Journal of the Brazilian Computer Society, 2024, 30:1, doi: 10.5753/jbcs.2024.3114

Promoting Children's Participation in a Participatory Design Process in a Rural School: A new role needed?

Dyego Carlos Sales de Morais [**Federal University of Pernambuco** | ***dcsm@cin.ufpe.br***]
Taciana Pontual Falcão [**DC/Rural Federal University of Pernambuco** | ***taciana.pontual@ufrpe.br***]
Patrícia Tedesco [**Federal University of Pernambuco** | ***pcart@cin.ufpe.br***]

Informatics Center, Federal University of Pernambuco, Av. Jornalista Anibal Fernandes, s/n, Cidade Universitária, Recife, PE, 50740-560, Brazil.

Received: 17 January 2023 • **Accepted:** 12 October 2023 • **Published:** 05 June 2024

Abstract In Brazil, Education of Rural Areas is a model which started with social movements and became a public policy with the aim of improving participation of people of rural areas in making decisions about the model of their education. Schools in that context need to improve access to scientific and technological knowledge, but ensuring that previous values and knowledge of the students about agroecology and sustainability are considered. Even though some studies focus on digital inclusion and teacher training to use technologies in rural schools, very few address the development of digital technologies by students themselves, in this context. Participatory Design (PD) is a method often used to develop technological artifacts that could help address this gap. Of particular interest in the context of Education of Rural Areas, PD includes a valid preoccupation with power balance between designers and target users in decision-making. However, this power balance is still hard to attain, even more when design involves vulnerable groups, like children. In this sense, models and frameworks of children's participation can give a more solid theoretical framing for PD with children. In this paper, we present a theoretical model for supporting PD with children which was drawn from theories of children's participation, and refined through its application for qualitatively analysing a design process of digital educational artifacts with children from rural schools in Brazil. We highlight children's autonomy in the creation of artifacts within a process managed by adults, which we interpret as a new role of children in PD which emerged from the educational context, that is children as artifact designers. The model proposed can be used for researchers and designers to plan or to analyse children's participation in PD interventions, helping them to employ methods that promote their autonomy and participation.

Keywords: Participatory Design, Children Participation, Rural Schools.

1 Introduction

In Brazil, there are two main educational models for rural contexts: education *in* rural areas, and Education *of* Rural Areas[1]. In the former, the urban educational model is transposed to rural areas, often serving interests of forming a cheap labour force with no critical behaviour, for the agriculture and livestock industries [Ribeiro, 2012]. When we refer to Education of Rural Areas, we mean an educational model which emerged from social movements' claims for public policies that ensure a participatory educational practice, built in partnership with the subjects from the rural territories, strengthening agroecology and family agriculture, and connected to daily life and human and social needs [Caldart, 2012].

National legislation and policies are in place to ensure the rights of rural populations to this educational model [Molina, 2012], but there is a lack of appropriate and specific educational material to be used [Molina, 2014], and in particular digital technologies (like mobile applications, educational games, etc.) developed by the rural population themselves. Aiming at addressing this gap, and strongly aligned with the ideology of Education of Rural Areas, our research project seeks to promote the participation of children from rural schools in the development of educational digital technologies which could be used in their contexts.

Including target users in the design of digital artifacts has been extensively discussed in Human-Computer Interaction (HCI), with rather consensual benefits [Rogers *et al*., 2011]. However, as the methods for involving users in design develop, the theoretical and philosophical perspectives for doing so also become more distinct. Including users in design mostly to achieve product's efficacy evokes an instrumental approach of participation, where it is viewed as a processual strategy for reaching an end [Bordenave, 1994]. But participation also can be emancipatory, enabling democratic experiences [Amstel, 2009], and related to affective and ontological perspectives, i.e. as means to obtain satisfaction and pleasure from doing an activity with others [Bordenave, 1994]. Different theories on participation reflect in HCI with movements from the more traditional efficacy-oriented method of user-centred design (UCD), to more power-balanced approach like co-design, and the even more "empowering" ideology of participatory design (PD) - each of them carrying their own methodological challenges.

Challenges around participation and power balance become greater when design is to be performed with vulnera-

[1]These expressions were freely translated from Brazilian Portuguese (*Educação no Campo* and *Educação do Campo*). In the Education area, the terms are consolidated and representative of different ideological views.

ble groups, like minorities, elderly people, and children. According to Druin [2002], who has performed longitudinal projects on designing with children, their participation is limited by the adults' view that they are incapable of making relevant contributions. Thus, their voices end up being replaced by those of their legal guardians or teachers, when in educational settings. Typically, they are involved in the initial phases of ideation, but rarely take part in actual decision-making about the artifacts [Landoni *et al*., 2016]. In this sense, Read *et al*. [2016] criticise some studies which claim to conduct Participatory Design (PD), but limit children's participation to short specific sessions, which prevent them from exchanging experiences with designers as well as from having a direct say about the result of the design process. Frauenberger *et al*. [2015] point to the need for studies about designing with children to be evaluated not only with regard to tangible results in the artifact's design, but also regarding their epistemology and the values children experience during the process.

In this paper, we apply a theoretical model which combines several theories on children's participation with children's roles in PD to a design process with children from a rural school in Brazil. This work extends a previous publication [Morais *et al*., 2022], at the Brazilian Symposium on Human Factors in Computing Systems, in 2022, where the model was presented and we illustrated how it could be used as a theoretical framework for analysing children's participation in design, helping to identify mismatches between project goals and actual situations in the process (particularly focused on decision-making); and to find ways of promoting children's autonomy. Here we apply the model, analysing a whole set of data from one school of the project, and, drawing on that, we create an extended model, with a new role of a child as artifact designer. So, the main contribution of this paper is the model built from literature and data analysed here and it goals to contribute with research projects that develop PD with children, by: serving as theoretical foundation, supporting planning of activities and methods, and guiding the qualitative analysis and interpretation of data.

In the next section, we present the model, based on relationships between theories on children's participation and children's roles in participatory design. In Section 3, we present our case study, with the results of the theoretical model's application. In Section 4, we present the extended model and discuss the main updates. We conclude the paper in Section 5, discussing the results of our case study, and pointing out ideas for future work.

2 Model of Children's Participation in the Design of Digital Artifacts

The model we propose is rooted on the key theories about children's participation [Hart, 1992; Shier, 2001; Treseder, 1997; Lansdown, 2005; Kirby *et al*., 2003; Trilla and Cámara, 2001], combined with roles of children in PD proposed in HCI literature. In this section, firstly we present such theoretical foundations of our model, and then establish relationships among them.

2.1 Children's participation

Participation can be interpreted as a result per se, or as a processual strategy to obtain something [Bordenave, 1994]. Nevertheless, there is a certain consensus that participation occurs when we are part of some social practice [Bordenave, 1994], especially when it is relevant for those taking part, and they have a voice in decision making [Hart, 1992]. Examples of social practices include citizens' claims for changes in their neighbourhood; collective processes of development of a digital game; and educational group activities - all of which involve collaboration and different possible roles.

There are several theories that focus specifically on child participation. They typically refer to people who are 0-18 years of age, and, accordingly, usual contexts of investigation are schools, community groups and other organisations or informal groups, excluding families [Hart, 1992]. Shier [2010] organised theories on children's participation in eight axes of analysis, including context, spaces and levels of participation. In this paper, we focus on the theories pertaining to the axis on levels of children's participation.

In rural contexts, most studies about children's participation use PRA (participatory rural appraisal) [Chambers, 1994] which is an extension of RRA (rapid rural appraisal). RRA is a consultative approach to improve the researchers' knowledge about the context through data collection and analysis, for their own use. On the other hand, PRA aims to involve people who live in the context of the research to participate throughout the whole process of appraisal, by collecting, analysing and using data for changing their own reality through collective actions. In PRA the researchers (outsiders) are facilitators of the process.

PRA has been applied with children with various goals, such as finding means to create libraries for schools in Nigeria [Osuchukwu and Edewor, 2016] and validating it as a low-cost method for identifying children who are socially perceived as having disabilities in a community in Kenya [Gona *et al*., 2006]. In Nigeria, PRA resulted in book donations which were distributed to all the rural schools in the community, even those without space for a library. And in Kenya, where the application of PRA resulted in an appointment that the PRA can serve as a base for rehabilitation based on a community, as an alternative to more costly surveys, carried out without the community's participation. Despite these applications of PRA with children, we did not find any models of levels of children's participation.

As we focus on levels of children's participation, one of these theories, Hart's Ladder of Participation [Hart, 1992], adapted from Arnstein's Ladder of Citizen Participation [Arnstein, 1969] has had a key role in promoting research in the field, through a document written for the United Nations Children's Fund (UNICEF). Hart [1992] argues that children's level of participation varies according to their developing motivations and abilities, and family and cultural context. Hart's Ladder of Participation [Hart, 1992] has three degrees of non-participation, and the following five degrees relate to genuine participation [2]. Next, we describe the first

[2] Hart used the term genuine participation to differentiate his ladder's five degrees of participation from the first three degrees of non-participation. So, genuine participation can be read as only participation, but we chose to

three degrees:

Manipulation: children are consulted by adults, but do not receive feedback nor share the process of analysis of their drawings or opinions. In the end of the process, results are presented by adults as if the ideas had been developed by children.

Decoration: children wear certain clothes, sing or dance in an event, but do not take part in its organisation, or understand the causes. Children are used to bolster the cause, but, different from Manipulation, adults do not pretend that the cause is inspired by children.

Tokenism: children seem to have a voice in the process, but their opinions are not truly taken into account. They do not have a choice about the subject or how to communicate it, and have little or no opportunity to formulate their own opinions.

