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Graphic design and user-centred design: designing learning tools for primary school

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Abstract

Does the contribution of children during the design process help graphic designers to create more efficient learning tools? In order to answer this research question, an experiment using both the user-centred design method and a traditional design method (without users' consultancy) was conducted. The aim of this study was to verify whether the user-centred design method is effective in the design of graphic learning tools for primary school. The results show, among other things, that there was a greater level of difficulty in designing projects without the participation of children, than designing with them. Finally, the use of the user-centred design method is recommended both in print and product design disciplines, especially when the target audience is very specific.

Introduction

In this study the use of the method called user-centred design is considered in order to help designers to understand how users interact and perceive a product during its project development. The user-centred design (UCD) approach—also known as user experience design, user interface design, human-centred design, human factor engineering, and usability engineering—is a method used to design digital products in which users are involved in all stages of product development. It has been used since the early 1980s. Previously, interface design had focused on technology—the technology-driven approach— in which users are not involved in the process of development (Mandel 1997). In contrast to the technology-driven approach, the UCD process is user-driven, meaning that users are involved in all stages of design and development of a product or service (Vredenburg 2003).

This method has been used in the development of digital media projects in order to help to design more operational interfaces for users. However, the methods used in the development of graphics or product design are usually different from this approach. In traditional graphic design projects, users can only contact the object in the final stages, and they do

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not have many chances to give their opinion about the design. Economic and production issues obviously have a greater weight in the decisions made at the early design project stages than does user participation.

In order to reflect on and propose actions on these issues, an experiment in a discipline of the design course at the University of Brasilia was conducted. The target public chosen were literate children between seven and thirteen years old. The aim of this study was to verify whether the user-centred design method is effective in the design of graphic learning tools for primary school. It is important to highlight that the word 'tool' is used in this study with the sense of both artefact and solution, whereas the wording 'learning' is related to both children's learning (the contents listed in the study), and design students' learning (how design students develop their methods and processes). Therefore, this research focused on the process design needed to achieve a product that has both efficiency and that can be used in the education process. The main research question of this study was: Does the contribution of children during the design process help graphic designers to create more efficient learning tools? Initially, a brief discussion of the theoretical basis for this study is presented. Then, the method study is presented, with the results, discussions and the study conclusions.

Theoretical approach

The most current definition of industrial design published by World Design Organization (WDO), concerns the relationship between quality of life and 'innovative products, systems, services and experiences' (WDO 2018). Design also means understanding the relationship between the results of processes and the effective construction of culture, emphasizing the production of meaning and significance. In this sense, design is a dialectical construction; designers change the world and their modification in culture generates (Bakhtin 1997) a repertoire that modifies users and designers.

Different methods and approaches are used in order to design different kinds of products. More than 50 years have passed since the first Design Methods conference (Design Research Society 2016) and many approaches and methods have been discussed during this time. Pazmino (2010), in her review of Design Methods, presents18 design models from 1962 to 2008 (e.g. Archer 1965; Jones 1978; Munari 1981; Cross 2006). She claims that nowadays design methods are needed due to the fact that the complexity of design problems seems to have increased because of the changes brought by globalization, new technologies, and sustainability, among other factors. In addition, she states that both the techniques and the tools of design methods should be included in the design process in order to improve the efficiency of the design process.

An approach commonly used in the design of digital projects is known as User Centred Design (UCD). According to Draper and Norman (1984), in the UCD approach, the purpose of the system is to serve the user and not a specific technology. In addition, they said that the design of the interface should be dominated by the needs of the users and that "the needs of the interface should dominate the design of the rest of the system". The International Organization for Standardization (ISO) also defines user-centred design, which they call Human-Centred Design. The ISO 13407 (i.e. the standard regarding human-centred design processes for interactive systems) says that Human-Centred Design is "characterized by: the active involvement of users and a clear understanding of user and task

requirements; an appropriate distribution of function between users and technology; the iteration of design solutions; multidisciplinary design" (Rubin and Chisnell 2008, p. 12).

The UCD process has been applied in the development of different kinds of digital media, such as website development (e.g. Troyer and Leune 1998), software development (e.g. Scaife and Rogers 1999; Gulliksen et al. 2005), interactive visualization design (e.g. Wassink et al. 2009) and digital TV (e.g. dos Santos et al. 2012). However, it seems that this method is not frequently used in the development of print-based products (Souto 2017). It is argued that graphic designers create without really understanding the needs and preferences of the users and that it is necessary to include a user-centred approach during the design process (Forlizzi and Lebbon 2002; Frascara 2004; Taffe 2015). The user's participation since the beginning of the project can be useful in a number of ways, such as: to better understand users' needs and habits, whether they are interested in the product or not, to get an impression of product (Souto 2017).

