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Using Design Thinking Tools to Inform the Design Process of a Massive Open Online Course on Using Scratch for Teachers

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Abstract

In this article, we present our findings regarding the use of design thinking tools to design a massive open online course (MOOC). Our research goal was to investigate the use of Persona and Empathy Maps in order to understand future students' needs. We followed a convergent parallel mixed method approach. Using a questionnaire, we collected data from 80 teachers interested in taking a future course on the Scratch language. We combined descriptive statistics, language processing methods, and design thinking tools (Personas and Empathy Maps) to analyze the data. Our findings were as follows: 1. Publicity for the course should emphasize that Scratch is an important tool that can be used by teachers in early childhood education; 2. The course should be designed taking into account that the future students may be senior teachers, with low familiarity with technology and poor knowledge of Scratch; 3. The course should have a module that explains what creative learning is, presenting different ways that Scratch can be used to foster it; 4. The course should have a module explaining the strengths and limitations of the Scratch programming language, comparing its features with the features of other programming languages; and 5. The course should have resources (such as discussion forums) to allow those with no technological background to overcome their fear of coding. In conclusion, the use of design thinking tools helped to understand the future students' needs, facilitating the design of a meaningful MOOC.

Keywords

MOOC, Persona, Empathy Maps.

Introduction

The Federal University of Sao Paulo regularly offers massive free-of-charge online certified extension courses. These courses aim to provide educational opportunities for anyone interested in developing their skills. In the first semester of 2002, we designed and delivered a massive course, *Introduction to Programming with Scratch*.

We decided to create this MOOC based on studies (da Silva Eloy et al., 2017) that pointed out that Scratch has been used mostly in face-to-face settings in Brazil.

The course we offered had the goal of teaching the basics of Scratch programming language to K-12 students. However, 51% of the people who took the course were teachers. We had teachers from all educational stages (early childhood education, elementary school, high school, universities, corporations, and NGOs). Based on this, we decided to create a new course specifically designed for teachers. However, we were presented with the issue of how to design a massive course that would meet the specific needs of teachers working with students at all stages of their education. In order to address this, we decided to use design thinking concepts and tools in order to better understand the teachers' needs. In this article, we present the process followed and the insights gained.

Literature Review

Researchers (Brown, 2008; Gobble, 2014; Plattner et al., 2010) pointed out that Design Thinking (thereafter DT) can be understood as a methodology that aggregates methods, tools, procedures, and knowledge from several different fields such as engineering, business, architecture, urban planning, software engineering, design, and social sciences in order to create artifacts such as products, processes, and services that solve real-life problems.

Researchers (Brown & Wyatt, 2010; Dorst, 2011) pointed out that DT is based on three pillars: Empathy (figuring out the customers' emotions, their feelings, needs, and problems), collaboration (working together with team members and customers in a meaningful way, sharing ideas and knowledge), and experimentation (development of rapid prototypes to explore possible solutions to the customers' needs and problems).

The projects that follow the DT method are accomplished by means of cyclical processes, evolving through different phases. There is still no consensus as to the number or name of the phases (Brown & Kātz, 2009). However, researchers (IDEO, 2015) suggested that at least three major phases should be followed: inspiration, ideation, and implementation.

During the inspiration phase, the designers listen to the client, gathering data about their needs (Brown, 2008). These needs can be understood as the project's requirements. The project then evolves into the ideation phase, where developers analyze different ways of addressing the requirements. The designers then create rapid prototypes to test the feasibility of each of the possible solutions (Brown & Kātz, 2009). By evaluating each prototype, they can choose the best one. Finally, the project evolves to the implementation phase, where the best prototype is fully developed, creating a final product/service that meets the client's requirements (Brown, 2008; Brown & Kātz, 2009).

