New relationships with scientific knowledge: affective dimensions in a project based on Design Thinking

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ABSTRACT

This work explores how Design Thinking facilitated new connections with scientific knowledge during the pandemic. DT was selected for its systematic approach, promoting engagement, cooperation, and universal prototype development. In 2021, 49 students participated, revealing the potential for improved scientific vocabulary and collaborative problem-solving.

INTRODUCTION

During the pandemic, students remained at home, attending remote classes. This period was marked by emotional (due to isolation) and academic issues. Facing this context, the research aimed to collect data in order to understand the students' engagement and their feelings towards the learning process (back to school) so that we can understand how intra and inter-subject relationships are established besides understanding how the subject-knowledge relationship is influenced by the situation around them.

The investigation was conducted in Barueri, a municipality located in the state of São Paulo, involving 49 students between the ages of 12 and 13 during the pandemic period. The participants have answered two questionnaires: the first one was applied before intervention in order to collect previous conceptions about scientific contents such as "virus" and "vaccine" and to gather information about their feelings and emotions during emergency remote teaching. The second one was applied after intervention with the same questions regarding scientific contents and also with questions concerning emotions and feelings about teamwork during the prototyping process.

The central aim of the research was to understand the cognitive and affective dimensions of students in their interaction with scientific knowledge through active methodologies such as Design Thinking. Specific objectives were outlined based on the central objective mentioned above and those are:

- Analyze how students appropriate scientific vocabulary and culture;

- Identify the emotions and feelings of the students regarding their work on the topic and their work within the group;
- Contribute to the field of education through Design Thinking;
- Compare students' perceptions of group work and associated emotions.

The Theory of Organization Models (MARIMÓN et. al., 1999) serves as the theoretical and methodological framework for data analysis. According to this theory, human beings construct their thoughts in a nonlinear manner, incorporating both affective and cognitive aspects in this construction. This theory. which builds upon Piaget's conception of mental structures and explores new horizons from the perspective of complexity, summarizing how the mind organizes thoughts through logic, desires, emotions and values that shape them (ARANTES, 2022).

DESIGN THINKING: AN ACTIVE APPROACH

The main objective of the research was to understand the cognitive and affective dimensions of students in and with the interaction with scientific knowledge through active methodologies such as Design Thinking (DT). According to Filatro e Cavalcanti (2018), DT can be viewed as a human-centered methodology that focuses on comprehending the concerns and challenges being addressed.

Design Thinking was the chosen approach for the intervention due to its systematic engagement with the subject matter and the individuals involved. It fosters cooperation and the development of a prototype that is usable by all. Filatro and Cavalcanti (2018) consider DT to be a humanistic approach as it seeks to understand the desires and issues at hand while centralizing the role of the human being in this journey.

Applied in science classes, Design Thinking is an effective approach as it integrates participants using its four pillars (empathy, collaboration, creativity, and optimism). Through prototyping, it was possible to observe group dynamics, witness the engagement with the proposed challenge, and note how scientific knowledge engaged students both individually and collectively.

As a foundational concept for this research, we will discuss the close relationship between Design Thinking, constructivism, and scientific literacy. There is clear alignment with the chosen active intervention methodology, as it involves "direct, participatory, and reflective engagement in the stages of the process" (MORAN, 2018), as defined by Araújo (2014) regarding the construction of the subject as a knowledge author.

Regarding emotional and cognitive aspects, science serves as a means to support, awaken, and empower a scientific subject who gains knowledge about themselves and the situations around them. Especially in the unprecedented context of a pandemic and an infectious disease, a holistic view of events becomes more than necessary.

What is advocated here is that through engagement with prototyping (using science as the key), students construct themselves cognitively and emotionally. Knowledge arises as a result of the subject's interactions with the environment in which they are placed (ARANTES, 2013). Understanding and relating to science seems essential for individuals to see themselves within this new reality they have experienced and continue to experience.

To arrive at the representation of thought construction, consideration is given to how the subject comprehends and deciphers the surrounding reality. To do this, they organize these representations and elements based on the meaning they assign to them and the relationships between these meanings and elements. Arantes (2012) also emphasizes that individuals abstract, selecting what is truly meaningful to them. The terms "meanings" and "elements" play a fundamental role in this research as they help us understand how thought models were created.

