meio de Design de Games por Crianças na Escola Inclusiva

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ABSTRACT: This paper examines the development of imagination and creativity in children with and without disabilities through game design. The study is based on Vygotsky's theories related to conceptual elaboration, imagination and creativity in childhood, and in advanced studies in game design with children. The Design-Based Research (DBR) was adopted as a methodological approach, configuring qualitative and collaborative research for game creation. Encounters were held weekly at a public school in the city of Itajaí, Santa Catarina, Brazil, for six months, involving a group of four nine-year-old children, including two with intellectual disabilities, and researchers and undergraduate students in the areas of computing, design, and education. The aim was to demonstrate the potential of the collective, creative and shared approach of game creation for the intellectual development of children in contexts of school inclusion. As a result, the framework "I've made my game" was defined for the development of games in school contexts. The analysis of the research results reveals the empowerment of the children involved in face of the proposed challenges, the intellectual operation at complex levels, the protagonism in the construction of solutions and the valorization of individual differences, favored by the collective and collaborative activities experienced in the process of creating digital games.

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

RESUMO: Este artigo examina o desenvolvimento da imaginação e da criatividade de crianças com e sem deficiência por meio do *design* de *games*. O estudo sustenta-se nas teorias de Vygotski relacionadas à elaboração conceitual, à imaginação e à criatividade na infância e nos estudos avançados em *design* de jogos com crianças. O *Design-Based Research* (DBR) foi adotado como abordagem metodológica, configurando pesquisa qualitativa e colaborativa de criação de jogos. Realizaram-se encontros semanais em uma escola da rede de ensino de Itajaí - SC, durante seis meses, os quais envolveram um grupo de quatro crianças de nove anos, dentre as quais duas com deficiência intelectual, pesquisadores e acadêmicos das áreas de computação, *design* e educação. Buscou-se demonstrar o potencial da abordagem coletiva, criativa e compartilhada de criação de jogos para o desenvolvimento intelectual de crianças em contextos de inclusão escolar. Como resultado definiu-se o *framework* "Eu fiz meu *game*" para desenvolvimento de jogos em contextos escolares. As análises dos resultados da pesquisa revelam o empoderamento das crianças envolvidas frente aos desafios propostos, a operação intelectual em níveis complexos, o protagonismo na construção de soluções e a valorização das diferenças individuais, favorecidas pelas atividades coletivas e colaborativas vivenciadas no processo de criação de jogos digitais.

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

1 Introduction

The development of digital games as a pedagogical proposal offers the use of technologies in education in an approach that favors the protagonism of students, who go from

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consumers to constructors of technological solutions. The strategy combines contemporary trends in the use of technology in education not only as a method, but also as a content or object of education. This tendency proposes the substitution of the use of technology as teaching software by a new technological paradigm, in which "the main source of productivity is the action of knowledge on one's own knowledge" (M. R. Oliveira, 2014, p. 162, our translation).

The creation of digital games as an educational approach is discussed by Kafai (2006), Li (2014), Moser (2015) and De Paula, Valente and Hildebrand (2016). The studies show significant advances in learning, since they allow to work on complex concepts and strategies and, in addition to the knowledge of technology, provide the interaction between different areas of knowledge (De Paula et al., 2016). To Kafai (2006), the constructionist approach through the creation of digital games allows the development of technological skills and new ways of thinking based on the use of the tools. According to Li (2014), the activities required for the development of a digital game favor the creation of a participatory culture and the preparation of the student for the 21st Century, based on pedagogical needs as principles of collaboration, freedom, support, sharing and reflection, favored by practice-based learning (Moser, 2015).

The activity of developing digital games is not trivial and requires the adoption of appropriate methodologies for its effectiveness as a pedagogical approach. Despite the existence of some frameworks for the development of digital games involving students (Li, 2014; Moser, 2015), when one considers the inclusion of students with disabilities, particularly intellectual ones, few studies are found. Börjesson, Barendregt, Eriksson, & Torgersson (2015) identified, in a study that evaluated the participation of children with disabilities in the technology creation process, that only 2.2% of the works focuses on people with intellectual disabilities and 13% of mixed groups, that is, children with different disabilities acting together. This motivated the research presented here.

When we think about children with disabilities, from the perspective of inclusive education, we can reflect on the possibilities of development favored by the creation of digital games. For this, we seek, in Vygotski's[4] assumptions closely related to the learning of students, especially those with intellectual disability and their school inclusion: collective, collaboration, experience, symbolic mediation, imagination and creativity (Vygotsky, 1987; Vigotsky, 2007; Vigotsky, 2010; Vygotsky, 2004). According to the author, the higher processes of infantile thinking arise from their process of social development through the translation to oneself of the forms of collaboration that the child assimilates during the interaction with the social environment that surrounds him/her (Vygotsky, 1987). It is the social interaction that precedes and sustains individual conduct, so that collectivity, collaboration with people and social experience give rise to the child's higher intellectual functions.

The lived experiences are preserved by our brain and facilitate its repetition. However, human intellectual capacity goes beyond merely repeating what is known; so we can combine and create. The ability to elaborate and construct from elements, to make new combinations with known elements, constitutes the foundation of the creative process (Vygotsky, 2004). Creative activity is the basis of everything we know that was produced by human hands, and

[4] In the author's works, we have found different spellings for his last name. Therefore, in this paper, we will respect the forms used.

it is the process necessary for intellectual development, as it allows the subject to create and modify his/her present, building his/her future.

The development of such skills and competencies is favored when backed up by methodologies that support the processes necessary for the complex achievement of a digital game. Thus, when we consider the assumptions of Vygotski and the absence of a methodology for creating digital games involving children with disabilities, we elaborated the following research question: What are the elements that constitute a methodological process that allows the creative performance of children with and without disabilities in the development of a digital game? As a thesis, we argue that a collaborative and mediated methodological process allows the creative performance of children with and without disabilities in the development of digital games. For that, we had as our objective the definition of a framework called "I've made my game", which proposes the production of digital games through a mediated process, favored by collective and collaborative work. The approach is based on the relationship with the other for the production of signs and meanings, resulting in the promotion of imagination and creativity (Alves, 2017).

