# Teaching Information Visualization through Situated Design: Case Studies from the Classroom

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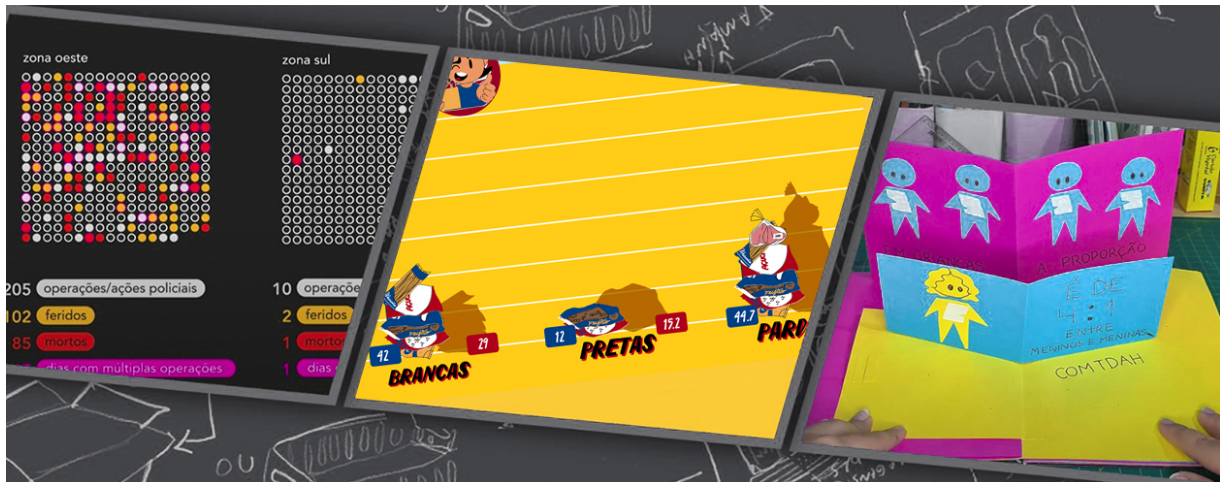
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Figure 1: A display of works by students from the Creative Data Visualization course

## ABSTRACT

In this article, we discuss an experience with design and situated learning in the Creative Data Visualization course, part of the Visual Communication Design undergraduate program at the Federal University of Rio de Janeiro, a free, public Brazilian university that, thanks to affirmative action policies, has become more inclusive over the years. We begin with a brief introduction to the terms Situated Knowledge, coined by Donna Haraway, Situated Design, based on the former concept, and Situated Learning. We then examine the similarities and differences between these notions and the term Situated Visualization to present a model for the concept of Situated Learning in Information Visualization. Following this foundation, we describe the applied methodology, emphasizing the importance of integrating real-world contexts into students' projects. As a case study, we present three student projects produced as final assignments for the course. Through this article, we aim to underscore the articulation of situated design concepts in information visualization activities and contribute to teaching and learning practices in this field, particularly within the Global South.

**Index Terms:** Situated visualization, situated learning, situatedness.

## 1 INTRODUCTION

This article explores the development of an information visualization course within the context of the School of Fine Arts at the Federal University of Rio de Janeiro (UFRJ), a free public univer-

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sity in Brazil known for its integration of teaching, research, and community engagement [22]. Maintaining the quality of education at Brazil's federal universities presents significant challenges, especially since the 1990s, as public and free education has faced declining state investment. Despite these challenges, public universities in Brazil continue to achieve the highest quality indices in higher education [20]. Admission to these institutions requires passing a highly competitive national exam, which used to favor students from wealthier families who attended better schools. Additionally, public primary and secondary schools, which are responsible for preparing students, struggle with high dropout rates due to a lack of incentives and the necessity for students to enter the job market to support their families.

In recent decades, laws have been enacted to address social and racial inequalities. Affirmative action policies have led to the reservation of places for black, brown, indigenous, public school, and low-income students at public universities. Specifically, the Quotas Law, implemented at UFRJ in 2013, ensures that 50% of undergraduate places are reserved for students who attended public high schools and are self-declared black, brown, indigenous, or disabled [12].

