Chatbot Development through Design Thinking Techniques: An Exploratory Study from Students' Perspective

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ABSTRACT

Text-based conversational agents (chatbots) have become central interfaces in modern interactive systems, widely used in contexts ranging from customer support to educational environments, personal assistants, and healthcare systems. However, developing chatbots is a challenging process, as it requires identifying requirements and understanding users' perspectives on these systems. In this context, Design Thinking (DT) has emerged as a promising approach for promoting creativity, empathy, and innovation in developing solutions centered on the needs of end-users. Therefore, it is necessary to incorporate DT into the Software Engineering curriculum to provide students with the skills needed to develop chatbots effectively. In this sense, this paper presents an exploratory study conducted with 13 undergraduate students aiming to investigate the DT cycles, with an emphasis on techniques that promote empathy in the conception, design, and evaluation of chatbots. The study involved participants in practical immersion activities, utilizing several methods to understand the context of use and the needs of users. We collected the data through diaries and questionnaires answered by the participants. The results show that participants were able to identify latent needs, generate more empathetic and contextually relevant proposals, and engage more actively in the design process.

KEYWORDS

Design Thinking, Chatbots, Students' Perspective, Software Engineering Education

1 Introduction

The current digital transformation landscape has driven organizations to invest in solutions that promote automation, personalization, and scalability in customer service [12, 10]. In this context, the growing demand for interactive and personalized solutions has driven the adoption of conversational systems, such as text-based conversational agents, commonly referred to as chatbots. Chatbots have been incorporated into customer service and communication strategies in various sectors, including healthcare, education, e-commerce, and public services [26]. One of the recurring challenges in developing *chatbots* is the ability to understand user needs and transform them into practical, high-quality solutions [18].

In general, chatbots have been developed with an emphasis on technical functionality and efficiency, often neglecting important elements such as clarity of communication, empathy in responses, and an understanding of the real-world contexts in which they are used by end users [15, 24]. The lack of attention to language, the appropriateness of responses, and the context of communication tend to compromise the quality of the user experience, resulting in an artificial, confusing, or misaligned interaction that fails to meet end users' expectations [30]. It compromises not only the usefulness of the chatbot, but also its adoption and acceptance [30].

In Software Engineering (SE), these challenges have broadened the debate about training professionals capable of designing systems that are not only functional but also effective, safe, and human-centered. According to the ISO/IEC 25010 model, the quality of a software product is defined by characteristics such as functionality, reliability, usability, efficiency, maintainability, and portability [19]. To promote these attributes from the early stages of development, it is necessary to adopt approaches that integrate technical and socio-emotional skills, such as empathy, active listening, and critical thinking [25, 17].

In this scenario, Design Thinking (DT) has emerged as a promising approach for developing user-centered digital solutions by combining immersion, ideation, and iterative prototyping practices [5, 43, 35]. From an educational perspective, DT offers students opportunities to experience processes that favor the design of solutions that better meet users' real needs and with higher perceived quality. By applying DT techniques in educational contexts, it is possible to create learning situations that sensitize students to the importance of quality attributes centered on the user experience, such as usability, accessibility, attractiveness, and suitability to the context of use [35, 38].

Although DT teaching initiatives are growing in the field of Computing, studies analyzing, from the students' perspective, how this approach contributes to the understanding and application of Software Quality principles are scarce. This gap is even more pronounced in specific domains, such as the development of chatbots, which present unique challenges in empathy, natural language processing, and interaction flow.

Based on this scenario, this work aims to investigate how Software Engineering students perceive the adoption of Design Thinking techniques in the design and evaluation of chatbots throughout the Human-Computer Interaction Practices course at Federal University of Pampa. Based on an exploratory study with 13 undergraduate students, we sought to understand how the experience of adopting and applying Design Thinking techniques contributes to the development of chatbots, as well as to the improvement of student competencies, including empathy, creativity, and user-centricity. To this end, the students participated in practical activities focused on the Design Thinking cycle, involving immersion techniques, interviews, observation, and empathic analysis, to identify and interpret real user needs.

We collected data through reflective questionnaires and analyzed qualitatively using coding procedures, seeking to identify emerging categories of meaning. The analysis was grounded in the interpretivist paradigm, recognizing the active role of participants in constructing lived experience and valuing their interpretations of the process. The results demonstrate how the application of DT contributed to the development of skills associated with empathy, creativity, and user-centricity, but also reveal students' difficulties in applying specific techniques and structuring more robust solutions. This work contributes to the discussion on teaching-learning strategies in SE, aiming to train professionals who are more sensitive to the perceived quality of the product. It also offers empirical evidence on the pedagogical use of DT in the context of conversational technologies.

2 Background

The use of chatbots has been gaining prominence in enabling faster, more accessible, and continuous communication between systems and end-users, meeting contemporary demands for personalized digital services [21]. However, developing a chatbot involves much more than creating visually appealing interfaces or quick responses. It is a complex process that requires a deep understanding of the context of use, the interaction objectives, and the users' needs [36]. To effectively meet quality requirements, chatbot developers must be involved from the early stages of design, adopting approaches that favor active listening, empathy, and the co-creation of meaningful solutions. The more these solutions align with the real needs of users, the more fluid the conversational experience will be, and the greater the perception of value, usefulness, and trust attributed to the system [6, 27].

Design Thinking has gained recognition as a creative approach to problem-solving. Instead of jumping straight into system development, this approach advocates first understanding who will use it, what they feel, do, desire, or experience [41, 16]. Design Thinking goes far beyond a ready-made tool or model; it represents a way of seeing challenges and seeking solutions, always focusing on people and their context [17]. DT facilitates the iterative creation of ideas in a freer and more continuous manner, with ample room to test, revise, and adjust as needed. Design Thinking process is based on three pillars [4]: what users truly need, what is technologically possible, and what is financially viable. To some extent, it seems simple, but the balance between desire, technique, and business is what ensures that an idea is, in fact, innovative and applicable in the real world [43].