We highlight the importance of research that presents three characteristics that give it an innovative character in the field of Education and Special Education: it results from an interdisciplinary work connecting education, computer science and game design; constructs an exclusive methodological process of creation of games that potentiates the collaboration and the mediation between children with and without deficiencies, in an effective experience of school inclusion; and establishes the role of children as creators of technology, not just users.

In this scenario, we bring to the analysis the empirical material collected in the research to define the framework "I've made my game". The research involved four nine-year-old students, including two with intellectual disabilities, and culminated in the creation of a digital game called "Toys that create life". This paper presents a cutoff of the interventions, specifically the stage "Creation of digital games" proposed in the framework. The choice for this stage, the most important and the longest of the research, is due to the greater emphasis on the creative processes of game design. The study was developed in the Observatory Group of Education Policies of the Graduate Program in Education of the University of Vale do Itajaí (Univali) and the project The schooling of students with intellectual disability: public policies, cognitive processes and evaluation of learning (Pletsch, Lunardi-Mendes, & Hostins, 2012). In addition, it received a grant from the Coordination for the Improvement of Higher Education Personnel (Capes) and the National Council for Scientific and Technological Development (CNPq) through doctoral fellowships and scientific initiation. We present, in the Method section, the methodological approach of the research, based on Design-Based Research (DBR); in the Results and discussions section, we describe the "I've made my game" framework and the results of the Digital Game Creation stage; and, finally, the conclusions of this paper.

2 Method

The methodological approach of the research was based on the DBR, which combines research in education with the problems and issues experienced in practice, in order to produce usable knowledge. The approach considers a deep collaboration between researchers and

participants in order to achieve the theoretical and practical objectives of the research, in order to result in practical educational changes to their maximum extent (Wang & Haffanin, 2005; Baumgartner et al., 2003). In DBR, researchers assume the role of designers and elicit the interactions they desire - leading to the development of theories - rather than simply observing interactions. The approach proposes the implementation of interventions, based on theoretical frameworks, through iterative cycles, providing the analysis and revision of the design in a systematic and permanent way (Barab & Squire, 2004). Its application has been relevant in research involving technology in education.

DBR is divided into four phases: Phase 1: analysis of a practical problem by collaborative researchers and participants; Phase 2: development of solutions informed by existing design principles and technological innovations; Phase 3: iterative cycles of testing and refinement of the solutions in practice; and Phase 4: reflections to produce "design principles" and improvement of the implemented solution (Amiel & Reeves, 2008; Herrington, Mckenney, Reeves, & Oliver, 2007). In the first phase, the research problems were identified, based on the literature review and the previous studies of the research group on the adoption of digital games in the inclusive education of students with intellectual disabilities (Schmidt, Alves, & Hostins, 2013; Hostins, Alves, Frisoni, & Mendes, 2014). In the second phase, we elaborated a draft of the framework for the development of games with children, based on the literature (Li, 2014; Moser, 2015; Sommerville, 2011; Novak, 2011) and experiences with participatory design (Alves & Lamim, 2015; Schmidt et al., 2013). The third phase consisted in the specification and refinement of the framework "I've made my game" through weekly workshops with a group of students, in which activities were carried out with the objective of creating a digital game. The fourth phase consisted of analysis of the research and documentation of the framework.

The research was approved by the Ethics Committee under Protocol No. 23083.007306/2012-61, authorized by the Education Department of the Municipality of Itajaí, Santa Catarina, Brazil, as well as by the children's parents or guardians through the Free and Informed Consent Form, including use of images. The participants of the research were four 9-year-old students from the 3rd grade of Elementary School from a public school. The group was also constituted by an academic of Computer Engineering and two researchers, one of Education and another of Computing. In view of the parents' and school's authorization for the research and considering the participation of children as co-creators, we have chosen to keep their real names. The group was composed by Leonardo, Manuela, Raphael and Vitória, all classmates of the same class. Raphael is diagnosed with Autism associated with intellectual disability and Vitória is diagnosed with intellectual disability. The reduced number of children was a choice of the research, which aimed to observe each student in particular, mediation with and between them and the establishment of the methodological process.

Through weekly workshops held at the school during a regular one-to-two-hour period, during six months, oriented activities were developed with the children in order to use techniques for building games in the areas of game design and computing and pedagogical techniques which required sharing of ideas and collaboration. The activities were planned by the researchers and reviewed at each encounter. The workshops provided subsidies for the definition of the next activities, as well as to search for new theoretical references of the research, thus constituting the structure for defining the proposed framework.

Data collection was done through photographic records, filming, forms, participant observation in the workshops, artifacts built by the children, software artifacts, among others. For analysis of the data, the narrative analysis was carried out based on the idea of reconstructing social events from the point of view of the subjects involved. This approach was significant to recompose the process of building the framework. The narrative as a method is opposed to the logical-scientific model and implies a subjective and interpretative approach that considers the individuals in their social environments, in order to interact and assign meaning to the objects of the world (Bamberg, 2012). Through the narrative of the workshops held with the children, we analyzed the behaviors, dialogues, evolutions and difficulties of the group. Throughout the narrative, we identified the categories that evidenced the research presuppositions, namely: mediation, collaboration, creativity and production. The evidence found in the narratives was aligned with the theoretical references, notably Vygotsky's works related to creativity, defectology and symbolic mediation (Vygotsky, 1987; Vigotsky, 2007; Vygotsky, 2004).