Some barriers for children's participation go beyond direct imposition from adults who manage the projects in which they are involved. For instance, the endemic culture of non-participation in society [Matthews, 2003] and children's choice between taking responsibilities in decision making and playing through their childhood [Percy-Smith, 2005]. Shier [2001] presents the following reasons for children's non-participation: lack of confidence, low self-esteem, shyness, previous experiences where they were not heard, and lack of culture of participation.

For Hart [1992], the necessary requirements for a project to be considered participatory are: children understand the goals of the project; they know who took the decisions related to their involvement and why; they have a meaningful (not "decorative") role in it; they volunteer for the project after it has been explained to them. These requirements are reflected in the next five degrees of the model, which refer to genuine participation:

Assigned, but informed: first degree of authentic participation, where children are assigned a specific role and are informed of the reasons for their participation and how it takes place.

Consulted and informed: children are consulted and give advice about projects or programs elaborated and executed by adults. Children know how their contributions will be used and are informed of the results of the decisions made by adults.

Adult-initiated, shared decisions with children: adults have the initial idea, but children are involved in every phase of planning and implementation of the project. They are part of the group of people responsible for decision making.

Child-initiated and directed: children have the initial idea and decide how the project will take place, while adults are available to help, but do not have a specific role in the project. This situation is very common in children's play, where children determine their own rules, but rare in broader projects, where adults tend to direct children.

Child-initiated, shared decisions with adults: projects or programs are initiated by children and decision making is shared with adults. Adults assume the role of 'animating'[3] and encouraging children's initiative, and children can make decisions from interacting with adults and learning from their experience.

Hart's Ladder of Participation [Hart, 1992] became a starting point for the analysis of child participation, being subject to criticism and improvements over the years, including revisions by the author himself [Hart, 2008]. Most criticism refers to the representation in the form of a ladder, which implies a growing sequence [Reddy and Ratna, 2002] and value hierarchy [Boyden, 1997], which is not necessarily the case: a rung of the ladder does not necessarily lead to the next higher one. Furthermore, the order of the rungs is problematic itself, as a process initiated and directed by children should probably be the highest level of participation, instead of children's initiative with decisions shared with adults [Ackermann *et al*., 2003]. Hart [2008] acknowledges some of the criticism and adds new contributions, highlighting: the need to think more broadly about how children participate in society; the importance of adopting different theories to evaluate children's participation in projects; and the need for new theoretical models.

Despite criticism, or building on it, several other researchers evolved Hart's degrees of genuine participation. Treseder [1997] considers the same five degrees, but represents them in a circular, non-hierarchical way, arguing that participation is dependent on the context and the categories placed lower in Hart's ladder are not necessarily faulty or inadequate. Based on Hart's ladder, agreeing with him that children have many spaces in their lives where they should be able to participate, Lansdown [2005] identified the following types of broader, non-exclusive processes:

Consultative processes: adults acknowledge children's opinions and experiences, but initiate, direct and manage the whole process without giving children the chance of controlling the results;

Participatory processes: initiated by adults, but counting with children's collaboration. Children can influence the process and express their questions and doubts about its conduction;

Self-initiated processes: adults are facilitators, but children control the process, with the power to take action and determine which issues will be addressed.

Another theory which also builds on Hart's ladder is from Trilla and Cámara [2001], classifying participation in:

Simple: children are present in the activities, being only spectators or performing actions that were planned without their intervention. They are seen as "recipients" of the activities.

Consultative: children have the opportunity to give their opinions, however there is no guarantee that they will influence project decisions.

Projective: children are "agents" in the projects, which are also theirs to plan and direct. This entails more commitment and responsibility.

Meta Participation: children themselves ask, demand or generate new spaces and mechanisms for participation, claiming to have their voices heard.

Also based on Hart [1992], Shier [2001] proposed the following levels of children's participation:

Children are listened to;

keep the author's term.

[3]'Animator' is the term used in some countries to describe the kind of professional who knows how to give life to the potential in young people.

Children are supported in expressing their points of view;

Children's points of view are taken into consideration;

Children are involved in decision making;

Children share power and responsibility in decision making.

Shier's model [Shier, 2001] also proposes three questions to assess the degree of commitment for each level of participation of a certain initiative, and how the organisation must evolve to be more supportive of children's participation: opening - are adults ready?; opportunity - are the resources, skills and knowledge necessary for new procedures met?; obligation - is there a requirement determined by the organisational policy? Shier's model [Shier, 2001] is represented as a matrix, with levels of participation as lines and degrees of commitment as columns, which maintains a certain hierarchy but is more fluid than Hart's ladder [Hart, 1992].

Kirby *et al*. [2003] adapt Shier's model excluding the first two levels (children are listened to; and children are supported in expressing their views) and adding the level: **children make autonomous decisions**. However, the authors recognize that often children require adults' contribution, and decisions depend on structures and adults' responsibility and power. Kirby *et al*. [2003] visual representation moves away from Shier's pathway [Shier, 2001] towards a more circular model like Treseder's [Treseder, 1997].

The typologies of children's participation presented so far can be visualized in the upper part of Figure 1, grouped by colour and labels from 1 to 4. Hart [1992], Treseder [1997], Shier [2001], Kirby *et al*. [2003] and Lansdown [2005] categories are placed under the four broader levels of participation proposed by Trilla and Cámara [2001]: simple, consultative, projective and meta participation [Trilla and Cámara, 2001]. The last rung of Hart's ladder [Hart, 1992] and the level proposed by Kirby *et al*. [2003] are situated between projective and meta participation, given that children tend to demand new spaces for participation when they initiate projects autonomously. Children's roles at the bottom of Figure 1 are discussed in the next section.

All of these theories on children's participation, despite dating of the decades of 90 and 2000, remain important and consolidated sources of reference. Particularly, the specification of roles of adults and children, and the recommendations for promoting higher levels of children's participation, are important contributions for projects seeking to effectively implement Participatory Design (PD) in the design of digital artifacts with children.

2.2 Participatory Design with Children

Participatory Design emerged in the 1970's in Scandinavia, from the partnership between unions and universities, as a reaction to the unemployment caused by industrial automation in factories. In this context, PD disseminated the respect to the worker's previous knowledge, involving them in the decision-making processes in the design of systems that they would use once finished [Spinuzzi, 2005]. Ehn and Kyng [1991] argue that the context in which PD started had elements that contributed to the discussion about democracy in a group, organisation and social levels, for instance that workers had excellent education, high syndication levels and adherence to marxism and a political ideology.

After the initial experiences, PD was used with different purposes, including in projects with children. It had three main trends: The first is the typical trend that aims at the project's success, by including end users in the construction process; the second is that children are entitled to shape the design of technologies they (and their peers) will use; the third is that children can benefit from the choices they make and from the learning they will have during the process, from the process in itself as well as from the technology control [Antle and Hourcade, 2022].

The current societal power structure is that children have to learn it all, and adults know everything to teach them. PD emerges as a possibility to provide democratic experiences to both adults and children, enabling them to exchange knowledge while interacting in a better balanced power fashion. However, even in such settings, researchers-designers struggle to give up the deeply rooted paternalistic attitude which springs from the perception that children are unable to provide valid contributions [Druin, 2002]. This perception, along with the fact that ethical requirements are more complex when doing research with children, often make researchers-designers resort to parents and guardians for consultation about the children [Druin, 1999].

With respect to the participation of children in PD, Druin's work [Druin, 2002] is pioneer in the area, categorising children's participation roles in technology production processes as: users, testers, informants, and design partners. As users, children interact with an already developed artifact, at the beginning or at the end of a design process, while being observed by researchers, who aim to understand the factors involved in the child-technology interaction, to, for instance, develop another artifact that bears refinements on the one observed. As testers, children test low, medium or high fidelity artifacts not yet made available to other users outside the design process, while designers analyse the interaction in order to support the development of improvements of functionalities. As informants, children work as consultants, providing ideas and opinions during the design process, while adult designers decide what to do with such information. As design partners, children contribute with ideas during the whole process, since they are considered to be important actors in the project, thus establishing a collaborative relationship with the adults and corroborating to mutual learning.

In the specific case of the educational context, Druin and Fast [2002] designed some roles of children in PD too. As learners, children explore, contribute and understand the invention process, similar to a classroom work. As critics, children recognize positive and negative points in inventions and can suggest changes, similar to informants. As inventors, children suggest new ideas for inventions, with the expectation that adults develop their ideas. As design partners, in an educational context, it is expected that children act similarly to the general context, sharing power decisions with each other and adults.

Based on Druin's work [Druin, 2002], other researchers have contributed both to the roles taken on by adults as well as to other possible roles for children. Yip *et al*. [2017] have drawn attention to the roles taken on by adults. When chil-

dren are design partners, so are adults, but when children are users, testers and informants, adults are, respectively, observers, test facilitators and interpreters. Such dyads are based on anthropology, psychology and sociology. The partnership process is dynamic, and it is necessary that adults seek an equilibrium with children in all roles taken on during the design process. To that end, the authors have proposed the following dimensions: facilitation, relationship building, design-by-doing, and elaboration. From the authors' perspective [Yip *et al*., 2017], facilitation is the most frequent role by adults; relationship building may be the most unbalanced; and the last two are the most balanced, with adults and children sharing demands and ideas. Adults' roles bring the intergenerational theme to the core of the debate, as well as the projective category of theories on child participation (see Projective column in Figure 1), with power sharing in the decision making between children as adults.

Besides the roles suggested in Druin [2002], other children's roles in PD were proposed, namely: process designers [Schepers *et al*., 2018], co-researchers [van Doorn, 2016] and protagonists [Iversen *et al*., 2017]. As process designers, children have power over process adaptations, moderating or performing activities moderated by adults. According to Schepers *et al*. [2018], authors that proposed this role have not specified the adults' role, although they state that the design process is an intergenerational activity. Thus, in this paper, we use the term "process co-designer" for both adults and children.