In addition to fostering innovation, DT has also been gaining ground in SE by supporting practices aimed at creating more humane and personalized solutions [17]. For a company to stand out, it's necessary to understand what will generate actual value for the user, and that value needs to be built from the beginning [11]. DT helps organizations solve complex problems by encouraging creativity from the very beginning of the project [22]. The application gains prominence in the requirements gathering cycle, more specifically, in the challenge of getting these requirements right, a critical stage of development that seeks to understand what the system truly needs to do. Robertson and Robertson [32] have already highlighted that this stage is one of the most important in systems development. Using DT appears to be a practical solution at this moment, as it helps capture information more humanly, based on observation, conversation, and testing with those who will use the system [35, 17].

While traditional development approaches tend to focus on functional specifications, Design Thinking proposes a shift in focus by prioritizing an empathetic understanding of the people involved in interacting with the system [35]. Vetterli et al. [42] reinforce this idea by proposing the union of DT and Requirements Engineering as a means better to address the challenges and uncertainties of early project development and propose more assertive solutions. Other studies indicate that combining DT with agile methods, such as Scrum, can further enhance results, making development cycles faster and more user-centric [13, 44]. Furthermore, Beyhl and Giese [2], and Souza [40] discuss DT as a modern approach to support Requirements Engineering. It helps not only to understand the problem better but also to involve different people in the process, which gives the project more strength and clarity from the outset. And considering the development of chatbots, this is even more important; these conversational agents need to converse naturally, understand context, be helpful, and still appear friendly [39].

There are different ways to apply Design Thinking. Paula and Cormican [7] conducted a study mapping two decades of DT use and found several models adopted in the literature. The model proposed by Brown [5] is the best-known and is structured into three major cycles: Inspiration, Ideation, and Implementation. It is helpful in both corporate and educational contexts. In this study, we adopted Brown's model because of its streamlined structure and suitability for organizing classroom activities.

3 Related Work

Pereira et al. [29] described the application of DT by a group of educators seeking to create a solution to improve student-teacher interaction in the classroom. The project followed the three cycles of DT (immersion, ideation, and prototyping), conducting student interviews, co-creation workshops, and rapid testing of interface prototypes. As a result, the teachers identified the main problems students faced (e.g., difficulty obtaining real-time feedback). They designed an interactive notification system that increased student participation in synchronous activities by 35%.

Retna [33] conducted a qualitative study with school teachers in Singapore to understand their experience with adopting Design Thinking in education. The research involved interviews with the teachers, who reported that using Design Thinking significantly helped develop important skills in students, such as creativity, autonomy, and problem-solving. However, the teachers also mentioned some challenges during the implementation of the approach, including a lack of time, limited resources, and the difficulty of transitioning from more traditional teaching to a more open, collaborative, and student-centered approach.

Ellwanger [9] investigated how the combination of Interaction Design, Experiential Design, and Design Thinking helps interactive software projects. They analyzed three web-based case studies, detailing how teams implemented ideation workshops, paper prototyping, and usability testing with real users. The results showed average gains of 40% in task efficiency metrics (time to complete actions) and 25% in user satisfaction compared to traditional development methods.

Valentim et al. [41] conducted a study with 17 graduate students applying DT to mobile app design. In an intensive two-week course, participants went through the inspiration (personas and empathy map) and ideation (brainstorming and co-creation workshop) cycles. The results showed that students particularly valued empathy as a defining feature and group collaboration, but struggled with the time constraints and lack of clarity of purpose associated with the techniques. The authors concluded that, even in short timeframes, DT encourages more creative and user-centric solutions, at the cost of more intensive initial learning.

These studies demonstrate different ways to apply Design Thinking in both education and interactive systems development, bringing benefits such as increased engagement, improved usability, and more enjoyable user experiences. There's a lack of a straightforward approach to applying Design Thinking to teaching chatbot development, which presents its own challenges in communication and conversation flow. Furthermore, few studies explore how students themselves perceive and experience the use of Design Thinking in these types of projects. This is where our work stands out. By analyzing students' opinions and experiences, we aim to understand what worked, what was challenging, and how this process contributed to the creation of more creative and human-centered solutions. With this, we strive to provide contributions that enable other educators and researchers to explore Design Thinking in the teaching of conversational technologies in a more precise and more targeted manner.

4 Empirical Study

This section describes the procedures adopted in the study conducted with undergraduate higher education students, whose objective was to analyze how these students perceive and apply the Design Thinking process in chatbots. In this work, we sought to understand the experiences, interpretations, and learning of the students themselves when using Design Thinking techniques.

4.1 Course Context

We conducted the study during the first semester of 2025 as part of the elective course Human-Computer Interaction Practices from the Software Engineering curriculum at the Federal University of Pampa (Unipampa), which is offered annually. The course focuses on practical activities designed to develop digital solutions with a strong emphasis on user experience. The course syllabus covers the following topics: definition, characteristics, and practices of *wicked problems*; Human-Computer Interaction applied to the software development process; methods, techniques, strategies, practices, and tools for integrating Human-Computer Interaction into the software development process; and applications in emerging software contexts.

To guide the development of the course, we adopted the Problem-Based Learning (PBL) methodology, a constructivist teaching and learning approach that encourages collaborative problem-solving of open-ended and real-world problems, promoting the development of skills such as critical thinking, creativity, decision-making, and communication skills [3, 31, 8]. We adopted PBL as a methodological framework to connect theoretical content with practical application throughout the course, allowing students to face complex problems with autonomy and protagonism.

