An Intervention with Technology for Parental Involvement in Kindergarten: Use of Design-based Research Methodology

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Abstract: Parental involvement in preschool education has an impact on children's learning, development and adaptation to school, and can be promoted through digital technologies. This research aimed to develop and test a digital platform, with functionalities for communication and content sharing between parents and educators and, at the same time, to assess the impact of using the platform in three participating institutions. The methodology used was Design-Based Research. Parents and educators were involved in all phases: preliminary study, development and evaluation. The results allow us to conclude that the most important functionalities are the sharing of activities carried out with children in kindergarten and a private messaging service. In terms of local impact, the intervention had different results in each kindergarten, associated with previous practices of using technologies for parental involvement and the roles assumed by the users within the platform.

1 INTRODUCTION

The importance of parental involvement in children's learning is widely recognized and documented, being positively associated with better school outcomes, better behaviour, higher learning expectations, and higher academic aspirations (Henderson & Mapp, 2002). Parental involvement has a significant effect on a child's adjustment to school and learning success, regardless of other factors such as the child's social class, gender or ethnic group (Desforges & Abouchaar, 2003). Furthermore, promoting parental involvement is positively associated with better outcomes for ethnic minority students (Jeynes, 2021).

At preschool age, it is associated with general development, social and cognitive development, preparation for school and the development of literacy skills (Skwarchuk et al, 2014) and math skills (Susperreguy et al, 2020). It is in preschool education that children benefit most from parental involvement in learning, whether at home or in kindergarten (Reynolds & Shlafer, 2010). Kindergarten is an inviting environment for parents to participate. They feel effective in the help they can provide and are motivated to give their children a good start in schooling (Stevenson & Baker, 1987). For this age group, the concept of parental involvement can be divided into three dimensions: involvement at home - active learning with the family; involvement in School/Institution – parents' participation in kindergarten activities; school-family communication – contacts between parents and educator about the child's development (Fantuzzo et al, 2013). The importance of parental involvement is recognized in government guidelines for preschool education in several countries (EACEA / Eurydice / Eurostat, 2014).

Children at these ages learn essentially in the restricted and immediate environments in which they live – the family and kindergarten (Bronfenbrenner, 1979). Portugal has curricular guidelines for pre-school education that give autonomy to kindergarten teachers, in their pedagogical activity and choice of methodology (Silva et al, 2016). Factors such as the individual characteristics of the children, the size of the group or the diversity of ages will influence the group's functioning, the pedagogical options, the projects developed and, finally, individual learning. All these variables make it difficult for parents to know what their children learn in kindergarten, which

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may reduce their active participation in this process. Good communication between kindergarten-family contexts can improve the knowledge of both about the child, influencing learning (Epstein, 2018). For kindergarten, communication with families is important to gather information about children and build an adequate curriculum, a stimulating environment and meaningful learning (Silva et al, 2016). For parents, the knowledge they have of what their children learn in kindergarten allows them to more easily think and carry out activities and games together, creating quality moments while encouraging the child to build knowledge.

Currently, as the Internet and digital tools are part of families' lives, a technological platform can be adopted as a means of communication and content sharing between parents and educators, increasing the possibilities of collaboration and reducing barriers to parental involvement, such as lack of time and availability (Hornby & Lafaele, 2018).

In addition, several studies indicate contributions of digital technologies in children's learning, in terms of language development, mathematics, knowledge of the world, multiliteracies, creativity, arts, motivation and collaborative learning (Herodotou, 2018; Burnett, 2010). The widespread access to mobile devices and educational apps by pre-schoolers has brought them new opportunities and ways of understanding, acquiring knowledge, and expressing themselves (Laranjeiro, 2021), although parents and educators struggle to identify apps with real educational value (Papadakis & Kalogiannakis, 2017; Vaiopoulou et al, 2021). Thus, a digital platform can also serve to share interactive educational content for learning activities with children.

The current Covid-19 pandemic has led countries around the world to close schools and implement distance learning solutions to reduce contamination. This situation has shown the need to improve communication between parents and teachers by digital means, and provide educational content online, for all ages (OECD, 2020).

With access to appropriate technological devices and digital content, parents can promote their children's learning at home. Using social web tools and private communication platforms, parents and educators can share information about their educational practices. Educators can form virtual groups that encourage parents to participate in kindergarten, and in their children's learning. Children can be involved in these dynamics, to acquire knowledge and develop skills, such as communication and collaboration with adults and other children.