There are several DT tools that could be used during the ideation phase to analyze the customer's needs. In our project, we chose to use two: The Persona and the Empathy Map. The Persona is an imaginary character created to represent a group of individuals with similar characteristics and behaviors (Lewrick et al., 2020; Plattner et al., 2010). Scholars (Brown & Kātz, 2009; Lewrick et al., 2018) suggest that the Persona should present demographic information (such as age and gender) and information about the objectives, motivation, and goals. Personas help to synthesize information about groups (So & Joo, 2017), aiding in understanding their similarities and differences.

The Empathy Map is a tool that allows the designer to understand the problem from the perspective of the customer, in other words, their needs (Cavalcanti & Filatro, 2016). The Empathy Maps usually present information in six categories (Corrêa et al., 2022; Lewrick et al., 2020): what the customer *sees* (what their environment is and where they will make use of the product/service), what the customer *hears* (what they have heard about the uses of the product/service), what the customer *thinks and feels* (what they think or feel about using the product/service), what the customer *says and does* (what they say about the product/service and how they use or intend to use it), what their *pains* are (the problems or difficulties for using the product/service) and what their *gains* are (the benefits that the use of the product/service may bring to the customer).

Design thinking has been used in fields such as marketing (Hisanabe, 2009), business (Vianna et al., 2011), software engineering (Dobrigkeit & de Paula, 2019; Faily & Lyle, 2013), nursery (Corrêa et al., 2022), engineering (Levine et al., 2016), and education (Wong et al., 2015). Design thinking is used in education in several ways, including teacher training (Harth & Panke, 2019), STEM education (Culén & Gasparini, 2019), service learning (Siniawski et al., 2016), medical education (Badwan et al., 2018), and business education (Çeviker-Çınar et al., 2017).

Recently, researchers (Shé et al., 2022) have begun to explore different ways of incorporating DT into course design in order to develop empathy with the students. In addition to that, researchers (Welsh & Dehler, 2013) have used DT in their courses with the goal of promoting a meaningful learning experience. More than that, scholars (Gyabak et al., 2015) also pointed out that design thinking can be used to design online courses. Scholars (Sözler, 2021) have also discussed the importance of DT in order to understand the needs of the students in online learning. Although there are several articles that describe the use of DT in education, it seems that there is still a lack of information on how to use DT in designing a MOOC and the insights it can bring. This article aims to address this gap.

Methodology

Research Design

We followed a convergent parallel mixed method approach. In this approach, the quantitative and qualitative data were collected simultaneously. The data were then analyzed together. We compared and interpreted the two kinds of data in order to see if there was convergence or divergence (Schoonenboom & Johnson, 2017).

The quantitative data gave us information about the demographics of future students (such as gender, age, years of working experience, academic background, etc.). The qualitative data gave us information about their sentiments, emotions, and way of thinking. We used design thinking tools (Personas and Empathy Maps) in order to connect the data, allowing an integrated view of the results.

Data Gathering Procedures

The data was gathered by means of an electronic questionnaire sent to the three largest Brazilian teachers' Facebook groups (*Teachers and tutors of distance learning courses* with 5,900 members, *Teachers from the State of Sao Paulo* with 26.500 members, and *Teachers from Sao Paulo City* with 27,000 members).

Eighty teachers answered the questionnaire. The questionnaire had two parts: the first was designed to collect data that would be used to create the Personas; the second part was designed to collect data for the creation of the Empathy Maps.

The first part had 10 close-ended questions and four open-ended questions. The second part had 7 open-ended questions. The first part of the questionnaire had questions related to *teachers' characteristics* (gender, age, etc.), and questions related to their *objectives, motivations, goals, and working conditions*.

The second part of the questionnaire had questions created in order to identify their *sentiments/emotion, ways of thinking and perspectives*. We created questions asking about what they teach (what they *say and do*), the adequacy of their working environment for teaching Scratch (how they *see* their work environment, internet connection, and computers per student), what they had *heard* about the uses of Scratch, what they *think and feel* about using Scratch in courses they teach. We also asked what difficulties they envisioned in using Scratch in their courses (their *pains*) and what benefits they envisioned (their *gains*).