We structured the PBL around a central research question that guided the entire investigative process: ***How can a chatbot help people better interact with their city, society, or community?***. Based on this question, we challenged the students to propose, design, and develop *chatbots* that adhered to a set of design guidelines aimed at encouraging innovation and social responsibility in the development of solutions. We required the group proposals to adhere to the following rules:

- **Rule 01** — Context-aware: The chatbot should be able to adapt its behavior based on the user's context, using information such as location, time, profile, interaction history, or preferences to offer more relevant and personalized responses.
- **Rule 02** — Promotion of collaboration: The chatbot should encourage interaction between users, which may include features such as mediated forums, group support, information-sharing mechanisms, or the application of collaborative models (such as the 3C model of collaboration or game theory).
- **Rule 03** — Operation in environments with limited connectivity: The chatbot should be functional even in contexts with low or no connectivity, using local storage and subsequent synchronization strategies to ensure data persistence and consistency.

We adopted in the course as its methodological axis an instructional experience based on *Design Thinking*, applied to the process of designing and prototyping chatbots. This experience was structured in three iterative cycles, aligned with the fundamental stages of DT, according to the model proposed by [4]: **Inspiration**, focused on the empathetic understanding of users and the problem; **Ideation**, dedicated to the generation and refinement of solutions; and **Implementation**, focused on the prototyping and validation of the developed ideas.

Thirteen students regularly enrolled in the course participated in the study. We previously informed all the students about the objectives of the practical experiential activity and that the collected data would be used exclusively for academic research

purposes. Participation was voluntary and formalized by signing a consent form, which ensured the confidentiality and anonymity of the recorded information, in accordance with the ethical guidelines for research involving human subjects.

At the beginning of the semester, students participated in a theoretical and practical introduction to Design Thinking, covering its origins, foundations, and main techniques. This initial training was accompanied by illustrative examples, guided discussions, and applied case studies. Subsequently, students were organized into multidisciplinary teams to develop, over the course of the semester, a chatbot designed to address a real-world problem related to the interaction between people and their community. The team organization sought to promote collaborative work, the exchange of ideas, and co-creation, core elements of both DT and the dynamics of PBL. The course evaluation process was continuous and formative, considering both individual student participation and the products developed as a group.

At the end of each DT cycle, we invited students to complete qualitative questionnaires composed of open-ended questions to capture their perceptions, learnings, and challenges related to the activities they experienced. Furthermore, as an integral part of the methodology, students also recorded their experiences through reflective logbooks, in which they reported both positive and negative perceptions about the application of the chosen DT techniques in their projects. These instruments served as the basis for the qualitative analysis presented in this paper. The course instructor and an observing researcher monitored and mediated all activities, working together to provide pedagogical guidance, mediate conflicts, and develop the data collection instruments.

4.2 Participant and Project Characterization

Table 1 presents an overview of the participants' profiles, their teams, and their self-reported prior experience. The first column identifies each participant by an ID; the second indicates the course project to which they were affiliated. The subsequent columns indicate the degree of prior familiarity with: (i) HCI concepts and practices, (ii) level of knowledge in DT, (iii) level of experience in systems development, (iv) experience in the software industry, and (v) previous experience with chatbots.

Table 1: Profile of participants involved in the projects.

ID	Projects	HCI	DT	Development	Industry	Chatbots
P01	Project 4	Medium	Low	Medium	None	Medium
P02	Project 5	Low	Low	Medium	Low	Medium
P03	Project 4	Low	Medium	Alta	Low	Alta
P04	Project 1	Medium	Low	Low	None	Medium
P05	Project 4	Medium	Low	Low	Low	Medium
P06	Project 5	Low	Low	Low	None	Medium
P07	Project 1	Medium	Low	Medium	Medium	Medium
P08	Project 2	Low	Low	Low	Low	Medium
P09	Project 2	Medium	Medium	Medium	Low	Alta
P10	Project 3	Low	Medium	Low	Medium	Medium
P11	Project 1	Low	Low	Alta	None	Alta
P12	Project 2	Low	Low	Low	None	Alta
P13	Project 3	Medium	Low	Low	None	Medium

Participants worked in five multidisciplinary teams, each responsible for designing, prototyping, and evaluating a community-oriented chatbot. Each team selected a specific domain (e.g., health, education, local services) and applied DT techniques iteratively across the three cycles (Inspiration, Ideation, Implementation). This diversity of project domains allowed students to explore human-centered design principles in distinct contexts, fostering creativity, empathy, and problem-solving skills. The five teams and their projects are summarized below: Project 1 - developed a conversational agent to connect donors and recipients of reusable school materials, promoting sustainability and social responsibility through circular economy principles; Project 2 - developed a chatbot offering emotional support and peer assistance to students in vulnerable situations, emphasizing empathy, mental health, and inclusivity; Project 3 - developed a chatbot to automate the organization and dissemination of local events, enabling users to discover, schedule, and share community and cultural activities; Project 4 - designed a chatbot integrated into public digital kiosks, providing real-time information and navigation assistance to urban citizens; and Project 5 - developed a conversational assistant to help patients schedule medical appointments and manage Treatment Outside the Home requests within the Unified Health System.

4.3 Study Design and Procedures

Our empirical study was structured based on three DT cycles [4]: Inspiration, Ideation, and Implementation. Each cycle lasted an average of five to six weeks and involved practical activities, the application of specific DT techniques, and qualitative data collection tools. During the process, students acted independently in choosing and applying the techniques to be used in their projects. Each week, each group selected, based on support materials provided by the instructor and exploratory research conducted on their own initiative, at least two DT techniques that they considered appropriate for the current situation and context of their project.

The following week, the groups presented the results of applying these techniques, preferably with real users, discussing both the findings and their perceptions of the effectiveness and applicability of each technique. They also anticipated the techniques they would employ the following week, promoting a continuous and iterative approach to teamwork organization. This systematic process of selection, experimentation, and reflection was crucial in consolidating active learning and fostering metacognition. The course instructor and class monitor acted as facilitators and moderators throughout the study, providing methodological support, answering questions, and offering formative feedback. At the end of each technique, students recorded their perceptions of the experience in their logbooks, highlighting both positive and negative aspects, as well as lessons learned. Furthermore, at the end of each Design Thinking cycle, the groups completed reflective questionnaires consisting of open- and closed-ended questions, aiming to deepen their understanding of the challenges faced, the lessons learned, and the effectiveness of the techniques used. These instruments were part of the

discipline's assessment and training process, promoting the consolidation of knowledge and the development of skills.