As co-researchers, children contribute by analysing data collected from their own practices [van Doorn, 2016]. As protagonists, they autonomously execute the whole design process, developing reflection skills about the technology and design abilities [Iversen *et al*., 2017]. When children are protagonists, adults encourage them to be the main guides of the process.

Several studies were performed in rural global south contexts (e.g. Kam *et al*. [2006], Lamichhane and Read [2020]), but only the work of Hussain [2010] brings considerations about child roles, which is the focus of our research. Hussain [2010] interviewed rural Cambodian children who used prosthetic legs in order to build better prosthetic legs from an understanding of their pains and needs. Children were invited to draw or write their opinions and wishes about their prosthetic legs, and give their feedback about prototypes developed by the researchers.

From this study, Hussain [2010] generated a design participation ladder, based on Hart's Ladder [Hart, 1992] and Druin's roles of children in PD [Druin, 2002]. For Hussain [2010], children can be included, when they are observed while testing products or prototypes, but are not given many opportunities to share views on needs and desires; consulted, when they are asked about their needs and desires, but are not directly included in the design process; and empowered, when they learn design skills and take part in developing new solutions. When children are only included, adults are the ones consulted to make decisions; when children are consulted, adults put efforts into finding ways for children to express their views according to their culture and level of development; and when children are empowered, adults put great effort into seeking and understanding children's opinion, and giving real possibilities for children to influence the end product.

In the case study, as children were only interviewed about their needs and the prototypes, and invited to draw about their prosthetic legs, they were only included and consulted. Hence, the author did not analyse situations of children's empowerment. Subsequent works of the author have not pursued the investigation of child roles based on Hart's ladder - instead they moved on to studying what they called "psychological empowerment" [Hussain *et al*., 2012].

Hagen *et al*. [2012] and Alhatem [2019] systematize the four roles proposed by Druin and Fast [2002], of the child as user, tester, informants and design partner, as well as the three from Hussain [2010],of the child as included, consulted and empowered. Hagen *et al*. [2012] and Alhatem [2019] agree that when children take on the role of design partner they are empowered and when they are users they are included. However, the authors do not agree in their understanding of the roles of testers and informants. While testers, Alhatem [2019] interpret them as being included, while Hagen *et al*. [2012] consider them to be consulted and while informants, Alhatem [2019] interpret them as consulted, while Hagen *et al*. [2012] consider them to be empowered. In our point of view, we agree with Alhatem [2019], since while testers, the children do not express themselves freely, are not consulted but included, and as informants they do not have the decision making power, and are thus not empowered, and only consulted.

All of the roles of children in PD presented in this section are shown at the bottom of Figure 1.

2.3 Model from theory

Our theoretical model (initially proposed in Morais *et al*. [2021b]), shown in Figure 1, relates the constructs originated in children's participation typologies (Section 2.1) and the roles played by both children and adults in the design process (Section 2.2). The goal of the model is to contribute with research projects that develop PD with children, by: serving as theoretical foundation, supporting planning of activities and methods, and guiding the qualitative analysis and interpretation of data.

When the child is included as a user, a learner or a tester, their participation is simple. In other words, they are assigned a function and carry them out, while researchers/designers watch them and take notes or guide/facilitate the test. In the educational context, they demonstrate that they are learning something or doing a task oriented by an adult, like a classwork. When the child is consulted as an informant, critic or inventor, their participation is consultative, since in this role, they are only consulted to talk about the artifact under development, but do not have power to make decisions like adults. When they are empowered as a design partner or co-researcher, their participation is mainly projective, since in those conditions they have more responsibility than in other roles, but do not demand new participation spaces.

Some roles taken by children are located on the borders between children's participation levels. One such example is when the child is a process co-designer or a protagonist, since their participation may be projective and/or meta-

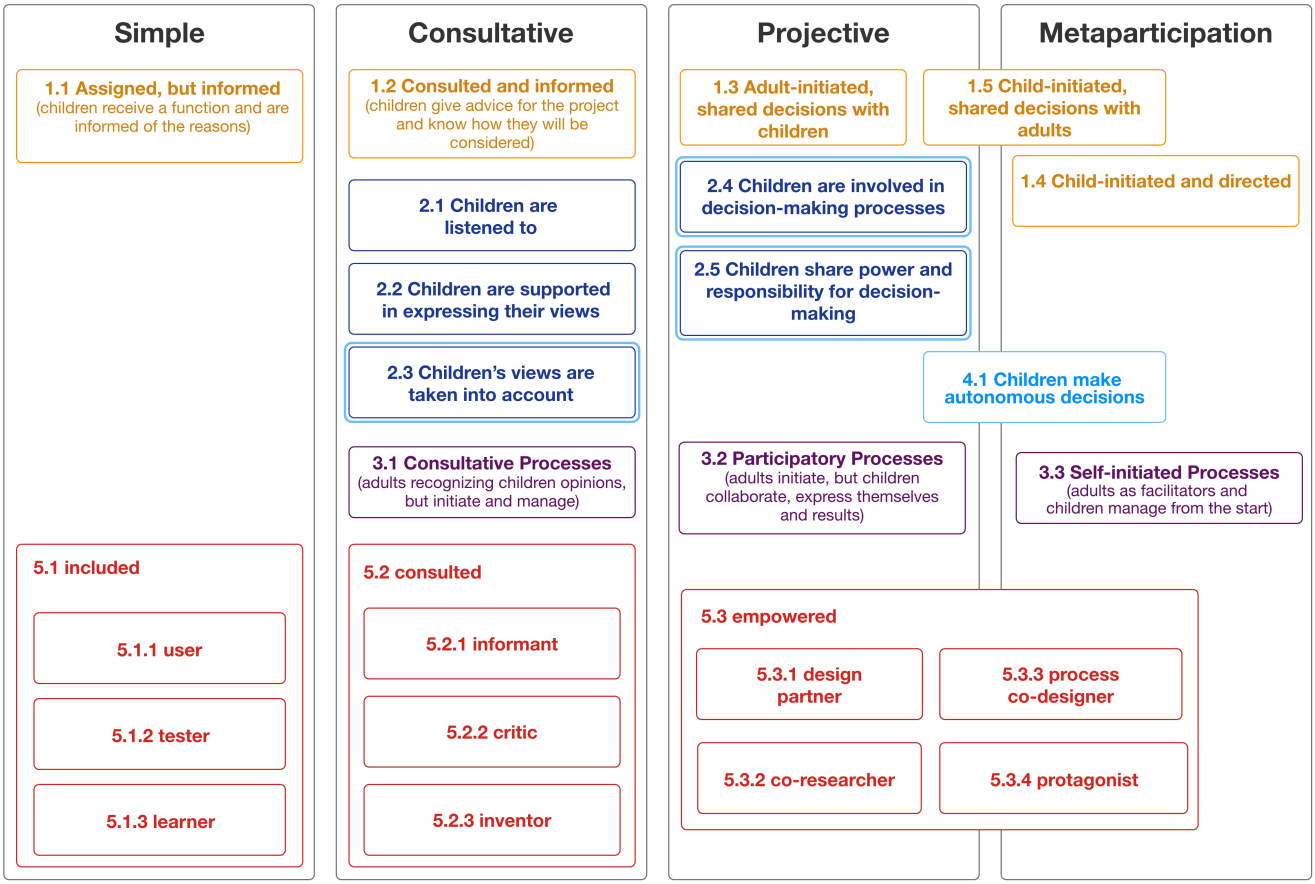

Figure 1. Theoretical model with child participation typologies and children roles in PD. The theory of Trilla and Cámara [2001] is represented in the four larger boxes. The elements labelled with 1 refer to Hart's theory [Hart, 1992]; with 2, to Shier [2001]; with 3, to Lansdown [2005]; with 4 and the last three with 2 (2.3, 2.4 and 2.5), to Kirby *et al.* [2003]; and with 5, roles of children in PD [Druin, 2002; Hussain, 2010; van Doorn, 2016; Iversen *et al.*, 2017; Schepers *et al.*, 2018].

participatory, due to the fact that they have more responsibility and share decision power with adults, and thus may demand new participation spaces, this being one of their objectives as protagonists. In these cases, they are empowered too.

While there is a greater concentration of children's participation levels in the consultative and projective types (Figure 1), the majority of children's roles in PD concentrates on projective participation. We can also observe a growing interest in children's roles to promote more autonomy, since the roles proposed by more recent works (process co-designer [Schepers *et al*., 2018] and protagonist [Iversen *et al*., 2017]) fit in meta participation.

For researchers who want to use the model to apply PD with children, we pinpoint the importance of considering the best type, level and child participation role for each context of application of PD with children, instead of trying to determine the levels and roles that promote children's autonomy the most, or building a hierarchy of roles, regardless of each project's goals. It should be noted that meta participation tends to be more seen in child play [Hart, 1992], without goals or well-defined criteria to design an artifact. Furthermore children may execute, with more or less satisfaction, a role and participation level in different contexts, or due to personal characteristics.

Such remarks are important so that we do not impose responsibilities that are too heavy for children to bear, but instead, practise attentive listening to their ideas, opinions and demands, including when those refer to new leisure spaces and/or participation.

Although we have found works in the rural context, they did not emphasize the children's participation level, nor the children's roles. The work closer to ours was that of Hussain [2010], despite the fact that its focus is a psychological empowerment model.