Participants

Eighty people answered our questionnaire, 39 female (49%) and 41 male (51%). The youngest one was 19 years old and the oldest was 67; the mean age was 42, the standard deviation was 10 years, the interquartile range was 13.5 and the mode was 40 years.

Data Analysis Procedures

First, we divided the data into four clusters: data from teachers in elementary schools, high schools, universities, and Corporations/NGOs. After that, we analyzed the quantitative data by means of descriptive statistics. We used the R software to do the calculations and visualize the data. In sequence, we analyzed the qualitative data, using the language processing method (Shiba et al., 2001) compiling the answers from the open-ended questions, disassembling that into sentences, and grouping the sentences into broader categories. After that, we created recurrent themes, phrases that synthesized the main ideas of the categories. In sequence, we created Personas using the results of the statistical analysis and the recurrent themes that gave information about participants' objectives, motivations, and goals. After that, we created the Maps of Empathy, using the recurrent themes related to the six categories described previously (think and feel, hear, see, say and do, pain, and gains). Finally, we compared and interpreted the data from Personas and Empathy Maps, looking for similarities and differences. This analysis led us to the discovery of our findings.

Results

Statistical Analysis

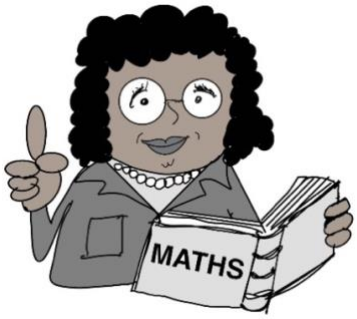
The respondents live in 18 of the 26 Brazilian States, the majority of them are from the State of Sao Paulo (56.25%, 45 respondents), followed by the State of Rio de Janeiro (12.5%, 10 respondents), Parana (6.25%, 5 respondents), and Rio Grande do Sul (3.75%, 3 respondents). The other States had one or two respondents. Ninety-one percent of the respondents were teachers: 1% in Early Childhood Education, 24% in Elementary Schools ,35% in High Schools, 22% in universities, and 9% from NGOs/ Corporations. Nine percent of the respondents were not teachers yet, but they were interested in becoming teachers. Forty-nine percent (49%) of the respondents had more than fifteen years of teaching experience, 18% had from 11 to 15 years, 8% from 6 to 10 years, 16% from 1 to five years, and 10% had no teaching experience.

The Personas and the Empathy Maps

The data collected was divided into four Personas: teachers from elementary school, from high schools, from universities, and from NGOs/Corporations. The Personas were created based on the information about the school levels where the respondents teach. Researchers (Lewrick et al., 2018) suggested that the Personas should have a name, a fictional live story, and information about their needs and aspirations. However, we decided not to name the Personas or add any fictional information about them. We decided to present the Personas in categories based solely on the data collected, not adding any fictional information that could mislead the analysis. However, we draw a picture of each Persona, in order to facilitate the identification and make the analysis more interesting.

The first Persona was named *Teacher from elementary school* (Table 1). The majority of teachers in this cluster are female. The quantitative data shows that even though they are very experienced they know very little about Scratch. The majority of the people represented by this Persona teaches Mathematics.

Table 1: *Persona 1- Teacher from elementary school.*

Persona 1	
Characteristics: Predominantly female (58%), on average 40 years old, the majority live in Sao Paulo (61%). Very experienced; the majority have worked for more than 11 years (73%). The majority have none (30%) or very low knowledge of Scratch (53%). Few have a Master of Science degree (16%) and many (37%) have taken specialization courses. The majority (70%) work in schools with adequate infrastructure (computers and internet connection) for teaching Scratch.	
Objectives, Motivation, and Goals: The majority want to use Scratch to teach Math (74%); others want to teach Portuguese, History, Geography, Science, and Arts.	