4.3.1 Cycle 1 – Inspiration. The first cycle focused primarily on deepening the understanding of the problem, mapping the context of use, and identifying users' real needs. We introduced student teams to the techniques of the Inspiration cycles, including open-ended and closed-ended interviews, non-participatory observation (also known as the fly-on-the-wall method), empathy mapping, the 5 Whys method, stakeholder mapping, and other relevant methods. At the end of the cycle, after applying the techniques, students completed the first reflective questionnaire, reporting their individual and group perceptions, the lessons learned, and the main challenges they encountered.

4.3.2 Cycle 2 – Ideation. In the second cycle, we challenged teams to generate and refine ideas for solving the problem identified in the previous stage. Techniques to stimulate creativity and collaboration were discussed and applied, including brainstorming, brainwriting, How Might We questions, prioritization matrices, and storyboarding. From the generation of multiple ideas, the groups selected the most viable solution, which aligned with previous findings and considered criteria of empathy, perceived value, and technical feasibility. The second questionnaire focused on analyzing how the students experienced the creative process, the decision criteria adopted as a group, and the connections made between the identified problem and the proposed solutions.

4.3.3 Ciclo 3 - Implementation. The final cycle of the empirical study consisted of high-fidelity prototyping and initial evaluation of the conceived solutions. The groups created prototypes of their chatbots using tools such as Figma, Miro, and, in some cases, manual workflows drawn on paper. The goal was to make the experience of interacting with the chatbot tangible, structuring the main dialogue flows and expected functionalities. The prototypes were tested in a controlled environment, with validations conducted among classmates and potential users, allowing for iterative adjustments. This stage was conducted based on formative assessment principles, emphasizing the importance of feedback in improving solutions. At the end of the cycle, the students completed the third questionnaire, focusing on the experience of transforming ideas into prototyped artifacts and their perceptions of the entire journey with DT. It is worth noting that, in addition to the reflective questionnaires, the students also kept individual logbooks throughout the study. These records served as a complementary collection tool, enabling the capture of subjective, positive, and negative perceptions about the use of DT techniques in their projects and promoting continuous self-reflection throughout the process.

5 Data Collection and Analysis

Data collection for this study was conducted systematically throughout the three cycles, aiming to understand how students experienced and evaluated the application of their techniques in the context of designing chatbots. Two main instruments were used: reflective diaries, completed weekly by the students, and structured questionnaires, administered at the end of each cycle.

The diaries consisted of individual records that students prepared at the end of each week. In them, participants reported their experiences applying DT techniques, highlighting both positive and negative perceptions, the difficulties they faced, the lessons they learned, and the impact of the chosen techniques on the project's progress. These reports served both as a pedagogical tool for self-reflection and as a qualitative source for analysis.

Additionally, at the end of each cycle, students responded to a questionnaire containing 21 statements evaluated on a five-point Likert scale, ranging from "Strongly disagree" to "Strongly agree" (see Table 2). These statements were organized into five thematic categories, each with a specific focus:

- **Perception of the Inspiration cycle**: examined the usefulness of the cycle in generating innovative ideas, stimulating creativity, engaging in activities, and understanding user needs.
- **Ease of Use and Application**: investigated the clarity of the proposed activities, the applicability of the techniques for students with little or no prior experience, and the comfort in using digital tools.
- **Group Work**: explored collaborative dynamics, such as collective contribution to ideas, respect for different perspectives, internal group organization, and the appreciation of individual contributions.
- **Overall Satisfaction**: sought to capture the level of student satisfaction with the experience, the motivation generated by the activities, and their perception of the adequacy of the workload allocated to applying the techniques.
- **Perceived Competence**: assessed how much students felt they had evolved in terms of creativity, ability to transform ideas into practical solutions, and understanding of the process of creating a chatbot.

Data analysis was conducted using a mixed-methods approach. Quantitative data from the questionnaires were analyzed descriptively, based on the frequency of responses per Likert scale level. Qualitative data, derived from both the questionnaires and the logbooks, were inspired by [37], which establishes a four-step qualitative analysis procedure that enables the identification of recurring patterns in students' perceptions. It is worth noting that all study artifacts are available in an artifact repository[1].

6 Results

6.1 Qualitative Result

The following section presents the qualitative results, structured according to the Design Thinking cycles.

6.1.1 Results from the Inspiration Cycle. The first stage of the empirical study, corresponding to the **Inspiration** cycle of Design Thinking, brought highly positive perceptions from the students. The analysis revealed that students considered the applied techniques effective in fostering a deeper understanding of the problem, users' needs, and possible *chatbot* functionalities. The first identified category was the perception that **Design Thinking proved efficient in this initial stage of development**, particularly by contributing to the humanization of solutions and broadening students' perspectives on the problem.

[1] https://figshare.com/articles/dataset/30341140

Table 2: Data collection instrument.