After more than a decade, the Quotas Law has been shown to not only democratize access to higher education but also to foster cooperative, less exclusionary, and less segregated values through the interaction of quota and non-quota students [2]. As a result, classrooms at free public universities in Brazil now feature students from diverse social groups with varying histories, backgrounds, and experiences. This diversity creates a fertile ground for the exchange of specific knowledge, which we describe as "situated" – encompassing the politics and epistemologies of location, positioning, and situating [13].

In this article, we focus on the concept of "situated design", grounded in the philosophical approach of Donna Haraway [13] and further developed by Jasper Simonsen and colleagues [21]. We will discuss the interconnected concepts of situated knowledge, situated design, situated learning, and situated visualization and their

contributions to information visualization practices.

Following this theoretical discussion, we will describe the Creative Data Visualization course, highlighting how the project methodology aligns with the presented concepts. We will then present three student projects developed from situated contexts, analyzed through the lens of the aforementioned theories. Finally, we will discuss the insights gained from these projects and their implications for information visualization teaching practices.

Our aim in this article is to highlight the notion of situated design in the development of students' information visualization projects, based on a model we designed for situated information visualization learning. We hope this article will enhance the understanding of situatedness and its application in future academic projects that aim to encompass real-world practices.

## 2  SITUATEDNESS

The term "situated," when related to "situated knowledge", "situated design", "situated learning" and "situated visualization", emphasizes the embodied and dependent nature of context and social practices, focusing on different aspects of human experience. By articulating these concepts from various authors' perspectives, we aim to provide a theoretical basis for the methodology that emerged from the Creative Data Visualization course and apply these concepts to the case studies presented.

The concept of situated knowledge argues that knowledge is not universal or objective but shaped by the specific historical, political, and social circumstances in which it is produced. It represents a "point of view from somewhere" [13] that acknowledges the partiality and specific position of those who produce and interpret knowledge. These reflections contribute to constructing a methodology that starts from real experiences and integrates design practices, specifically in information visualization design.

Situated design [21] builds on the idea of situated knowledge to emphasize the contextual nature of design, recognizing that design processes occur in specific situations involving multiple and varied participants. The authors suggest that in most of the situated design process, it is necessary to highlight the designer's interpretation of the context and assign "localized, embodied, and partial" meanings [21]. By "localized," they mean that the designer must be immersed in the specific context for which they intend to create and design; "embodied" refers to the idea that all knowledge is rooted in the experiences and contexts of its producers [13]; "partiality" implies that knowledge is non-universal and arises in specific historical, political, and situational circumstances. This contrasts with the vision of universal design methods that can be applied identically in different contexts to achieve similar results. Instead, situated design recognizes that design methods must be adapted and appropriate to the specific project and situation in question, constituting localized practices [3].

Situated visualization emphasizes the physical environment where these visualizations are incorporated [19] or displayed in places relevant to people[4]. The latter work, which analyzed 44 related research studies, highlights a predominant focus on technical-centric approaches, mainly using AR to visualize data in the physical environment. Although this work tends towards a spatial understanding of the concept, the authors propose expanding this view by introducing five perspectives on situatedness: space, time, place, activity, and community [4]. Despite this expansion, we believe that the concept of situated visualization, as proposed by these authors, is not fully applicable to our research, as the projects were designed in the classroom context with specific characteristics. However, the notions of place, activity, and community will be important for the following analysis.

Situated learning, although criticized for its excessive emphasis on context [1], focuses on participation, challenging the idea that effective learning can take place in an environment separate from the practice for which one is being trained [16]. Therefore, it is essential to incorporate real-world contexts into situated teaching and learning to promote authentic learning and the acquisition of advanced knowledge [14].

The terms used emphasize the importance of context and social relationships. Generally, the approaches described here oppose the idea of universal solutions by emphasizing a dynamic and adaptive nature. Despite their similarities, each term focuses on a different aspect of human experience. Situated knowledge centers on the production and validation of knowledge [13]. Situated design focuses on the design process and the creation of solutions [21]. Situated visualization concentrates on displaying information meaningfully within a specific environment [4].

