ChatGPT and ideation

a study on the effect of the use of the tool on design student's creativity and creative process.

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Thank you.

Summary

This study investigates the impact of ChatGPT on design students' creativity and their approach to the ideation process. Based on Glăveanu's 5A's creativity framework, the research focuses on how the use of ChatGPT influences creative actors, actions and artifacts, as well as it's affordance regarding critical appraisal. A mixed-methods approach was employed, combining quantitative analysis of design concepts and survey data with thematic analysis to gather qualitative insights from interviews and open-ended questions. Thirty-five design students participated in a within-group experiment, generating ideas under two conditions: with and without ChatGPT assistance. The findings reveal that while ChatGPT fosters quick generation of ideas, it can also reduce creative confidence and engagement, potentially narrowing exploration of the creative space. The study highlights a need for balanced integration of AI in creative workflows, offering recommendations for educators, practitioners, and tool developers to enhance the use of ChatGPT within ideation without undermining human creativity. Limitations and future directions for research also discussed.

Content

1. Introduction

Generative AI (Gen AI) refers to artificial intelligence systems capable of creating new content—text, images, audio, or video—by learning from existing data. These systems recognize patterns and generate content that mimics human-made material. Examples of Gen AI tools include ChatGPT, Gemini, and Midjourney, among others.

The use of Gen AI has surged across both personal and professional contexts, becoming one of the fastest technology adoptions in history. By mid-2024, 39% of U.S. adults had used Gen AI, and nearly two-thirds of organizations globally reported its use, particularly in marketing, product development, and design (Bick et al., 2024; McKinsey & Company, 2024). Adobe (2024) reports that 83% of creative professionals use Gen AI, with 20% required to do so by employers or clients. These figures highlight the growing influence of Gen AI in creative workflows.

Many digital tools that support the creative process have integrated Gen AI features. For instance, Adobe Illustrator uses generative AI for creating vector illustrations from text input, while Figma AI aids in visual inspiration searches, copywriting, and generating visual designs. Miro's AI supports clustering notes, generating diagrams, and other functions. However, more general tools like ChatGPT, while not specifically designed for creativity, have played a pivotal role in popularizing generative AI, gaining 1 million users within five days of release and 100 million monthly active users within two months (Reuters, 2023).

Due to its free availability, ChatGPT is more accessible than specialized design tools. It is now widely used in creative activities, such as content creation and ideation, helping writers, marketers, and designers craft engaging narratives and concepts. As articles on platforms like Medium suggest, ChatGPT is also finding its place in design workflows (Medium, n.d.).

With its growing adoption in creative fields, questions emerge about how ChatGPT impacts human creativity, especially since it was not specifically designed for this purpose. Some fear that over-reliance on AI could lead to diminished creative abilities or the homogenization of creative output (Ray, 2023). Furthermore, design tools can cause fixation effects, where designers may focus too early on overly detailed solutions (Nelson et al., 2018). Therefore, understanding ChatGPT's impact on designer workflows and creativity is critical, which forms the goal of this project.

1.1. Research Questions

Creativity, widely regarded as the generation of ideas or solutions that are both novel and useful (Sääksjärvi & Gonçalves, 2018), plays a critical role in design by integrating functionality, aesthetics, and user experience. To understand and study the multifaceted nature of creativity in design, we turn to Glaveanu's (2012) **5As framework**, which provides a holistic perspective by examining five interconnected elements: **action**, **artifact**, **actor**, **affordances**, and **audience** (see **Figure 1**). By considering creativity through these different elements, we define three research questions.
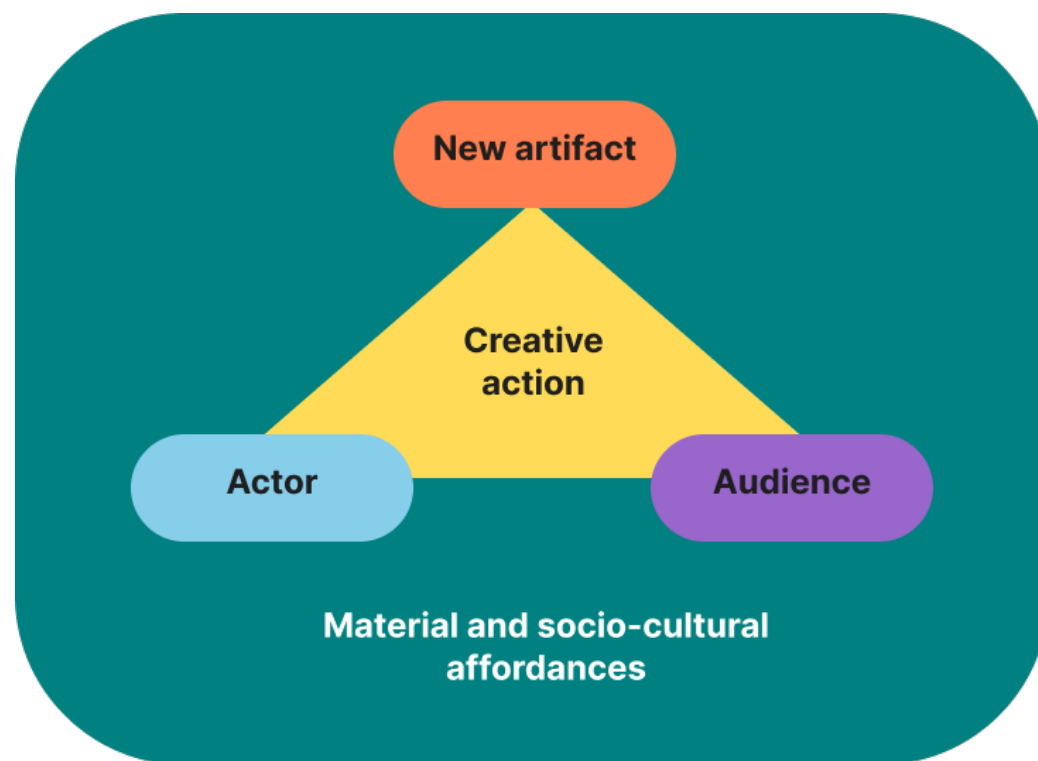
FIGURE 1: GLAVEANU'S (2012) 5A'S CREATIVITY FRAMEWORK. CREATIVITY IS VIEWED AS A DYNAMIC SYSTEM WHERE AN ACTOR PERFORMS A CREATIVE ACTION, INFLUENCED BY AUDIENCES AND THE MATERIAL AND SOCIAL AFFORDANCES, LEADING TO THE CREATION OF A NEW CREATIVE ARTIFACT.

The **creative action** element encompasses dynamic behaviors central to creativity, such as ideation approaches like fluency (generating many ideas) and flexibility (shifting between different ideas or strategies). Activities like inspiration search, sketching, and experimenting are integral to this element.

Inspiration search is particularly important because it plays a pivotal role in generating creative ideas and shaping their quality (Gonçalves, 2016). ChatGPT, with its capacity to provide vast amounts of information and ideas, represents a potential source of external stimuli, offering designers new pathways for creative exploration.

In the 5A's framework, the **artifact** represents the tangible or conceptual outcomes of the creative process, which can be evaluated based on dimensions like novelty, workability, relevance, and

thoroughness (Dean et al., 2006). The quality of these creative outputs varies throughout the design process. Early stages prioritize divergent thinking and fluency, focusing on generating a wide range of ideas. Later stages emphasize refinement and coherence, requiring outputs to meet higher standards of workability and thoroughness with the design brief.

The **actor** element focuses on the individual designer and their relationship with the creative task. Creative confidence—the belief in one's ability to generate valuable ideas—plays a crucial role in how designers engage with the creative process (Karwowski et al., 2019). Along with their existing problem knowledge, the cognitive process of co-evolution (Dorst & Cross, 2001), where problem and solution spaces evolve together, enables designers to iteratively refine their understanding of the challenge, improving both ideation and solution development.

In the 5A's framework, **affordances** shape opportunities for creative action through the environment and tools. Engagement in the creative action is closely tied to affordances, as stimulating environments and tools keep designers immersed in the process, which is crucial for producing high-quality outcomes. However, it is through critical appraisal—the evaluation of both ideas and tool outputs—that designers refine their work. The level of abstraction or relatedness of inspiration (Gonçalves et al., 2013) can foster or hinder exploration, but it is the designer's ability to appraise these inspirations and ideas critically that ensures effective creative outcomes.

The interaction between designer and tool presents unique challenges for critical appraisal, particularly in determining when to accept, modify, or reject ideas. In the interaction between a designer and a tool like ChatGPT designers must balance their own insights with the tool's output to evaluate when to accept, modify, or reject suggestions. This requires careful judgment to avoid over-reliance on the tool while ensuring innovative and effective creative outcomes.

The **audience** element in the 5A's framework highlights the role of those who engage with and evaluate the creative work. For designers, this often includes clients, target users, and, in educational settings, teachers. Each audience brings its own set of expectations, needs, and feedback, which influences how designers adapt their ideas to meet practical requirements and ensure usability.

While the audience plays a significant role in shaping the final creative outcomes, this study focuses on the internal processes of the designer in relation to ChatGPT's affordances. By examining the interaction between the designer (actor), the creative activity (action), and the creative outcome (artifact), we aim to explore how ChatGPT influences the internal creative process rather than external evaluations.

These considerations frame the **central focus of this study: understanding how incorporating ChatGPT into the ideation process impacts designers' workflows and creativity.** This investigation is grounded in four of the five dimensions of the 5A's framework, excluding "Audience" to maintain a focused exploration of ChatGPT's influence. To achieve this, the study is guided by **three key research questions (RQs):**

RQ1: How do designers approach the ideation process and inspiration search when using ChatGPT?

This question aims to explore the differences in creative actions when designers utilize ChatGPT compared to when not using any generative AI. Understanding these shifts helps educators update design curricula, practitioners adapt their methods, and UI/UX developers refine tools to better align with natural inspiration-seeking behaviors.

RQ2: How does the use of ChatGPT influence designers' creative confidence, exploration of problem and solution spaces, and the quality of their outcomes?

This question examines the psychological and cognitive impact of ChatGPT on designers, including its effect on confidence, problem-solving approaches, and output quality. The findings can inform strategies to integrate AI in education and practice while guiding the development of tools that encourage creative exploration and maintain high-quality outcomes.

RQ3: How does the use of ChatGPT affect designers' critical appraisal of chat outputs and their ideas?

This question focuses on understanding how designers critically evaluate both ChatGPT's suggestions and their own ideas in the creative process. It is crucial for exploring how designers maintain their judgment and foster trust in AI while avoiding overreliance or uncritical acceptance of its outputs. Insights from this question can inform strategies to strengthen critical thinking skills, refine the balance between trust and skepticism in AI interactions, and guide the development of tools that encourage reflective and intentional creative decisions.

In summary, by utilizing Glaveanu's 5As framework, it allows me to investigate the nuanced ways in which ChatGPT, as an external tool, interacts with key elements of the creative process. The three research questions outlined will guide our exploration of ChatGPT's influence on ideation, creative confidence, creative outcome, and critical appraisal, providing insights into the evolving role of generative AI in design practice.

RQ2
How does the use of ChatGPT influence designers' creative confidence, exploration of problem and solution spaces, and the quality of their outcomes?

Artifact
- Artifact creative quality
- novelty, workability, relevance, and thoroughness (Dean et al., 2006)

RQ1
How do designers approach the ideation process and inspiration search when using ChatGPT?

Creative action
ideation approach, fluency and flexibility, inspiration search, sketching.

Actor
- Creative Confidence
- Problem Knowledge
- Cognitive process of co-evolution (Dorst & Cross, 2001)

Audience

Material and socio-cultural affordances for creative engagement and critical appraisal of ideas

RQ3
How does the use of ChatGPT affect designers' critical appraisal of chat outputs and their ideas?
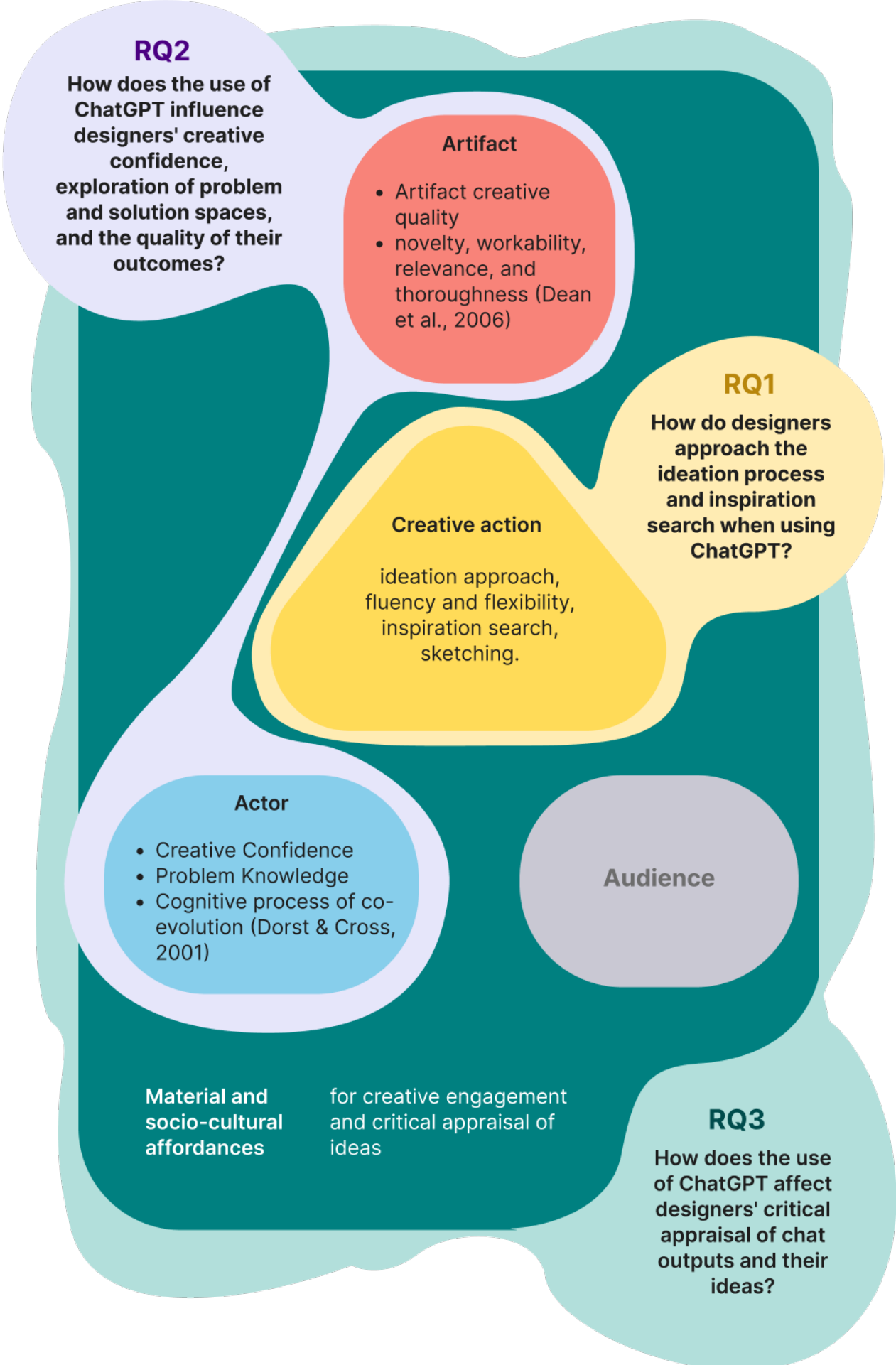
FIGURE 2: INTEGRATION OF RESEARCH QUESTIONS WITHIN GLAVEANU'S (2012) 5A'S CREATIVITY FRAMEWORK. RQ1 FOCUS ON THE DIFFERENCES IN CREATIVE ACTION WHEN USING CHATGPT, RQ2 FOCUS ON THE RESULTING ARTIFACT QUALITY AND PSYCHOLOGICAL AND COGNITIVE IMPACT ON THE ACTOR, LASTLY RQ3 FOCUS ON HOW THE TOOL AFFECT THE AFFORDANCE OF APPRAISAL OF THE OUTPUTS AND IDEAS.