Affirmatives – Likert scale (1 a 5)
Perception of the DT cycle
I01 — This cycle helped generate innovative ideas for the chatbot.
I02 — The techniques applied in this cycle helped my team think creatively.
I03 — I felt engaged during the activities proposed in this cycle.
I04 — The ideas generated in this cycle have real potential for implementation.
I05 — This cycle contributed to a better understanding of the chatbot user's needs.
Ease of Use and Application
I06 — I found it easy to understand what needed to be done in the activities of this cycle.
I07 — I was able to apply the techniques even without previous experience with them.
I08 — I felt comfortable using the tools and techniques adopted in this cycle.
Teamwork
I09 — Working as a team made a difference in the team's ability to come up with good ideas.
I10 — The group activities helped us listen to and consider different opinions.
I11 — The environment of the current cycle helped everyone participate and respect each other's opinions.
I12 — Even as a team, it was easy to organize and implement ideas.
I13 — I felt more involved in the development of the chatbot.
I14 — I felt my ideas were valued during the activities in this cycle.
Personal Satisfaction
I15 — How would you rate your overall satisfaction with this cycle?
I16 — How satisfied were you with the level of creativity stimulated in this cycle?
I17 — How satisfying was the time spent applying the techniques in this cycle?
Perceived Competence
I18 — I feel like I learned and evolved after going through this cycle.
I19 — The activities really made me think more creatively.
I20 — By applying these techniques, I better understood how to transform ideas into practical solutions.
I21 — The experience with these techniques helped me better understand the process of creating a chatbot.
Open-Ended Questions
Methodology Effectiveness
OQ1 — How did Design Thinking, specifically in this cycle, contribute (or not) to devising more humane, creative, or efficient solutions for the chatbot?
Collaborative Work
OQ02 — In your view, what was the role of teamwork during this cycle?

Students reported that direct contact with users, combined with techniques such as interviews, empathy maps, and *stakeholder* analysis, helped them think about more human, creative, and user-centered solutions. P05 stated that it was *"essential to think about more human, creative, and efficient solutions for the chatbot"*, emphasizing that these activities brought them closer to real user needs through observation and active listening. Complementing this view, P12 mentioned that *"by listening to real users, I understood their emotional and practical needs, which helped us create more empathetic interactions for the chatbot"*, indicating that direct user contact influenced both language and functionality choices for the solution.

In addition to fostering humanization, the Inspiration cycle provided students with an expanded understanding and broader vision of the problem, helping them define what should—or should not—be addressed by the *chatbot*. P10 noted that this stage helped them understand *"the real problem people face in accessing the TFD (the group's chatbot proposal)"*, while P08 recognized that the process contributed to understanding *"what was important and how we could solve the problem"*. P02 also mentioned that the DT approach was effective in *"understanding potential stakeholders, how we would build our project, and the challenges they face"*. These accounts show that the investigative process also worked as a guide to define scope, empathize with users, and prioritize relevant functionalities.

Another highlight was that DT also supported the identification of new requirements and previously unforeseen opportunities. P06 pointed out that the process revealed user needs that would not have been identified without the DT techniques: *"they greatly helped identify new requirements for the idea, allowing us to discover user needs we would never have imagined otherwise"*, demonstrating the method's power to uncover insights invisible to more traditional approaches. P13 reinforced this view, noting that the process was helpful to *"support the gathering of requirements and to structure the product better"*, indicating that DT broadened students' perspectives on chatbot possibilities.

This cycle was also crucial for prioritizing functionalities and focusing on what truly needed to be solved, as P08 observed: *"this inspiration cycle helped us understand what was important and how we could solve the problem"*. In addition, students highlighted that techniques such as interviews and empathy maps helped them think of more assertive solutions for their target audience. As P07 stated: *"techniques like interviews and empathy maps helped us better understand our audience and think of new solutions that were truly necessary for the chatbot"*.

Another important aspect observed was the use of techniques to identify and understand the needs of stakeholders. P11 pointed out that this helped *"identify stakeholders, the problems they face, and how to solve them in a more human-centered way"*. P02 highlighted that DT was *"very effective in understanding potential stakeholders, how to build our project, and the difficulties they face"*. This mapping process was important for structuring the chatbot's operational logic and understanding the various audiences it would impact.

The second identified category was the perception that **teamwork during the Inspiration cycle was useful for development**. Students reflected on the role of collaboration, viewing it as a crucial factor in the project's quality. The exchange of ideas among teammates brought different perspectives and experiences that enriched the process of defining the problem and possible solutions.

For example, P05 mentioned that *"each member brought different perspectives, experiences, and unique perceptions that greatly enriched the process of understanding the problem"*. P06 also valued having more than one point of view on the project, which led the group to discuss solutions more deeply: *"Teamwork was very important for generating new ideas, since we had people with different experiences and ideas, offering distinct points of view that contributed to creating new functionalities."* Finally, P04 reinforced this by stating that *"the plurality of ideas and ways of thinking always adds up to a more complete project"*, indicating that collective engagement influenced the cycle outcome and allowed for more refined and aligned decisions.

This collaborative dynamic not only generated more ideas and reflections but also supported decision-making and scope organization. As P08 noted: *"teamwork was important when deciding what should or should not be included in the scope"*. P09 also observed that group processes helped broaden their human perspective, connecting technical work to a more empathetic and sensitive approach.

6.1.2 Results from the Ideation Cycle. The second stage of the empirical study focused on the **Ideation** cycle of DT. After the initial Inspiration cycle, this stage aimed to help students transform previously collected data into concrete solutions for the chatbot, promoting idea generation and building functionalities aligned with user needs. Students considered this cycle crucial for shaping the project, stimulating creativity, strengthening teamwork, and bringing them closer to the real problem.

The first identified category was the perception that DT in the Ideation cycle **helped students think of more human, creative, and efficient solutions for the chatbot**. One of the main points highlighted was the ability to focus and better understand user needs. P06 emphasized that the process *"helped us understand user needs and apply a wide range of features in the project"*, while P12 noted that *"the Ideation cycle helped us think of more creative and human solutions for the chatbot. We explored different ideas before and during prototyping, which made the project more focused on real user needs."* These reports indicate that students managed to keep the user at the center of the process even during idea generation and refinement, maintaining the empathy built earlier.

Another recurring point in participants' comments was that DT, in this cycle, stimulated creativity and improved idea development, allowing them to find more original solutions. P07 stated that this was the stage where they could *"think outside the box and propose more human and creative solutions for the chatbot... the Ideation cycle helped a lot"*, showing that the team viewed functionalities with a more user-centered lens rather than just as technical tasks.

Students also reported that the use of Ideation techniques made the project more engaging, both technically and humanly. P04 stated that this cycle *"was essential to turn the chatbot into more than just an automated response tool... it gave it a more human context"*, showing that design decisions became increasingly focused on the user experience.