Based on the survey of various situatedness experiences, we developed the concept of situated learning of information visualization, expanding the notion of situated visualization and incorporating real-world contexts [14]. In the next section, we present the course and the applied methodology, further developing the concept of situated learning in information visualization.

## 3  METHODOLOGY

The Creative Data Visualization course was conducted during the second semester of the 2023 academic year and the first semester of 2024 for undergraduate students in Visual Communication Design at UFRJ's School of Fine Arts. The course aimed to deepen theoretical and reflective thinking and develop data visualization practices through classroom activities, data collection and mapping exercises, lectures, and seminars. Based on the fundamental contributions of educators such as John Dewey [6] and Paulo Freire [11, 10], we designed the activities with the understanding that each student would have the potential to understand and interpret social problems based on their experiences. Therefore, the activities would be incentives for the student to have "command of himself" [6] and be able to be an agent of social reconstruction.

With a similar approach, Paulo Freire's concept of critical pedagogy [11] understood students as active agents in the learning process and proposed that education should be used as a tool for self-construction. For Freire [10], the starting point for any political project is an understanding of reality and the forms of action and struggle that already exist on the ground. As we intend to show, by encouraging students to talk about their experiences and places, the approaches of these educators are very close to what we propose as situated learning.

### 3.1  Activities in class

Initial activities were designed to enhance cognitive development and understanding of data representation forms. We began the course by presenting numerous examples of data visualization and conducting structured analyses of selected cases. The first activity involved producing and visualizing data from everyday actions. Students created visualizations of their eating habits, study times, clothing colors, and other daily activities and hobbies. This exercise, lightly inspired by "Dear Data" [17], sparked significant class participation and discussions about the generated data and visual encodings.

Another intermediate activity involved the physical visualization of information using polymer modeling clay of various colors to create tangible representations of a dataset presented in class. This activity aimed to teach data visualization concepts while encouraging creativity and collaboration, allowing students to compare different approaches to the same dataset. We also included a sketching activity facilitated by Visualicards, a set of cards developed at LabVis, our lab at UFRJ, featuring different types of visualizations and their descriptions. Through gamified tasks, the students ended up with a set of type cards from which they selected one to represent a given dataset.

To provide a theoretical foundation, students presented seminars based on readings from book chapters [23, 7] and academic papers. The main objectives of this activity were to deepen their theoretical knowledge of information visualization, develop their critical analysis and communication skills, and encourage reflection on the ethical and social implications of data usage.

These activities fostered greater interaction among classmates, making learning active [6]. Through practices using various materials and a theoretical understanding of data visualization, we situated the students in a process of making data tangible, embodied, and experiential [8], maintaining a close conceptual relationship with the proposal of situated design [21].

The objectives of all activities were to:

- promote an understanding that data sets and the choices made to represent them are incomplete or imperfect ways of representing the world, and

- understand data visualization as a personal and contextual expression, thereby challenging the merely technical nature of data.

With these objectives in mind, the intermediate activities encouraged students to explore themes from a situated context, emphasizing localization, embodiment, and partiality.

In the second half of the course, the focus shifted to the final project. We provided technical classes on data cleaning and visualization software [18, 5] to equip students for their final projects. The intent was for students to use these tools to better understand the data and inform their representation choices.

As the course progressed, through its iterations and discussions centered on data visualization activities, we developed a model for the final course project. The primary objective of this model was to synthesize the practice and development of situated information visualization. Building upon the concepts discussed in Topic 2 regarding situatedness, the model emphasizes the unique processes and specific environments of each student. Technical learning was not the focus of the situated pedagogical approach as technics tend to change over time, but occurred as a consequence of students' need to express themselves.Thus, the Situated Learning of Information Visualization model prioritizes the particularity of these processes over the universality and technicity of the stages involved.

Project evaluation considered the class presentation and the submission of a comprehensive report on the entire process. We believe that each student's vision is incorporated into the data visualization at this stage. This aligns with Haraway's concept of knowledge produced in "specific historical, political, and situational circumstances"[21], which is therefore partial knowledge— a view from a place, an interpretation by the student. Ultimately, the situated context from which the students began enabled a particular view of the subject, producing a situated design.