To address these research questions an experimental study and mixed method approach was employed:

Theoretical background report section 2

A literature review was conducted to establish the theoretical framework for the study, focusing on current understandings of creativity and the use of Generative AI. Insights from this review informed the development of the questionnaires and shaped the content of the interviews.

Within-group study report section 3

An experimental within-group study was conducted with 35 students from THUAS's UXD course. Participants ideated under two conditions: without using Generative AI and using ChatGPT.

Data analysis

Insights were derived from collected data (including sketches, generated concepts, ChatGPT transcripts, and pre/post questionnaires and interviews) to address the research questions regarding ChatGPT's impact on ideation.

Quantitative analysis

The study first quantitatively analyzed the creative quality of concepts and the pre/post questionnaires by comparing results from the two experimental conditions.

validates and expands findings

Thematic Analysis (TA)

Secondly, qualitative analysis was conducted on interviews and open-ended post-questionnaire responses using Thematic Analysis to identify themes that validate and expand insights related to the research questions.

Discussion report section 4

Findings from the quantitative and qualitative analyses were compared and discussed in relation to the theoretical background.

Recommendations report section 4

Implications from educational, product, and user perspectives are discussed, along with recommendations on how ChatGPT can be utilized and designed to better support the creativity of designers, especially novices. Suggestions for future research are also provided.
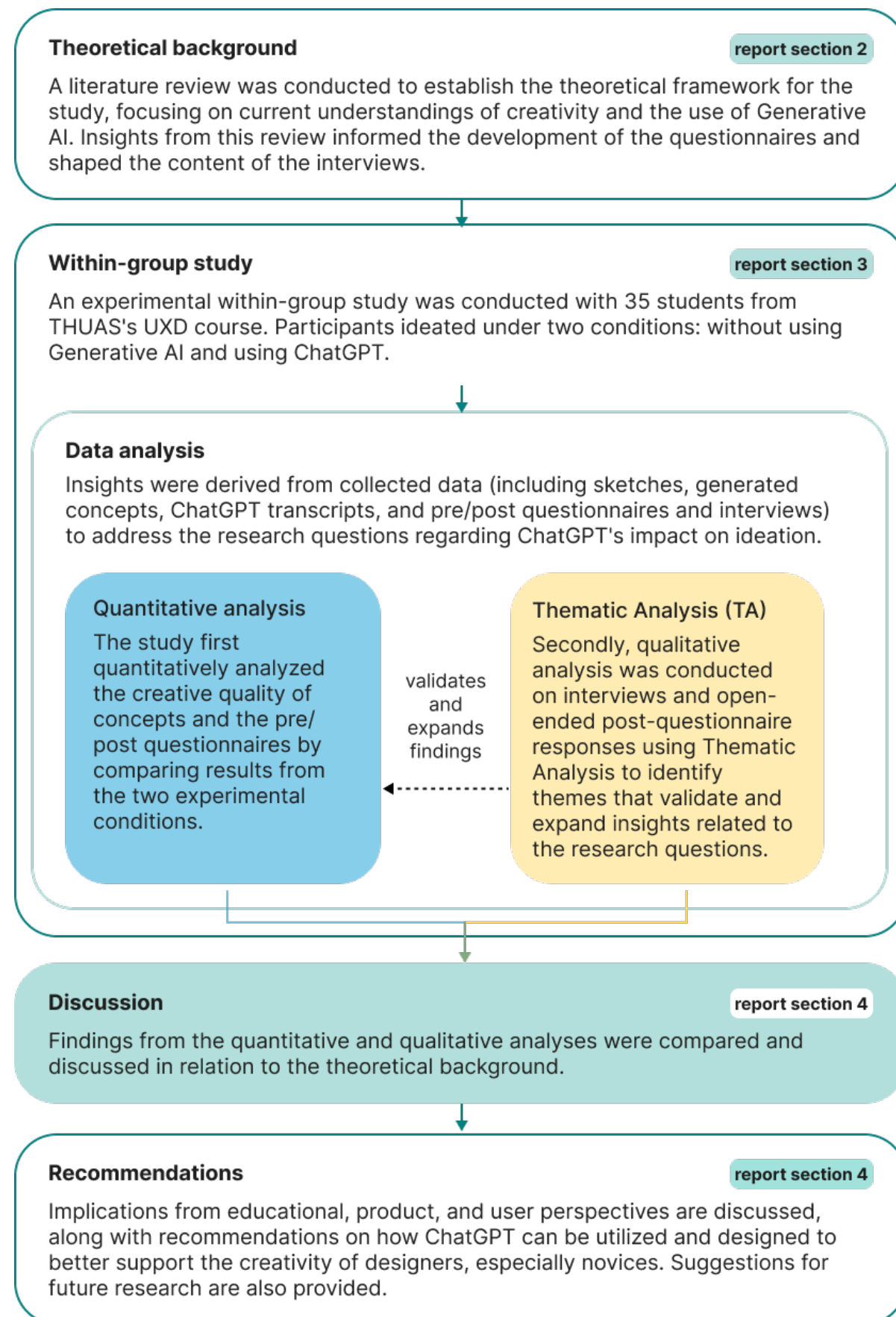
FIGURE 3: OVERVIEW OF THE MIXED-METHOD APPROACH TO ANSWER THE RESEARCH QUESTIONS. THE RQS AND THEORETICAL BACKGROUND INFORMED THE DESIGN OF AN WITHIN-GROUP EXPERIMENTAL STUDY WITH A FINAL SAMPLE OF 35 DESIGN STUDENTS. SEVERAL INSIGHTS WERE DERIVED FROM THE QUANTITATIVE AND QUALITATIVE ANALYSIS OF THE DATA (SKETCHES, CONCEPTS, CHATGPT TRANSCRIPTS, AND PRE AND POST EXPERIMENT QUESTIONNAIRES) RESULTING IN THE DISCUSSION OF RESULTS AND RECOMMENDATIONS ON HOW TO BETTER PROTECT DESIGNER'S (SPECIALLY NOVICE) CREATIVITY WHEN CHATGPT.

2. Theoretical Background

2.1. Creative process and inspiration search

The creative process generally involves three stages: problem preparation, idea generation, and idea evaluation (Warr & O'Neill, 2005). Designers gather information to understand the problem, generate ideas by combining existing knowledge, and then evaluate those ideas for relevance and effectiveness. However, this process is not linear; designers often iteratively redefine both problem and solution simultaneously, a phenomenon known as co-evolution (Crilly, 2021). Early ideation relies on divergent thinking, generating a wide range of possibilities, followed by convergent thinking to narrow down and refine ideas based on feasibility and creativity.

Since ChatGPT was not specifically designed for creative work, it can present challenges by conflicting with common mental models of ideation. Its text-based interface does not align well with designers' typical preference for visual stimuli (Gonçalves et al., 2016). Although textual stimuli, particularly those with appropriate semantic distance, can inspire creative thinking (Gonçalves et al., 2013), ChatGPT's reliance on prompts makes it interesting to explore how designers will balance proximity to the problem with the need for abstraction. Staying too close to the problem could lead to fixation, while too much abstraction may hinder meaningful exploration (Fu et al., 2012).

Additionally, Nielsen (2023) notes that AI tools like ChatGPT shift the interaction from being command-based to intention-based, requiring designers to communicate their broader intent rather than give step-by-step instructions. This shift may create difficulties during the early stages of ideation, where problem definitions are still evolving and articulating clear intent can be challenging. Another issue to consider is AI hallucinations, where ChatGPT generates inaccurate or irrelevant outputs (Ray, 2023), which can mislead designers, potentially derailing the creative process or causing focus on incorrect problem areas.

Inspiration search is another important action within the ideation process. External stimuli, such as images, objects, or texts, play a critical role in ideation by triggering new ideas or reframing problems (Gonçalves, 2016). ChatGPT can serve as a source of inspiration, offering curated responses that differ from the vast, unfiltered results of traditional search engines.

Gonçalves (2016) highlights the importance of keyword formulation, noting that conventional tools often fall short in supporting problem framing and keyword definition. ChatGPT's self-attention mechanism allows it to handle inputs at various levels of abstraction (Ray, 2023), potentially making it more effective in responding better to a wider range of queries.

Gonçalves (2016) emphasizes the importance of reflection in selecting the most beneficial sources of inspiration. While conventional search engines like Google provide vast results, requiring designers to sift through unlimited stimuli, ChatGPT offers a more curated, limited set of responses, automating part of the selection process. It remains unclear how this affects designers' engagement, creative thinking, and outcomes.

Time constraints are another factor in the design process. As shown by Dorst & Cross (2001), time pressure can limit exploration, often leading designers to settle on initial ideas rather than fully engage in co-evolution. ChatGPT's ability to quickly generate outputs might help designers explore more dimensions of the problem and solution space under tight deadlines.

1.2. AI and creativity

Several studies explore AI's impact on creativity. De Peuter et al. (2021) suggest that AI can enhance creativity by aiding in problem-solving and ideation. Designers can leverage AI-generated outputs to speed up ideation while integrating their expertise to guide and assess solutions (Saadi & Yang, 2023). Therefore, the interaction between designers and AI appears central to the successful integration of tools like ChatGPT..

However, questions remain about how ChatGPT affects the quality of creative work. ChatGPT generates ideas by mimicking patterns found in its training data, but it lacks human creativity's intentionality and originality (Runco, 2023). While it can produce both conventional and novel ideas, its reliance on existing patterns risks creating derivative content that may lack the uniqueness found in human-generated works (Ray, 2023). As AI becomes more integrated into workflows, it is essential to understand not only how it affects creative outputs but also how it reshapes the overall creative process.

This concern extends into educational environments, where overreliance on ChatGPT has been observed. Stojanov et al. (2024) found that university students heavily relied on ChatGPT

for tasks like content acquisition, information retrieval, and summarization. Similarly, Hasanein & Sobaih (2023) noted that while ChatGPT offers quick solutions, it can discourage independent thinking. Ray (2023) highlights the concern that overreliance on AI systems like ChatGPT could reduce engagement in critical thinking and creativity.

The potential impact on originality and authenticity is another significant issue. There is concern that over-reliance on AI-generated ideas could lead to homogenization, making designs less distinctive (Jones, 2023). Additionally, ethical questions about authorship and ownership of AI-generated content present challenges for intellectual property rights (Anderson, 2022). Furthermore, there are concerns that the emotional and personal nuances of human creativity may be eroded by algorithmic influence (Lee, 2021).

1.3. Creative confidence

Creative confidence refers to the belief in one's ability to think and act creatively across various domains (Karwowski et al., 2019). It comprises two elements: creative self-efficacy, which is their confidence in performing specific creative tasks, and creative self-concept, which reflects a broader perception of oneself as a creative person (see Figure 4).

Creative self-efficacy
Belief in their capability to perform creatively on specific tasks in particular contexts

Creative confidence
Belief in one's ability to think or act creatively across various domains

Creative self-concept
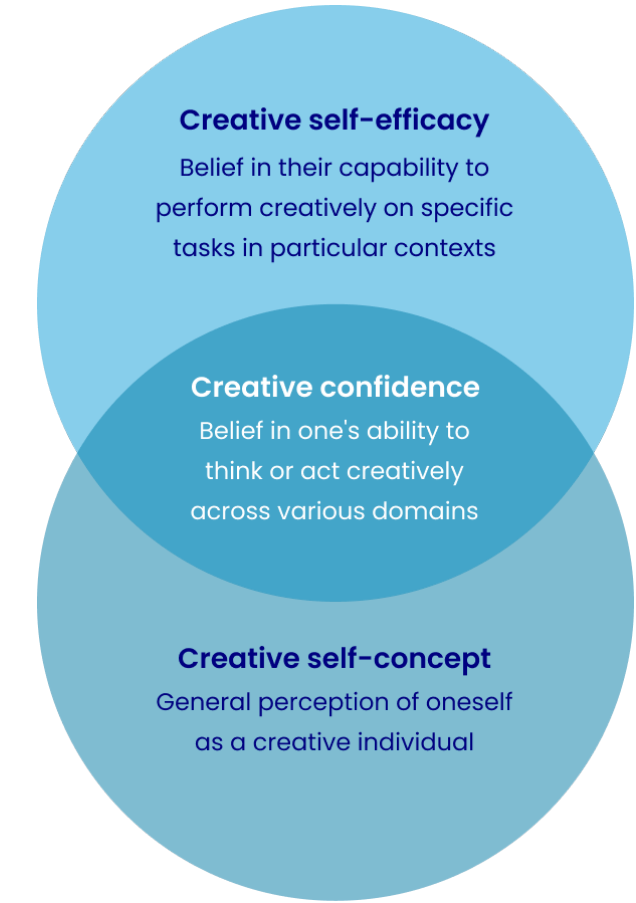General perception of oneself as a creative individual

FIGURE 4: CREATIVE CONFIDENCE (KARWOWSKI ET AL., 2019) ONE'S CREATIVE CONFIDENCE IS THE RESULT OF THEIR GENERAL PERCEPTION OF BEING A CREATIVE INDIVIDUAL AND THEIR CAPABILITY TO PERFORM CREATIVELY IN SPECIFIC TASKS.