Furthermore, it was observed that the Ideation cycle expanded solution possibilities and boosted creative idea generation. P05 reported that through the applied techniques, the group managed to *"generate more creative ideas aligned with real user needs, putting ourselves in the user's place and identifying new points to consider"*. He also added: *"the Ideation cycle was important to broaden our view of potential chatbot solutions."* The use of brainstorming, try it yourself, and mind maps proved effective in combining previously collected insights with new approaches to problem-solving.

Others also emphasized that Ideation was key to making the chatbot more humanized, as it encouraged a more sensitive connection with the community. P01 stated that *"we explored different alternatives with the community, considering their doubts and needs. This resulted in a more welcoming, simple, and relevant chatbot"*, showing how this cycle helped transform the chatbot into a more human-centered tool.

Finally, some students highlighted the impact of the wide variety of techniques used, which provided new ways to look at the problem and enrich discussions. P03 mentioned that *"the various techniques adopted helped bring a new perspective to our discussions and ideas"*, reinforcing that the combined use of methods was effective in breaking technical rigidity and expanding creative repertoires.

The second category emphasized that **teamwork during the Ideation cycle was essential for chatbot development**. Students realized that collaboration not only fostered idea generation but also improved decision alignment and the construction of more complete solutions.

Reports such as P07's show how exchanging perspectives among team members helped merge ideas and strengthen the creative process: *"each person brought a different vision, which really helped improve the ideas. We exchanged, listened, and built together, making the solutions more complete and aligned with our goals."* P11 mentioned that the group collaboratively decided on the prototype and interface: *"each of us had a vision of how the interface should look, and together we merged and decided on one while co-designing the prototype."*

P02 emphasized how peer interaction fueled creativity: *"teamwork was fundamental for idea generation and stimulating creativity... it's always good to have another pair of eyes to catch details we might miss."* P04 pointed out that the diversity of viewpoints led the group to reflect on different social contexts: *"the Ideation cycle with teamwork gave us various viewpoints on the same context, helping us think about chatbot development across different social realities."*

Despite these positive contributions, some challenges also emerged. P12 acknowledged that group work can lead to conflicts, though it remains essential: *"it was really necessary... there's too much work for one person. But conflicts can happen."* P09 reflected on interpersonal learning and decision-making, saying that he learned to disagree and express opinions respectfully: *"it was a learning experience to work in a team on this project."*

6.1.3 Results from the Implementation Cycle. Finally, in the **Implementation** cycle, participants emphasized how DT techniques helped make the chatbot more effective and better aligned with users' real needs. This cycle not only allowed ideas to be put into practice, tested, and refined, but also enabled continuous adaptation based on user feedback.

P11 reported that hands-on testing with users allowed the team to put their ideas into practice and understand, through testing, what truly worked: *"it was at this stage that we could put ideas into practice and understand, through tests, how people actually interacted with the system. From that, we noticed aspects that could be improved, such as the registration process.. many users preferred a simpler form."* This shows how practical engagement uncovered critical usability issues and guided design improvements.

P03 also highlighted the importance of developing with a user-centered mindset, stating that *"it contributed completely, helping us put ourselves in the position of a real user and then implement based on that."* This reinforces that empathy remained a core principle throughout every stage of the project. Moreover, the direct interaction with users generated valuable reflections that informed and improved the ongoing design decisions.

P12 noted that the implementation process evolved into a continuous loop of testing and learning, where ideas were repeatedly tested and refined. He observed that *"this process gave us new ideas to enhance features we had already built, even before testing them with users."* The cycle also allowed the team to refine what had been developed so far. P13, for instance, commented that he understood how this stage was essential to improving the way

the *chatbot* interacts with users, recognizing the iterative nature of DT as a learning-driven process.

Student P06 emphasized the importance of understanding what should actually be included in the prototype from the user's perspective: *"It contributed a lot to helping us understand what needed to be implemented in the prototype and what would be best from the user's point of view."* Similarly, P05 pointed out that the techniques helped the group better identify user pain points and seek more suitable solutions to address them.

Finally, P02 added that the tests revealed critical usability issues, stating that *"we had the opportunity to observe key usability, communication, and comprehension problems"*, while P10 noted that new ideas emerged during testing: *"It helped us think of some additional screens for the chat."* These observations reinforce that implementation was not only a validation step but also a source of fresh insights that expanded the solution's scope and usability.

As in previous cycles, teamwork was seen as a crucial factor for success. Participants emphasized how idea sharing, task division, quick adjustments, and diverse perspectives contributed to making the chatbot more functional and coherent with users' expectations.

P11 reported that collective discussions after testing were essential for making adjustments: *"When discussing the test results as a group, we were able to have different perspectives to adjust the project."* This shows how collaborative reflection supported more accurate design decisions. P13 also noted that teamwork made it possible to combine different skills and knowledge to advance the project: *"Through teamwork we were able to combine our knowledge and skills, resulting in faster progress."* Even though the group had limited mastery of the tools, collaboration allowed them to move forward steadily. P02 further highlighted that the diversity of perspectives helped generate more creative and efficient solutions: *"Each team member brought a different perspective, which enriched the process."*

P12 also commented on the team's commitment and engagement throughout the process, noting that: *"It was complicated to find a time when everyone was available, since we were in different classes and had different responsibilities. However, we did our best to divide and complete the tasks. Once we understood each other better, it became easier to overcome disagreements and criticisms, as well as to analyze our own work critically, which helped us improve."* This engagement helped keep the group united and productive. Finally, P05 observed that frequent meetings were essential to generate ideas and align decisions: *"We were encouraged to hold meetings daily to align ideas and suggest new points for improvement."* This demonstrates how the team organized itself actively to maintain momentum and ensure the project's progress during the implementation cycle.