3 Results and discussions

Digital games have characteristics that set them apart from other genres of *software*. In them, one does not think only of needs to be fulfilled for the accomplishment of a task, but in the interaction that they must provide, in the immersion to generate the fun, in the satisfaction, in the visual or sonorous art and in the feelings that must provoke. This makes the process of developing a digital game to have this differentiation, including essential design activities to ensure that the goals of the game are achieved.

In industry, we have found Novak's (2011) proposal for the development of digital games through a process composed of stages: Concept, Pre-production, Prototyping, Production, Alpha, Beta, Gold and Post-production. At the beginning of the process, the game idea is created, its target audience defined, resources needed and its potential assessed; then the game is specified; the idealized game is brought to reality through prototypes. Production is the stage at which the game is actually developed: art, interface, sound and programming are created and will result in the finished game. Alpha, Beta and Gold are the stages in which the game is evaluated and tested before it goes to the market. Finally, post-production is the stage that will address any defects revealed and generate new versions with replacements and improvements. This process defines all the necessary steps to the success of the construction of a game; however, it is insufficient for research, because it is focused on the product to be constructed, and does not include educational aspects, nor activities involving children.

When considering the participation of students in the game development process, Moser (2015) proposes and evaluates the methodological framework *Child-centered game development* (CCGD). Just like Novak's process, CCGD is divided into phases: analysis, concept, design, implementation, and evaluation, but it differs by adding different design techniques adopted for the desired purposes. The flexibility of the instantiation of the framework and the freedom of the adoption of the design techniques allow the approaches proposed by Moser. From a learning perspective, the proposed pedagogical strategy is student-centered design, which aims to understand their needs, to understand how they learn, to have motivation as the basis of learning, to consider diversity (working with flexibility) and have growth as a

challenge. The approach considers the creation of a positive interpersonal relationship, respect and consideration of children's speech and the encouragement of higher order thinking and self-regulation (Moser, 2015).

The principles advocated by the CCGD are particularly interesting and connect especially with our research because of its concern with children's protagonism, interaction and development of thinking. We highlight the connection with the principles proposed by Vygotsky in relation to symbolic mediation and creative and imaginative activity, necessary for the development of higher mental processes. Thus, we align the concepts of these works with the concepts of learning in Vygotsky to define the framework "I've made my game" that aims to develop games with and by children in an educational perspective.

The "I've made my game" framework requires the active participation of those involved - educators, undergraduate students and children - through activities that encompass pedagogical and design steps for the development of a digital game. To do so, the process is composed of four stages, as shown in Figure 1, namely: (i) Involvement, (ii) Experience, (iii) Transposition and (iv) Creation of digital games. We emphasize as transversal action the symbolic mediation, understood as a necessary condition for each stage or activity to be performed and the basis for the cognitive development proposed in the subprocesses (Alves, 2017).

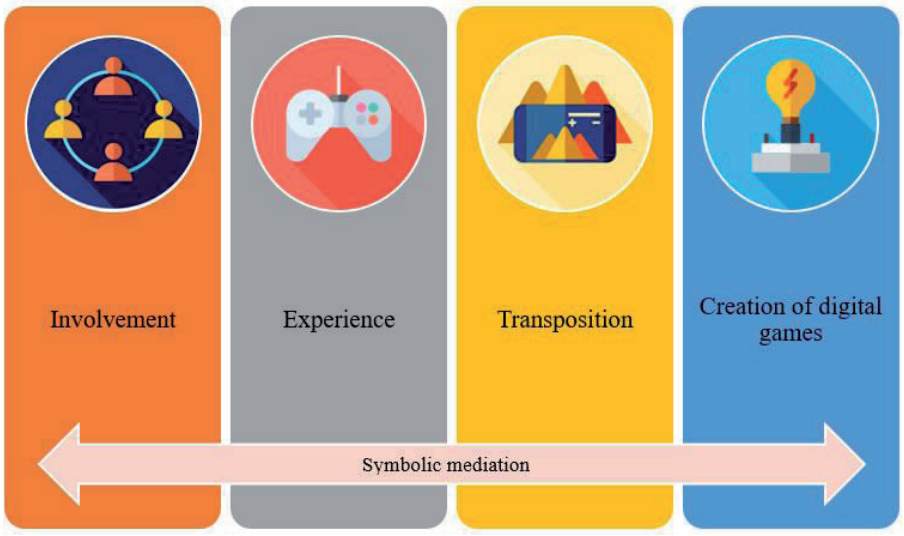

Figure 1. Framework "I've made my game"
Source: Alves (2017, p. 61)

The Involvement stage consists of the participants' engagement in the project and his/her integration. This is an essential step in establishing a trusting relationship between educators and children, enabling them to move on to later stages. In addition, it enables educators to identify some characteristics of children in terms of learning and relationship, pointing out guidelines for planning activities. These aspects are particularly relevant when the group involves children with some type of disability. In activities with children, we carried out

collaborative and collective activities to create a story, using as resources the construction of characters and scenarios with scraps, drawings and textual production.

The *Experience* stage aims to increase children's knowledge about analog and digital games. The wealth and variety of experiences allow the accumulation of materials necessary for the imagination (Vygotsky, 2004); therefore, it is necessary to expand this experience if the development of children's creative activity is desired. We believe that for the creation of new games, experience with games and the reflection of the elements that compose them are indispensable. The activities proposed in this stage are moments of leisure and reflection with analogical games (board games, card games) or digital (on personal computers, tablets, smartphones). To do so, we conducted leisure activities with different games.

The *Transposition* stage proposes to promote the perception of the child about the process of creating a digital game. Unlike the Experience stage, where the children used ready-made games, at this stage they will create their own games in digital media. Here we propose the elaboration of games that use authoring tools in games that are simple and accessible to the level of knowledge of the children. The reflection on the elements that make up a game - rules, goals or objectives, results and feedback, conflict, interaction, representation or plot (Prensky, 2012) - and the creation of games collaboratively were of fundamental importance for the stage of game construction by the children. Here, the premises for collective work were established: learning how to negotiate, discussing their ideas, respecting their partner, thinking together about solutions to problems.