Creative confidence is shaped by internal factors, like personal beliefs, and external factors, like feedback, making it a dynamic and malleable construct. Hasanein & Sobaih's (2023) qualitative research suggests that ChatGPT can boost student confidence by providing immediate, accurate responses, fostering a sense of mastery. This could indicate a similar effect on designers' creative confidence. However, relying too heavily

on AI for automating creative tasks might also diminish creative self-efficacy, as designers could feel outperformed by AI in specific areas, which undermines their belief in their own abilities. Furthermore, Karwowski et al. (2019) emphasize that active involvement in creative processes is essential to maintaining a strong creative self-concept. If automation reduces this engagement, it could negatively affect designers' confidence in their creativity over time.

1.4. Critical appraisal and trust

A crucial phase of creativity is idea validation, where solutions generated during earlier stages are critically assessed and either refined or discarded (Cropley, 2011). Dorst & Cross (2001) showed that experienced designers critically evaluate both the novelty and relevance of their ideas, as well as the reliability of the information used to inform their solutions.

One key phase of creativity is idea validation, where solutions generated during earlier stages are critically assessed and selected or discarded (Cropley, 2011). Dorst & Cross (2001) study showed that experienced designers engage in critical appraisal not just of their technical solutions but also of the creativity and novelty of their ideas, furthermore experts also critically evaluate the relevance, reliability, and completeness of the information to inform both their problem framing and solution generation. Given its role in the creative process, it is essential to consider how ChatGPT influences critical appraisal. Unlike traditional search tools, ChatGPT presents outputs in a human-like, confident manner, which may reduce uncertainty but can also lead to overtrust in its responses. This trustworthiness can be misleading, especially

since ChatGPT is known to generate biased or inaccurate outputs due to the biases in its training data (Ray, 2023). Moreover, since it relies on an existing database of patterns, it may present familiar or conventional solutions, limiting opportunities for designers to creatively reinterpret problems.

In conclusion, understanding how ChatGPT influences critical appraisal is essential to evaluating its role in the creative process. It's human-like responses can lead to overtrust, potentially allowing biased or incomplete information to impact decision-making. Since ChatGPT often offers familiar or conventional solutions, it may limit creative reinterpretation of problems. Therefore, maintaining a critical approach to both the ideas and the tool itself is crucial for fostering innovative and reliable design outcomes.

Building upon these theoretical insights, the present study seeks to empirically examine how ChatGPT affects designers during the ideation phase. To investigate this, we designed an experimental study involving design students, aiming to assess the impact of ChatGPT on their creative processes in terms of idea generation, creative exploration, confidence, and critical evaluation. The following section details the study, its methodology, the procedures employed, and

3. Experimental study

While widely accessible and helpful for generating quick outputs, ChatGPT raises concerns about diminishing creativity and independent thought (Ray, 2023), that is particularly concerning for students still developing their creative identities. Hence, our experiment took part within the educational environment with design students. The research aims to understand how best to integrate AI without undermining the designer's creativity through our three research questions:

RQ1
How do designers approach the ideation process and inspiration search when using ChatGPT?

RQ2
How does the use of ChatGPT influence designers' creative confidence, exploration of problem and solution spaces, and the quality of their outcomes?

RQ3
How does the use of ChatGPT affect designers' critical appraisal of chat outputs and their ideas?

To answer these questions, we designed an experiment to capture differences in ideation and creative outcomes with and without the use of AI. The experiment was embedded in the User Experience Design (UXD) program at The Hague University of Applied Sciences (THUAS), providing a real-world context for examining AI's impact in design education. Participants were students from the Project Studio 1 (PS1) course.

The UXD is a 3-year international bachelor's program, where students develop their design skills through various courses and hands-on projects. PS1, a key second-year course, involves exploring user experience design beyond single-user interfaces. In groups, students designed interactive spaces under the course theme of "shared spaces".

A total of 96 students participated in the course, divided into 16 groups of approximately six students. They worked with real clients on design briefs, with a total of six different client projects (summarized in Table 1).

TABLE 1: OVERVIEW OF THE DESIGN BRIEFS ASSIGNED TO STUDENTS.

Brief number and title	Summarized description
Brief 1: A citizens' assembly space for the future	Design a meeting place where government, developers, and citizens can collaborate to stimulate participation in the Central Innovation District (CID) by sharing information and encouraging citizen engagement.
Brief 2: Classroom Datafictions	Create a design to explore the potential and risks of predictive analytics in education and workplaces, prompting reflection on privacy and autonomy issues.
Brief 3: Physical Framework for Visually Presenting Local Data	Develop an interactive installation that presents local government data in a multi-sensory way, improving communication between citizens and authorities.
Brief 4: Focusing on the experiential knowledge of amateurs, club members, and volunteers in mobile heritage communities	Design a way for amateurs and volunteers to share their knowledge of mobile heritage, connecting them with other heritage domains while minimizing additional workload.
Brief 5: Taalexplorium - new times need new languages; the library as playground for inventing new ways of expression through language	Create a playful, interactive machine that translates language in innovative ways, drawing attention in public spaces such as libraries, schools, and festivals.
Brief 6: experience centre in the innovation playground - Paris Proof Camp	Create a playful, interactive machine that translates language in innovative ways, drawing attention in public spaces such as libraries, schools, and festivals.

The PS1 course assignment followed a three-diamond approach of Creative Problem Solving (Figure 5). In the first diamond, problem finding, students underwent a research phase, exploring the problem space of their brief. This diamond resulted in the group defining "How Might We" (HMW) questions to guide their ideation. Second diamond was individual ideation, and when the data collection for this experiment took place. Students had to converge into six design directions based on their HMW questions. For the purposes of this study, this was divided into two ideations. The first should be done without use of any generative AI, and converge into three directions. The second should be done with the use of chatGPT to ideate the remaining three design directions. The last diamond, used the output of the previous phase, for

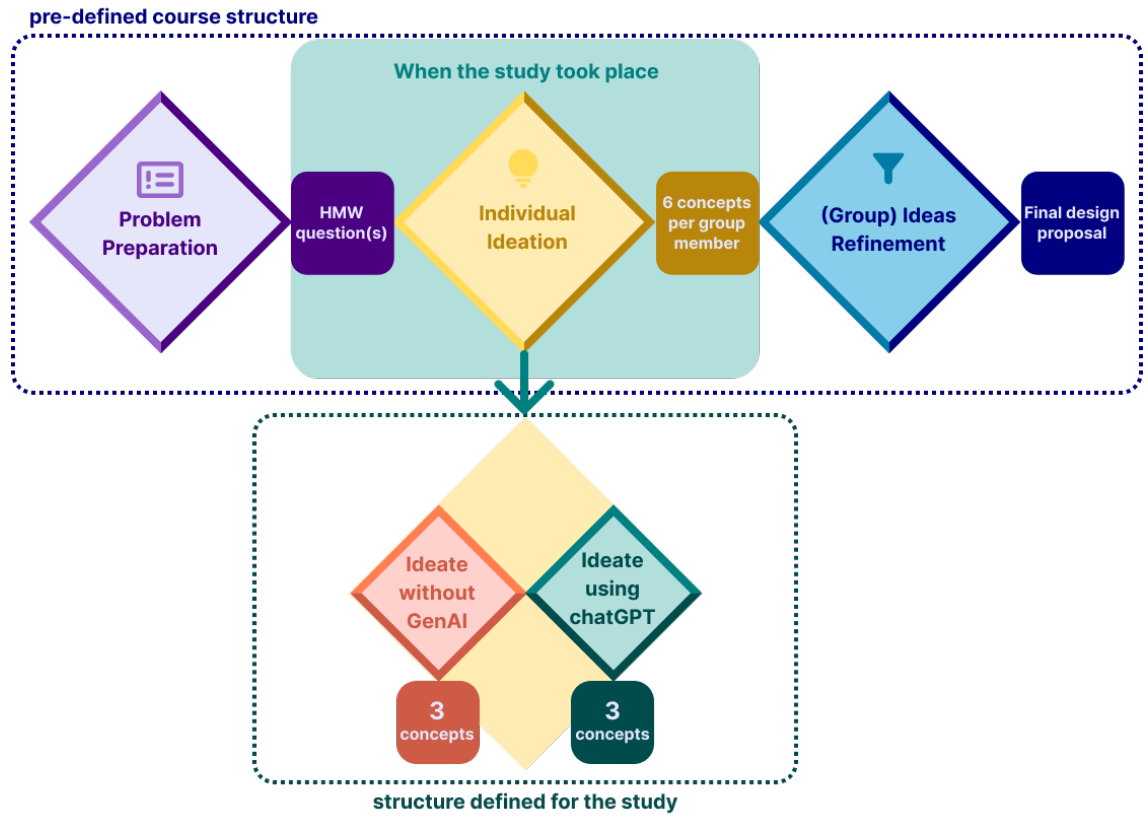a group ideation and convergence into a final proposal, and was no longer part of this study.

FIGURE 5: EXPERIMENT PLACEMENT WITHIN THE PS1 COURSE STRUCTURE. THE FIGURE ILLUSTRATES THE PHASES: RESEARCH (PHASE 1), RESULTING IN "HOW MIGHT WE" QUESTIONS TO GUIDE IDEATION; INDIVIDUAL IDEATION (PHASE 2 AND WHEN DATA COLLECTION TOOK PLACE), ADAPTED TO INCLUDE TWO EXPERIMENTAL CONDITIONS—WITHOUT AND WITH CHATGPT; AND GROUP IDEATION (PHASE 3), WHICH, ALONG WITH PROBLEM PREPARATION, WAS NOT PART OF THIS STUDY.

Given the constraints of embedding the experiment within a course, we encountered several limitations:

- The design concepts had to be documented using a template that could not significantly increase students' workload (the redesign of this template is detailed in the Data Collection section).

- Idea generation was completed as an individual homework assignment, limiting our ability to observe the creative process in a controlled setting.
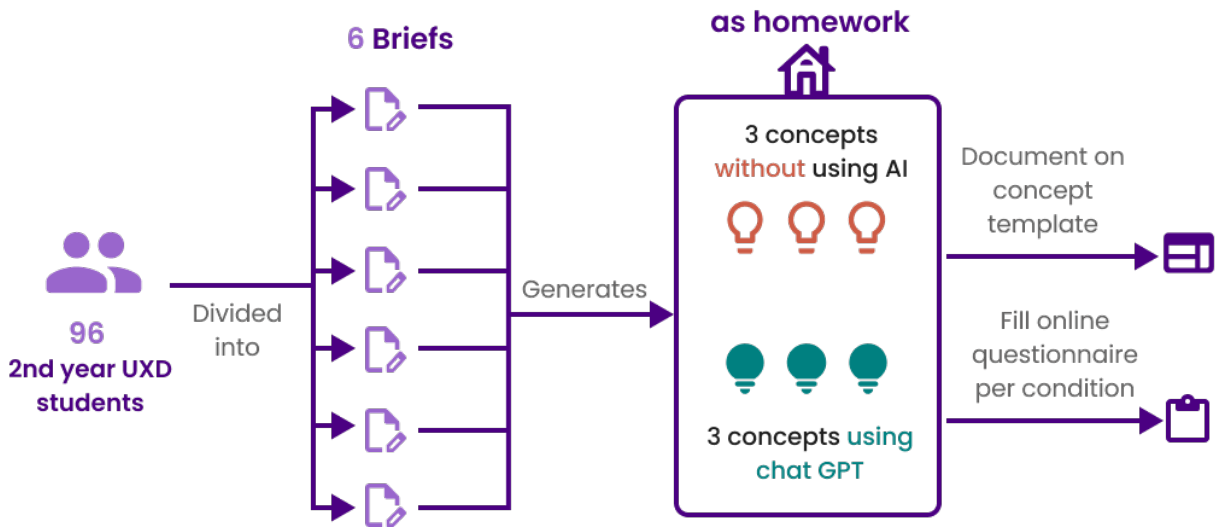

FIGURE 6: INDIVIDUAL IDEATION SETUP. EACH OF THE 96 STUDENTS WORKED ON ONE OF SIX BRIEFS. AS HOMEWORK, THEY GENERATED SIX DESIGN CONCEPTS—THREE WITHOUT GENERATIVE AI AND THREE USING CHATGPT. THE EXPERIMENT INCLUDED A REDESIGNED CONCEPT TEMPLATE AND ONLINE QUESTIONNAIRES FOR DOCUMENTING THEIR RESULTS AND REFLECTING ON THEIR EXPERIENCE IN EACH CONDITION.

The experiment setup was aligned with the existing course structure, with a few additions. We introduced a kick-off session to ensure all participants had basic knowledge of ChatGPT, redesigned the concept template (pilot tested beforehand), and distributed three online questionnaires at different stages of the experiment. These details are further elaborated in the Data Collection section.

3.1. Participants

Participants were recruited during the kick-off session for the ideation part of the course, with follow-up recruitment in the next studio class for those absent. Out of 96 students, 63 agreed to participate. To be included in the final sample, students needed to complete all required experiment materials: a pre-experiment questionnaire, two in-process reflections, the concept templates, and ChatGPT transcripts. Only 35 participants met all these criteria, forming the final sample (N=35). Table 2 provides an overview of the number of students fulfilling each criterion.

TABLE 2: NUMBER OF STUDENTS THAT FULFILLED EACH CRITERIA FOR DATA CONSIDERATION

Criteria	Total students
Signed consent form	63
Completed pre-experiment questionnaire	55
Filled online reflections for both experiment conditions	38
Submitted complete concepts template	49
Provided ChatGPT transcripts	45
Fulfilled all criteria	**35**

The final sample consisted of young adults aged 20 to 29, with 44.1% aged 21 and 76.5% between 20 and 24 years old. One participant mistakenly reported their birth year as 2024 and was excluded from the age-related percentages. Figure 7 shows the sample age distribution.