3 A Case Study

In order to validate a possible use of the proposed model, we present how it may be employed for qualitative analysis, applying it to video data collected from DEMULTS-Campo. DEMULTS-Campo is an action-research [Merriam and Tisdell, 2015] project[4] based on a historical cultural approach [Morais and Rocha Falcão, 2019] [Morais *et al*., 2021a]; [Peres *et al*., 2020] and is organised as interventions through communities of practice formed by students and researchers, with the goal of co-designing and co-developing digital educational artifacts. In this process, students are encouraged to develop their computational thinking, design abilities, self-management and autonomy, besides learning about the specific contents of each artifact. DEMULTS-Campo is strongly aligned with the ideology of Education of Rural Areas, seeking to promote the active participation of children from rural schools in the development of educational digital technologies which could be used in their contexts.

3.1 Data Collection and Analysis

The data corpus analysed with our theoretical model comes from an intervention structured as cycles of action-research of the research project DEMULTS-Campo in schools. Data analysed in this paper come from an intervention performed in a rural middle school located in a rural town in the northeast of Brazil, which were chosen because they followed the guidelines of the model of Education of Rural Areas. This choice was defined with municipal education administration, which also gave us support with transport for researchers. The town has a strong historical bond with sugarcane plantations, which can be seen in its flag that has a picture of sugarcane. The school was very close to the sugarcane mill, whose lands spread in the town and its outskirts.

Twenty sessions took place, during 19 weeks in 2019 (only one meeting took place in 2020, before the interruption of the activities due to the COVID19 pandemic). The activities took place in the opposite term from regular classes, with 3-hour sessions. The project asked for schools select 90 students (45 for each one), but our meetings began with about 30 students in each school shift. Additionally, some children dropped out during the process. In the end, there were 10 students in the morning group and 27 students in the afternoon group. The students were recruited by the school administrators from an inclusive perspective, i.e., considering diverse profiles. The quantity of students in each subgroup was defined as the process developed. There were subgroups with up to 8 students, except one of the afternoon school (LimpezaPlay) which was built from a merge of two groups and because of that there was 11 students.

We were five researchers (from Pedagogy, Computer Science and Design). Two researchers helped students with programming. In the morning group, each researcher worked with a group of 5 students each, which developed games about harvest season and sugarcane off-season. In the afternoon group, one researcher worked with the group which developed an app (about organic garden), and the other one helped the other three groups which developed games (about selective garbage collection and compost). The other researchers moved between the groups. Schoolteachers were not directly involved, but three technician (practitioners) in agroecology helped students and researchers to understand the science behind the students' discourse about their previous experiences in the rural context. They already had previous agroecology practices in the school with the students with organic gardens and a composter. The goal of the artifacts was to be used in the students' lives and by other students in rural schools.

The three agroecology technicians and the five researchers collaborate with all groups according demands of students, except programming researchers who had main groups to collaborate, but also supported the others. The Table 1 presents a summary with activities shift of the sessions, type and name of artifact, numbers of children with IDs (of the children that appear in the results of this paper) used in analysis process

[4]DEMULTS's project works with children and teenagers with participatory design to design and develop digital educational artifacts. DEMULTS is a acronym which means Educational Development of Sustainable Multimedia, or in portuguese: *Desenvolvimento Educacional de Multimídias Sustentáveis*. In that project we worked, since 2011, in schools in urban areas, and, since 2017, works in rural schools. More informantion about the project including the cycles of action research can be accessed at https://demults.com.br/

and who was the researcher responsible for programming support them. In line with ethical guidelines, the identities of participants are not disclosed, thus only initials are used in the transcription indicating if the speaker is a student (S), a researcher (R) or a agroecology technician (T).

The following ethical procedures were taken. First of all, the lead researcher got in touch with the school administrators and presented the project. They formally agreed for the school to take part and were responsible for recruiting the students. The project was also presented to the students, who were free to opt in or out. For those who agreed, an informed consent form was sent to parents or legal guardians. The form adheres to Brazilian norm 466/2012[5] of the National Health Council on research with human beings, presenting the research goals, duration, activities and location. The risk for volunteers was considered low, only related to the possibility of discomfort, but still students were guaranteed the right to opt out at any time without any kind of consequence. Only students who brought the signed consent form could participate in the research. The one student who was over 18 years of age signed his own Informed Consent Form.

During the process of development of the digital artifacts, we used as data collection instruments: field diary (written and audio notes from participant observation); interviews with participants; students' drawings, photographs and video recordings. However, for the purpose of this case study, data analysed comes only from video recordings of students performing the activities[6]. The transcriptions of video recordings presented in this section include participants' speech, as well as non-verbal cues such as body posture and movement and manipulation of objects. The signs in Table 2 are used to enrich the transcription of speech.

We used interactional analysis [Jordan and Henderson, 1995] to investigate how participants interact with each other and with objects and interfaces throughout the development of the digital artifacts. Interactional analysis, proposed by Jordan and Henderson [1995], aims to investigate human interaction in the environment in which it takes place, having one of its analysis focuses precisely on the participation structure, which investigates how much the participating subjects participate in a common task and a focus of attention [Jordan and Henderson, 1995]. This is in line with our unit of analysis which was child participation, focusing on the structures of participation, analysing who has more (or less) power in decision making processes. In the case presented in this paper, through video analysis (considering gestures, postures and speeches, according to the method of interactional analysis), we coded interactions between children and adults to analyse child participation, using the categories of the proposed model, within a deductive approach. We note that, although DEMULTS-Campo's structure in communities of practice aims for students' participation, it was not conceived nor performed based on the theoretical model of child participation used for analysis.

[5] https://conselho.saude.gov.br/resolucoes/2012/Reso466.pdf

[6] The videos were only of the children interacting with us and with each other during the sessions (with an external camera). For the data analysed and presented in this paper, we did not use a screen recorder software.

3.2 Analysis of Children's Participation

The phases of each DEMULTS cycle are shown in Figure 2. These phases have been adjusted from various school interventions within the context of the project, which has been conducted since 2012. In this section, we describe each phase and analyse child participation from the theoretical categories of the proposed model, considering the original goals of the project in each phase with regard to participation and contrasting such expectations with actual levels of participation.

Considering the definition of the process as a whole, child participation can be classified as simple, as children are presented to a predefined process with a fixed structure, and informed about the phases. However, going into each phase of the project, or even analysing specific activities, we found different levels of child participation, as discussed in the next sections. Due to the nature, duration and quantity of activities during the ideation phase, there are more decision-making episodes in this phase

3.2.1 Invitation and Presentation

In order to form the group of students to participate in the project, the administrators of the school invited students with different profiles. In the first meeting, the research team explained the project to students, including the goal of developing educational digital artifacts, and the schedule for the activities. In a dialogue circle, children were encouraged to share their expectations and ask questions. In the following session, a braindrawing activity **?** was conducted where children were asked to express their conceptions about technologies, digital technologies and their use in daily life. TVs, computers, refrigerators, stoves, stereos, and more frequently smartphones emerged from this activity.

The activities in this phase were important for students to experience having their voices heard and power in decision-making, since in the end of braindrawing they discussed and reached a consensus about which drawing best represented the group's understanding about technology. The braindrawing activity revealed that students have access to digital and analogic technologies, deconstructing the idea that rural areas are places of backwardness, lacking any type of technology.

In this phase, we expected children's participation to be **consultative**, with children assuming the role of **informants**, since they would be asked to express their expectations for the project (orally or drawing), so that researchers could understand their characteristics and background and plan the activities of the following phases of the process.

Many children did not feel at ease to give their opinions during the meeting, keeping quiet, and also many of them needed assistance in braindrawing, because at first they did not understand the activity. Therefore, their participation was, as expected, **consultative**, because **they were helped by adults to express their ideas** in the dialogue circle and braindrawing, and the main role was **informant**, because the ideas were important for adults to start understanding the context.

Table 1. Groups of students and their respective shift, artifacts and programming researcher

Activities shift	Type of artifact developed	Name of the artifact	Number of children (with ID)	Main researcher of programming involved (with ID)
Afternoon	App	MyHorta	8 students, including S1, S2, S3, S4, S5, S9	R1
Afternoon	Game	LimpezaPlay	11 students, including S6, S7, S8, S10 e S11	R2
Afternoon	Game	EcoRural	8 students	R2
Morning	Game	A Fazenda escondida	5 students	R1
Morning	Game	(Without a name, but about sugar cane cultivation)	5 students	R2

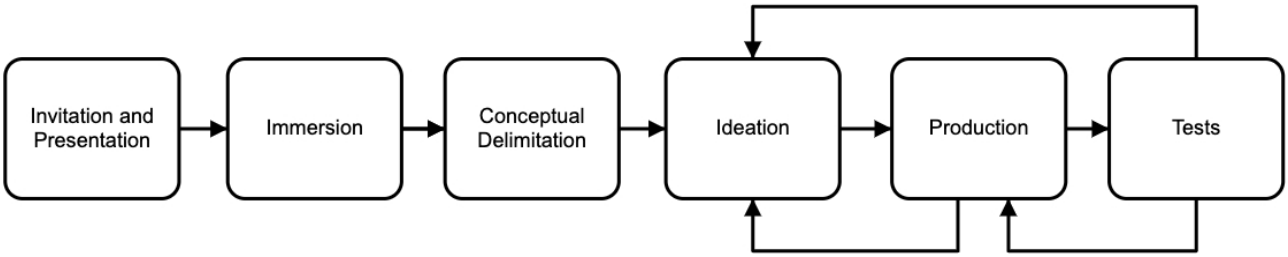

Figure 2. Phases of the process of development of educational digital artifacts conducted within the action-research project.

Table 2. Signs used in transcription

Sign	Mean
CAPITAL LETTERS	Emphasis
[[	Simultaneous utterances
::	Long vowel
(())	Subject's activity
/.../	Cut in transcription

3.2.2 Immersion

The goal of this phase was to encourage children's exploration of their own social and cultural context, while also allowing researchers to better understand children's daily life and the problems they face. So, the first activity planned was to have students perform interviews with their family members. The interviews' script was built with the students and focused on their family's routine and how they conquered their territory for planting and living. Then, in groups, students discussed the results of their interviews and were asked to draw storyboards to represent one or more activities related to their family's routine. Storyboards were used in this phase considering that they could be further developed later in the project, as scripts for digital games.