6.2 Quantitative Results

The responses revealed a tendency toward agreement across the three cycle, with emphasis on aspects such as creativity, team collaboration, engagement, and focus on user needs. These results reinforce the participants' favorable view of the adopted process.

In the category **Perception of the DT cycle** (I01 to I05), the data indicate that students perceived the Inspiration cycle as particularly stimulating for creativity and the generation of innovative ideas. In the Ideation cycle, this trend continued, although some responses, as seen in statements I03 and I04, revealed a certain neutrality, suggesting that some students encountered difficulty in transforming ideas into more concrete proposals. In the Implementation cycle, a generally positive perception was observed, although in some cases, such as I01, there were more neutral responses, which may be related to the practical challenges of this cycle. Nevertheless, I05, related to understanding user needs, remained positively evaluated throughout the process, reinforcing the role of DT in this regard.

In the **Ease of Use and Application** category (I06 to I08), the three cycles presented similar and high average scores. Students were quite comfortable in all cycles, reporting that they were able to understand and apply the proposed techniques, even without prior experience in this area. In particular, I07 indicated that the choice of tools was appropriate for the class profile, as few reported difficulty implementing them.

Regarding **Teamwork** (I09 to I14), all three cycles were well-evaluated, but with interesting variations. In the ideation cycle, statements related to the exchange of ideas and active listening (I09 and I10) stood out, which is consistent with the objective of this stage. During implementation, the perception of engagement with the project and appreciation of individual contributions increased (I13 and I14), demonstrating that, as the chatbot took shape, students felt more connected to the final product and the collective effort.

The **Personal Satisfaction** category (I15 to I17) revealed a general feeling of contentment with the experience across all three cycles. The stimulated level of creativity (I16) was particularly noteworthy during the inspiration stage, while the perception of time invested (I17) proved slightly more challenging in the final stage, indicating that execution required more effort, which is expected during delivery and testing.

In the **Perceived Competence** category (I18-I21), students indicated that their experience with DT directly contributed to the development of relevant skills. I20, regarding the transformation of ideas into practical solutions, stood out during the implementation stage, demonstrating that students felt real progress in their creative abilities. I21 indicated that their understanding of the chatbot creation process gradually solidified over the course of the cycles.

Overall, the questionnaire responses indicate that the students not only understood the stages of Design Thinking but also experienced the practical effects of the approach at various points. The process enabled them to move beyond a theoretical understanding and begin making decisions based on real-world user experiences, group discussions, and concrete testing. Each cycle had its own specific contribution: inspiration sparked empathy and new insights; ideation fostered collaboration and openness to possibilities; and implementation consolidated learning by bringing the proposal closer to reality.

7 Discussions

Data analysis revealed that the application of Design Thinking altered the way students approached the development of chatbots. In addition to guiding the technical process, DT contributed to

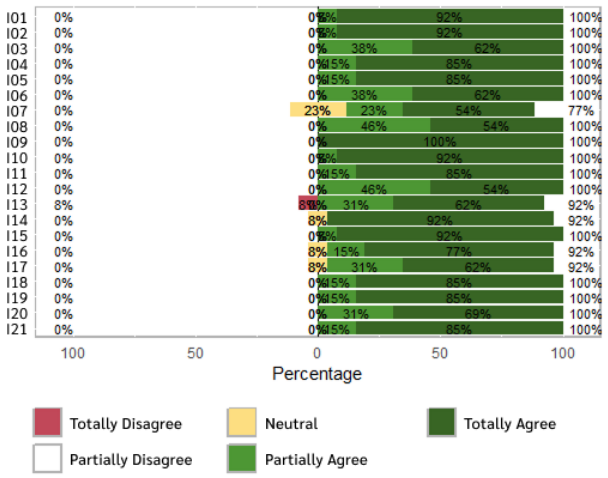

Figure 1: Student Responses to the Inspiration Cycle.

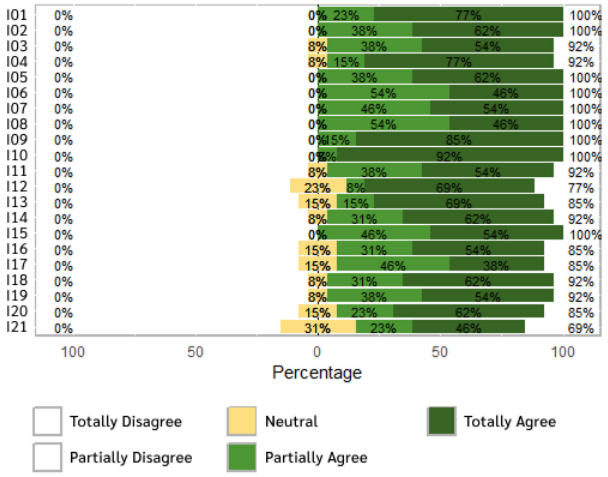

Figure 2: Student Responses to the Ideation Cycle.

changes in the way they thought, collaborated, and made decisions as a team throughout the three project cycles.

In the Inspiration cycle, reports indicate that students identified relevant aspects of the problem that would have been difficult to perceive without active listening and direct contact with users. Several students reported that a proper understanding of the problem to be solved emerged only after this interaction, demonstrating that DT not only guided the project technically but also fostered a shift in thinking and approaching the solution from the user's perspective.