The potential of design as a channel for dialogue between educators and their students is high, because they can invigorate the teaching–learning process, creating a harmonious combination between individual and collective improvement (Coutinho and Lopes 2011). In designing learning tools, especially for children, many aspects should be considered, such as: the complexity of the content in relation to the children's age and knowledge, the level of details, the material attributes, the manipulation with the material, and the visual characteristics (e.g. images, typography). Coutinho (2006) claims that it is necessary to rethink the textbook in a way that does not make learning difficult for the child. Therefore, an in-depth knowledge of children's preference and needs seems to be able to assist in the design of efficient, appropriate and attractive learning tools for them.

This study brings a new contribution to understanding the impact of including children during the design process in order to help designers create more efficient learning tools.

Method

Experimental design

The study compared the design of graphic projects developed using the UCD method (with the participation of the target public during the project development) with the design of graphic projects developed without the participation of the target public. The aim of this study was to understand the impact of the participation of the target audience on the final product, including its positive and negative aspects. In addition, the design students' perceptions of the participation of the audience (or non participation) of in graphic design projects were investigated.

Three main parameters were used to compare processes/results in group A with the process/results in group B. The first parameter was the difference in visual complexity between the work of groups A and B. The second parameter was the comparison between the projects with the most innovative or traditional look in children's projects. The third parameter was based on the possibilities for use and performance by children.

Learning content

In order to understand the project, it is relevant to give a very brief description of the Brazilian Midwest region. Brazil is divided into five regions that have huge physical, biological

and cultural differences. The Midwest region, which comprises landscapes such as the Brazilian Savannah or 'Cerrado', and the Pantanal, has an incredible diversity of flora and fauna. This region is important because it houses the Federal District and the capital of Brazil, Brasilia. The history of this region is related to the country's efforts to occupy its entire territory. Culturally, the region is known in Brazil as the birthplace of a movement of Rock and Roll that slowly spread to other regions of Brazil. From the point of view of the flora and fauna, there are different fruits and animals only found in this region.

Participants

There were 21 undergraduate design students in total working on the design of the products and 25 children that participated in the experiments. As mentioned above, the students were divided into two groups and 10 sub-groups with 2 or 3 students in each group. The undergraduate students were attending the first Graphic Design Project on the Bachelor Design Course at the University of Brasilia. Children were from 7 to 13 years old.

Procedures

This project developed under the subject Graphic Design 1 on the Bachelor Design Course at the University of Brasilia. The students were asked to develop a design project in groups. The solution set was to be used for more than one child, which means collective use, not individual. Both groups received the same instructions.

The students were divided into two groups: group A with 10 students working in pairs, with 5 sub-groups in total, and group B with 11 students with 5 sub-groups, 4 pairs and a sub-group of three students.

Group A was taught about communication, design communicative functions, methods and media. They also received references to research on child psychology and behaviour. They were asked not to talk to or interview children at any stage of the project.

In contrast, Group B attended a class on user-centred design and was requested to work with groups of children during the project development. Mandel's (1997) four UCD stages were required to be used in the project development. The stages were: analyse, design, construct, validate. The students of Group B received a copy of texts on the method of UCD and stages of a UCD project, and they were required to choose a group of children to work with immediately. The target public chosen were literate children between seven and thirteen years old. The experiments were carried out in the children's school environment. The groups were free to arrange their contact with children, what methods they would use (e.g. questionnaires, interviews), and the number of times they would need to meet them during the project development. The students were encouraged to choose the methods to apply according to the children's group.

After the projects were completed, they were evaluated by both a team of three examiners and also by students of all groups. The examiners were lecturers in Graphic Design (PhDs) with expertise in this area. The methods used to evaluate the project were a focus group discussion followed by the heuristic evaluation of the examiners. The students that designed the projects and the examiners participated in the focus group. The criteria used to evaluate the projects were: (1) suitability of the product to the audience, (3) functionality and suitability of the content of the product; (3) creativity and aesthetic quality; (4) completeness and technical feasibility of the product. In addition, they were also asked their

opinion on whether or not to use the UCD method during the graphic design process, based on the project results.

Results

In relation to the final projects, we see a variety of products created: 3 board games, 1 domino game, 2 panels, 1 pop-up book, 1 set of objects containing a book, 1 illustrated book, and 1 pop-up book mixed with a game.

Group A worked only with information about the history, the region, the content to be presented to the public, and the foundations of design, information and communication. They could not ask children's opinions about the project during the development process.

Group A was divided into 5 sub-groups. Each group created a different product: board game, domino game, printed panel, pop-up book, and set of objects containing a book, and the target public age considered to develop the project was 7 to 11 years old.