The investigation about the history of the territory where the students live is linked to the Education of Rural Areas' ideology, seeking a connection with the ethics and values of the rural population. The history of how the land was conquered by the families presents conflicts that reveal the difference between the interests of small farmers and those of big industries. By bringing this into light, the goal is to bring children closer to their territory's history to strengthen their identity and sense of belonging, valuing the idea that they can have life projects in the places where they live.

For the activity of building the interviews' script, we expected child participation to be **projective**, since students were invited to write the script together with the researchers, assuming the role of **design partners**. As for the storyboards, children were expected to discuss among themselves and bring elements from the interviews to the stories.

Children who participated in developing the interviews' script indeed had **projective** participation, as expected, acting as **design partners**. However, we observed that several children had very little participation in defining the interviews' scripts, and conducting and analysing the interviews. We believe that this might be due to the hierarchical structure of the educational model, and also some children's personality. Children who did not participate in creating the scripts, but performed interviews with their family, had **simple** participation, with **delegation with information** since they became **learners**, because they did the activity as homework.

Within **projective** participation, the storyboard activity was guided by adults, but children were autonomous to create their stories based on their everyday life. During this activity, adults helped children, asking questions to stimulate children's creativity and reflection, but leaving the decisions about the storyboards entirely to them. As children were expected to **make autonomous decisions**, and not in conjunction with adults, they cannot, in this specific activity, be characterised as design partners. So, for situations where adults guide the process, but children make autonomous decisions about the artifact, we found no corresponding role in the model presented in Section 4. Therefore, we create a

new role called **artifact designer**. An example is illustrated in the following excerpt of a researcher's field diary: "a student guided the construction of the story, but when some of his peers suggested changing one characteristic of the storyboard, he and the other peers agreed".

We also perceived situations of self-managing, where children made decisions about tasks within the groups. We could see this as children acting as process co-designers at the level of group work organisation, but they did not make decisions at the level of phases of the process (as this was not a possibility in the context of the project, which had predefined phases).

To sum up, in the immersion phase, the expected **projective** participation did occur more frequently, with children assuming different roles in the different activities. Additionally, the **consultative** participation was observed too.

3.2.3 Conceptual Delimitation

From the problems and routine situations identified in the Immersion phase, the Conceptual delimitation consisted of integrating students' previous knowledge (rooted in their daily life in rural areas) with scientific and curricular contents which could be aggregated to the digital artifacts. From this phase on, the agroecology technician played a key role in integrating practical knowledge students already had about planting and harvesting, with scientific and curricular contents. Through discussions with the students, researchers sought to encourage reflections and also learn more about students' interests and potential problems to be addressed in the rural context. The problems from students' life were organised in categories, generating topics that formed the starting point to defining the themes of the digital artifacts to be developed. This phase also included a guided tour given by the technician to the agroecological garden with a composter, kept in the school yard. What is planted there is used in the school kitchen.

The agroecological garden in the school is an approximation with the goals of Education of Rural Areas, because there the children could learn, research and practice planting without pesticides, which represents a healthier and more sustainable model of production than practised by large industries.

Children's participation in this phase was expected to be **projective**, with adults guiding the process, but with students with decision making power about the concepts and problems they would address in the artifacts. In practice, the **projective** level of participation was confirmed, as researchers only determined that the product would be a digital artifact (mobile application, game, tangible interface with Arduino board, etc.), with the goal of strengthening Education of Rural Areas. But within this scope, children were free to present problems and solutions. In this sense, children acted as **design partners**.

3.2.4 Ideation

In this phase, students made choices about the artifact they would develop, choosing the type of artifact, drawing sketches, and writing scripts and storyboards. Five groups opted for digital games, and one group for a mobile application. During the next phase (production), very often children came back to adjust or complement their sketches, scripts and storyboards. For this reason, in our analysis, we consider the activities of ideation independently of the phase during which they were executed. The alignment with the Education of Rural Areas in the activities of ideation, could be observed since the participative process that begins with adults and ends with children proposing democratic spaces of voting, debate and consensus; and goes up to the artifacts contents. Another point worth mentioning is that the alignment with the Education of Rural Areas happened when agroecology technician T1 was explaining about the harms of chemical pesticides and the benefits of natural repellents. S1 said, at the time "we saw this when we visited MST (Landless Workers' Movement)". The MST is one of the cornerstone movements of Education of Rural Areas and is widely attacked by agrobusiness representatives. It was based on meetings among several movements that defend land reform, including MST, that the first legal cornerstones of Education of Rural Areas. Due to this reason and due to the fact that children were building knowledge as they were developing artifacts, their knowledge stemming from previous knowledge exchanges with this movement shows an alignment with a project for Education of Rural Areas. S2 and S3 said that the main change of the project in their lives is that they will now stimulate and help their family members to cultivate an organic vegetable garden and composting, since they have now studied it and know how to help and that their family members already do it, but it is not as well taken care of as the one at school. S2 also mentioned how it could be of financial help, since they have already heard their mother say that she spends too much with food. In this sense, there is not only an alignment, but a strengthening of the political project of Education of Rural Areas.

The expectation for these activities was that children would have a **projective** participation, being **design partners** with the researchers, sharing decisions about the artifacts. However, while analysing the data, we observed various levels of participation and children's roles, such as learner, critic, inventor, design partner, and process co-designer, exemplified in this subsection.

Besides those, the role of artifact designer also emerged, characterised by a higher level of children's autonomy with respect to the adults. This role was more frequent than the others in data analysis. It could be observed in the decision about whether the artifacts would be games or apps, up to the decisions about which elements would be present in each screen, as shown in the examples in the following. In the App group, a student came up with the following idea, without adult intervention: "we could build an app about vegetable gardens", in the sixth meeting. In this circumstance, she could be taking on the role of inventor, if the artefact were developed by adults or other children. However, since she will be part of the development team, the role that better describes her participation is that of artifact designer. In the eighth meeting, the group discussed the interface, as follows.

1. ((S4 handles the mouse. She is between R1 and S5, who look intently at the screen))

2. R1: Very good. And so what? What did you imagine for this first screen? We would only show the name? There will be something else, no?? (gestures and looks at the students))
3. S4: there is (inaudible) ((looks at the partner)) there is something that one can press immediately
4. R1: press immediately?
5. S4: as in enter.. ((looking at R1))

At this point we can see the roles of facilitator and encouragement provider of the researcher when guiding the process with trigger questions, avoiding influencing the children's decisions about the artefact. In this case, the children make decisions autonomously. This has also occurred in the game LimpezaPlay, as follows:

1. ((S6 and R2 are standing up, behind S7 and S8, who are sitting down in front of the screen, mouse and keyboard))
2. S6: this is kind of crazy
3. R2: Are you missing something?
4. S6: she could answer that.
5. R2: What thing?
6. S6: when she spoke.. It is::[[
7. S8: "what do I need to do?" She could answer.
8. //
9. R2: humrum.. What do you think, S7?
10. S6: But if she thinks it is ok like that [[
11. S7: it is like.. I think it is alright (inaudible)
12. R2: sorry?
13. S7: it is ok if I may add one thing ((looks at R2))
14. R2: You mean, may I add another thing so that I is ok?
15. S7: ((averts his look, as if thinking about it and nods yes))

Here we can see S6 taking on the role of critic, at first, acknowledging a problem (line 2), and then S6 and S8 suggested an improvement as inventors (lines 4, 6 and 7). Here S6 is not a design partner, since who makes the final decision is S7, who, due to that, takes on the role of artifact designer. Adult R2 also does not take the role of design partner, but the one of process designer, since they only guides the process (lines 3, 5 and 9) helping the children to express themselves (lines 4, 6 and 7). In this case, the **children made decisions autonomously**, but one can see an unequal power relationship amongst them, where S7 has more power than S6 and S8 over the final definition. This is due to the fact that the contents produced so far was, in its majority, the result of S7's work. We interpreted this fact as an example of acknowledgement amongst the children that those who have more participation in the authorship, have more authority over the decisions. S6 and S8's participations are on the border of the **consultant** and **projective** levels. Thus, previous participation tends to create more responsibility and participation.

In the following moment, R2 takes on a more professorial role, requesting an activity out of the face to face encounter, as follows: "I think that you may start thinking about this until Monday, to get here with a more consolidated discourse". In this case, the students were **learners**, exercising **simple participation**, upon being made aware of the goals, they executed an activity delegation by the adult. Simple participation, different from the project standards in such cases, happened due to the fact that the adults managed deadlines and only one researcher mediated the, up until then, three game groups. This did not happen in the APP group, that had a researcher fully dedicated to them. The children researched autonomously and brought the results of their efforts to the encounter. We interpreted this as a result of the leadership proactive profile of some of the children of this group.

Figure 3. Technicians and students co-creating a dialogue between characters for a game.

There are also records of adults and children taking on the role of **design partners**. An example is when the agroecology technician T1 discusses with S6 the role of the neighbours of LimpezaPlay in a subsequent encounter. In this case, S6 brings their contributions to the artefact, which demonstrates a transition from the role they took in the previous encounter, the role of **inventor**, to **design partner**, gradually taking on the co-authorship of the game.

1. T1: because composting in itself will precisely (inaudible) solo and:[[
2. S6: but after we put the composting process in, the soil does not get better and healthier? ((looks at the technician))
3. T1: it generally is, is it not? It generally is… because you will act in the sequel, is it not? About the issue (inaudible) to put here[[
4. ((S6 and T1 point to the notebook while reading together))
5. S6: ((reads information written on a paper - inaudible)) with this composting process (inaudible) would be better? Yes, much stronger and healthier [[
6. T1: and healthy. There you go. We are done.