N 34   Mean 22.64

76.5% in early 20's

- 20 years: 4 (11.8 %)
- 21 years: 15 (44.1%)
- 22 years: 3 (8.8%)
- 23 years: 2 (5.9%)
- 24 years: 2 (5.9%)
- 25 years: 2 (5.9%)
- 26 years: 1 (2.9%)
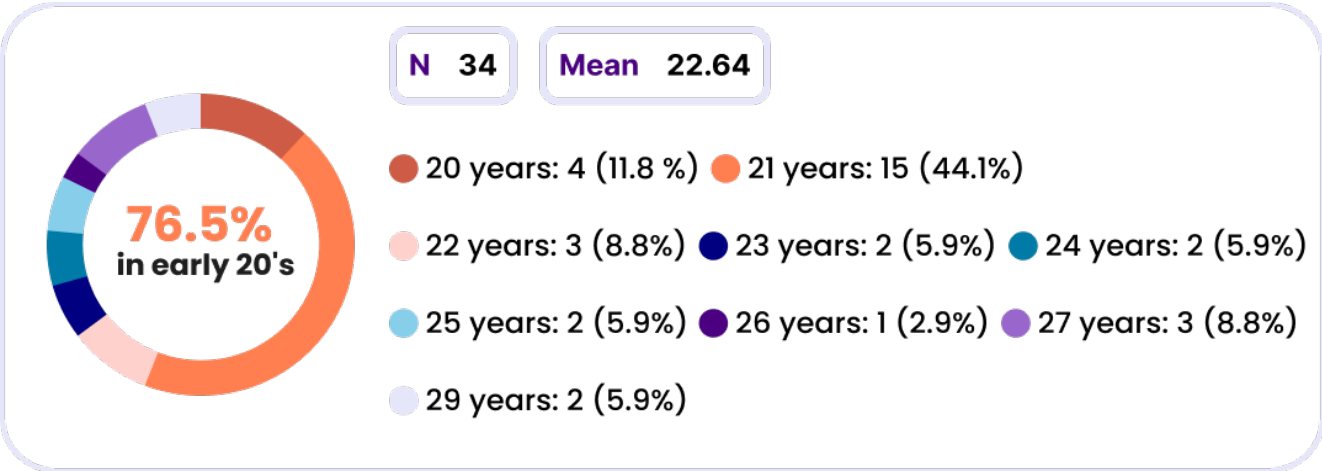- 27 years: 3 (8.8%)
- 29 years: 2 (5.9%)

FIGURE 7: AGE DISTRIBUTION OF THE SAMPLE. ALL PARTICIPANTS WERE IN THEIR 20S, WITH 44.1% AGED 21, AND 76.5% IN THEIR EARLY 20S.

The sample was 77.1% female (27 participants) and 22.9% male (8 participants). Figure 8 display the gender distribution.

N 35

77.1% female

- Female: 27 (77.1%)
- Male: 8 (22.9%)
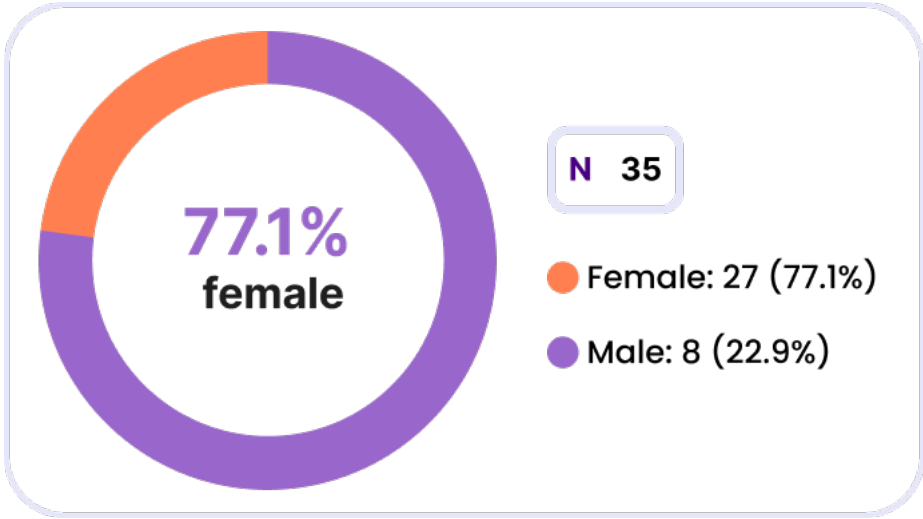
FIGURE 8: SAMPLE GENDER DISTRIBUTION. THE SAMPLE CONSISTED PREDOMINANTLY OF FEMALE STUDENTS (77.1%).

The regional distribution of the sample is as follows: 77.1% from Europe, 8.6% from Asia, 5.7% from the Middle East, and 2.9% each from Africa, North America, and South/Central America. Figure 9 show the regional distribution.

N 35

77.1% european

- Africa: 1 (2.9%)
- Asia: 3 (8.6%)
- Europe: 27 (77.1%)
- Middle East: 2 (5.7%)
- North America: 1 (2.9%)
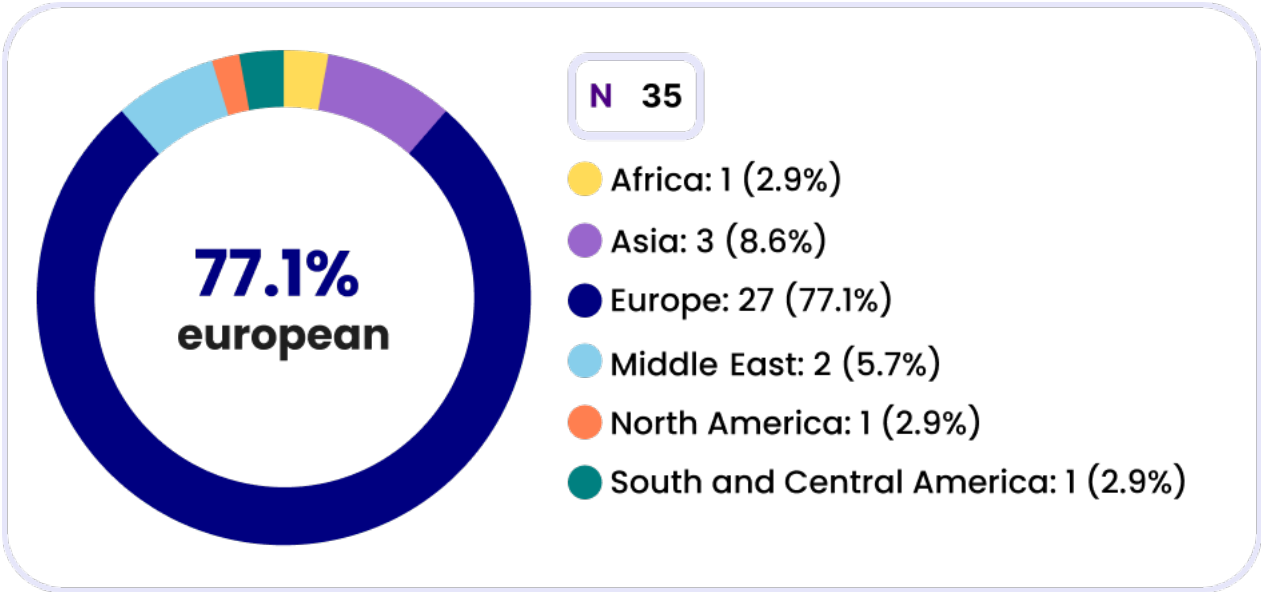- South and Central America: 1 (2.9%)

FIGURE 9: SAMPLE REGION DISTRIBUTION. THE SAMPLE CONSISTED PREDOMINANTLY OF EUROPEANS (77.1%)

3.2. Data Collection

Due to the constraints of the course, we implemented a within-group design. Personal characteristics such as baseline abilities, personality, or cognitive capacity of the individual involved in the creative activity might influence their creative actions (Glăveanu, 2012). The within-group approach help isolate individual differences and increase the confidence to which we can attribute to the use of chatGPT any differences in the dependent variable conditions.

Due to the educational nature and constraints of the assignment we decided on having a within-group design for the study. We adapted to the course constraints by separating the six design directions ideation in two parts so we could compare results in-between. First students were asked to ideate and generate three concepts without the use of any GenAI tool. For the second part, they should ideate again three concepts but using chatGPT in any way they saw fit to aid in their creative process.
To minimize the carryover effects between experiment conditions, participants were explicitly instructed to ideate the first three concepts and reflect on the process before moving on to the ChatGPT-supported ideation. This step ensured the first set of ideas was not influenced by the use of AI. Lastly, triangulation with qualitative data (interviews and open-ended questions) provided further insights on participants' perceptions of each condition.

There were three key moments in the experiment procedure that resulted in data for our analysis. Pre-experiment we had participants fill an online questionnaire. The second stage involved the within-group experiment, where participants engaged in ideation under two conditions (with and without the use of ChatGPT). Finally, interviews were conducted with a smaller subset of participants who volunteered after completing their assignments. Figure 10 provides an overview of the data collected at each phase, with each stage explained in more detail below.
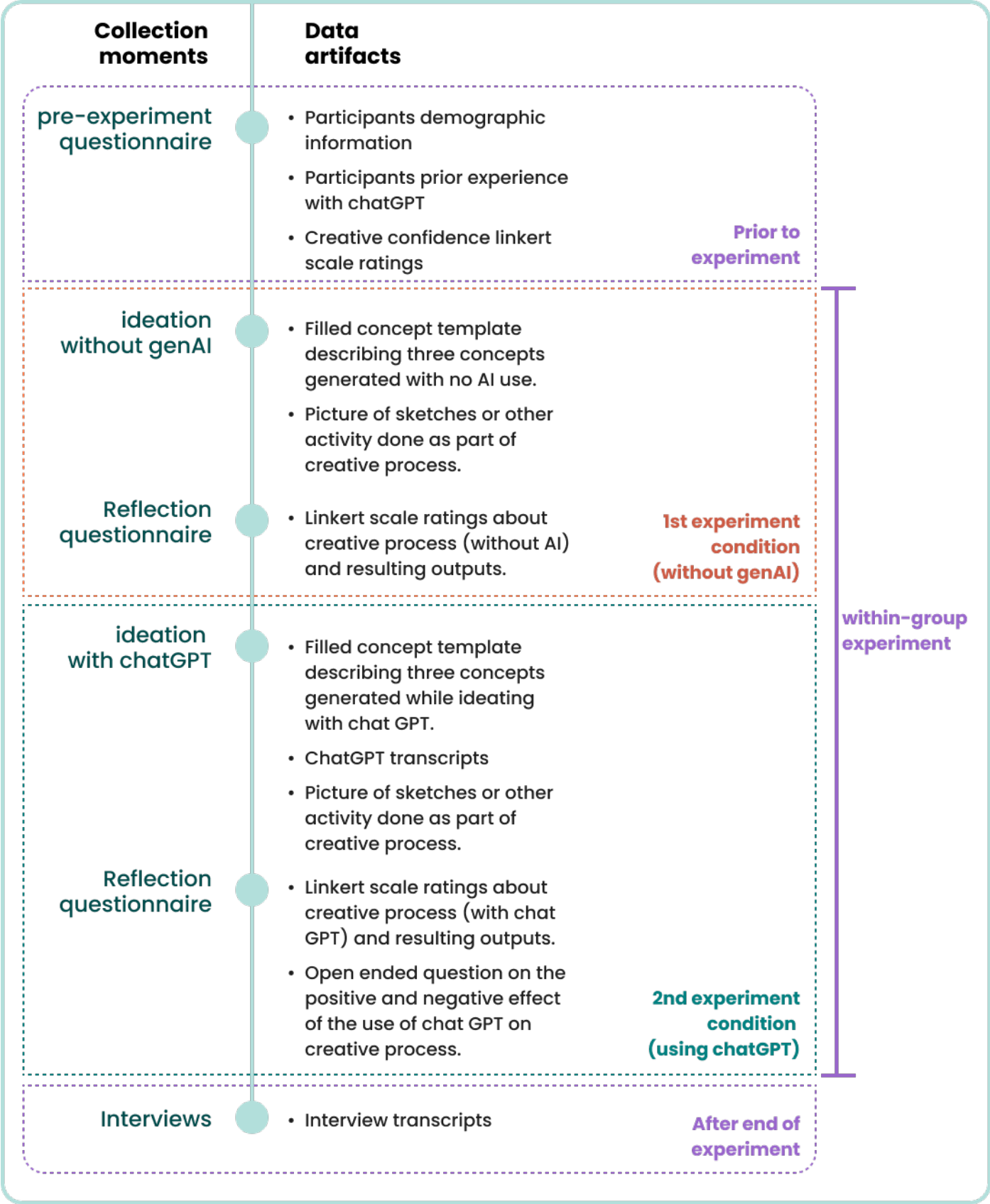

Collection moments | **Data artifacts**

pre-experiment questionnaire
- Participants demographic information
- Participants prior experience with chatGPT
- Creative confidence linkert scale ratings

Prior to experiment

ideation without genAI
- Filled concept template describing three concepts generated with no AI use.
- Picture of sketches or other activity done as part of creative process.

Reflection questionnaire
- Linkert scale ratings about creative process (without AI) and resulting outputs.

1st experiment condition (without genAI)

ideation with chatGPT
- Filled concept template describing three concepts generated while ideating with chat GPT.
- ChatGPT transcripts
- Picture of sketches or other activity done as part of creative process.

Reflection questionnaire
- Linkert scale ratings about creative process (with chat GPT) and resulting outputs.
- Open ended question on the positive and negative effect of the use of chat GPT on creative process.

2nd experiment condition (using chatGPT)

within-group experiment

Interviews
- Interview transcripts

After end of experiment

FIGURE 10: DATA COLLECTION TIMELINE AND ARTIFACTS

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ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   27

3.2.1. Pre-experiment

During a kick-off class, we presented the study's goals, recruited participants, and distributed consent forms. This session also ensured that all students had a basic understanding of ChatGPT and prompt-engineering techniques , as according to Ray (2023) by employing prompt engineering techniques, users can guide the AI model to generate more accurate, relevant, and useful responses. A complete overview of the kick-off presentation can be found in the Appendix of this report.

Before ideation, participants completed an online questionnaire covering demographics, prior experience with ChatGPT, and creative confidence (Karwowski et al., 2019). This last served as a baseline for comparison between the two parts of the study. Table 4 shows the questions we used to measure creative confidence and related constructs. The full pre-experiment questionnaire is available in the appendix.