2 METHODOLOGY

This research aimed to plan, develop and evaluate a multimedia platform, to answer the question: what features and contents should a multimedia platform have to promote parental involvement in the learning of children who attend kindergarten?

From this research question, two types of answers were expected: 1) a general contribution to the theory - Design principles that can be applied in educational interventions in similar contexts; 2) a local contribution, related to the impact of using the platform on the parental involvement of a group of participants. The research team collaborated with the technological team of a multimedia company. Four kindergarten classrooms, four educators and 94 parents participated, collaborating in all phases of the project: definition of the platform; prototype testing and use; final evaluation of the platform (as a technological product) and evaluation of the intervention (impact of use).

Ethical and privacy issues were assured during the research. Participants received information about the project, goals, expected results and their intended participation. They gave informed consent and volunteer to participate. Data collection respected GDPR and ensured anonymity and pseudonymization. The treated data were presented to interested participants, guaranteeing accuracy and transparency.

The Design-Based Research (DBR) methodology was adopted, taking into account the characterization of the problem, the objectives, the research question, the context and participants in the study. DBR is used in the development of interventions to solve a complex educational problem and, at the same time, improve knowledge about the development process and characteristics of the intervention (Plomp, 2013). The intervention can include technological prototypes, content and environments that use technology, with a potential impact on teaching and learning. The development process is iterative, consisting of cycles of analysis, design, evaluation, until reaching a satisfactory approximation of an ideal intervention. Anderson and Shattuck (2012) add that the DBR is developed in a real educational context, therefore, the results are used to improve local practices and evaluated to inform theory. The context must be carefully characterized, as the Design Principles that emerge must reflect the conditions of the intervention (Nieveen & Folmer, 2013). The intervention should include collaboration between researchers, professors, users and experts, who work together to better align the research process and

results with the needs and expectations of society (Grunau & Gössling, 2020), which is a condition for Research and Responsible Innovation (RRI). DBR combines qualitative and quantitative techniques for data triangulation and validation of results, at different stages of development (Nieveen & Folmer, 2013), although there is a greater tendency to use qualitative techniques to understand the complexity of real situations (Ross et al., 2008).

For all these reasons, the DBR methodology was chosen for the development of this project. The platform was built to modify a specific situation, which was to increase parental involvement in learning using technology. There was a continuous collaboration of researchers with the technological team, kindergarten teachers and parents, who were involved in all phases of the project. The development of the platform was interactive and iterative, that is, the platform was used and evaluated in context, corrected, modified and enhanced to improve the intervention, in three development cycles. A combination of qualitative and quantitative techniques was used for data collection and analysis at different stages.

For this study, Plomp's (2013) DBR operationalization model was adapted as follows:

- Preliminary study, consisted of characterizing the context; literature review of projects that used technologies for parental involvement; search of existing platforms, surveying the needs of educators and parents;

- Iterative development of the platform, in three cycles of analysis, design, formative evaluation, until reaching the final product: First cycle - functional specifications, paper prototype, usability tests and evaluation; Second cycle - functional prototype, pilot implementation in kindergartens for use by educators and parents, intermediate evaluation; Third cycle – final product, use in kindergartens until the end of the school year;

- Final evaluation of the platform's impact on parental involvement in children's learning, practical results of the intervention and contributions to theory with Design Principles and suggestions for future studies.

Table 1 shows the combination of data collection techniques used in each phase, according to different objectives.

Table 1: Data collection in each phase.

Preliminary study	
Characterize the context; survey of parents' needs	Questionnaire
Characterize the context; survey of educators' needs	Interview
Survey existing platforms	Web search
Development	
Test paper prototype with users	UI-UX tests
Understand parental involvement practices	Questionnaire (parents), Interview (educators)
Monitor participation in the platform	Database of posts
Monitor accesses and visits to the platform	Automated collection by analytics software
Support /feedback from participants	Email, meetings, research notes
Involve children in the dynamization of the platform	Participant observation
Evaluation	
Analyse content published on the platform	Database of posts
Analyse accesses and visits over time	Automated collection by analytics software
Educators' perception about the use of the platform	Interview
Parents' perception about the use of the platform	Focus Group