The image above shows a collaboration between adult and child, both of them pointing at the notebook. However, through the dialogue, it is possible to observe a professorial attitude from T1, who has the power of validating conceptually what was done by S6. This is necessary sometimes in the educational context, since children do not always have the necessary knowledge and are, while developing the artifacts, researching and learning about the concepts their artifacts carry with them.

There were also moments where children were **process co-designers**, such as the one that happened in this same group, where S10 suggests: "Let's vote!", in order to define something for the game; this can also be seen in another moment where S11 arrives at the group and S7 says something on the lines of: "he will draw, we will do this and you will do that", self managing the group's internal activities, even with-

out impacting the more structural issues pertaining to process stages or deadlines. In the App group, the **process co-designer** role was observed much more, since a leadership and autonomy profile was much more evident, specially from S9 and S1, as shown by the excerpt of a field diary below.

"S9 always stimulates a democratic vote in the interaction… She never says: 'ok, so this is it'. She always asks: 'So, people, what do you think?'. She looks at one by one. As people nod in agreement, she says: 'All right, so this is it.'" Here we observe how the adults' attitude may have influenced the children to make decisions collectively and democratically. We can also find excerpts where the adult researcher shows that they have learned from an agroecology technician and corrects a child with respect to the usage of orange skins in composting. In this instance, the adult researcher was a learner, which made it possible, in a second moment for him to co-create with the child.

We have some evidence of **non-participation**, but none linked to the categories of Hart [1992], which denote a usage of the time and image of the children, without making it possible for them to have power in decision making. Our records are of divergence between the adult and child activities, for instance, children drawing something that would not be used in the game, only to let time pass by. We interpreted this divergence due to the large number of children per adult, which occurred more frequently in the games groups, which had only one programming researcher adult for all children.

3.2.5 Production

The goal of this phase of the process is to prototype the artifacts (digital games or apps). To this end, all children were presented to the block programming software Scratch[7], except one group which chose to develop a mobile app, and therefore was presented to App Inventor[8] (also based on block programming, but specific for creating mobile interfaces). There were no formal classes, but the researchers presented the main possibilities offered by the software tools and more specific functions were learned by children on the go, according to the functionalities they needed to implement (based on the storyboards), with the help of the researchers.

The project goals were to democratise the knowledge about how to build technologies. It has an alignment with the purpose of Education of Rural Areas because technology is a reality for the children of rural areas, but they need to take part in the process of building them, in opposition to only importing or consuming from urban areas. Thus, children experienced the whole participatory process of developing an educational game or app. It is very important for Education of Rural Areas because didactic materials are majoritarily produced without participation of people from rural areas.

The interaction between students, researchers and technicians in this phase is crucial, as they need to collaborate to be able to develop the artifacts, which require knowledge about programming, design and agroecology. It is common to cycle back to the ideation phase during production, to make changes to the narratives or interaction flow, but it already was presented in the last subsection. So, here we present only what we found in production activities. In this phase, we expected **projective** participation, with students as **design partners**.

During production, the most frequent activity was pair programming, sometimes with the adult as pilot, when it was necessary to demonstrate the practise of some programming concepts to develop some specific feature; other times with children as pilots, when they were experimenting programming and design tools or after they had learned with adults. Therefore, in the first moment, the level of **simple** participation was observed and the main role assumed by students was **learner**, because the researchers taught about programming and illustration, **helping children to express** their ideas.

As the process went on, children gained more autonomy and started trying to solve programming problems with the researcher. In this case, the researcher was not a teacher, but a co-programmer or a design partner, because he or she was trying to solve problems with the children. Such situations were often perceived in moments of gameplay decisions. For example, after a researcher gave his opinion about the differences in the time needed for users in general to complete the game challenges as compared to the developers of the game, students in one group decided to invite a peer from another group to test their game, so as to help them determine the ideal time the players should be given to solve the game challenges. Adults and children were involved, but children calculated and decided the appropriate time.

Additionally, an episode worth mentioning involved the same researcher who was mediating the activities of three groups developing digital games with similar themes (recycling and compost). Facing difficulties to assist all students in programming and to keep the timeline of the project, the researcher came up with the idea of integrating the games. In order to guarantee a democratic decision, the researcher suggested that children should vote. The outcome was to merge two games and keep the third separate. This episode can be classified as adult-initiated with full decision by the children, which matches Kirby *et al*. [2003] category of **children with autonomy to make decisions** (merging the games or not), but within structures suggested and mediated by adults (the voting). In this case, the role assumed by children was being responsible for making decisions about their artifacts, while adults were guiding the process - which was not found in the theoretical model presented in Figure 1, and was also observed in the immersion and ideation phases.

3.2.6 Tests

The last phase of the project consists of students conducting tests of their prototypes with other people (typically peers from other classes, who were not participants of the project). Students present their artifacts to others, having the opportunity to share, and ask them to try them out. In this process, they are expected to observe and take notes of aspects to be improved in the artifacts. Thus, students are expected to act as **co-researchers**, collecting and analysing data. We could not conduct this phase in the case study presented here, due to the suspension of school activities caused by the outbreak of the COVID 19 pandemic.

[7] https://scratch.mit.edu/

[8] https://appinventor.mit.edu/

4 Extended Model

The main contribution of this work is the refined model (Figure 4) that may be used by research works before going to the field, in activities planning, or after that, in the analysis of collected data. It is important to emphasize that the model proposed here is an adaptation of the previously presented model (Figure 1). In the model presented in Figure 1, the roles of children in the PD are built from analysis focused on the process as a whole. On the other hand, in addition to contemplating this level of abstraction, we also included a level of granularity in which we focused on activities that occurred in each session, which brings greater specificity to the presented results.

Therefore, the changes proposed here are made mainly based on what we observed in the case study. On the other hand, aiming to enable other projects to use the model, we maintain the categories not observed in the case study, but with specific markers that express the results of the present study, which are: a black square for the categories that were not observed in the case study; a black circle for those that were observed in a different type of participation in relation to the first model; and with a star, the new role of children in the DP.

The main alteration on the theoretical model presented previously was the creation of children's roles of artifact designer in PD. This role's creation was justified by the lack we perceived in the other roles, and that prevented us from characterising situations where the child has autonomy in artefact creation, but not within the process, while the adult guides the process and does not contribute with the artefact; they are not process co-designers, since they do not have the power to manage deadlines, nor to manage the process stages; nor they are inventors, since they develop their ideas and not the adults.

Besides this addition, some categories that were not found in our records were marked from the model. Children's roles marked with a black square in Figure 4 were those of the child as user and the child as co-researcher. The child as a user was not seen due to the fact that we did not have artefact tests finalised in our process. The child as co-researcher was not seen since the children did not analyse data from their own practices, although they did research quite a lot about the artifacts.

The participation level of Shier [2001] "children are heard" was not observed in the case study, since this category assumes that adults will not necessarily operationalize what they hear from children, which does not go in line with the project that aims that children develop their own ideas. That is why it is marked with a black square in Figure 4.

Other alterations were needed in the category framing. These are marked with a black circle in Figure 4. Based on the data, we realised that children are supported to express themselves not only as consultants, but with trigger questions made by adults that guide the process, where children have total autonomy on the decisions about the artifacts, and thus are, often, better located in a projective participation.

We also realised that many autonomous processes are of projective participation and not of meta-participation, since in most cases children did not ask for new participation spaces. In truth, this occurred only once in the immersion that arose from the idea that they had a closet in school so they did not have to take their heavy rucksacks on rainy days, making it easier to come to school. This could have motivated the creation of new school participation spaces, such as a student club, but since the project focus were on digital educational artifacts, we decided to go down another track.

5 Conclusion

Although Education *of* Rural Areas needs participation of people of rural areas to contextualise and build an education model which considers their values and needs, there are not many studies about the development of digital technologies by students in this context. On the other hand, involving children in the design process of digital artifacts is ridden with challenges, since children are usually seen as incapable of producing valid contributions. PD is a way to overcome such challenges, and has, at its core, the intentional power sharing between designers and representatives of the target audience (children, in this case). However, PD may be strengthened by children's participation theories that are already consolidated in the literature, and whose constructs may help with defining methods to execute an adequate power sharing with children in different contexts.

In this paper, we presented the application of a theoretical model built from the relationship between children's participation levels and roles of children and adults in PD, to analyse data collected in an action-research project in rural schools. We highlight the need of a mostly projective participation, due to the Education *of* Rural Areas context, where the project under analysis was inserted. During our analyses, we have noticed a variety of levels and roles, but this level of children's participation was the most observed in the project situations, with children and adults taking on the roles of design partners, especially in pair programming and in the conceptual brainstorming realised during the conceptual delimitation. We have also identified a frequent role for which we did not find a correspondence in the theoretical model, when children had total decision autonomy over the artifact, but not over the process.

We have noticed that the involvement of children in the educational context has the specificity that they, as representatives of the target public of the developed artifacts, are still in their formative process and do not possess the domain of the problem, different from the application of PD in other contexts. Moreover, we have observed that the adults had sometimes a professorial attitude of approval (almost never of disapproval), of students' proposals, and frequently an attitude of process mediators. Such attitudes show a specificity of the school context, where, as educators, adults wished to promote children's autonomy, often abdicating from their own voice so that the children could assume full authorship of the artifacts built and learn, along the process, about agroecology, programming and design.