Linkert Scale statement	Reasoning
I am creative	Directly relates to creative self-concept (CSC), capturing an individual's general self-perception as a creative person. This aligns with the stable and identity-driven aspects of creative self-concept. (Karwowski et al., 2019)
I know I can efficiently solve even complicated problems	Short Scale of Creative Self (SSCS) Items Measuring Creative Self-Efficacy (CSE) (Karwowski et al., 2018)
I trust my creative abilities	
I have proved many times that I can cope with difficult situations	
I am sure I can deal with problems requiring creative thinking	
I am good at proposing original solutions to problems	
Compared with my friends, I am distinguished by my imagination and ingenuity.	CSC often involves social comparisons, shaped by cultural and peer interactions that reinforce beliefs in one's unique creativity (Karwowski et al., 2019).
I am confident I can come up with a creative way (i.e., original and useful) to solve my design challenge for PS1	Task-specific nature of CSE (Karwowski et al., 2019)

TABLE 4: CREATIVE CONFIDENCE PRE-EXPERIMENT LINKERT SCALE STATEMENTS

3.2.2.   Ideation: within-group setup and artifacts

IN THE COURSE OF ONE WEEK
Participants were asked to follow this order at home, but having control over the time used for each part.
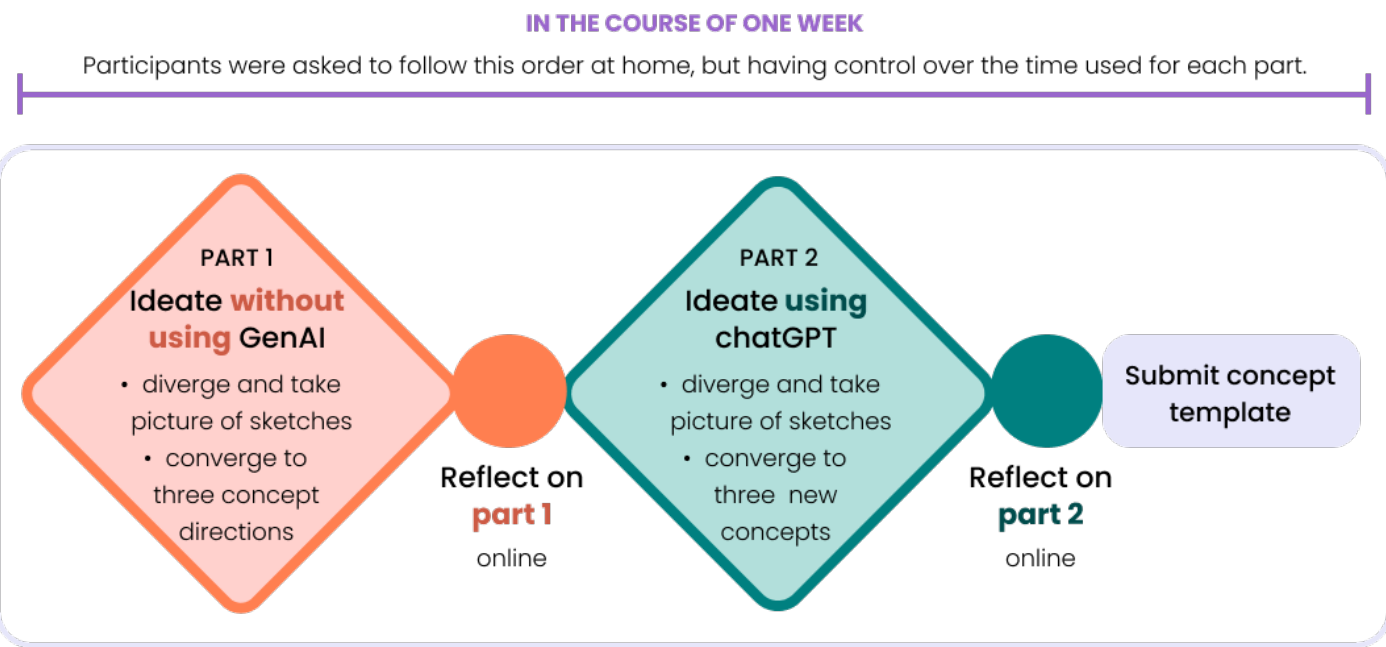

FIGURE 11: IDEATION IS DIVIDED IN TWO PARTS AS SETUP FOR WITHIN-GROUP EXPERIMENT. DATA COLLECTED INCLUDE SKETCHES, CONCEPT TEMPLATE WITH SIX CONCEPTS, REFLECTIONS ON EACH EXPERIMENT CONDITION.

Our experiment had two conditions (Figure 11): ideation without any generative AI compared to ideation using chatGPT. Students ideated within the first condition, documented three concepts using a structured template and reflected on the process through an online questionnaire. Only once all these steps were done could they repeat the process within the second condition (using ChatGPT).

There were no restrictions in terms of what ideation techniques to use for their ideation process. They were asked to take pictures of all sketches, notes, and techniques during the two ideation stages. Furthermore, they were asked to number them according to the order they were created, so we could better visualize how one idea might have influenced the following ones.

Part 1 Diverging without using Generative AI
Please take a picture of the sketches you made during the process of diverging and upload.
If you had separate ideation sessions per concept, you can identify what concept they relate to by adding the concept number (1,2,3).
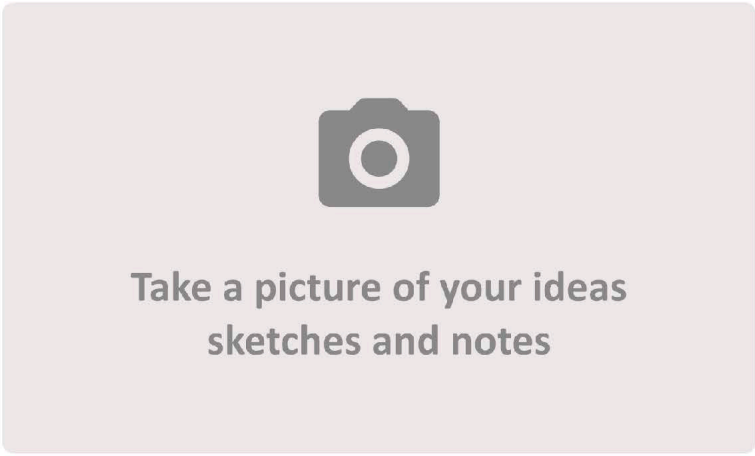

Take a picture of your ideas
sketches and notes

FIGURE 12: SPACE ON THE TEMPLATE FOR THE PICTURE TAKEN OF DIVERGING SKETCHES/NOTES.

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ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   29
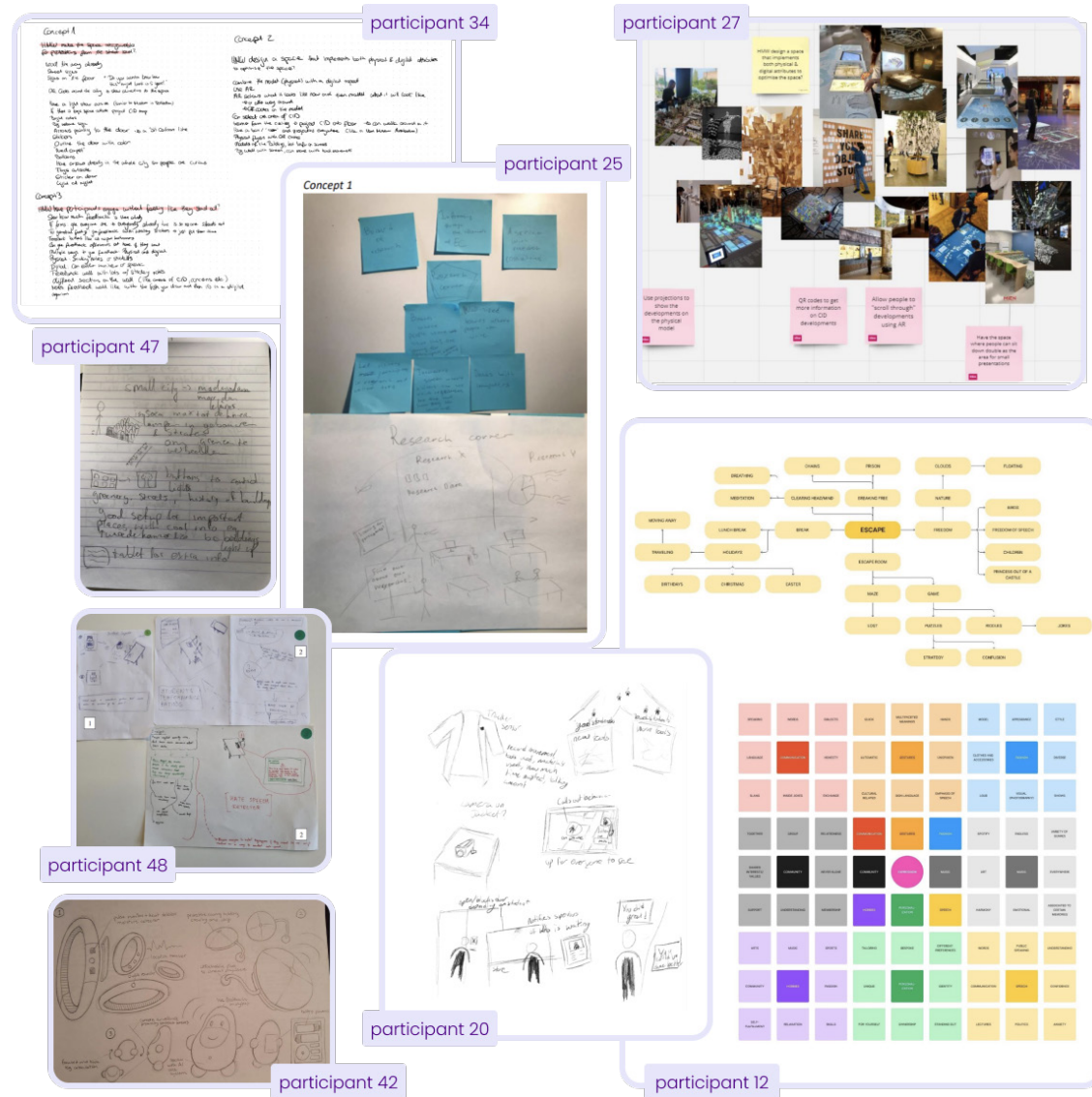
FIGURE 12: EXAMPLES OF VARIETY OF DIVERGING STAGE OUTCOME PROVIDED BY PARTICIPANTS. DIVERGING ARTIFACTS REPORTED VARIED IN FROM DIGITAL, ANALOG, TEXT- BASED, IMAGE-BASED, SKETCHES IN DIFFERENT REFINEMENT LEVELS, MINDMAPS, ETC.

A. Pilot test

For each of the concepts, participants filled out a template to describe their design. Several versions of the template were discussed and iteratively refined. To ensure clarity and usability of the template and attached instructions, a pilot test was conducted with three volunteer first-year UXD bachelor students at THUAS. This step ensured the final version would be clearly understood by the second-year students.

An interesting insight came from the pilot testing session: we initially explained the first part of the study as "normal ideation" and the second part as using ChatGPT. However, one student commented, "But my normal ideation is with ChatGPT." This remark highlighted the potential prevalence of use of generative AI tools by students in academic environments, and the relevance of doing this study.

Students were shown the template and asked to provide feedback on any unclear elements, explaining what they understood or how they would answer specific questions. The key points for validation were:

- **Template length:** Ensuring the template did not significantly increase their workload.
- **Clarity:** Determining whether the instructions were clear on the overall experiment procedure as well as how to fill out each part, and whether an example was necessary.

Based on feedback from both students and the course coordinator, the template was shortened. Help text replaced multiple questions, some misleading questions were clarified, and the procedure's order and rules were refined. Additional instructions were added to experiment procedure checklist and kick-off presentation. At the request of the course coordinator, a requirement to include a quote from their previous research was also reintroduced. The full procedure checklist provided to all participants is available in the Appendix. The final concept template will be detailed in the following section.

B. Concept template

Students were given a word document that contained the template for all concepts that they had to deliver in the order they were supposed to be created according to the experiment procedure. For both parts of the experiment, students were asked to give each concept a name, include a quote from their research (a course requirement), describe the design challenge, explain their concept, and attach a sketch or image representing it. Figures 13 show the final version of the template used in the study and the specific information requested.

- For concepts created without generative AI, students were also asked to mention any external inspiration sources.
- For concepts created with chatGPT, they were asked to describe how the tool influenced their ideas and to include a link to their anonymized chatGPT conversation, which was used for the qualitative analysis.

We clarified that they could use AI to generate concept images for both parts, as long as this step was taken after completing the concept description to avoid influencing their ideas. The complete template can be found in the appendix.

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Template for concepts designed **without any GenAI tool**

participant ID   order of ideation   experiment condition

Group#: **0** / Participant #: **0**   **First Concept**   **Without** Generative AI

Replace with an image of your concept

sketch or image to illustrate concept →

concept title →
Replace with concept title

quote from research →
Quote
What was said in your research that inspired this direction.
"Replace with quote"

framing of the problem (how might we...) →
Design Challenge
The current state of things and the problem you are trying to solve.
Replace with design problem description

concept description: goal, user interaction, form, etc →
Design direction
Please explain the goal of this concept compared to the current state. Briefly describe the design's appearance, form, function and the user interaction.
Replace with design direction description.

If they searched for external creative stimuli: information, →
External Inspiration
If applicable (e.g., I searched for [ ] on [ ] and saw this [image, information, etc] of [ ] and thought [ ]).
Replace with inspiration.

Template for concepts designed **using chatGPT**

Legenda
→ data identification
→ general concept information
→ specific to first experiment condition
→ specific to second experiment condition

participant ID   order of ideation   experiment condition

Group#: **0** / Participant #: **0**   **Fourth Concept**   **Using** Chat GPT

Replace with an image of your concept

sketch or image to illustrate concept →

concept title →
Replace with concept title

quote from research →
Quote
What was said in your research that inspired this direction.
"Replace with quote"

framing of the problem (how might we...) →
Design Challenge
The current state of things and the problem you are trying to solve.
Replace with design problem description

concept description: goal, user interaction, form, etc →
Design direction
Please explain the goal of this concept compared to the current state. Briefly describe the design's appearance, form, function and the user interaction.
Replace with design direction description.

How the output from chatGPT inspired the concept direction →
Use of chat GPT and how it led to this concept
Describe any specific GPT interaction that inspired you to come up with this concept (e.g., After doing [ ], GPT's [response, suggestion, question] made me think of [ ]).
Replace with answer

Link to chatGPT transcript →
Chat GPT Conversation Link
Select share on the top right of the conversation interface, select "copy link" and paste below.
Replace this with the chat link

FIGURE 13: TEMPLATE FOR THE CONCEPTS OF EACH EXPERIMENT CONDITION. IT INCLUDE SOME COMMON INFORMATION THAT DETAILS THE CONCEPT, AND SOME SPECIFIC DATA = TO GET INSIGHT ON DESIGNERS APPROACH AND INSPIRATION SEEKING WITHIN EACH CONDITION.

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ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   33

C. Reflection Questionnaire

Students were asked to evaluate their ideation process using Likert scale statements related to various aspects of creativity. Since direct observation of their creative process was not possible, these questionnaires provided valuable insights into how the participants experienced their creativity with and without ChatGPT. Both parts of the experiment used the same statements, allowing us to compare perceptions between the two ideation conditions. In the second condition the reflection included additional statements and open-ended questions to specifically address the participants' experiences with ChatGPT. Below is an overview of the questionnaire statements and their reasoning. The complete questionnaire is available in the appendix.

TABLE 5: POST-IDEATION REFLECTION LINKERT SCALE STATEMENTS FOR COMPARISON OF EXPERIMENT CONDITIONS.