The Empathy Map for Persona 1 (Table 2) shows that Persona is not familiar with computational reasoning, nevertheless, she thinks Scratch would be adequate to teach the children how to program.

Table 2: *The Empathy Map for Persona 1- Teacher from elementary school.*

Think and Feel: Even though the majority of the teachers were not familiar either with programming languages or Scratch, they thought Scratch would be adequate to teach their students to learn how to program.	
Hear: They have heard that Scratch is easy to use. They have also heard that Scratch increases students' motivation to learn.	**See:** The majority work in schools with adequate IT resources, but some have classrooms with fewer computers than necessary and internet connections that are not reliable.
Pain: They think the students will face difficulties learning. They also fear that they will face IT problems (not enough computers and unreliable internet connection).	**Gains:** They believe that Scratch will allow the students to develop programming skills and logical reasoning.
Say and Do: They want to teach their students to code, and create games and animations. They also want to use Scratch to teach Math.	

The second Persona was named *Teacher from high school* (Table 3). The second Persona is predominantly male. This Persona has many characteristics in common with Persona 1; both are very experienced and both know very little about Scratch. The majority of the people represented by this Persona also teach Mathematics, however, the teachers from high school teach a higher number of different subjects. Their academic background is similar to Persona 1, however, there are few more teachers with Master of Science and Doctoral degrees.

Table 3: *Persona 2- Teachers from high school.*

Persona 2	
Characteristics: Predominantly male (57%), on average 43 years old, the majority live in Sao Paulo (61%). Very experienced, the majority have worked for more than 11 years (73%). Most have none (54%) or very low knowledge of Scratch (39%). Very few (4%) have a Doctor of Science degree; a few have a Master of Science Degree (20%) and have been enrolled in specialization courses (21%). Half (50%) work in schools with adequate infrastructure computers and internet connection) to teach Scratch.	
Objectives, Motivation, and Goals: The majority of them want to use Scratch to teach Math (66%); others want to teach Portuguese, History, Geography, Humanities, Science, English, Physical Education, and Arts. They believe that Scratch would allow the students to develop programming skills and logical reasoning.	

The Empathy Map for Persona 2 (Table 4) shows that this Persona is familiar with computational reasoning and programming languages and they want to use Scratch to teach the students how to create diverse applications.

Table 4: *The Empathy Map for Persona 2- Teachers from high school.*

Think and Feel: The majority are familiar with other programming languages, but not with Scratch.	
Hear: They have heard that Scratch is a good tool to teach coding and develop games.	**See:** The majority work in schools with adequate IT resources.
Pain: They fear they will have difficulties learning Scratch. They also think the students will face difficulties. They also fear that they will face IT problems (not enough computers and unreliable internet connection).	**Gains:** They believe that Scratch will allow the students to develop programming skills and logical reasoning. They think the students will become more motivated to learn.
Say and Do: They intend to use Scratch to teach the students to create games, animations, simulations, graphics, comics, and coding. They also want to use Scratch to teach Math. A few want to use Scratch in interdisciplinary projects.	

The third Persona was named *Teachers from Universities* (Table 5). This Persona is different from the previous Personas: it represents teachers that are not only very experienced but also many of them have Doctor of Science and/or Master of Science degrees. However, they also have very low knowledge of Scratch.

Table 5: *Persona 3- Teachers from Universities.*

Persona 3	
Characteristics: Half are male and half are female, on average 43 years old, and the majority live in Sao Paulo (39%), very experienced. The majority have worked for more than 11 years (84%). Most have none (78%) or very low knowledge of Scratch (17%). A large number have attended graduate courses; 39% have a Doctor of Science degree and a Master of Science Degree (22%). The majority (83%) work in schools with adequate infrastructure (computers and internet connection) for teaching Scratch.	
Objectives, Motivation, and Goals: The majority of them want to use Scratch in different ways (to create codes to control robots, to create animations and games, to create graphs).	