These first steps sought to build a conceptual framework for children on digital games, as well as to promote the collective and collaborative work necessary to create a new digital game to be proposed by the group, legitimizing what Vygotsky (2004, p. 30) states: "No invention or scientific discovery can occur before the material and psychological conditions necessary for it to occur have appeared. Creation is a historical, cumulative process where every succeeding manifestation was determined by the preceding one".

The process of *Creating digital games*, the longest in the process, consists of applying digital game development techniques, such as brainstorming, idea cards, among others, in the specification of a digital game with children, mediated by educators and undergraduate students. The implementation, led by the latter with the participation of children, proposes that the creative process is not limited by the complex knowledge required for coding, nor the authoring tools that establish specific genres of games. In the end, the children should be able to play the game they created together with the undergraduate students.

The stage of creation of digital games is based on recognized processes in the area of game design and adapted to the needs of the pedagogical proposal of the research. It is organized in the Concept, Design, Development and Evaluation phases and, in parallel, we apply the Reconstitution phase of the process, focused on the resumption of activities in the previous stages and reflection on what was learned. As a focus of this paper, we have examined in more detail the activities developed with the children in order to analyze their results.

In the creation of the digital game, 15 encounters were held with the children, culminating in the design, development and evaluation of the game "Toys that create life". At

that stage, the participations of the undergraduate students and designers were fundamental for the realization of the game. These carried out transposition activities of the specifications of the game for the digital medium in the laboratory, either by the graphic creation, or by the programming of the game. The next subsections detail each phase of this research step.

3.1 Phase of concept

The *concept* of a digital game is to specify the main ideas that should compose it. It is necessary to answer some questions such as: who will play? Why is the person going to play? When? Schuytema (2013, p. 12, our translation) elucidates that this stage of game development is "a time for discussions, brainstorming and evaluation of competing games".

We proposed the w-questions cards activity, in which some questions are asked that the group should discuss and respond to, to reach consensus (Moser, 2015). The answers will permeate the goals of the game being built. Through dialogue, the group defined some aspects of the game that would be developed, such as: the target audience of children between 7 and 10 years old; tablet or cell phones; game for leisure; can be played anywhere; possible to learn something.

In particular, the question on "What?" would the game be about was the one that elicited more discussion, as the children thought of elements such as stars, store, power, instead of the theme of the game. We noticed that Raphael was silent almost all the time, just nodding at the questions we were asking him, seemingly oblivious to the discussion. However, at some point, the boy reflected on his preference for the game "Angry Birds"[5] and brought to the discussion his opinion on what he liked or disliked in games. Through the mediation of researchers and classmates, Raphael created relationships about what was being discussed and his knowledge about games, which allowed him to participate actively and suggest that the game had "stars" and "power to shoot".

The next activity to define the concept of the game consisted of brainstorming. This activity proposes to throw about ideas, not judgments, and then analyze them to define the game. We emphasize, initially, the importance of a script, or story, of a game, which justifies the gameplay and the goals of the digital game. Leonardo raised his hand and suggested: "why don't we use our story that we created and transform into a game?", referring to the story created in the stage of Involvement. The reflection of Leonardo was favored by the activity of reconstitution of the process that was carried out moments before with the children.

The reconstitution of the process was accomplished through the creation of a display in the form of timeline. On it, images and small texts were glued on every month of the activity. The children recognized in the images what they had accomplished, remembered, discussed and pondered about the productions and the results. The reconstitution was resumed at various moments during the creation of the games, always with the purpose of reflecting the lived experience, as we can observe in the evolution of the display throughout the project (Figure 2). According to Cathcart (2017, p. 23, our translation), "The activities carried out, distributed

[5] *Angry Birds* is a series of digital games developed by Rovio Entertainment. In its first version, slings are used to throw the birds and to eliminate the pigs. Official site: https://www.angrybirds.com/.

on the timeline in the form of images of the group's experiences, became elements of self-generated stimulation, capable of promoting behavioral changes and meaningful learning".

Figure 2. Evolution of the process reconstitution timeline
Source: Alves (2017, p. 146, 187, 209).

The group decided to adopt, due to Leonardo's suggestion, the story created at the beginning of the project. We developed an activity adapted from idea cards in which each participant should draw or write an idea for the game, as we can see in Figure 3 (a). This technique consists of distributing some cards and registering simple ideas in each of them, then shuffling them and grouping them into pairs, generating new combinations of ideas (Fullerton, 2014). This activity is democratic, in the sense that everyone can give their opinion, defend it, listen to the opinion of others, and then come to a consensus of what the game should be like.

In order to decide on the main elements and mechanics of the game, we elaborated an evaluation sheet in which each child, researcher and undergraduate student, should express their opinion on the presented ideas. In this sheet, we analyzed the appropriateness of the proposed game to the story, its potential for fun, the attendance to the defined target audience and the complexity of its development. We used stickers that expressed with "faces" and colors - yellow, green and red - to indicate our opinions, as we can see in Figure 3 (b).

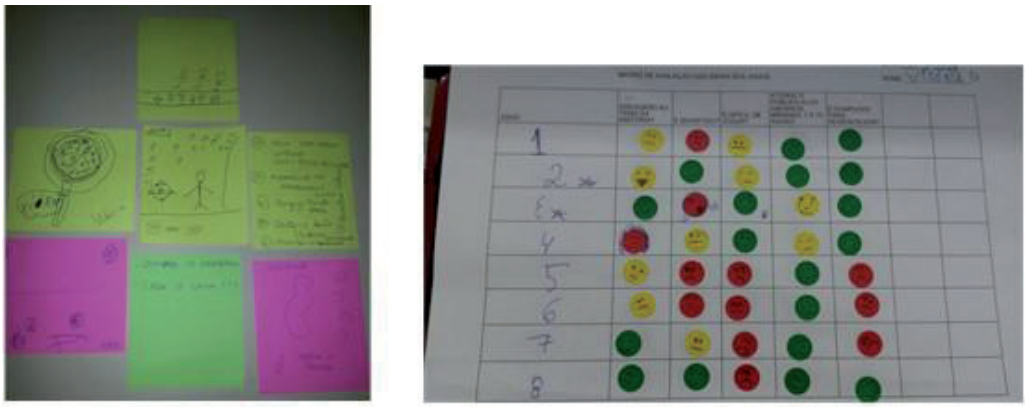

Figure 3. First ideas of the digital game
Source: Alves (2017, p. 151).