## 3.2 The Situated Learning of Information Visualization model

In the model created for Situated Learning of Information Visualization (Figure 2), four stages were applied to the creative process of information visualization in the final project of the course.

The stages for developing the project considered each student's perspective on the context. We expanded the notion of situated visualization [4] by understanding the notion of location from spatial, temporal, local and social perspectives. According to the first stage of the model, students were free to select their topics, provided they addressed some social aspect of the real world, thereby operating from a situated context. In the data collection stage, students present the provenance of the data collected, which can come from various sources such as reports from government or NGOs and research institutes. In the mapping 'I&' design stages, students
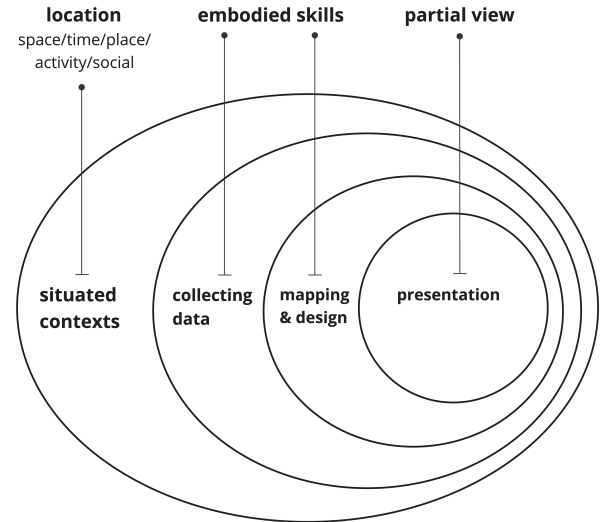


Figure 2: Model for *Situated Learning of Information Visualization*

engaged in iterative processes of mapping, and visualization sketching. This stage constitutes the embodied skills phase, demonstrating that when faced with limitations and difficulties, the visualization design was sometimes revised or altered. For presentation, students are encouraged to create a narrative based on their interests in choosing the topic, presenting the entire process of collecting, mapping and the decisions for creating the information visualization.

The model underscores the significance of context, interests, and experiences of each student. We recognize that this construction was informed by the specific profiles of the students who participated in the course. However, we believe that the model can be applied in other courses or by other educators. The intrinsic characteristics embedded within the model render the pedagogical approach, grounded in situated learning for information visualization, both unique and adaptable. A pedagogical approach can be characterized as situated through several key principles that emphasize:

- contextual relevance;

- collaborative learning;

- situated knowledge.

By contextual relevance, we mean that educators and learners should engage with real-world problems, enhancing the applicability of their knowledge and skills. Collaborative learning involves collaboration among educators, students, and community members in relation to the project being carried out. The final principle is situated knowledge, which seeks to explore the knowledge shaped by the cultural specificities and histories of each student.

These principles, along with the stages of the model, demonstrate how the situated pedagogical approach can be effectively applied. This approach is particularly productive when teachers and students aim to understand the complexities of specific places and communities and seek solutions through the visualization of information. Below are examples of projects based on this approach.

## 4 IMPLEMENTING SITUATED LEARNING OF INFORMATION VISUALIZATION IN THE CLASSROOM

In the Creative Data Visualization course, each student was required to deliver an information visualization project in their chosen for-

Figure 3: Sketch for the data visualization of police violence in favelas.



Figure 4: Print Screen of animated data visualization of police violence in favelas.



Figure 5: Prototype of the pop-up book for the information visualization about Attention Deficit Hyperactivity Disorder (ADHD)

mat: physical, animated, or interactive. They were allowed to simulate the interaction if needed. The selected case studies were chosen for their alignment with the course's objectives and their capacity to foster the iterative processes that underpin the Situated Learning of Information Visualization model.

### 4.1 Visualizing Police Violence in Favelas

This first case study addressed the issue of violence in the favelas of Rio de Janeiro, one of the Brazilian states with some of the largest favelas [15] in the country. The student who created this work lived in the western zone of Rio de Janeiro, close to one of the city's most violent favelas. Concerned by the impact of police operations experienced in her surroundings, the student decided to gather data on this subject for the four different zones of Rio de Janeiro to compare the unequal way in which the city is affected by these operations.