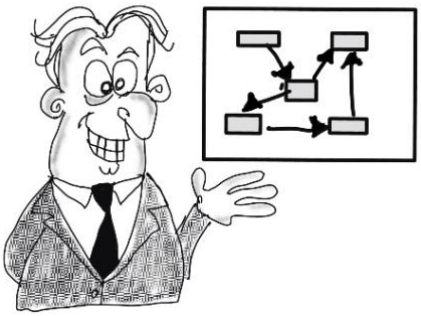
The Empathy Map for Persona 3 (Table 6) revealed that this Persona has several different ideas of using Scratch in classroom. However, as the previous Personas, they have almost no knowledge about the Scratch features.

Table 6: *The Empathy Map for Persona 3 "Teachers from Universities".*

Think and Feel: They believe that Scratch will allow the class to be more interesting, making the students more engaged.	
Hear: They have heard that Scratch can be a useful classroom tool, facilitating the learning process.	**See:** The majority work in schools with adequate IT resources.
Pain: They fear having difficulties learning. They also think the students will face difficulties learning.	**Gains:** They think Scratch will make the classes more interesting; they think the students will be more motivated to learn.
Say and Do: They want to use Scratch to teach diverse subjects such as quality control, microbiology, games, anatomy, and simulation, to create graphics, and to develop new products.	

The fourth Persona was named *Teachers Corporations and NGOs* (Table 7). This Persona is predominantly male and also had few knowledges of Scratch. Their main focus is on using Scratch for training.

Table 7: *Persona 4- Teachers from Corporations and NGOs.*

Persona 4	
Characteristics: Predominantly male (71%), on average 41 years old, the majority live in Sao Paulo (43%). The majority have worked for more than 11 years (57%). Many have none (43%) or very low knowledge of Scratch (29%). Most of them have taken specialization courses (57%); 30% have Master of Science Degrees and 14% have Doctorate Degrees. The majority (71%) work in schools /corporations with adequate infrastructure (computers and internet connection) for teaching Scratch.	
Objectives, Motivation, and Goals: The majority of them want to use Scratch to create corporate/NGO training, making the class more interactive.	

The Empathy Map for Persona 4 (Table 8) reveals that this Persona sees Scratch as a tool that could be used in corporate training in order to foster interaction and make learning more enjoyable.

Table 8: *The Empathy Map for Persona 4.*

Think and Feel: They think Scratch is a useful programming language and can be used to foster creative learning.	
Hear: They have heard that Scratch is an interesting tool that will enhance the learning experience.	**See:** The majority work in corporations/NGOs with adequate IT resources.
Pain: They are not sure how to use Scratch.	**Gains:** They think the students will interact more and that learning will increase.
Say and Do: They want to use it in training and to create games and animated stories.	

Discussion

It was interesting to notice that from the 80 teachers who answered the questionnaire only one teacher was from early childhood education. We may speculate that Brazilian teachers in early childhood education don't know about Scratch or ScratchJr (a version of Scratch designed for young children with ages from five to seven). Therefore, we learned that we should publicize the course among early education teachers. We also learned that the course we are designing should have a module describing ScratchJr and its features. This led us to our first finding; *Publicity for the course should emphasize that Scratch/Scratch Jr are tools that can be used by teachers in early childhood education and the course should have a module on ScratchJr.* This finding is aligned with the findings of other researchers (Delacruz, 2020; Flannery et al., 2013) who pointed out that ScratchJr is appropriate for young children.

Analyzing the four different Personas, we found several similarities: they are more than 40 years old and very seasoned teachers (more than 11 years of experience). However, they have no or little knowledge of Scratch. The data also suggested that they have low familiarity with technology. This brought us our second insight; *The Scratch course should be designed taking into account that the future students may be senior teachers, with low familiarity with technology and poor knowledge of Scratch.* This finding is in accordance with the findings of other scholars who pointed out that teachers may face difficulties in learning new technologies because they lack digital competency (Instefjord, 2015; Starkey, 2020).