The activity of evaluating ideas was particularly interesting, as it revealed preferences, behaviors, likes and dislikes of children. Manuela and Leonardo responded quickly about a certain game, and then wanted to go immediately to the next. Vitória and Raphael, on the other hand, needed help to read the questions and reflect on their opinions. Mediation was important in this task, as we had to lead the group in the same rhythm, requesting that everyone waited for the others in order to evaluate the next game. We also asked Manuela and Leonardo to help Vitória and Raphael; however, in the anxiety of finishing quickly, the children would respond for them rather than assist them. In these interactions, Raphael's position was important, who did not accept that the classmate responded for him, which is revealed in his statement: "Leo only wants to put that green", complaining about Leonardo who would not let him respond. Here we note the importance of what Vygotsky elucidates to us about the collectivity and the need for the participation of the child with disability in a group. To Vygotsky, the incomplete development of the higher functions of the child with disability is a superstructure secondary to the his/her disability:

> 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, 1987, p. 223).

The data reported on the game proposal evaluation sheets were compiled in order to reveal the main aspects of the game that would be built. The exercise valued the ideas of each member of the group and, at the same time, converged on a single idea, or a combination of ideas, selected democratically. The intention was for everyone to reflect on their partners' proposals and to critically appraise their own suggestions. This analysis allowed the following activities to be performed, in order to detail the game.

From the ideas selected for the creation of the digital game, Raphael elaborated some drawings and defined a script in which an evil toy would steal the coins of the game. Raphael revealed in this activity how much he was involved with the creation of the game. He suggested elements proposed by the group - the coins, he included a toy as villain, he built the whole plot. Then Vitória also created her scenarios and presented her ideas. She emphasized in her speech the influence of Raphael's script: "Here is the girl, right? She was sleeping, she slept inside the bed, right? Then there was a little boy who is the little brother, who is Gabriel. He was looking at the coins, he wanted to get her coins to buy something. It was the creepy bed".

Leonardo, who gave the original idea of the game, developed by his classmates through the drawings, suggested that all ideas were used, and concluded: "Otherwise there will be a fight, one wants one, the other wants the other ...".

We emphasized how each one contributed with their ideas and drawings, how the classmates' suggestions helped to build new ideas and Leonardo's concern that all ideas were used in the game. Vygotsky describes a similar experience lived by Tolstoy in a collective literary production with children and concludes:

> Correctly and scientifically understood, the concept of education does not at all mean artificially inculcating children with ideals, feelings, and moods that are totally alien to them. The right kind of education involves awakening in the child what already exists within him, helping him to develop it and directing this development in a particular direction. (Vygotsky, 2004, p. 51).

According to Schuytema (2013), creativity in game design has as its vital resource knowledge in games, their forms and their genres, deconstruction and analysis of the parts, in order to understand how they contribute to the whole of the game. When we started from this assumption, we looked for games that were similar to the ideas of the children so that we could make some experiences and extract more elements for the game to be built. Each child received a tablet or mobile phone with the games to be evaluated: Blocky Raider; Lily's Journey, Creative Fox and Super Chaves World (Alves, 2017). After playing them, they filled out a scorecard in which we identified the following elements of each game: title, goals, characters, enemies, obstacles, interface and functionality. The activity allowed the group to reflect on the games and their elements. Manuela compared the game Creative Fox in terms of mechanics: "*It is the same, very similar to Mario*", referring to Nintendo's Super Mario game; Leonardo pondered about the gameplay of Blocky Raider: "*When the wall opened, a few thorns rose, then we could not pass*", noting the difficulty of the game; Vitória mentioned Lily's Journey interface: "*It had the little arrow that it would take to four sides*"; and Raphael extrapolated the game Super Chaves World imagining Kiko, character of the show "Chaves" [6], as an enemy.

By uniting the ideas of the game to be created with experiences with similar games, the group defined the main elements of the game. They jointly completed a sheet similar to the one completed for the games evaluated. In this activity, many discussions arose, new ideas appeared, details were elaborated. It was defined that the goal of the game would be to collect garbage and with them to assemble recyclable toys. There would be a villain, a trash can, who would want to pick up the garbage collected and stop the player. However, everyone spoke

[6] *Chaves* is a Mexican TV series shown on television.

at the same time, suggestions came out of context, lacking a unanimous understanding of what was being defined. On that day, Vitória, who was always participatory and talkative, was sulking and silent. She left the table and started talking about another game idea, and she moved around the room as if she were the character. As Leonardo watched Vitória, he suggested that we created a play to simulate the game, each one would interpret an item of the game, such as the trash, the obstacles, the character. Intuitively, Leonardo proposed an activity called "Experimental Prototype". The proposed activity started the new phase of the process.

3.2 DESIGN PHASE

The design phase aims to develop the concept of the game, in order to detail all aspects necessary for its implementation. A prototype is a manifestation of design that allows the project participants to experience a particular aspect of the game, emphasizing one set of characteristics over another. They are especially useful for the discussion of ideas, serving as an instrument of communication between designers and users. They may be scaled models, a set of screens, or paper sketches (Rogers, Sharp, & Preece, 2011).