3 RESULTS

3.1 Preliminary Study

The Parent questionnaires (n = 59), interviews with educators (Ed1, Ed2, Ed3, Ed4), platforms available on the market (n = 12) and the literature review helped to understand the most important features, the perceived advantages and potential constraints on the use of the platform. The analysed data helped to characterize the context. Parents mentioned using the Internet (100%), daily (88%), on the computer (96%) and mobile phone (96%). Their children also accessed technology at home, especially the tablet (76%) and the computer (71%). Parents used technology to do activities with their children (85%). The educators also used the internet on a daily basis, for personal matters and teaching activities with the children ("Search (web)… around a topic we are working on" Ed1) and allowed the children to use the computer independently ("Inside the classroom, we have several areas and one of the areas is the

computer. They can go there to play and work." Ed3). From this part of the study, it was concluded that the group had good technological affinity, a favourable condition for the planned intervention. Regarding features, on a scale of importance from 1 to 5, the features most valued by parents were: news and events schedule (both with an average of 4.52), photo and video gallery (average of 4.48) and a private messaging service with the educator (average 4.25).

These were also the features most commonly found on existing platforms on the market. The educators agreed with the parents about the most important features, but considered that the platform should also gather the parents' contacts, the children's history ("the entire history of the child, whether in terms of health or in terms of evolution, records, assessments we do…" Ed2) and function as a social tool to encourage parents to share suggestions for activities and links to digital educational resources ("it would be fun to be something more interactive. We (educators) could post the activities we do with the children and they (parents) could comment." Ed4). The existing platforms, which were more suited to the kindergarten context, focused on disseminating information about the institutions' activities, but did not provide strategies or suggestions to parents, who could contribute more actively to their children's learning. Both parents and educators pointed out that an advantage would be the platform providing information to parents, helping to start conversations with children about what they learn. These aspects are highlighted in the literature: a digital platform can inform parents about what their children are learning, guide parents in creating new learning opportunities at home, and involve parents in distance activities with kindergarten (Grant, 2011). Also, as advantages, parents considered that the most important thing is access to updated information about activities carried out in kindergarten. The educators mentioned the automation of communication and the promotion of parental feedback. These advantages are also the most reported in the literature (Knauf, 2016). Regarding constraints, parents expressed a general concern with the protection of personal information, in particular, the sharing of photographs where children were identified. Educators indicated the lack of time to update information on the platform. An in-depth presentation of the preliminary study is available in Laranjeiro, Antunes & Santos (2017).

3.2 Development

This phase was divided into three cycles of development. In the first cycle, the functional

specifications were defined, and a paper prototype was drawn up for a first formative evaluation with users. A paper prototype is a simulation of the main pages of the platform, which serves to test usability at an early stage of development, when it is easier to introduce changes and improve the user experience (Nielsen, 2003).

The platform was planned to have a group area, for communication and information sharing between the educator and parents of children in the same classroom; a personal area, for private communication between educator and parent (1:1); an institutional area, with unidirectional communication from kindergarten to parents. Public areas were excluded, respecting the apprehension shown by parents and educators in the preliminary study.

A paper prototype, representing the three areas of the platform, was created and submitted to user interface and user experience (UI-UX) tests with parents and educators (Figure 1).
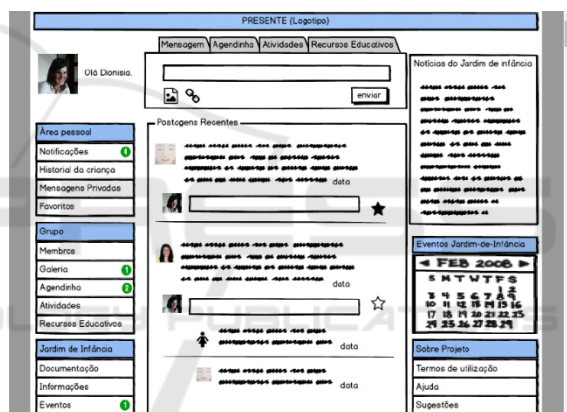

Figure 1: Paper prototype.

At this stage, the topics to be evaluated were the relevance of the content, the consistency of the design and the expected practicality, that is, whether the product was expected to be used in the context for which it was created (Nieveen & Folmer, 2013). The tests were carried out by the researcher with four educators and four parents, and they followed the same procedures. Individually, users looked at the first screen and described what they saw. Then, they "walked-through" the screens, performing tasks requested by the researcher (e.g., "see if you have new messages"), while users "thought aloud", commenting on the tasks they were doing. At the end, an interview was carried out to understand the attitudes and expectations regarding the future use of the platform. The evaluation with users allowed to verify the general understanding of the project by both profiles and to identify some improvements and

changes to the initial prototype: create new areas (edit profile, personal page, meals), merge different areas into one (events and agenda; documentation and information); simplify the field of writing comments, present contents in chronological order (links, agenda and activities). From the interviews it emerged that users valued the platform. The educators intended to use it daily to share activities with parents, while parents assumed a weekly use, more oriented towards communication with the educator than to sharing information with other parents, or to carrying out educational activities with their children.