The Personas and Empathy Maps also let us understand that the teachers have a limited vision of the Scratch potential; they see Scratch more as a tool for developing programming skills than as a tool to foster creative learning. This brought us the third insight; *The Scratch course that we are going to build should have a module that explains what creative learning is, presenting different ways that Scratch can be used to foster it.* This finding is in accordance with the findings of other researchers, who pointed out that Scratch is not only a programming language but a tool for creative learning (Resnick, 2018).

The analysis of Persona 3 and its Empathy Map also helped us to understand that university teachers, unfamiliar with Scratch language, imagine it will allow them to perform simulations that Scratch is not able to do (or is not the best programming tool for). This brought us the fourth insight; *The Scratch course should have a module explaining the strengths and limitations of the Scratch programming language, comparing its features with the features of other programming languages.* This finding is in accordance with the findings of other researchers (Harvey & Mönig, 2010) who pointed out the limitations of the Scratch language (not allowing recursion, and weak support for data structures).

The data also revealed that many teachers who don´t know how to code fear that their students will face difficulties learning how to code. We may speculate that the teachers are projecting their own difficulties onto the students. This finding is in accordance with the findings of other researchers (Lloyd & Chandra, 2020; Ng, 2017) who pointed out that teachers, who didn´t have coding experience while they were students, would not be confident teaching it. This led us to our fifth insight; *The course should have resources (such as discussion forums) to allow those with little or no technological background to overcome their fear of coding, with the support of the teacher and other students.* This is aligned with the findings of scholars, who have pointed out that mental models may create barriers to learning (Sterman, 2000).

Conclusion

The use of design thinking tools (Personas and Empathy Maps) in mixed method analysis proved to be an adequate choice. It allowed us to aggregate the qualitative and qualitative data in a meaningful way, helping us to have a better understanding of the needs of our client, the teachers who would take the Scratch course. It helped us to comprehend their technological difficulties, their fears, and their mental models. It helped us to design the course in a more effective way, not only focusing on teaching Scratch's programming features but also covering the concepts of creative learning. In addition to data, the use of DT tools allowed us to have ideas for improvement in the process of publicizing the course in order to reach teachers from childhood education. More than that, it helped us learn that the course should have a module explaining what ScratchJr is and how to use it.

The analysis also helped us to see the necessity of making clear, to the potential public, the strengths and weaknesses of Scratch, avoiding frustration from those who enroll.

However, it is also important to reflect on the difficulties that occurred during the research development. As described previously, we sent a questionnaire to the largest Brazilian teachers' Facebook groups, groups with thousands of teachers. However, only 80 teachers agreed to answer it. We may speculate that researchers interested in following our research approach will face similar difficulties in receiving the answers of potential students.

Based on our experience, we proposed the following brief guidelines:
1. Try to reach the potential students by searching social networks groups (such as Facebook and LinkedIn)
2. Develop a questionnaire with questions that facilitate the process of the creation of the Personas and the Empathy Maps
3. Follow a mixed method approach in order to understand the connection between the qualitative data (the answers to open-ended questions) and quantitative data (the answers to close-ended questions)
4. Design the course based on this analysis, creating course modules that address the potential students' needs.

Finally, we may say that based on the evidence here presented, we considered that the main contribution of this investigation to the science is the *proposal of incorporating DT tools in the process of designing a MOOC. We demonstrated that the use of the Persona and the Empathy Maps allows having a deeper understanding of the potential students' needs, allowing us to design a course that could become meaningful to them.* We may speculate that, by doing so, it will possibly increase their engagement and reduce the dropout rates.

For future research, we intend to apply DT during the ideation phase of the course, again involving the teachers who answered the first questionnaire. We intend to work in a collaborative way, presenting them with the course design in order to see if the modules are created to meet their needs. In so doing, we intend to gather their feedback and improve the course even further.

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