The "Experimental Prototype" technique is an alternative that allows children to validate the game's ideas through a physical simulation, such as a theater play or children play (Buchenau & Suri, 2000 as cited in Moser, 2015). In this activity, the children interpreted the characters and acted as if they were the "game", verified if what was idealized would work in practice, identified difficulties or problems and proposed improvements. This technique facilitated the understanding of the game, especially for children who have difficulty in abstraction, since the game has become "physical" or "real". Figure 4 shows the simulation activity of the game, in which the children took turns in different elements and characters.

Figure 4. Moments of game simulation through experimental prototype
Source: Alves (2017).

In the simulation we observed the so-called "make-believe" that is so necessary to the process of individual and collective imagination, the elaboration and re-elaboration of concepts through language, the bodily experience of the constructed history, the incorporation of differentiated roles in the game, anticipation of the facts thought in the construction of the

history of the game, the search for solutions to the problems experienced, the communion in the creation of signs. As Vygotsky (2007) emphasizes, the sign is produced in the relations between men and, as human production, affects the participants in these relations.

The simulation sparked a problem that became the source of numerous discussions throughout the project: how would the character defeat the enemy Trash can? To this end, innumerable suggestions have emerged that were warmly discussed until a consensus was reached. This was particularly important because it gave rise to the opportunity to solve a problem in a collaborative way. From the questions and the ideas, Raphael took the initiative to draw a solution on the whiteboard (Figure 5). His attitude aroused in Manuela the interest of also drawing a picture on the board, and from that, everyone could decide what would be the best strategy for solving the problem.

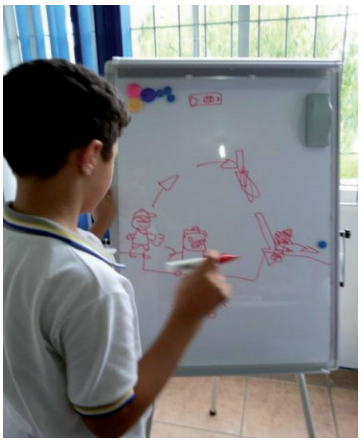

Figure 5. Raphael draws how to defeat the trash can in the game
Source: Alves (2017, p. 200).

The interaction provided in the activity, as well as in many others during the project, is fundamental for human development. To M. K. Oliveira (1995, p. 38), it is through the concrete interpersonal relationship with other men that the individual will come to internalize the culturally established forms of psychological functioning. Vygotsky understands that this culture is a "stage of negotiations" in which concepts and meanings are constantly recreated and reinterpreted.

The next activities consisted of prototyping the characters of the game. The children defined the "controllable" characters - boy and girl -, the "boss" trash can and recyclable toys that would be assembled in the game. For that, we used drawings and prototypes with scraps. They were transposed to the digital media by a designer and evaluated by the group to verify reliability with the project ideas. For example, in Figure 6, we see on the left the creation of a mermaid by Vitória, who initially built the object with scrap and then drew and painted on paper (a), alongside the digital version of the mermaid (b). Vitória also created an elephant, but this time, without the use of concrete material, but by means of drawing, in which she indicated which scraps would make up the animal: PET bottle, spoons, soda straws and cord. The girl demonstrated in this activity her capacity for abstraction, because she could create

something from her imagination, without the need for the concrete signs used in the first character.

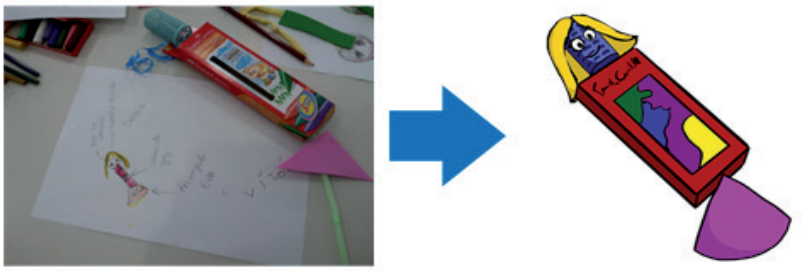

Figure 6. Mermaid created by Vitória
Source: Alves (2017, p. 194, 196)

3.3 Development and evaluation phases

Although they are understood as two different phases, since they have different objectives, development and evaluation occur concomitantly because one generates subsidies for the other, in an iterative process of game development. The first one aims to implement the game designed on the chosen target platform, since the evaluation aims to perform tests of the developed game and refine it until reaching an appropriate level for its release.

The implementation of the game by the Computing undergraduate student was accompanied by the children, who made successive evaluations of the versions of the game, so that they could see the game step by step becoming real in the digital environment. In a first version, there was no scenario, no characters, only placeholders[7], and only the mechanics of the game were tested. This surprised the children; however, it was important for them to realize that the computer would do what was determined, and that the game would not be transported to the machine simply or automatically. The game code was introduced in order for the children to understand that there are programming languages. They altered the values of variables and realized the effect in the game: the character jumped higher or did not get off the ground. They had fun and pointed out the flaws and suggestions for the game to reflect what they had imagined.

3.4 Finalization of the digital game creation process

The "Toys that create life" game was completed, and, according to the children's requirements, it was made available on the Google Play Store to run on mobile devices running the Android Operating System. The final game consists of a platform stage and six minigames. Figure 7 shows some *screenshots* of the game.

[7] Placeholders are graphical objects used during prototyping and are replaced later by graphics created or acquired in a game project.

(a) Interface de início do jogo (b) Lixeira ataca personagem

Figure 7. Images of the game "Toys that create life"
Source: Alves (2017, p. 216).

Some final evaluations were carried out with the purpose of verifying that the game was in accordance with the specifications of the group and allowing a reflection about the whole process to build it. We questioned the children who the authors of the game were. At first, they said it was the undergraduate student. We made the children reflect on what was in the game (characters, toys, a trash can, mechanics, scenery) and who had defined it all. The answer this time changed and they understood that the game had been built by everyone. Here we emphasize the importance of the feeling of protagonism of each child in the process of creating the digital game.