This situation led to the fact that one of the most recurring children's roles does not fit adequately in any of the roles of the theoretical model, since there was not, in its majority, artifacts' co-creation between adults and children, which would

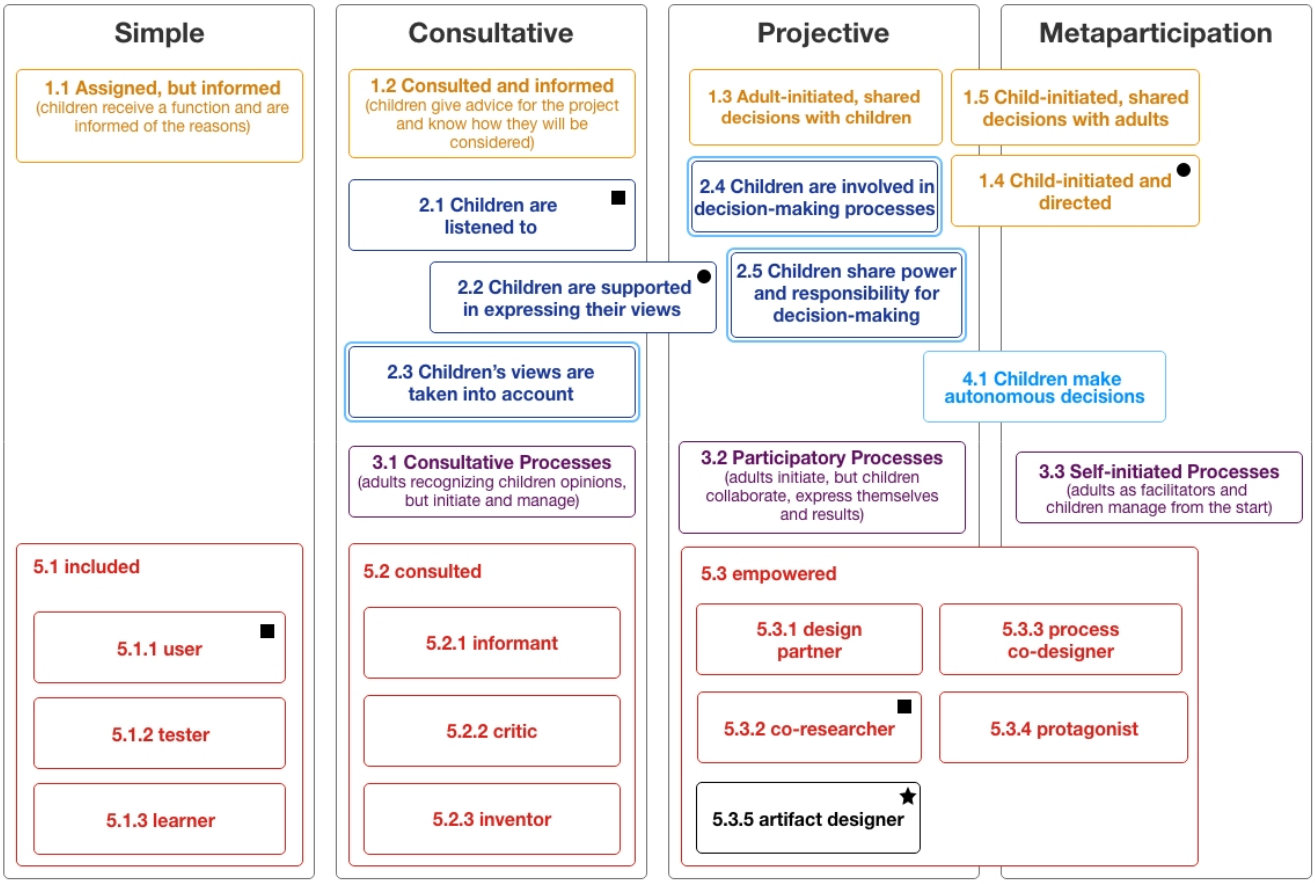

Figure 4. Theoretical model with child participation typologies and children roles in PD. The theory of Trilla and Cámara [2001] is represented in the four larger boxes. The elements labelled with 1 refer to Hart's theory [Hart, 1992]; with 2, to Shier [2001]; with 3, to Lansdown [2005]; with 4 and the last three with 2 (2.3, 2.4 and 2.5), to Kirby *et al.* [2003]; and with 5, roles of children in PD [Druin, 2002; Hussain, 2010; van Doorn, 2016; Iversen *et al*., 2017; Schepers *et al*., 2018], including the artifact designer. The elements with a black square were not observed in the case study; with a circle, have been moved between frames; and with a star, are new.

have classified them as design partners. Neither have the children guided the process, which would have classified them as protagonists or process co-designers. In practice, children had autonomy to create artifacts, but did not express their opinions about the process, while adults helped them only with time management and process stages, relinquishing the decision-making power over the artifacts.

As a limitation, we point out that the cycle of the project under analysis did not have any occurrence of meta participation (when children demand new decision spaces and guide the process). This type of participation is more common in children's play without adult supervision, but we believe that it does not occur much in intergenerational situations, due to the adults' power concentration that gives limits to the children's autonomy. Such characteristics are related to the hierarchical culture where intergenerational relationships are based on society and the school context. Another limitation of our study was the large number of children per researcher in the games group compared to the app group. It is our belief that the smaller this proportion, the greater the probability that the adult will be able to mediate the idea of one child so that the group can make a decision, as opposed to the adult approving it and putting it forward.

In this case study, the model provided a theoretical frame for data analysis or for planning participation levels and roles of children in a project of PD in a rural educational context. As future work, we intend to create guidelines for the Education *of* Rural Areas, with phases, activities, roles of children, levels of children's participation and political goals of this model of education. And then we intend to validate this in a new cycle of action research. Applying the theoretical model to different contexts of PD with children may lead to a more robust proposal that brings together consolidated constructs from the scientific literature so far, and evidences from empirical research developed in the HCI community. This may also reveal aspects or categories of child participation that are specific to certain contexts, depending on culture, institutions and social hierarchies.

Declarations

Funding

This study was financed in part by the Conselho Nacional de Desenvolvimento Científico e Tecnológico - Brasil (CNPq) given that Dyego Morais had a PhD scholarship.

Authors' Contributions

Dyego Morais contributed to the conception of this study, analysis, and writing. He is the main contributor and writer of this manuscript. Taciana Pontual and Patricia Tedesco participated in the validation of the study, review and final editing. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

Aiming to maintain the anonymity of participants, the data collected cannot be shared.

References

Ackermann, L., Feeny, T., Hart, J., and Newman, J. (2003). Understanding and evaluating children's participation: A review of contemporary literature. *London: Plan UK/Plan International*. Available at: https://www.participatorymethods.org/resource/children-changing-their-world-understanding-and-evaluating-childrens-participation.

Alhatem, M. (2019). Children involvement in participatory design process: A background review. *International Journal of Advanced Trends in Computer Science and Engineering*, 8:474–483. DOI: 10.30534/ijatcse/2019/7581.42019.

Amstel, F. M. v. (2009). Políticas de participação no design de interação. In *Proceedings of the 4th Information Design International Conference/ 3rd InfoDesign Brazil / 3rd Congic*. Sociedade Brasileira de Design da Informação – SBDI. Available at: https://www.usabilidoido.com.br/arquivos/politicas_participacao.pdf.

Antle, A. N. and Hourcade, J. P. (2022). Research in child–computer interaction: Provocations and envisioning future directions. *International Journal of Child-Computer Interaction*, 32:100374. DOI: 10.1016/j.ijcci.2021.100374.

Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of planners*, 35(4):216–224. DOI: 10.1080/01944366908977225.

Bordenave, J. E. D. (1994). *O que é participação*, volume 8. Brasiliense São Paulo. Book.

Boyden, J. (1997). Childhood and the policy makers: a comparative perspective on the globalization of childhood', in a. james and a. prout (eds), constructing and reconstructing childhood: Contemporary issues in the sociological study of childhood. london: Falmer press. brennan, s. and noggle, r.(1998), john rawls's children', in s. m. turner and gb matthews (eds), the philosopher's child: Critical per-spectives in the western tradition. rochester, ny: University of rochester press. cassidy, c.(2006a). *Child and Community of Philosophical Inquiry', in Childhood and Philosophy: Journal of the International Council of Philofophical Inquiry with Children*, 2(4). Available at: https://www.taylorfrancis.com/chapters/mono/10.4324/9780203362600-16/childhood-policy-makers-comparative-perspective-globalization-childhood-allison-james-alan-prout.

Caldart, R. S. (2012). Educação do campo. *Dicionário da educação do campo*, pages 259–267. Available at: https://www5.unioeste.br/portalunioeste/images/files/GEFHEMP/Textos_Bloco_I/01_B_-_Roseli_S_Caldart_-_Educa%C3%A7%C3%A3o_do_Campo.pdf.

Chambers, R. (1994). The origins and practice of participatory rural appraisal. *World development*, 22(7):953–969. DOI: 10.1016/0305-750X(94)90141-4.

Druin, A. (1999). Cooperative inquiry: Developing new technologies for children with children. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '99, page 592–599, New York, NY, USA. Association for Computing Machinery. DOI: 10.1145/302979.303166.

Druin, A. (2002). The role of children in the design of new technology. *Behaviour and information technology*, 21(1):1–25. DOI: 10.1080/01449290110108659.

Druin, A. and Fast, C. (2002). The child as learner, critic, inventor, and technology design partner: An analysis of three years of swedish student journals. *International Journal of Technology and Design Education*, 12(3):189–213. DOI: 10.1023/A:1020255806645.

Ehn, P. and Kyng, M. (1991). Cardboard computers: Mocking-it-up or hands-on the future. In *Design at work*, pages 169–195. CRC Press. Available at:https://www.taylorfrancis.com/chapters/edit/10.1201/9781003063988-11/cardboard-computers-mocking-hands-future-pelle-ehn-morten-kyng.