Questionnaire Item	Reasoning
Overall ideation experience	
The ideation process stimulated creative thinking.	Reflects participants' perception of cognitive stimulation, aligning with theories of creative process and thinking (Lubart, 2001).
I generated a lot of ideas.	Captures fluency, a key dimension of divergent thinking defined by the ability to produce numerous ideas. (Dumas & Dunbar, 2014)
I explored unconventional design inspirations.	Captures flexibility, as creativity involves shifting perspectives and breaking away from conventional patterns. (Runco, 2004)
I approached the problem and ideas from multiple perspectives.	
Concept development and evaluation of ideas	
The ideation resulted in the development of useful concepts.	Measures perceived creative output usefulness, as a core requirement of creativity, where a novel idea also needs to be relevant and applicable. (Plucker et al.,2004)
The ideation resulted in the development of novel concepts.	
I thoroughly re-examined and challenged my own ideas.	Measure the extent and ease of appraisal of ideas, given the role of idea evaluation in refining and validating ideas to ensure both novelty and relevance. (Lubart, 2001)
I found it easy to evaluate and critique my ideas effectively.	

Questionnaire Item	Reasoning
Personal engagement and confidence	
I feel confident with my design choices.	Assess designer's creative confidence (Karkowski et al., 2019)
I am confident I came up with a creative ideas to solve my design challenge for PS1.	
I felt engaged throughout the process of creating the concepts.	Measures engagement as active participation in creative tasks, correlate with motivation, and affect both the process, results (Zielińska et al., 2024) and self-belief(Karwowski et al., 2019).
I felt in the flow during concept ideation.	Flow happens when challenges match a person's skills, leading to a focused and productive state that promotes creativity (Csikszentmihalyi, 1990).
My energy level was high throughout the process.	Measure their energy level along the creative process as according to Vaughan (1973) each stage of creative development requires progressively more energy. Furthermore, energy level affects cognitive efficiency and creativity (Csikszentmihalyi, 1988)
My knowledge on the problem increased throughout the process.	Problem exploration enhances understanding, key in co-evolution models of design creativity (Dorst & Cross, 2001).
Inspiration search	
It was easy to convey my needs and intentions when seeking inspirational materials.	Effective inspiration search relies on the ability to clearly define needs and intentions, which guides keyword selection and search strategies. This ensures the discovery of relevant stimuli that align with the problem or design goals (Gonçalves et al., 2013).
I found inspiration that was relevant to the problem or to my goal.	

Questionnaire Item	Reasoning
Specific to use of chatGPT (only 2nd experiment condition)	
Incorporating the use of chat GPT in my ideation process was intuitive.	Evaluates how ChatGPT supported creative workflows and whether participants found it a reliable, trustworthy and valuable addition to their process.
Communicating what I intended or wanted to the chatbot was easy.	
The chatbot provided suggestions that were relevant to the problem or to my goal.	
I felt confident sharing my ideas with the chatbot.	
I would recommend chat GPT as a useful tool for ideation process.	
To what extent do you feel using chat GPT impacted your creative process?	

TABLE 7: POST-IDEATION REFLECTION OPEN QUESTIONS USED FOR TRIANGULATION WITH QUANTITATIVE DATA.

Open-ended questions	Reasoning
Impact of chatGPT on creative process (only 2nd experiment condition)	
In which ways did Chat GPT supported your creative process?	Qualitative data for triangulation
In which ways did Chat GPT harmed your creative process?	

D. Interviews

A total of 25 students volunteered for interviews through their consent forms. An email invitation was sent with a link for them to schedule a 30-minute interview through Calendly. Ultimately, five participants booked interviews: one was conducted online via Teams, while the remaining four took place in person at the THUAS campus. The goal of the interviews was to gather in-depth qualitative data on their ideation approaches, experiences, and reflections. The interview transcripts were also analyzed as part of the overall data collection. The interview script can be found in the appendix.
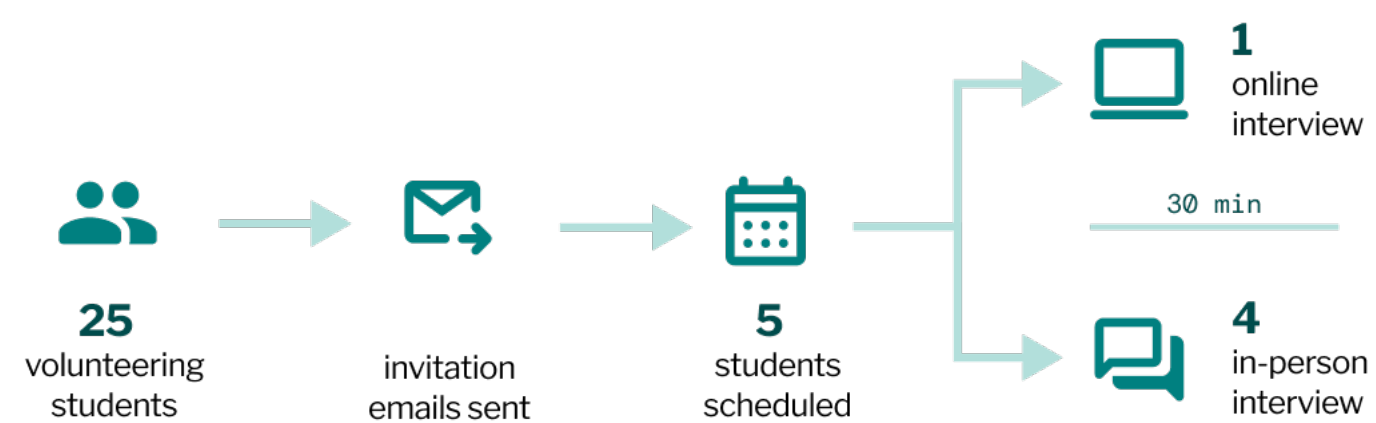

1 online interview

30 min

4 in-person interview

25 volunteering students

invitation emails sent

5 students scheduled

FIGURE 14: INTERVIEWS OVERVIEW. VOLUNTEERS STUDENTS THAT SELECTED A SLOT FOR A 30 MIN INTERVIEW, OF THE 5 INTERVIEWS, ONE WAS DONE ONLINE AND THE REST IN-PERSON.

3.3. Data Analysis

The study utilized both quantitative and qualitative analysis methods (Figure 15). For the quantitative analysis, two independent judges—experienced designers with five or more years of experience in UX design—blindly scored the concepts across different creativity dimensions, as defined by Dean et al. (2004). The scores were analyzed using SPSS to assess differences in creativity between concepts generated with and without the use of ChatGPT. The Likert scale responses from the pre-experiment and post-experiment questionnaires were also analyzed using SPSS to determine any significant changes in participants' perceptions of their creativity and ideation process across the two conditions.

To support these quantitative findings, we performed a qualitative analysis of open-ended questions, interview transcripts, and ChatGPT transcripts, focusing on themes related to the research questions. We used thematic coding to identify recurring themes and insights. We also conducted an Inter-rater Reliability (IRR) test to evaluate the consistency and agreement between the coding done by the primary author and a second researcher. Both coders independently analyzed and categorized the qualitative data based on the mapped codes and themes, ensuring the reliability of the qualitative findings. The coding scheme and validation process will be further detailed in a later section of this report.

By triangulating the quantitative and qualitative findings, we were able to form comprehensive understanding of ChatGPT's influence on the creative process. The analysis of the results with the theoretical framework on creativity allowed the formulation of recommendations on how designers can leverage ChatGPT's capabilities without detracting from their own creativity.

Triangulate results

Data collected	Quantitative analysis	Qualitative analysis	
pre-experiment questionnaire		Participants prior experience with chatGPT	
Filled Concept Templates	Concepts generated with no GenAI use. **VS** Concepts generated while ideating with chatGPT. *comparing creativity dimensions (novelty, relevance and clarity) measured and explicitly combined (Dean et al., 2006)		RQ2
Reflection questionnaire	Linkert scale ratings about the creative process (without AI) **VS** Linkert scale ratings about the creative process (with chat GPT)	Thematic analysis of open ended answers on the positive and negative effect of the use of chat GPT on creative process.	RQ1, RQ2, RQ3
Interview		Thematic analysis of interview transcripts	

RQ1: How do designers approach the ideation process and inspiration search when using ChatGPT compared to when not using it?

RQ2: How does the use of ChatGPT influence designers' creative confidence, exploration of problem and solution spaces, and the quality of their outcomes?

RQ3: How does the use of ChatGPT affect designers' critical appraisal of chat outputs and their own ideas?
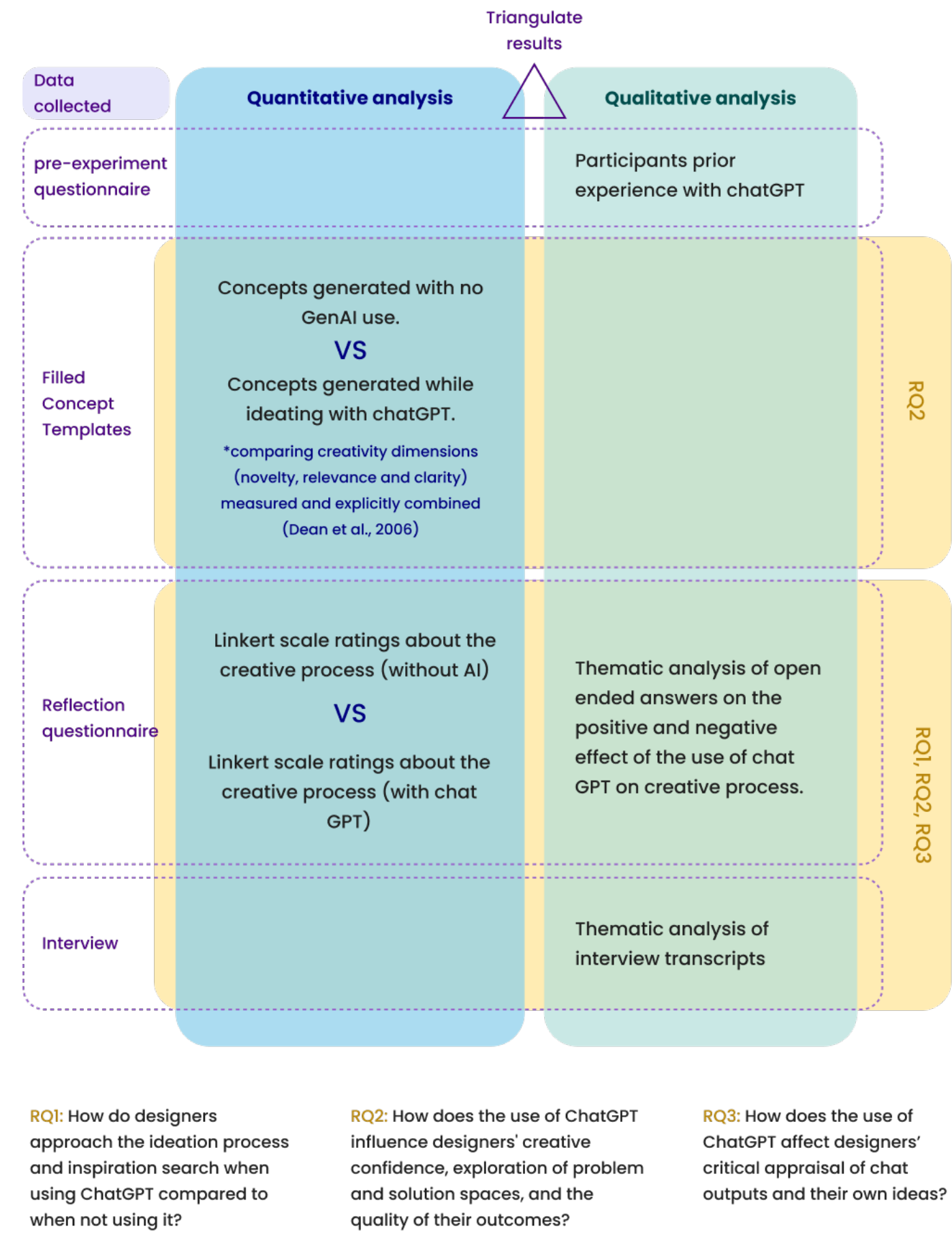
FIGURE 15: DATA ANALYSIS OVERVIEW PER RESEARCH QUESTION. COMPARISONS OF LIKERT SCALE SCORES AND THEMATIC ANALYSIS OF INTERVIEWS AND OPEN-ENDED RESPONSES ADDRESSED ALL RESEARCH QUESTIONS. ADDITIONALLY, FOR RQ2, WE SCORED AND COMPARED THE CREATIVITY OF DESIGN CONCEPTS BETWEEN CONDITIONS.

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ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   39

3.3.1. Quantitative analysis of design concepts creativity

To evaluate the quality of the design outcomes, two experts blindly assessed the concepts. The criteria for selecting these experts were: 1) they had to have, or be pursuing, a Master's degree, and 2) they needed at least five years of experience in UX design.

The evaluated creative dimensions were based on Dean et al. (2006) and included novelty, workability, relevance, and specificity, each with two sub-dimensions. Each dimension was evaluated separately and then combined for an overall score. However, only five dimensions were deemed relevant for this study (Figure 16), given that the design concepts were still in their initial stages. The students were not expected to provide detailed concepts, meaning that some sub-dimensions lacked enough information for proper evaluation. Therefore, the assessment focused on dimensions that allowed for the evaluation of diverse and creative ideas that were relevant to the design briefs, even at this early ideation stage.

FIGURE 16: CREATIVITY DIMENSIONS AND SUBDIMENSIONS (DEAN ET AL., 2006). THE FOLLOWING SUB-DIMENSIONS WERE MEASURED: ORIGINALITY, APPLICABILITY, EFFECTIVENESS AND CLARITY. FOR WORKABILITY WE DID NOT USE THE SUB-DIMENSIONS GIVEN THE EVALUATORS LIMITED FAMILIARITY WITH THE DESIGN BRIEF CONTEXTS.

We excluded **Paradigm Relatedness**, as it would require evaluators to have a deep understanding of each brief's context. Given that the evaluators' knowledge was based only on the design briefs, evaluating this dimension would not have been reliable. We also excluded Rarity, as it is time-consuming to assess, and our evaluators had a limited time available. However, Novelty, a key dimension in creativity, was still represented through the originality of the ideas.

We did not consider **Implementability** and **Acceptability** either, as it would have been difficult to assess how easily an idea could be implemented, or its social, legal, or political acceptance, without more detailed concepts. The evaluators, being unfamiliar with the specific context of the briefs, would also struggle to make these judgments. However, we retained Workability, as it provided a general measure that could be evaluated based on the constraints outlined in the design briefs.

Relevance to the brief was essential, even at this early stage. Therefore, it was evaluated the concepts' applicability and effectiveness—whether the ideas addressed the problem at hand and whether the ideas had the potential to solve it if developed further. These two sub-dimensions were combined to assess the overall relevance of the creative outputs, which also helped evaluate the effectiveness of using ChatGPT.