The concept of creating a game was changed throughout the process. Initially, to Vitória, it consisted of "downloading" from the internet; to Leonardo, "copy to a CD". As they were experimenting with the different stages of the process and building the digital game, the children understood what was needed: "*You have to draw, create the scenery, characters*" Leonardo argued. Manuela said: "*I die in front of him*", when she was asked how they could explain the game development process to another person, noting how complex the digital game was.

Leonardo's emotion when he defeated the Trash can for the first time – "Hey! I passed it, I passed it, I passed it, I passed it" – emphasizes the importance in the process of successfully completing the game, because this effectively closes the creative process, the crystallization. Vygotsky, about crystallization, or material form assumed through creative activity, states:

> Such products of the imagination have a very long history, which perhaps it would be worthwhile to outline briefly. One could say that their development takes a circular path. The elements out of which they are constructed were taken by the human inventor from reality. Within the mind of this inventor, in his thoughts, these elements underwent complex reworking and were transformed into products of the imagination. Finally, once they were given material form, they returned to reality, but returned as a new active force with the potential to alter that reality (Vygotsky, 2004, p. 21).

The process of creating the digital game revealed important aspects in the children's attitudes and in the relationship between them all. In the beginning, the group had difficulties in working in team, which we observed in the creation of the story with the scrap toys. Through

the proposed activities and intervention of the researchers, the children began to cooperate more, seeking to contribute their ideas or to complement the ideas of the classmates. When observing the production of a partner, children were often inspired by their productions, and, at other times, they acknowledged the work of their classmates, praising them. Raphael, who at first just stared at the floor, began to verbalize and interact more. Vitória and Manuela had moments of complicity when they celebrated a decision about an idea of the story. Leonardo recognized that everyone's idea needed to be respected. Vitória felt safe to teach the teacher how to play. The group of shy students who met at the beginning of the project became a joyful team that learned to collaborate and respect each other, making it feasible to create the game collectively. It is important to emphasize that this was possible because the approach allowed everyone to participate in an equal way, enabling the children to act in different ways and reveal their skills and abilities, regardless of their disabilities.

The "I've made my game" framework, which aimed at producing the digital game, favored collaborative and mediation actions, which also implied creativity and the consequent production of artifacts. However, this is not a linear movement; on the contrary, they are complex relationships that have been established at every moment during the interaction with the children. It means that collaboration can generate creativity, which favors mediation, which, in turn, facilitates collaboration, and so on.

4 Conclusions

In view of the objective of discussing the use of game design as an educational approach to the development of the intellectual and creative capacity of schoolchildren, the research started from the hypothesis that a collaborative and mediated methodological process allows the creative performance of children with and without disabilities in the development of digital games. To do so, we defined a framework, called "I've made my game", which contemplates all the design and pedagogical stages necessary for the development of digital games in the school context, including children with intellectual disabilities.

The adoption of Design-Based Research was determinant because it allowed the specification of the framework insofar as the activities were developed with a group of children of the third grade of Elementary School. We adopted concepts from the area of games and computer design, as well as studies that use game design as a pedagogical approach, but it was in the practice of the school that the process was established as the skills and difficulties of the children faced with the challenges were considered.

In this process, researchers and research built the path, redesigned stages and negotiated meanings. In this experience, or in this "stage of negotiations", as Vygotsky (2008) would say, imagination and creativity were built collectively, between peers, but they were woven with the threads of subjectivity of each child, who, in their own way and with their experiences, was positioned by him/herself and demarcated his/her authorship in the creation.

The investigation experience sought to highlight not only the methodological process of creation, but also the protagonism of the children in building solutions for the game. When we considered the objectives of the research, we identified, in the configuration of the process and its practice, results and primordial conceptions, namely: (i) the differentiation, that is,

the configuration of a group of children with the same school age, but with characteristics of differentiated learning; (ii) collectivity, collaboration and experience as guiding principles in all design decisions; (iii) mediation, in which the researchers had a relevant role in the construction of the creative repertoire, based on the elaboration and re-elaboration of concepts and the development of technological skills; (iv) the use of design techniques to drive creative processes and game development, resulting in ways of thinking based on the use of tools; (v) the exploration of different forms of literacy - corporeal, imagery, iconographic, sonorous, written, computational; and (vi) the institution of collective practices of recording and reflection on what was accomplished in order to decide the next steps.

In Raphael, Vitória, Manuela and Leonardo's narratives, the evidence of the principle of sharing and reflection, which consists of thinking about their own ideas and their classmates', about the development process and the products constructed – "*we must draw, create the scenery, characters*" - says on how to build a game. "*Testing was missing!*", Leonardo pointed out after evaluating some digital games that did not work. All ideas will have to be used, Leonardo concluded – "*Otherwise there will be a fight, one wants one, the other wants the other*". "*I die in front of him*", said Manuela when asked how she would explain the process of developing the game to another person, noting how complex it was to develop the digital game. In these narratives, the children demonstrated their learning, reflected on the lived experiences, constructed new concepts, used different languages, exercised their freedom and respect for the other.

In another perspective, researchers from different areas - design, education and computing - learned to share knowledge, mediate individual and collective creation processes and learn from children. They also built new concepts in game design and recognized creativity and collaboration as a vital resource for their development and interface with contemporary education.

References

Alves, A. G. (2017). *Eu fiz meu game: Um framework para criação de jogos digitais por crianças* (Doctoral dissertation). Universidade do Vale do Itajaí, Itajaí, SC, Brazil. Retrieved from https://www.univali.br/Lists/TrabalhosDoutorado/Attachments/142/Adriana%20Gomes%20Alves.pdf.