This was evident in quotes demonstrating how data collected through techniques such as interviews and empathy maps directly influenced decisions related to chatbot functionality and language. Design decisions began to incorporate not only technical aspects but also users' emotional and social considerations. This sensitivity, resulting from the immersion process, is consistent with studies,

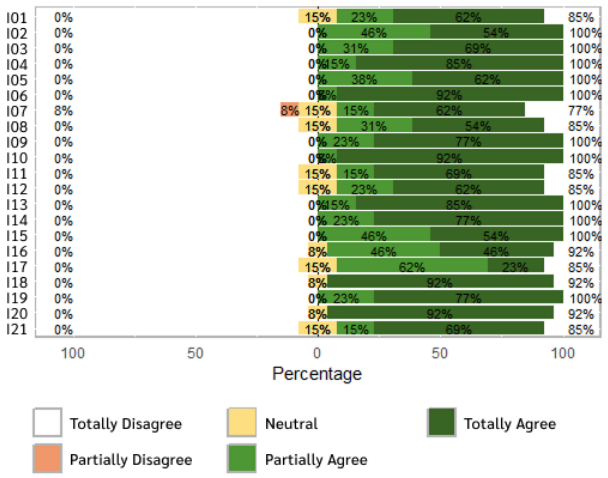

Figure 3: Student Responses to the Implementation Cycle.

such as that of [14], which report that direct contact with users in the early stages of design broadens contextual understanding and favors the development of more empathetic solutions that are tailored to the target audience's real needs.

Design Thinking was well-received by students, helping to broaden their perspective on problems, foster greater empathy with users, and encourage involvement in project decisions. The process was valued for making development more human, practical, and connected to people's real needs.

The students also argued that, without DT, they would not have been able to identify specific behaviors, demands, and limitations of the target audience. These findings are corroborated by [34], which highlighted the creative unlocking generated by tools such as exploratory interviews and empathy maps.

In the Ideation cycle, the data showed an increase in the quality and diversity of ideas generated. Techniques such as brainstorming, brainwriting, and prioritization matrices facilitated the exploration of more creative and unconventional alternatives. The exchange of experiences among team members was also crucial in developing more innovative solutions. This collective practice aligns with the findings of [1], which demonstrate the potential of DT to enhance engagement and empathy in educational projects. Another important result concerns the change in students' perception of the role of chatbots. They began to see them not only as technical systems, but also as channels for interacting with users, which motivated decisions such as adjusting the tone of speech and including more welcoming responses. This perception is also observed in [28] in the context of educational conversational interfaces.

Students valued the techniques for contributing to the construction of chatbot functionalities more aligned with user needs.

During the Implementation cycle, user testing revealed limitations in the chatbots the students were developing, such as confusing workflows and unclear language, highlighting the importance of continuous evaluation. Corroborates this perception [20], who noted that this stage also strengthened the students' sense of responsibility, requiring effective collaboration in reviews and feedback cycles. Despite challenges such as time management and task division, many students attributed the development of their solutions to collective effort. This dynamic is consistent with the findings of the meta-analysis conducted by [45], which indicates significant increases in engagement, creativity, and a sense of belonging in educational contexts mediated by DT.

Additionally, the quantitative data reinforce the qualitative evidence. Across all cycles, we observed high agreement on statements related to the clarity of activities, empathy, creativity, ease of applying techniques, and perceived competence. The most frequent highlights were statements related to creativity (I02, I16), understanding user needs (I05, I20), and teamwork (I09, I13).

Compared to studies that apply DT in mobile or web development, our findings reveal some traits in chatbot development. Chatbots demand more attention to conversational style, tone, and empathy in language rather than just visual layout or navigation structure. For example, [34] discuss design practices essential for human-AI dialogue and [46] highlight that user satisfaction depends heavily on concrete and empathetic responses, more so than on visual elements. In DT applied in mobile research, the focus tends to be on interface visuals, screen flows, and functional structures typical of app design [41]. Consistently, our students perceived that designing human interactions mediated by text requires a deeper level of empathy and communicational sensitivity, which made the Inspiration and Ideation stages even more central in their design process.

The results show that the use of Design Thinking contributed not only to the technical improvement of projects but also to the development of socio-emotional and metacognitive skills. The training experience provided a space for critical reflection, active listening, and collaborative decision-making, fundamental aspects for the development of professionals who are more context-sensitive and capable of designing technological solutions with greater purpose and responsibility. A recent study by [23] corroborates this perspective, indicating that Design Thinking promotes the development of critical thinking and self-regulated learning in Computer Science education.

Overall, the Design Thinking experience was positive, both in terms of the results achieved and the process itself. Students became more engaged, reflected on what they were creating, and learned to better manage team decisions. Along the way, they became more aware of the impact their solutions can have and better prepared to build technology with more purpose and care.

Even when faced with challenges related to group organization, task division, and practical application of techniques, students identified the process as a space for active learning, in which collaboration and contact with real users contributed significantly to the maturation of ideas and the refinement of solutions.

8 Final Remarks

This study examined how DT can support the development of chatbots that are more aligned with user needs, drawing on the practical experience of undergraduate higher education students. The results indicate that DT significantly contributed to increasing empathy, stimulating creativity, and engaging students in project decisions, thereby favoring the creation of more human, relevant, and contextualized solutions. The techniques applied throughout the three cycles enabled a deeper understanding of users, allowing for the identification of more appropriate requirements and the refinement of prototypes based on testing and real-world feedback. Furthermore, collaborative work was a key factor in strengthening the exchange of ideas and fostering collective learning.

In addition to the points mentioned above, several limitations should be considered when interpreting the results. The first refers to the sample size and profile, which consisted of students from a single course and institution, limiting the extent to which the findings can be generalized to other educational settings. Another limitation concerns the exploratory nature of the study, which did not aim to compare performance across different methods, but rather to understand students' formative perceptions of Design Thinking. Finally, the short duration of the project cycles imposed some constraints on the deeper application of specific techniques and on the external validation of the chatbots developed. Even so, these limitations do not diminish the relevance of the findings. They strengthen the study's pedagogical contribution by highlighting the potential of Design Thinking as a practical and reflective approach in Computing Education, encouraging future research to explore its use in different courses and learning contexts.

As future work, we will investigate how classic SE techniques can be adapted and combined with user-centered approaches to support the development of chatbots. The goal is to propose and validate a specific process that incorporates these practices with methodologies such as DT, encompassing everything from defining conversational requirements to prototyping and evaluation with real users. This proposal aims not only to systematize the development of conversational agents but also to improve SE education, promoting a more integrated approach that combines technical skills and sensitivity to human needs.

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