In the second development cycle, a functional prototype was developed for use/testing in kindergartens (Figure 2). It included the following features:

▪ Personal area: Child history - sharing information about the child between parents and educator (1:1); Favourites - save posts; Notifications - inform when there are new posts; Edit profile;

▪ Group area: Activities - sharing suggestions for activities, sharing activities done in the classroom; Events - sharing of educational events; Educational links - sharing of educational sites and digital resources;

▪ Kindergarten area: institutional news shared by the educator.
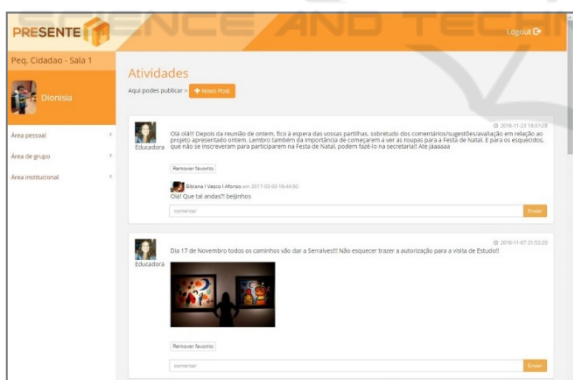

Figure 2: Functional prototype.

In Laranjeiro, Antunes & Santos (2018), all procedures and test results with users are presented, as well as the structure and functionalities defined for the platform.

The pilot began, with meetings in kindergartens (KG1, KG2, KG3), to present the platform and understand the practices of parental involvement prior to the intervention. The fourth kindergarten classroom dropped out because the educator was on maternity leave.

From the interviews with the educators, it was concluded that they were all active in parental involvement, but had different technological strategies. Ed1 used email and created a weekly digital newsletter, which was posted online and shared with her classroom parents. Ed2 used multiple digital media for parental involvement: a private Facebook® group, email, Messenger®, a cloud service for sharing photos and Skype® for video calling. Ed3 only used email occasionally.

Parents answered a questionnaire (n=45), with the three dimensions of parental involvement – involvement at kindergarten, involvement at home, communication with the educator. It also questioned about the use of technology for parental involvement. It was concluded that parents essentially valued the dimensions of communication with the educator and involvement at home. Digital technologies were most used in parental involvement at home (Figure 3). Thus, the platform, which was designed to facilitate these aspects, was well positioned to be adopted by parents.
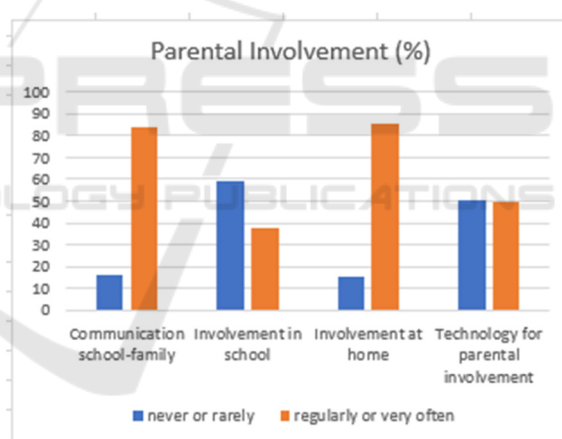

Figure 3: Participants' parental involvement chart.

During the pilot, the researcher followed the evolution of the platform's use. Visits and accesses were monitored through a web statistics program. User posts collected on the platform were analysed using content analysis to systematize qualitative data according to the frequency of occurrence of certain terms and text meanings (Bardin, 2004). Feedback received through periodic contacts with educators (e-mails, phone calls and meetings) and parents (e-mails) allowed to fix bugs in the platform and identify improvements that were implemented in the last development cycle, such as online security measures and the inclusion of image galleries.

The pilot implementation ended with interviews with educators (Ed1, Ed2, Ed3) and two focus groups with parents (n = 15; n = 5) to obtain more in-depth information about their use of the platform.