Initially, the student envisioned an interactive visualization that the user could filter by zone, month, and year. The system would returns the status of police operations for that selection as well as the chances of death and injury. However, this approach presents challenges in calculating statistical probabilities and does not satisfy the initial objective of comparing zones.

After several drafts (Figure 3 ), her idea matured and took the final form (Figure 4) of an animation that simultaneously showed data on police operations, deaths, and injuries in the city's four zones, day by day, over the course of one year. This visualization fulfills the author's main objective of tracking inequalities in the impact of police operations in different zones, allowing data to be compared in real-time.

Each red dot represents a police operation with death. When placed side-by-side, the dot charts from the north, west, south, and central zones highlight the unequal distribution of violence in the city. The southern and central zones, home to the wealthier population, show less violence. The visualization prompts reflection on

a specific problem in Rio de Janeiro: police operations that systematically impact the lives of the least privileged citizens.

This work exemplifies the notion of situated design, as the student starts from her own experience, assuming an embodied position to create a visualization from her social context. The final visualization reflects inequality within a specific social structure by comparing data from the city's four regions.

### 4.2 A Personal Account of a Student with ADHD

The next student's project concerned Attention Deficit Hyperactivity Disorder (ADHD). The student chose this topic because she had been diagnosed with the disorder as a young adult. This late diagnosis suggests the existence of a gender bias that favors boys, who often receive the diagnosis in childhood and can thus begin treatment earlier. According to student research, boys are twice as likely to be diagnosed with ADHD, following a prevailing myth that girls are more focused, quiet, and calm. This bias implies that the symptoms of the condition are often ignored.

Motivated by the narrative possibilities of visualizing information in a physical format, the student created a prototype of a pop-up book containing data and information related to gender bias in the diagnosis of ADHD (Figure 5). The artifact engages users by encouraging interaction through opening, closing, and pulling parts of the book to reveal complete information. Understanding data and information becomes playful and reflective.

The data were collected from the Brazilian Attention Deficit Disorder Association (ABDA). As with all creative works, the pop-up book's content is the author's interpretation of a problem within the context she is addressing. For Simonsen and colleagues, the designer's interpretations "are crucial to the outputs and results of the process" [21]. Interpretation must also be situated by combining theoretical, methodological, and empirical knowledge.

By exploiting the tactile sense to convey information on a topic sensitive to her, the student exercises Haraway's situated knowledge as it is partial and embodied, exploring part of the problem from her experience.
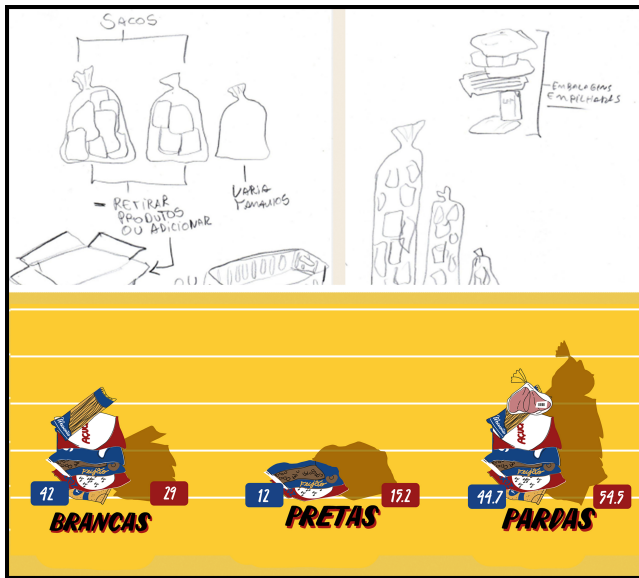
Figure 6: Sketch (above) and visualization of food safety/insecurity data by race/colour

## 4.3 Food Insecurity

The third and final project addressed the issue of food insecurity. The students chose this topic because their families had received basic food baskets from the government for some time. The basic food basket, distributed by the federal government, is a set of foods items intended to ensure the human right to adequate nutrition, promoting health and well-being for the Brazilian population. It consists of fresh or minimally processed foods, such as beans, cereals, roots, vegetables, meat, eggs, milk, sugars, fats, and coffee, which can vary depending on the location.