As mentioned earlier, in pursuit of data validation, the Theory of Organizing Models of Thought (MORENO MARIMÓN et al., 199) will be used to identify the abstracted elements and the meanings attributed to them. This will also help identify the relationships and implications established by participants as they organize their thoughts regarding the pandemic (and the discussed content) and the emotions and feelings they experienced while working with Design Thinking.

METHODOLOGY

Using two questionnaires in order to gather data we sought to identify the organizing models of thought concerning the conceptual contents of "virus," "vaccine," and "methods of protection against COVID-19," examining which abstracted elements were highlighted and what meanings we can attribute to them. We also identified organizing models of thought related to feelings and emotions when working in groups using active methodologies during the pandemic and upon the return to in-person classes. Furthermore, we aimed to draw a parallel between the learning of conceptual contents and the emotions experienced throughout the prototype production process.

The data collection procedure was carried out through the administration of two online forms using Google Forms, titled "Research: Cognitive and Affective Dimensions in Active Methodologies: The Emergence of New Relationships with Scientific Knowledge".

The research adheres to Resolution No. 510/2016 of the National Health Council, which governs the ethical norms and procedures for research involving human subjects.

Both questionnaires aimed to understand the feelings and emotions of the students during the period of emergency remote learning. Additionally, as we believe that affectivity plays an essential role in the individual's relationship with themselves and their surroundings, it was important to inquire about their feelings towards scientific knowledge. We also sought to understand how they felt working alone during this period, given that social distancing measures hindered group activities and collaborative work.

INTERVENTION

The intervention took place in two seventh-grade classrooms, involving a total of 49 students. The intervention's objectives were to develop social skills when working in groups and bridge the gap between scientific knowledge and the reality of a pandemic.

Following the steps of Design Thinking (DT) and utilizing some strategies presented by Cavalcanti and Filatro (2016), the theme was introduced through a dialogue about the pandemic in its broader context. Below, the reader will find the steps, along with a brief descriptor of what was accomplished.

For the definition of the strategic challenge (one of the DT stages), questions about the pandemic were raised: "What do you know about the presented context? What is the profile of the people involved in the problem? What do these people need or want? What technologies can help the people involved?". With the classrooms divided into groups, students had time to discuss these questions and create slides for subsequent presentation and discussion. These slides served as a diary, not only for expressing individual and group emotions but also for systematizing information and reflecting on the prototype.

The empathetic interview aimed to understand the emotions, motivations, thoughts, and perspectives of the stakeholders involved in the strategic challenge. At this stage, students interviewed peers and family members precisely to assist in defining the strategic challenge. The questionnaire for conducting the interview was developed by the students with the guidance of the teacher.

The selection of prototypes was guided and pre-structured by the teacher and author of this research, taking into account the students' reflections on the topic. Each of the groups highlighted a theme, whether it was combating misinformation, explaining about vaccines, or creating methods for older individuals to use technology for communication with others. Due to preventive measures, the prototypes were developed digitally, and because of the students' familiarity with social media, most of them used Instagram as a means to reach and address the identified problem.

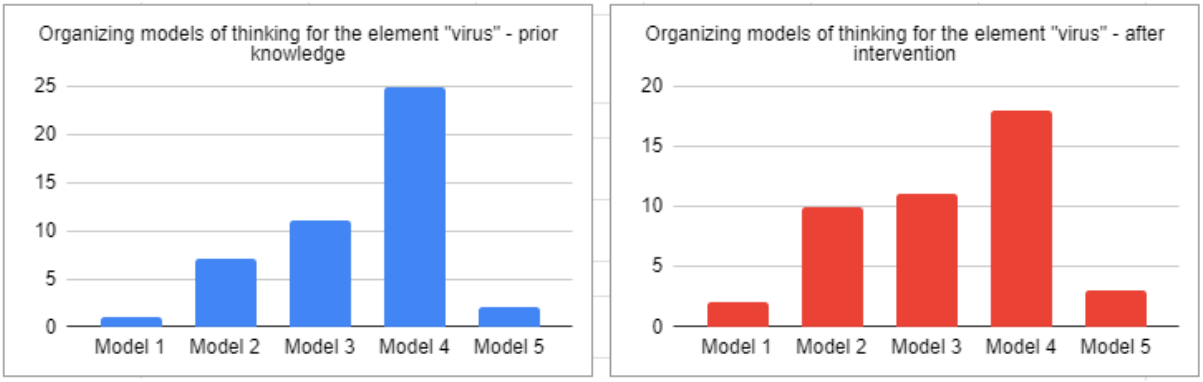
RESULTS

The research is qualitative in nature, and the organizing models of thought depict how thoughts are structured concerning working in groups using a current issue (pandemic) as the project's driver. During the period of emergency remote learning, a sense of loneliness and inadequacy was prevalent among the students.