3.3 Evaluation

The final evaluation aimed to verify the practical use and effectiveness of the intervention, that is, whether the platform was used in the context for which it was developed and served to achieve the expected results (Plomp, 2013) - to promote parental involvement in the learning of children in kindergarten. In the final evaluation, web statistics, the content published on the platform and the content of interviews and focus groups were analysed.

Communication and interaction were different in the three kindergartens. There were also considerable differences in the two profiles (parents and educators). In KG1, there was a high amount of communication in all directions (between parents, parent-educator), initiated by the educator or parents (proactive), or in response to comments (reactive). Parents shared events and proactively created photo albums. In KG2, there was no communication between parents, only between parents and educator, always initiated by the educator, with parents replying to comments. In KG3, there was communication in all directions, but reduced. Parents proactively shared links to articles on education and parenting and replied to comments from each other and from the educator.

The educators were the main drivers of the platform. They posted 46 activities, 23 links, 15 events and responded to nine comments from parents (e.g., "He has been very attentive to the world. So attentive he even needs a magnifying glass." - Ed1 "). Parents took on different roles - 40 remained observers (no participation), 31 responded to messages/posts (reactive participation), 10 started new conversation topics (proactive participation). The web access statistics were high (4,935 visits in ten months), which seems to indicate that the parents took a passive role on the platform, perhaps because their goal was just to visualize information, or because they needed time to become familiar with a new social tool (Wenger et al., 2002).

The areas with the highest number of publications were: Activities (48), where educators shared activities carried out with the children, encouraged parents to participate in kindergarten and to publish on the platform; Links (34) where users essentially shared videos, links to photographs and educational articles; Events (18), where they shared kindergarten events, leisure events and educational events.

Parents' comments had varied content: they added information about the child (36 comments), (e.g.: "he is very stubborn, he never wants help."), they added information about activities at home (10 comments) (e.g.: "He's been reading this story a lot... Why do you have such big ears? It's to hear you better!"), Feedback (25 comments), greeting (22 comments), general information (7 comments), technical questions (8 comments). Some comments denoted great enthusiasm and satisfaction (6 comments) (e.g., "Sooooo gooooood!!! Mom loves your kisses too :) Good job!!!"); and complicity with the educator (13 comments) (e.g., "Love is in the air (Ed3) - "It's normal it's spring… And on top of that the educator is always fostering marriages"). Comments about the child and comments about activities at home or kindergarten have the greatest influence on learning, as they provide information about the contexts, which educators and parents can use in learning (Lopez & Caspe, 2014). The other types of comments are also important to maintain active and positive communication and establish a climate of trust for long-term relationships (Moll et al., 1992). It can be concluded that the platform promoted parental involvement, in the dimension *school-family communication*, because it generated communication and content sharing about children's learning between parents and educators.

The interviews and focus groups made it possible to know the perception of educators and parents about the use of the platform. Some results are summarized. The parents' reasons for accessing the platform were the sharing of activities carried out in kindergarten, interesting games proposed by the educators and the insistence of the educators. The features considered most useful were those that promoted group sharing - educational links, events, activities, photo gallery. Regarding the inclusion of children in the project, six mothers said they used the platform with their children, to show photos and talk about the activities, which means that the platform generated parental involvement, in the dimension *involvement at home* (e.g.: "yes, we talked informally, how was it, if she liked it, if she didn't… the conversation flowed and that was good").

Both profiles suggested improvements for the future, in particular, the possibility to manage notifications and better usability on mobile devices. The perceived advantages of the platform were the immediate sharing of information about the daily lives of children in kindergarten, promoting more continuously online school-family communication

("I think they (parents) end up having a more trustworthy portrait of what our day-to-day is. I think that's where it contributed the most." – Ed1). The constraints mentioned were the lack of time and excess work that the educators already had, the dynamization being centred on the educators, some technical difficulties and, in the case of JI2, the fact that they already use other communication tools.

4 DISCUSSION AND CONCLUSIONS

This research proposed to achieve two types of contributions: a general contribution - Design Principles of the intervention and the platform; and a local contribution - the impact of using the platform on the involvement of parents participating in a local intervention. The information generated in the three phases of the research, the participation of three kindergartens, educators and parents with different parental involvement strategies and different technological uses, the triangulation with theoretical studies and other existing platforms, allowed the creation of guidelines for the design of a technological intervention in similar contexts. The most relevant features and content for the platform are summarized, as well as other indications that stood out for the success of the intervention.