Alves, A. G., & Lamim, T. B. (2015, November 11-13). Criança co-criadora de jogos digitais: um estudo de caso com aplicação da abordagem do Design Participativo. *Paper presented at the Simpósio Brasileiro de Jogos e Entretenimento Digital*, Teresina, PI, Brazil, 14. Retrieved on January 5, 2016 from http://www.sbgames.org/sbgames2015/anaispdf/artesedesign-full/147376.pdf.

Amiel, T., & Reeves, T. C. (2008). Design-Based Research and Educational Technology: Rethinking Technology and the Research Agenda. *Journal of Educational Technology & Society,* 11(4), 29-40.

Bamberg, M. (2012). Narrative Analysis. In U.-D. Reips, & H. Cooper (Eds.), *APA handbook of research methods in psychology: Research designs: Quantitative, qualitative, neuropsychological, and biological* (Vol. 2, pp. 291-310). Washington, DC, US: American Psychological Association.

Barab, S., & Squire, K. (2004). Design-Based Research: Putting a Stake in the Ground. *The Journal of the Learning Sciences,* 13(1), 1-14.

Baumgartner, E., Bell, P., Hoadley, C., Hsi, S., Joseph, D., Orrill, C., . . . Tabak, I. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher,* 32(1), 5-8.

Börjesson, P., Barendregt, W., Eriksson, E., & Torgersson, O. (2015, June 21-24). Designing technology for and with developmentally diverse children - A Systematic Literature Review. *Proceedings of the International Conference on Interaction Design and Children – IDC*, Boston, MA, USA, 14. doi:10.1145/2771839.2771848.

Cathcart, K. D. (2017). *Criação de jogos digitais por crianças: Processos colaborativos de aprendizagem na escola inclusiva* (Doctoral dissertation). Universidade do Vale do Itajaí, Itajaí, SC, Brazil. Retrieved from https://www.univali.br/Lists/TrabalhosDoutorado/Attachments/143/Karla%20Demonti%20Passos%20Cathcart_.pdf.

De Paula, B. H., Valente, J. A., & Hildebrand, H. R. (2016). Criar para aprender: Discutindo o potencial da criação de jogos digitais como estratégia educacional. *Tecnologia Educacional,* 54(212), 6-18.

Fullerton, T. (2014). *Game design workshop: A playcentric approach to creating innovative games* (3rd ed.). Boca Raton: CRC Press.

Herrington, J., Mckenney, S., Reeves, T. C., & Oliver, R. (2007). Design-based research and doctoral students: Guidelines for preparing a dissertation proposal. In C. Montgomerie & J. Seale (Eds.), *Proceedings of EdMedia 2007: World Conference on Educational Multimedia, Hypermedia & Telecommunications* (pp. 4089-4097). Chesapeake, VA: AACE.

Hostins, R. C., Alves, A. G., Frisoni, B. C., & Mendes, G. (2014). *Tecnologias Assistivas Digitais: inovação e acessibilidade em jogos digitais para pessoas com necessidades especiais.* Itajaí: Univali.

Kafai, Y. B. (2006). Playing and making games for learning: Instructionist and constructionist perspectives for game studies. *Games and Culture*, 1(1), 36-40. doi:10.1177/1555412005281767

Li, Q. (2014). *Learning through digital game design and building in a participatory culture: An enactivist approach* (Vol. 14). New York: Peter Lang.

Moser, C. (2015). *Child-Centered Game Development* (Doctoral dissertation). University of Salzburg, Salzburg, Austria.

Novak, J. (2011). *Desenvolvimento de Games* (2nd ed.). São Paulo: Cengage Learning.

Oliveira, M. K. (1995). *Vygotsky: Aprendizado e desenvolvimento - um processo sócio-histórico* (2nd ed.). São Paulo: Scipione.

Oliveira, M. R. (2014). Revendo a discussão: Do mito da tecnologia ao paradigma tecnológico. In R. H. Tavares, & S. D. Gomes (Eds.), *Sociedade, educação e redes: Desafios à formação crítica* (1st ed., pp. 155-172). Araraquara, SP: Junqueira&Marin.

Pletsch, M. D., Lunardi-Mendes, G. M., & Hostins, R. C. (2012). *A escolarização de alunos com Deficiência Intelectual: Políticas públicas, processos cognitivos e avaliação da aprendizagem.* [n.l.]: UFRRJ, UDESC, UNIVALI. Project funded with CAPES resources.

Prensky, M. (2012). *Aprendizagem baseada em jogos digitais*. São Paulo: Senac São Paulo.

Rogers, Y., Sharp, H., & Preece, J. (2011). *Design de Interação: Além da interação humano-computador* (3rd ed.). São Paulo: Bookman.

Schmidt, A. F., Alves, A. G., & Hostins, R. L. (2013). *Desenvolvimento de soluções em interação para jogos digitais acessíveis.* Itajaí: UNIVALI.

Schuytema, P. (2013). *Design de Games: Uma abordagem prática.* São Paulo: Cengage Learning.

Sommerville, I. (2011). *Engenharia de Software* (9th ed.). São Paulo: Pearson Prentice Hall.

Vygotsky, L. S. (1987). *The collected works of L. S. Vygotsky - Volume 2: The fundamentals of Defectology*. New York, Boston, Dordrecht, London, Moscow: Kluwers Academic/Plenum Publishers.

Vygotsky, L. S. (2004). Imagination and Creativity in Childhood. *Journal of Russian and East European Psychology*, 42(1), 7-97.

Vigotsky, L. S. (2007). *A formação social da mente: O desenvolvimento dos processos psicológicos superiores* (7th ed.). São Paulo: Martins Fontes.

Vygotsky, L. S. (2008). *Pensamento e linguagem* (4th ed.). São Paulo: Martins Fontes.

Vigotski, L. S. (2010). Quarta Aula: a questão do meio na pedologia. *Psicologia USP, 21*(4), 681-701.

Wang, F., & Haffanin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational technology research and development,* 5, 1-6. doi:10.1007/BF02504682.

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