Some dimensions, such as **Completeness**, which focuses on later stages of refinement, were excluded as they were not applicable to this early ideation phase. Similarly, **Implicational Explicitness**, which requires critical thinking and detailed cause-and-effect reasoning, was not suitable for this stage. However, we did include **Clarity**, as early-stage ideas still need to be communicated clearly enough to be understood and evaluated, and this was particularly relevant in exploring ChatGPT's text generation capabilities.

A. Evaluation set-up

As a preparatory step for the analysis of the design concepts by the two independent experts, the concepts were organized by design brief, with all personal information removed. We created a Google Form for each brief so that the evaluators could focus on one brief at a time. Additionally, we developed a Figma prototype with instructions, links to the brief, and concept cards that displayed each concept's design challenge, description, and accompanying image. This allowed evaluators to easily toggle between the form and the concepts (see Figure 17).
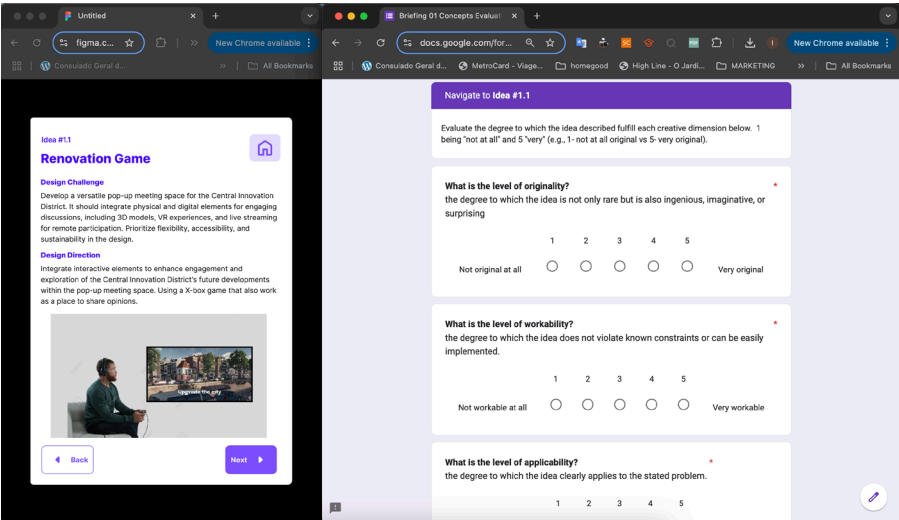

FIGURE 17: EVALUATOR COMPUTER SET-UP. EVALUATORS SAW IMAGE, DESCRIPTION OF DESIGN CHALLENGE AND DESIGN DIRECTION OF THE IDEA BEING EVALUATED NEXT TO THE ONLINE FORM.

Before starting the evaluations, the experts were briefed on the different creativity dimensions and instructed to focus exclusively on each dimension individually while scoring. They were also told to focus on the design descriptions rather than the images, as the latter varied in refinement (Figure 18). Each evaluator completed one brief's evaluation in person with the researcher to clarify any questions. Given the time-intensive nature of the task, the evaluators were allowed to work at their own pace over three weeks. A total of 214 concepts were evaluated across six different briefs (see Table 8).
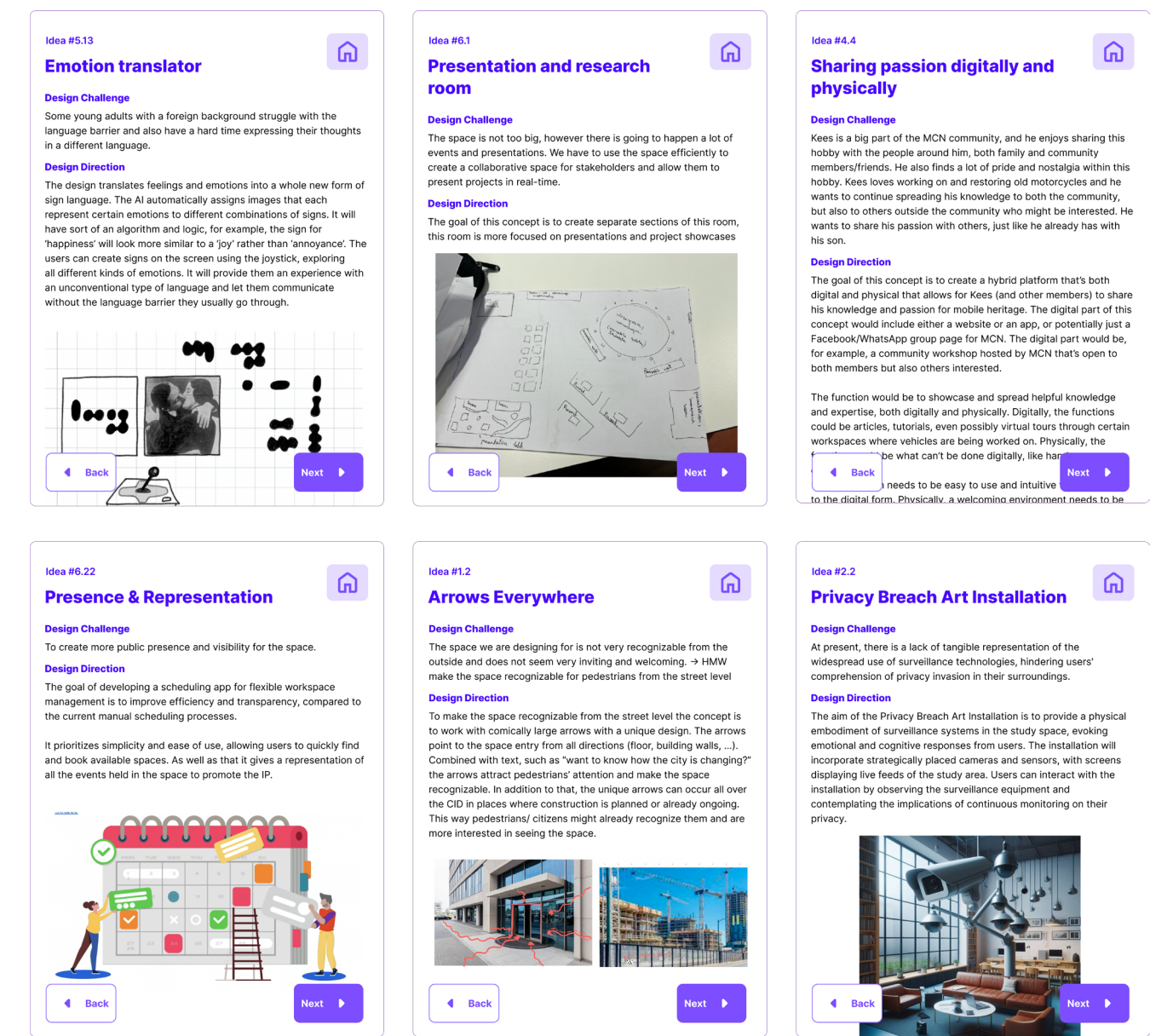
FIGURE 18: A SAMPLE OF THE VARIED REFINEMENT OF IMAGES AND CONCEPT DESCRIPTIONS. STUDENTS' CONCEPTS VARIED FROM VERY LONG DESCRIPTIONS, TO ONE SENTENCES AND IMAGES ILLUSTRATING THEM INCLUDED PAPER AND DIGITAL SKETCHES, GOOGLED ILLUSTRATIONS AND IMAGES, AS WELL AS AI GENERATED ONES.

TABLE 8: OVERVIEW OF PARTICIPANTS AND CONCEPTS PER DESIGN BRIEF. A TOTAL OF 214 CONCEPTS WERE EVALUATED, OF WHICH HALF WERE IDEATED IN EACH OF THE EXPERIMENT CONDITIONS.

Brief number and title	Participants	Concepts
Brief 1: A citizens' assembly space for the future	7	42
Brief 2: Classroom Datafictions	11	70
Brief 3: Physical Framework for Visually Presenting Local Data	3	18
Brief 4: Focusing on the experiential knowledge of amateurs, club members, and volunteers in mobile heritage communities	6	36
Brief 5: Taalexplorium - new times need new languages; the library as playground for inventing new ways of expression through language	4	24
Brief 6: experience centre in the innovation playground - Paris Proof Camp	4	24
Total	35	214

The experts followed the same procedure for each evaluation (see Figure 19). They began by selecting one brief at a time to review. First, they read the design brief provided to the students. Next, they split their screen between the prototype containing the design concepts and the corresponding online evaluation form. This setup allowed them to view and assess each concept sequentially, in the same order they were presented. This process was repeated for each brief and its associated concepts until all evaluations were completed.
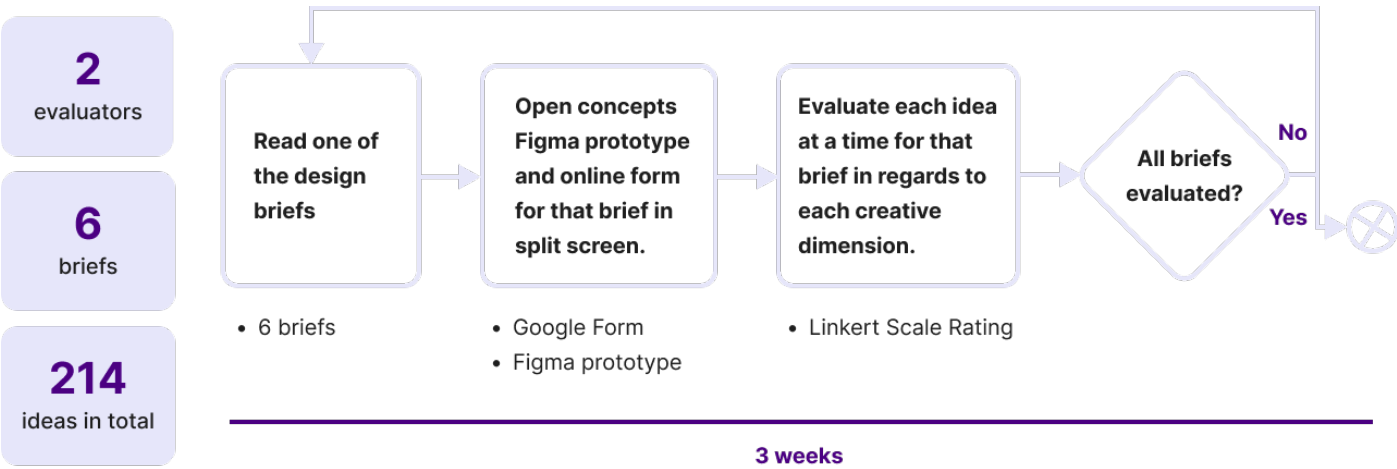

FIGURE 19: CONCEPT EVALUATION PROCEDURE. EVALUATORS FOCUSED ON CONCEPTS RELATED ONE BRIEF AT A TIME, READING SAME BRIEF GIVEN TO THE STUDENTS, AND THEN RATING EACH CONCEPT IN RELATION TO EACH CREATIVE DIMENSION.

B. Statistical analysis

The evaluator's ratings were analyzed using SPSS. Since the different dimensions had to be explicitly combined to measure creativity, we first conducted a reliability test to assess consistency between items within each evaluators' ratings. Evaluator 2 had a Cronbach's alpha of 0.684, while Evaluator 1 had 0.718, with the acceptable threshold set at 0.7. After removing the Workability dimension, the reliability scores increased to 0.770 for Evaluator 1 and 0.734 for Evaluator 2. Given the initial concern about the ability to rate Workability sub-dimensions and feedback from the evaluators regarding its difficulty, especially due to the lack of detail in some concepts, we decided to exclude this dimension from further analysis.

Next, we calculated an overall creativity score by combining the evaluators' ratings and conducted another reliability test. When Applicability and Effectiveness were combined into a single Relevance score, the Cronbach's alpha was 0.614, which is below the acceptable threshold (0.7). However, when we considered the sub-dimensions Novelty, Applicability, Effectiveness, and Clarity separately, the Cronbach's alpha increased to 0.786, an acceptable level. This improvement indicates that separating these components provides a more reliable and consistent measure. Thus, we explicitly combined these four sub-dimensions and computed the mean to calculate the overall creativity score for the different design directions.

The next step involved comparing the creativity scores of designs ideated with and without ChatGPT. A normality test (Shapiro-Wilk) was conducted on the computed creativity scores, which returned a significant non-normality of the data distribution (Sig < 0.001). Therefore, we used the non-parametric Wilcoxon Signed-Rank Test to analyze the differences between the two conditions.

Since each participant produced three concepts per condition, we first conducted the test by comparing individual ideas, without consolidating the scores by participant. Later, we calculated the mean score per participant for each condition, allowing us to analyze the impact of ChatGPT on the overall creative performance of participants. In both cases, we analyzed the data in across the entire sample and by individual brief. The results of these analyses are detailed in the next section.

3.3.2. Quantitative comparison of reflection results

The reflection rating on the creative confidence section was quantitively analyzed, comparing ratings from the two experiment conditions (with and without the use of ChatGPT). In the case of creative confidence, we also compared each experiment condition results with the pre-experiment creative confidence ratings, to check if it the impact only happens when using chat GPT, or while ideating in general.

A normality test was performed on the computed difference between questions ratings from part 1 and 2. All questions had a Sig <0.05 in the Shapiro-Wilk, so data was not normally distributed (Table N). Consequently a a non parametric test was selected, and the Wilcoxon Signed-Rank Test was performed for each question. The analysis results will be detailed in the results section. We also considered the ratings that were exclusively related to the use of chat GPT to gather more context on their experience with the tool.

TABLE 9: NORMALITY TEST (SHAPIRO-WILK) RESULTS. NONE OF THE STATEMENTS WAS NORMALLY DISTRIBUTED, HENCE A NON-PARAMETRIC TEST (WILCOXON SIGNED-RANK) WAS USED TO COMPARE CONDITION RESULTS.

Questionnaire Item	Sig
The ideation process stimulated creative thinking.	0.005
I generated a lot of ideas.	0.005
I explored unconventional design inspirations.	0.002
I approached the problem and ideas from multiple perspectives.	0.010
The ideation resulted in the development of useful concepts.	0.007
The ideation resulted in the development of novel concepts.	<0.001
I thoroughly re-examined and challenged my own ideas.	0.022
I found it easy to evaluate and critique my ideas effectively.	<0.001
I feel confident with my design choices.	0.005
I am confident I came up with a creative ideas to solve my design challenge for PS1.	<0.001
I felt engaged throughout the process of creating the concepts.	0.009
I felt in the flow during concept ideation.	0.005
My energy level was high throughout the process.	0.028
My knowledge on the problem increased throughout the process.	0.013
It was easy to convey my needs and intentions when seeking inspirational materials.	0.006
I found inspiration that was relevant to the problem or to my goal.	0.037

3.3.3. (Qualitative) thematic analysis of interviews and open-ended questions

We conducted a thematic analysis of the interviews and open-ended responses using Atlas.ti. A deductive coding approach (Atlas.ti, 2024) was employed, guided by pre-defined codes (Table 10-12) derived from the themes present in the research questions and reflection questionnaires. This alignment with the research questionnaires allowed for clearer triangulation between qualitative and quantitative data and alignment with research questions.