The most valued features are those that allow the sharing of activities carried out with children in kindergarten, whether it is a chronology of posts or an image gallery. Others were also used, mainly the sharing of events and links. Another feature often mentioned as necessary was notification of new content. In terms of content, parents mainly wanted to see their children's activities and know how they spend their day, but the platform must have the flexibility to integrate different interests and types of content.

The dynamization depends essentially on the educators. They played an important role in e-moderating, releasing new content, encouraging participation and replying to comments from parents. If educators do not assume this role, participation may be residual. The educator must be able to set aside time for this task. It is essential that the platform is easy to use, with quick content insertion (for example, uploading multiple images at the same time), and without many mandatory fields. Parents can take on different roles - passive observers, reactive or proactive participants. This is because their interests are also different. Some parents just want to receive

information about their children, others want to communicate with the educator, a smaller group likes to share content with other parents. The group itself and its previous relationship can influence participation, and for this reason, the platform must be prepared for different types of communication (one-way, two-way and multi-directional). Due to lack of time, the institutional area was not updated by educators, although it was always considered important, so it seems that an administrative profile could be useful to update information, such as cafeteria menus, events and kindergarten news. Mobile access seems to be a condition for more frequent use, so the platform must be optimized for these devices. The privacy and security of information must be guaranteed and explained so that parents feel safe to join and participate in the platform.

Regarding the local impact, the three cases (KG1, KG2 and KG3) had different results, which may be explained by the different strategies of parental involvement with technology that each educator had previously.

Before the pilot implementation, the KG1 educator was already using technologies for parental involvement, in particular, a weekly newsletter created by her. However, creating the newsletter was a lot of work and the educator wanted a more automatic way to communicate with parents and receive feedback, so there was a good predisposition to use the platform. In this group, during the pilot, there was an intensive use of the platform, which fulfilled its functions as a tool for parental involvement, in the dimensions of school-family communication and parental involvement at home.

At KG2, the parents and the educator were already using various digital communication tools regularly. For this reason, they made many suggestions in the preliminary study to define the platform. However, during the pilot implementation, the educator shared publications on the platform, but the parents did not participate, and continued to use the tools they already used before. In this group, an experience was carried out, including the children in the dynamization of the platform. Children shared their drawings and videos, which resulted in the parents' punctual and intense use of the platform to see and comment their child's activities. In this dynamization, the platform promoted parental involvement at home and school-family communication, briefly fulfilling its function, but was not adopted in the long term.

In KG3, there were no previous habits of using technologies for parental involvement, only occasionally email. The educator made a great effort

to dynamize the platform and obtained little participation from parents, which generated frustration and a residual participation at the end of the pilot. However, at the beginning of the new school year, the institution contacted the researcher, as the parents wanted to use the platform again. Five new virtual rooms were created for the institution, not only for the kindergarten, but also for the day care centre. In this kindergarten, the platform did not have a major impact on parental involvement during the pilot implementation, but it did have an impact as a way to raise awareness of the need to use technology for these purposes. Thus, the intervention came to change an educational situation with a technological product, which is the purpose of DBR.

The limitations found in this research are typical of the methodology. DBR involves several people with different profiles and rhythms – researchers, technological team and users (Kelly et al., 2008). The research required time to collect and analyse data at various stages. The technological team had reduced availability, due to the reconciliation of several projects simultaneously. Educators and parents were conditioned by schedules, school calendars, and personal availability. These restrictions limited technological development, which may have influenced the results.

DBR is long, due to its cyclical and iterative character (Anderson & Shattuck, 2012). As technology evolves rapidly, DBR can take a long time to respond, so cycles should be brief. The pilot period was short, for users who needed time to adapt to the platform (Wenger et al., 2002). The case of KG3 is an example of this need. A study on the evolution of the use of the platform in consecutive years in this kindergarten would be interesting.

Another limitation is the difficulty in generalizing the results. It is not possible to use representative samples of reality in software development, as it would be necessary to analyse large amounts of data generated between development cycles. Even with small samples it is difficult due to the variety and amount of data generated and triangulated in all phases (The Design-Based Research Collective, 2003). Thus, the products are tested in small groups and launched on the market. Later, with continued use and new data, they evolve into optimized versions.

For the future, it will be necessary to make some changes to the platform, to resolve the constraints on its use, in order to be adopted in other kindergartens, where it can contribute to parental involvement.

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