Figure 1 shows an image of a project developed by Group A. The project is a domino game to be played by two or four children containing 40 cards; 10 contain information about historical characters, 10 folklore facts and 20 fauna facts. The dynamics of the game is like the domino game, but the player must associate the image of the character to the descriptions of the character on the table.

On the other hand, Group B used the user-centred design method and therefore worked with children's participation during different stages of the process. As explained in the procedures section, the groups were free to arrange their contact with children, to decide what methods to use in their contact with children (e.g. questionnaires, interview), and to define the number of times they would need to meet them during the project development. Figure 2 shows an image that illustrates a product developed by Group A. This project is a board game about the work and life of the poet Cora Coralina in her hometown, aimed at teaching children to locate the places that were references for

Fig. 1 Project 2, Board game, by Group A (without children's opinion). *Source*: Authors
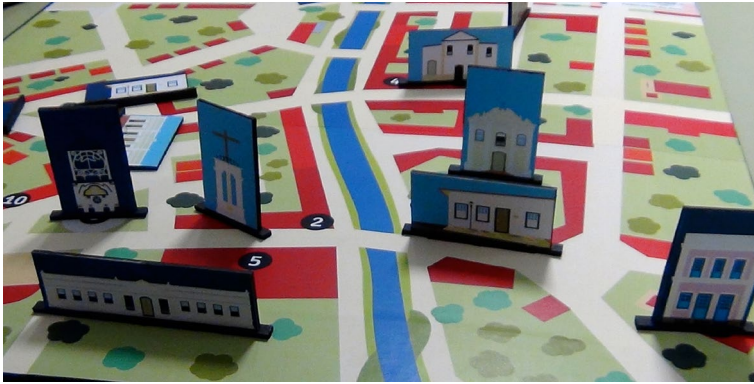
Fig. 2 Project 7, Board game, map of Goiás Velho, Cards and game pieces, by Group B (which used the UCD method). *Source*: Authors

the poet. It contains a board game, rules, pieces and cards with questions and answers. The palette of colours resembled the houses of the old city of Goias Velho, and the sky colour is typical of the Brazilian Cerrado. The group conducted three interactions with 5 children from 10 to 13 years old. In the first one, the designers verified whether the choice of the topic was of interest to children, and asked about the kind of activities that children like to do in groups. In the second stage, each of the designers worked with a group of 3 children in order to think of game possibilities and concepts. In the third stage, the developers took a sketch of a board game, observed the children playing and took notes on the main difficulties and their lack of understanding.

In contrast, the findings show that there was a greater level of difficulty in designing projects without the participation of the children, than designing with the participation of children. This can be illustrated with the book about Brasilia (Fig. 3). This book is about a secret comparison between the figure of President Juscelino Kubitschek and the emperor of Egypt, Akhenaten, involving the cities created by each of them. It is a pop-up book that can be read in pairs or in fours. Each player initially receives reading

Fig. 3 Project 4, Pop up book, by Group A (without children's opinion). *Source*: Authors

glasses with coloured lenses that allow the user to view secret messages throughout the book. The proposal was to create a translation for the children's book, Secret Brasilia.

It was observed that the book is engaging; it has nice illustrations and beautiful graphic design. Although the result of the book was interesting, its level of complexity is very high for the target audience.

On the other hand, the projects that included children in the development process, products designed with a medium level of complexity, were considered suitable for the audience. They seem to help awaken the creativity and interest of the child, without the extra difficulty that could alienate them from the activity. Figure 4 shows an image of a project that illustrates this point. Three participants developed the project and included 3 children from 7 to 8 years old. The product created is an object between a board game and a popup book that teaches children about fruits, their origin and their role in nature. Children took part in the experiment twice. First, children were asked to read two books in order to see their difficulty in reading and their interest in the books. Then, the designers asked children to identify fruits that they did not know.

In relation to the organization of images and appearance, it was observed that in the projects that involved the children the students used features like 'layers', defined by Lupton and Phillips (2008) as one of the most sophisticated graphic design processes to assign different data types. Other design features used were Grid Systems (i.e. to arrange elements) and Fantasy (i.e. to help children understand cultural and regional characteristics). Figure 5 illustrates a project that used layers in the design processes. This project is a panel containing the characteristics of the Cerrado during periods of rain and drought. In order to view the information, children should use glasses with colour filters in red, blue and green.