A household is considered to be food insecure if, in the last three months, its residents have experienced at least one of the following situations: a) they were worried that they would run out of food before they could buy or receive more food; b) they ran out of food before they had the money to buy more food; c) they ate only a few types of food that they still had after the money ran out.

Food insecurity can be classified as mild, moderate, or severe, according to restrictions in the quality and quantity of food consumed by residents, and affects 27.6% of Brazilian households [9]. They identified data by region of the country, age, and race/colour, as reported by the head of the household interviewed. The students chose to focus on race/colour data and created a poster illustrated by a graphic inspired by the leaflets used by Brazilian supermarkets to advertise their main offers. Using the data, they built a semantic panel comprising the groceries offered in basic food baskets. The work presents bar graphs made up of piles of these types of food to show the share of the population of each race/colour living in food security, with a shadow of the same pile of food in the background illustrating the percentage of food insecurity (Figure 6 ).

## 5 Discussion

In the field of information visualization, the ability to interpret, design, and critique visual representations of data is crucial. These skills are not just technical but also highly contextual, as the effectiveness of a visualization often depends on its alignment with the specific needs, values, and understanding of its intended audience. Therefore, teaching information visualization through situated design involves grounding projects in real-world problems and scenarios.

Assigning projects that require students to address actual issues or topics of interest brings them closer to a situated design project. Visualizing data on social issues, personal experiences, or scientific phenomena allows students to engage with tangible data, making the learning process more impactful.

In the three works presented, we see the articulation of the situated context with some of these real-world problems: police violence in the peripheral neighborhood of Rio de Janeiro, a gap in the diagnosis of ADHD between men and women, and food insecurity in Brazil. These themes were highlighted by the students because they were deeply embedded in these contexts, researching from a specific place that is particular, lived, and experienced by them.

Developing these themes through data visualizations within the course's specific timeframe (one semester) also suggests alternative ways of understanding the concept of situatedness in teaching and classroom practices. While this article highlights the final projects of the course, the curriculum includes other activities that helped consolidate the information visualization project pathway. These activities were based on John Dewey's pedagogical approach, which involves integrating abstract thinking with the experience of doing. From Dewey's perspective, the teacher acts as a facilitator, responsible for helping the students find their purpose and guiding them in their quest to achieve it.

The results of the course activities, both the initial and final projects, showed that theoretical and methodological knowledge was combined with real experiences. This approach paved the way for thinking about localized, embodied, and partial projects, revealing the characteristics of situated design.

## 6 Conclusion

The Creative Data Visualization course at the Federal University of Rio de Janeiro successfully integrated the principles of situated learning, demonstrating how real-world contexts can enhance the teaching and practice of information visualization. By grounding projects in the lived experiences of students, the course fostered a deeper understanding of data and its social implications.

The three case studies presented—visualizing police violence in favelas, addressing the gender gap in ADHD diagnosis, and highlighting food insecurity—exemplify how students can leverage their personal context to create meaningful and impactful visualizations. These projects show that when students engage with data that holds personal and social significance, their learning becomes more motivated, and their designs are more reflective of the complex realities they aim to represent.

The course's approach, based on Dewey's and Freire's pedagogical principles, emphasized the integration of abstract thinking with hands-on experiences, empowering students to be agents of transformation through experience-based projects. This method allowed for the creation of localized, embodied, and partial projects aligned with the principles of situated design.

The findings from these case studies and the creation of the Model for Situated Learning of Information Visualization suggest that situated learning can be a powerful tool in data visualization education. By encouraging students to draw from their personal experiences and social contexts, educators can help them create visualizations that are not only technically proficient, but also deeply meaningful and reflective of the world around them. This approach has the potential to improve data visualization education in the Global South, making it more relevant and impactful for students and their communities.

In conclusion, the integration of situated learning principles in information visualization education highlights the importance of context and personal experiences in the design process. By fostering an environment in which students can connect their lived experiences with their academic work, educators can cultivate a deeper,

more nuanced understanding of data visualization, ultimately leading to more effective and socially relevant designs.

## FIGURE CREDITS

All images are from author's archives.

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