Frauenberger, C., Good, J., Fitzpatrick, G., and Iversen, O. S. (2015). In pursuit of rigour and accountability in participatory design. *International Journal of Human-Computer Studies*, 74:93–106. DOI: 10.1016/j.ijhcs.2014.09.004.

Gona, J. K., Hartley, S., and Newton, C. R. (2006). Using participatory rural appraisal (pra) in the identification of children with disabilities in rural kilifi, kenya. *Rural and Remote Health*, 6(3):1–10. Available at:https://search.informit.org/doi/abs/10.3316/informit.543188396745498.

Hagen, E. S. *et al*. (2012). Co-designing with children: Collecting and structuring methods. In *DS 71: Proceedings of NordDesign 2012, the 9th NordDesign conference, Aarlborg University, Denmark. 22-24.08. 2012*. Available at:https://www.designsociety.org/publication/38546/Co-Designing+with+children%3A+Collecting+and+structuring+methods.

Hart, R. A. (1992). *Children's Participation [microform] : From Tokenism to Citizenship. Innocenti Essays No. 4*. United Nations Children's Fund. Distributed by ERIC Clearinghouse [Washington, D.C.]. Available at:https://catalogue.nla.gov.au/catalog/5559318.

Hart, R. A. (2008). *Stepping Back from 'The Ladder': Refl ections on a Model of Participatory Work with Children*, pages 19–31. Springer Netherlands, Dordrecht. DOI: 10.1007/978-1-4020-6416-6$_2$.

Hussain, S. (2010). Empowering marginalised children in developing countries through participatory design processes. *CoDesign*, 6(2):99–117. DOI: 10.1080/15710882.2010.499467.

Hussain, S., Sanders, E. B.-N., and Steinert, M. (2012). Participatory design with marginalized people in developing countries: Challenges and opportunities experienced in a field study in cambodia. *International Journal of Design*, 6(2). Available at:https://www.ijdesign.org/index.php/IJDesign/article/view/1054.

Iversen, O. S., Smith, R. C., and Dindler, C. (2017). Child as protagonist: Expanding the role of children in participatory design. In *Proceedings of the 2017 Conference on Interaction Design and Children*, IDC '17, page 27–37, New York, NY, USA. Association for Computing Machinery. DOI: 10.1145/3078072.3079725.

Jordan, B. and Henderson, A. (1995). Interaction analysis: Foundations and practice. *The journal of the learning sciences*, 4(1):39–103. DOI: 10.1207/s15327809jls0401$_2$.

Kam, M., Ramachandran, D., Raghavan, A., Chiu, J., Sahni, U., and Canny, J. (2006). Practical considerations for participatory design with rural school children in underdeveloped regions: Early reflections from the field. In *Proceedings of the 2006 Conference on Interaction Design and Children*, IDC '06, page 25–32, New York, NY, USA. Association for Computing Machinery. DOI: 10.1145/1139073.1139085.

Kirby, P., Lanyon, C., Cronin, K., and Sinclair, R. (2003). *Building a culture of participation: Involving children and young people in policy, service planning, delivery and evaluation*. Department for Education and Skills. Available at:https://dera.ioe.ac.uk/id/eprint/17522/1/Handbook%20-%20Building%20a%20Culture%20of%20Participation.pdf.

Lamichhane, D. R. and Read, J. C. (2020). Play it my way: Participatory mobile game design with children in rural nepal. In *Cross-Cultural Design. User Experience of Products, Services, and Intelligent Environments: 12th International Conference, CCD 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings, Part I*, page 325–336, Berlin, Heidelberg. Springer-Verlag. DOI: 10.1007/978-3-030-49788-024.

Landoni, M., Rubegni, E., Nicol, E., and Read, J. (2016). How many roles can children play? In *Proceedings of the The 15th International Conference on Interaction Design and Children*, IDC '16, page 720–725, New York, NY, USA. Association for Computing Machinery. DOI: 10.1145/2930674.2932222.

Lansdown, G. (2005). *¿ Me haces caso?: El derecho de los niños pequeños a participar en las decisiones que los afectan*. Bernard van Leer Foundation. Available at:https://www.observatoriodelainfancia.es/oia/esp/documentos_ficha.aspx?id=1930.

Matthews, H. (2003). Children and regeneration: setting an agenda for community participation and integration. *Children & Society*, 17(4):264–276. DOI: 10.1002/CHI.745.

Merriam, S. B. and Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. John Wiley & Sons. Book.

Molina, M. C. (2012). Legislação educacional do campo. *Dicionário da educação do campo*, pages 453–459. Available at:https://www5.unioeste.br/portalunioeste/images/files/GEFHEMP/Textos_Bloco_I/07_-_M%C3%B4nica_C_Molina_-_Legisla%C3%A7%C3%A3o_Educacional_do_Campo.pdf.

Molina, M. C. (2014). Políticas públicas em educação do campo: avanços e desafios do pnld campo. *Livro Didático e Educação do Campo. Belo Horizonte: Faculdade de Educação da UFMG*, pages 25–33.

Morais, D., Falcão, T. P., e Peres, F. A., and Tedesco, P. (2021a). Processos de desenvolvimento participativo de

tecnologias digitais educacionais nos contextos urbano e da educação do campo. In *Anais do XXIX Workshop sobre Educação em Computação*, pages 111–120, Porto Alegre, RS, Brasil. SBC. DOI: 10.5753/wei.2021.15902.

Morais, D., Falcão, T. P., and Tedesco, P. (2022). Children's participation in the design of digital artifacts in rural schools. In *Proceedings of the 21st Brazilian Symposium on Human Factors in Computing Systems*, pages 1–11. DOI: 10.1145/3554364.3559110.

Morais, D., Falcão, T., and Tedesco, P. (2021b). Participação infantil no design de artefatos digitais: Considerações teórico-metodológicas. In *Anais do XX Simpósio Brasileiro sobre Fatores Humanos em Sistemas Computacionais*, Porto Alegre, RS, Brasil. SBC. Available at:https://sol.sbc.org.br/index.php/ihc/article/view/19343.

Morais, D. C. S. and Rocha Falcão, T. P. (2019). Abordagem participativa de desenvolvimento de jogos digitais educacionais no contexto escolar. *Revista Brasileira de Informática na Educação*, 27(01):132. DOI: 10.5753/rbie.2019.27.01.132.

Osuchukwu, N. P. and Edewor, N. (2016). Make the children read: Participatory rural approach in school libraries in umueri, nigeria. *Library Philosophy & Practice*. Available at:https://digitalcommons.unl.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=3793&context=libphilprac.

Percy-Smith, B. (2005). I've had my say but nothings changed! where to now? critical reflections on children's participation. In *Paper presented at Emerging issues in the Geographies of Children and Youth Conference*. Brunel University. Available at:https://uwe-repository.worktribe.com/output/1049543.

Peres, F. A. e., Pontual Falcão, T., and Morais, D. (2020). Demults: Desenvolvimento educacional de multimídias sustentáveis. *Ludicidade, jogos digitais e gamificação na aprendizagem*. Book.

Read, J. C., Fitton, D., Sim, G., and Horton, M. (2016). How ideas make it through to designs: Process and practice. In *Proceedings of the 9th Nordic Conference on Human-Computer Interaction*, NordiCHI '16, New York, NY, USA. Association for Computing Machinery. DOI: 10.1145/2971485.2971560.

Reddy, N. and Ratna, K. (2002). A journey in children's participation. *Bangalore: The Concerned for Working Children*. Available at:https://www.concernedforworkingchildren.org/wp-content/uploads/A-Journey-in-childrens-participation.pdf.

Ribeiro, M. (2012). Educação rural. *Dicionário da educação do campo*, pages 295–301. Available at: https://www.epsjv.fiocruz.br/sites/default/files/l191.pdf.

Rogers, Y., Sharp, H., and Preece, J. (2011). *Interaction design: Beyond human–computer interaction*. John Wiley Sons. Book.

Schepers, S., Dreessen, K., and Zaman, B. (2018). Rethinking children's roles in participatory design: The child as a process designer. *International Journal of Child-Computer Interaction*, 16:47–54. DOI: 10.1016/j.ijcci.2017.12.001.

Shier, H. (2001). Pathways to participation: Openings, opportunities and obligations. *Children & society*, 15(2):107–117. DOI: 10.1002/chi.617.

Shier, H. (2010). Teoría de la participación infantil y su relevancia en la práctica cotidiana. *E. d. CESESMA, Incidencia de niños niñas y adolescentes como ciudadanos/as activos/as en Nicaragua. San Ramón, Matagalpa: Universidad del Norte de Nicaragua*. Available at:https://www.harryshier.net/docs/Shier-Teoria_de_participacion_infantil.pdf.

Spinuzzi, C. (2005). The methodology of participatory design. *Technical communication*, 52(2):163–174. Available at:https://www.ingentaconnect.com/content/stc/tc/2005/00000052/00000002/art00005.

Treseder, P. (1997). *Empowering Children and Young People: A Training Manual: Promoting Involvement in Decision-making*. Save the Children Fund. Book.

Trilla, J. and Cámara, A. M. N. (2001). Educación y participación social de la infancia. *Revista Iberoamericana de Educación (OEI), 2001, num. 26, p. 137-164*. DOI: 10.35362/rie260982.

van Doorn, F. (2016). *Children as co-researchers in design: Enabling users to gather, share and enrich contextual data*. PhD thesis. Available at:https://pure.tudelft.nl/ws/portalfiles/portal/4732335/5.

Yip, J. C., Sobel, K., Pitt, C., Lee, K. J., Chen, S., Nasu, K., and Pina, L. R. (2017). Examining adult-child interactions in intergenerational participatory design. CHI '17, page 5742–5754, New York, NY, USA. Association for Computing Machinery. DOI: 10.1145/3025453.3025787.