In this project, the students applied three questionnaires during three different stages of the project development for 5 children from 9 to 10 years old. The first questionnaire was to find out what children knew about the Cerrado and their difficulty in understanding this content. The second questionnaire is on aesthetic issues, and the final one was developed in order to refine the content and texts to be addressed. The first questionnaire contained

Fig. 4 Project 9, Book cover, and part of the prototype of the board game, detailing pop-ups, structure and pieces of the game, by Group B (which used the UCD method). *Source*: Authors

Fig. 5 Project 6, Final panel, layout and drawings, by Group B (which used the UCD method). *Source*: Authors

12 questions, the second two, and the third questionnaire 5. All had open answers from which resulted a qualitative interpretation. Among the findings of the questionnaires are: (1) Children do not associate the cerrado with the region they live in; (2) all children preferred a more realistic rather than cartoonized design; (3) in general, they like science and art classes because in these classes they experiment and discover new things, and they are more dynamic classes; (4) They also like group work because they can be with friends; (5) Everyone liked the idea of the mural and thought it would make the lesson more interesting, but some found it difficult to see some details with the blue filter because it was too dark. These questionnaires helped the students to better understand the children's knowledge and interest and also to assist them in improving the content based on children's perception.

Munari (1997) defines Fantasy as the most freeing design approach of all, but stresses that it does not take into account the viability of the project. However, it has been realized that the Fantasy approach can be used together with the User-Centred approach to help in the design of narratives and stories with feasibility and understanding.

Discussion

The examiners and the students that evaluate the projects pointed out that in general the projects that included the children during the project development are more effective than the ones that did not involve the children. Among the main reasons are: the suitability of the level of complexity of the project to the audience, the suitability of the content in relation to the audience knowledge, the use of creative design features (e.g. layers, grids, fantasy), technical feasibility, which made the projects more organized and appealing to children to use them.

Usually, Graphic Design students are encouraged to deal with customers. However, the user only arises in specific disciplines, such as in digital design and ergonomics. It was also noticed that the presence of the user during the development of projects makes the process a little more time-consuming. On the other hand, it removes the need to rework, and it helps to achieve final products that users find more satisfying. From the point of view of both graphic design and the products developed, it is important to highlight that these kinds of experiments should be repeated more times with the same group of students in order to measure students' commitment to the project, and their particular characteristics related to the project development.

Regarding the difference in visual complexity (first parameter), it was verified that group A (without children's opinion) designed artefacts with more visual and verbal information than group B (which used the UCD method). In relation to the comparison between innovative or traditional look (second parameter), it was verified that group B presented a greater variety of characteristics and graphic effects than Group A. Finally, regarding the possibilities for use and performance by children (third parameter), it was verified that in Group B, attention was drawn to the text, which was rewritten many times until the children gained a full understanding of the content. On the other hand, in Group A children ended up with artefacts that required more reading time because they contained more text.

Conclusion

Based on these results, it is concluded that it is not good practice for designers to assume that they know the users without researching them. In learning materials, this can result in poor learning. Thus, the contribution of this study is to demonstrate both for design students and designers that they need to understand their users, to include them in the design process and to develop a more empathetic design in a collaborative way.

The answer to the main research question—'Does the contribution of children during the design process help graphic designers to create more efficient learning tools?'—is yes. The findings suggest that using user-centred design is an effective method and shows new ways of teaching project design for students in the initial phase of the undergraduate Graphic Design course. In summary, the learning tools designed by the group that used the UCD method, as shown in the results of this study, are more efficient than the group that did not use the HCD method, since this group designed didactic materials that were more suitable for children's knowledge, more innovative, and also visually more appropriate and attractive.

This study shows that designers should take into account the user-centred design method during different stages of the process development. Not only digital design disciplines, but other disciplines such as print and product design, may also benefit from using this method. The user-centred method is especially relevant when the target audience is very specific. In this situation, the project solutions resulted in greater assertiveness of design. However, it is necessary to refine the method by adapting the process to the need of a particular project. It is also important to develop steps in which designers will invite users to participate in the project, considering both the type of project and the characteristics of the participants (e.g. age, literacy, etc.). It was observed that even though the participants belonged to the same age range (from 7 to 13), there were differences in the levels and stages of development of the children that made it difficult to generalize the findings. Therefore, it seems that it is necessary to investigate children within a narrow age range.

It can be said that the user-centred design approach, particularly for developing projects for children, may at first cause a feeling of creative deprivation in the designer. This may happen due to the requirements of the project and the commitment to attending the real needs of the users. On the other hand, during the development of the project the designers realized that the dialogue with users made the project into a kind of co-authorship.

In addition, it is important to highlight that the experiments were applied in the natural environment of the primary students—that is, in their school environment. This fact helped designers to understand the children's context, their environment, limitations and possibilities, the dynamics of their games and other types of interactions. Among other things,

it also showed that this type of product is usually used in a group, involving games and dynamics, and some with teachers' participation (e.g. in project 9).

For future work, the use of such products and their acceptance by the target audience should be measured. This will be done in order to verify whether the products that had the users' participation were successful and also to understand better the user-centred method applied to different contexts and users.

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