Through careful examination and analysis of the interaction between elements and meanings, we were able to propose organizing models of thought for the pre-existing conceptions. These models were presented in two arrangements: one related to thought organization with meanings assigned to "virus," and the other related to meanings attributed to "vaccine."

Those graphs below represent a comparison between the element “virus” as a prior knowledge and after the intervention.

Graph 1 - Organizing models for the element “virus”



Source: The author.

Corresponds to the organizing models of the first stage (in blue) respectively:

- Model 1, comparison between viruses and bacteria;

- Model 2, implies that viruses are cells that cause harm;

- Model 3, implying a cause/consequence relationship between viruses and diseases;

- Model 4, viruses are living beings and cause diseases;

- Model 5, viruses have specific morphological characteristics.

Corresponds to the models of the second post-intervention stage (in red), respectively:
- Model 1, viruses are bacterias;

- Model 2, viruses are acellular;

- Model 3, viruses have specific morphological characteristics;

- Model 4, viruses as a cause of disease;

-Model 5, viruses as something between the living and the non-living.

Students, from primary to high school levels, may confuse viruses with bacteria because these two types of microorganisms are often discussed in the context of the causal relationship between disease and symptoms or disease and contamination. Furthermore, scientific knowledge about viruses and bacteria is constantly evolving, and keeping up with discoveries on the subject can be challenging, especially considering the pandemic scenario where the spread of fake news was rampant.

Due to the complexity of diseases and, in the case of COVID-19, its high contagion rate, the classification of viruses as living or non-living organisms drew attention. Both in the pre-existing conceptions questionnaire and the one administered after prototyping, responses encompassing both classifications were found.

The organizing models regarding the element "vaccine" are less diverse in the stage after prototyping.

Regarding the meanings attributed to the element "methods of protection," we noticed that students more frequently correlated vaccines as a method of protection against the novel coronavirus after the entire prototype development process.

There are various ways to conceptualize knowledge in Science, and this was observed through the systematization of students' thinking. The models of thought organization helped us understand, in this context, how reality is addressed based on these scientific knowledge.

The models were diverse, but nonetheless, we were able to observe a certain regularity of interactions between elements and meanings present in the individuals' discourse.

DISCUSSION

Based on the researcher's reflections and observations, a more sophisticated vocabulary is evident in the responses following the prototyping phase. Some regularities were identified:

- The model of viruses and bacteria was found in both questionnaires, as well as the model of viruses as a cause of disease;
- The model that vaccines trigger immune responses appeared in both stages of questionnaire administration.

The research had found different models based on the participants' answers. More specificity was found in the conceptual contents after the prototype was developed, in addition to a more robust scientific language, corroborating the initial thought about the link between Design Thinking and scientific literacy. Less variation of models regarding the definition of vaccines, since the meanings attributed were better explained after intervention. Regarding the emotional aspects students have demonstrated positive thoughts about working as groups as they prototyped. They also mentioned difficulties in working as individuals during the pandemic and feeling of "loneliness" was mentioned several times.

CONCLUSION

Design Thinking appeared to be a valuable strategy for the execution of the project in question. When applied as a methodology with an active teaching approach, it enables students to solve real-world problems through a collaborative and self-centered approach. According to Brown (2008), DT is "an integrated thinking process that includes empathy, problem definition, idea generation, prototyping and testing."

By implementing Design Thinking as a teaching methodology, students are encouraged to develop skills such as creativity, critical thinking, and teamwork. They also learn to deal with uncertainty and adapt to changes. According to Kimbell (2011), Design Thinking is also capable of promoting "character education" as it encourages respect for others and collaboration. This active participation of the individual can be related to Jean Piaget's theories of cognitive development. According to Piaget (1976), learning is an active process that occurs through the interaction of the individual with the environment. Therefore, Design Thinking aligns with Piaget's constructivist approach.

This research field has proven to be rich, and the theoretical connections are numerous, as it integrates constructivism, scientific literacy, and active teaching methodologies.

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