TABLE 10: PRE-DEFINED CATEGORIES FOR RESEARCH QUESTION 1. THE FINAL THEMES ARE DETAILED IN THE RESULTS SECTION.

RQ1: How do designers approach the ideation process and inspiration search when using ChatGPT?		
Research question concepts/topics	**Categories**	**Description**
Creative process	Creative approach	Captures how designers integrate ChatGPT into their creative ideation, focusing on strategies like combining existing ideas, generating new concepts, or using ChatGPT for inspiration.
	Creative thinking	Evaluates how the use of ChatGPT influenced the designer's creative process, either by enhancing their thinking or by imposing limitations.
	ChatGPT (mis)fit within ideation process	Evaluates how the use of ChatGPT influenced the designer's creative process, either by enhancing their thinking or by imposing limitations.
Inspiration seeking	Inspiration search approach	Explores the different ways designers approached ChatGPT for inspiration, focusing on methods such as searching for abstract ideas or seeking out specific concepts.
	Inspiration search ease	Explores the different ways designers approached ChatGPT for inspiration, focusing on methods such as searching for abstract ideas or seeking out specific concepts.
	Search output format	Designers found that the outputs generated by ChatGPT sometimes failed to fully address their search goals or design intentions, leaving gaps to fill.

TABLE 11: PRE-DEFINED CATEGORIES FOR RESEARCH QUESTION 2. THE FINAL THEMES ARE DETAILED IN THE RESULTS SECTION.

RQ2: How does the use of ChatGPT influence designers' creative confidence, exploration of problem and solution spaces, and the quality of their outcomes?		
Research question concepts/topics	**Categories**	**Description**
Problem and solution space exploration	Fluency	Refers to the total number of ideas produced with ChatGPT during the ideation process, emphasizing both volume and variety.
	Flexibility	Describes how well ChatGPT was able to provide a range of ideas from different perspectives, supporting designers in exploring diverse creative directions.
	Knowledge on the problem	Explores how interacting with ChatGPT expanded or enhanced the designer's understanding of the design problem and its potential solutions.
Inspiration seeking	Creative outcome throughness	Explores the different ways designers approached ChatGPT for inspiration, focusing on methods such as searching for abstract ideas or seeking out specific concepts.
	ChatGPT output novelty	Considers the originality of the idea, emphasizing its uniqueness and whether it represents a new, unexpressed concept.
	ChatGPT output relevance	Evaluates how well the suggestions from ChatGPT align with the designer's original objectives or design goals.
Creative confidence and engagement	Creative confidence, ownership and pride	Explores the level of pride and personal connection designers feel toward ideas generated with ChatGPT, particularly in terms of how creative they perceive the outcome to be.
	Engagement in the creative process	Examines how engaged the designer remained in the creative process while using ChatGPT, particularly whether the tool enhanced or reduced their active involvement.
	Energy level	Explores how the designer's energy level influenced and was influenced by engagement with ChatGPT, particularly in terms of relying on the tool to streamline ideation.

RQ3: How does the use of ChatGPT affect designers' critical appraisal of chat outputs and their ideas?		
Research question concepts/topics	**Categories**	**Description**
Critical appraisal in relation to ideas, chatGPT and its output.	Context impact critical appraisal	Reflects how the specific project context or the nature of the interaction with ChatGPT shaped the designer's level of critical evaluation of its output and suggestions.
	Personal attitude to the use of chat GPT	Captures the designer's personal feelings, preferences, and attitudes toward using ChatGPT in their creative process. and how these attitudes influence their overall engagement with and reliance on the tool.
	Human-like and matter-of-fact language	Designers commented on the tone of their exchanges with ChatGPT noting how that influenced their engagement with the output.
	Trust and critical appraisal	Indicated a level of distrust and critical appraisal through action taken

During a first cycle of coding, we analyzed the qualitative data based on these pre-defined categories identifying quotes that corresponded to these themes. We also introduced new categories when insights relevant to the research questions or interpretation of results that did not fit within any of the pre-mapped categories.

In a second cycle, I reviewed the quotes and refined the analysis by splitting the categories into sub-codes based on the themes present, and reviewing the naming for codes, categories and themes for clarity. I performed a last review of the different themes and categories, refining the themes, splitting, or combining them as needed, to best represent the data insights.

Subsequently, I organized the themes by research question and wrote definitions for all categories and codes. We provided in an Atlas.ti file the list of codes along the data—open-ended responses from the questionnaires and two of the five interviews—to a second coder without any pre-defined quotes, allowing the coder to independently define the quotes based on the provided list of codes. The second coder was also instructed that multiple codes could be assigned to a single quote.

We performed an inter-rater reliability test using Krippendorff's alpha (c-a-binary) as the metric, which resulted in an initial alpha of 0.714, indicating moderate agreement. Upon comparing the codings, I noticed some overlapping themes. After merging these overlaps and aligning on minor disagreements, we recalculated the inter-rater reliability test, resulting in an improved Krippendorff's alpha of 0.812.This validation process helped ensure the reliability of the coding and the robustness of the qualitative findings. The themes are detailed in the Results section of this report, and a complete list of codes, categories, and themes can be found in the Appendix.
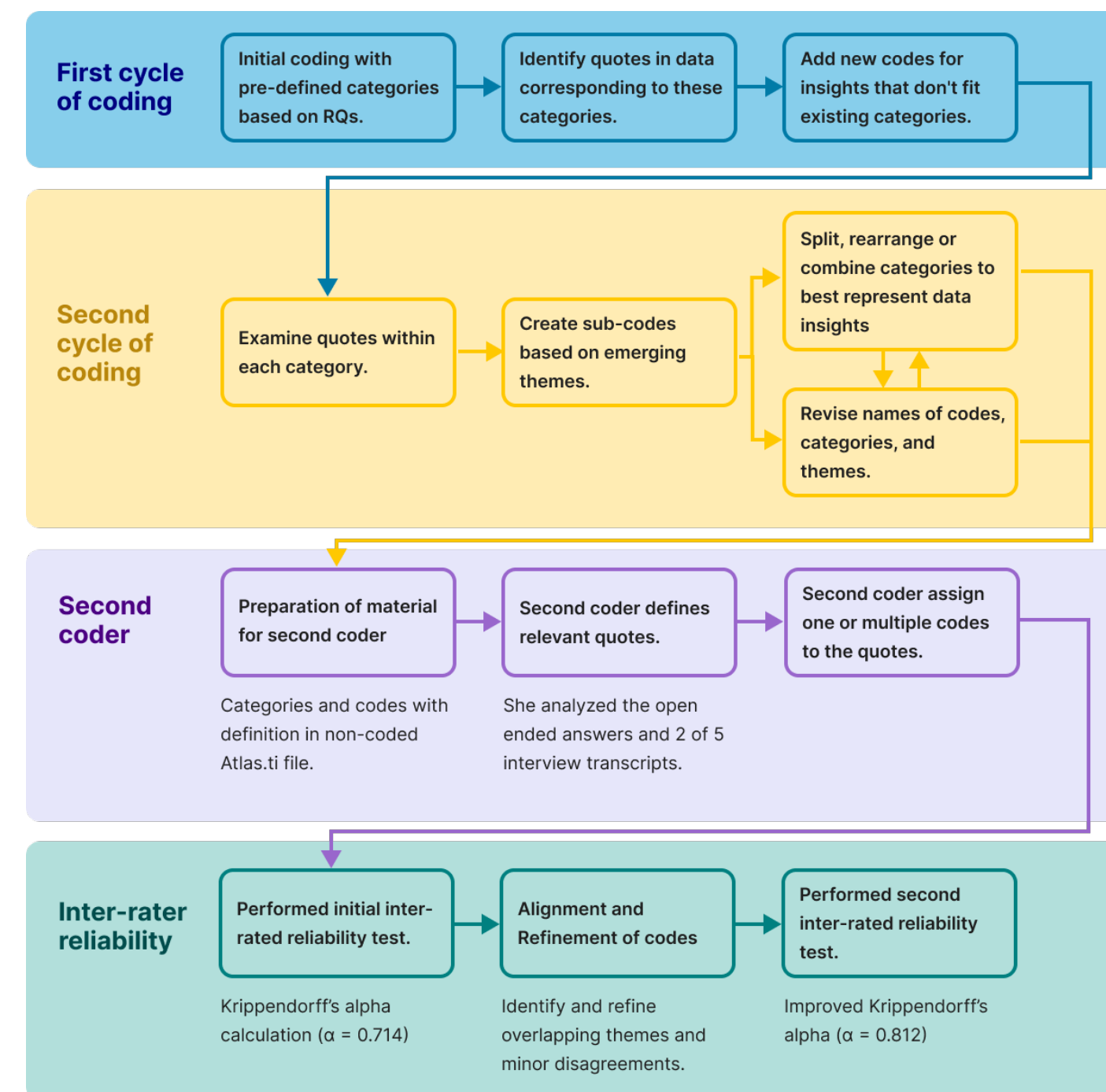

FIGURE 20: OVERVIEW OF THEMATIC ANALYSIS PROCESS.

3.4. Results

3.4.1. Pre-experiment

Within the pre-experiment questionnaire, participants were asked about their use of ChatGPT. This provided a baseline understanding of their familiarity and prior experience with the tool, which could influence their approach during the experiment. Additionally, it offered insights into how ChatGPT is being used outside the research context.

Participants were asked about their recent use of ChatGPT. 94.7% had used ChatGPT in the month prior to the experiment, with 54.3% using it at least once or several times a week. Figure 20 illustrates the frequency of ChatGPT use before the experiment.

● I haven't used it: 2 (5.7%) ● A couple of days in the month: 12 (34.3%) ● At least once a week: 7 (20%) [N 35]

● Several times a week: 12 (34.3%) ● Everyday in the last month: 2 (5.7%)
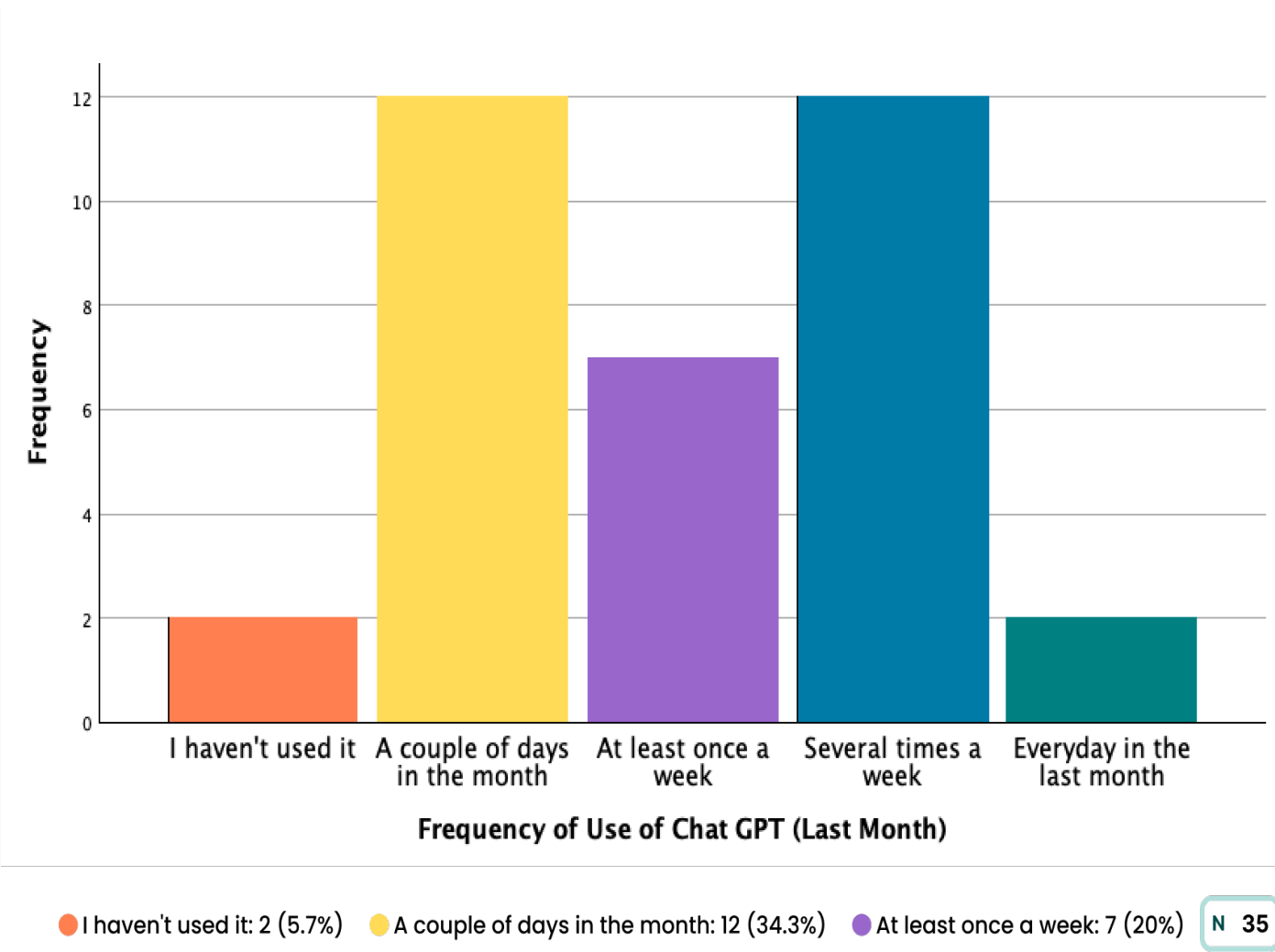
FIGURE 20: FREQUENCY OF USE OF CHAT GPT IN THE MONTH PRIOR TO THE EXPERIMENT. 94% OF PARTICIPANTS HAD USED CHATGPT IN THE PREVIOUS MONTH.

Participants also rated their proficiency in using ChatGPT on a scale from novice to advanced:

- **Novice:** Unfamiliar with its functionalities for ideation.
- **Inexperienced:** Aware of its uses but rarely applied.
- **Intermediate:** Some experience using it in creative workflows.
- **Experienced:** Comfortable leveraging its capabilities.
- **Advanced:** Regular use in creative workflows, exploring many features.

The majority of participants (51.4%) rated themselves as intermediate, 34.3% as experienced, and 14.3% as inexperienced, indicating that most participants were somewhat confident using ChatGPT for creative purposes. Figure 21 displays proficiency frequency.

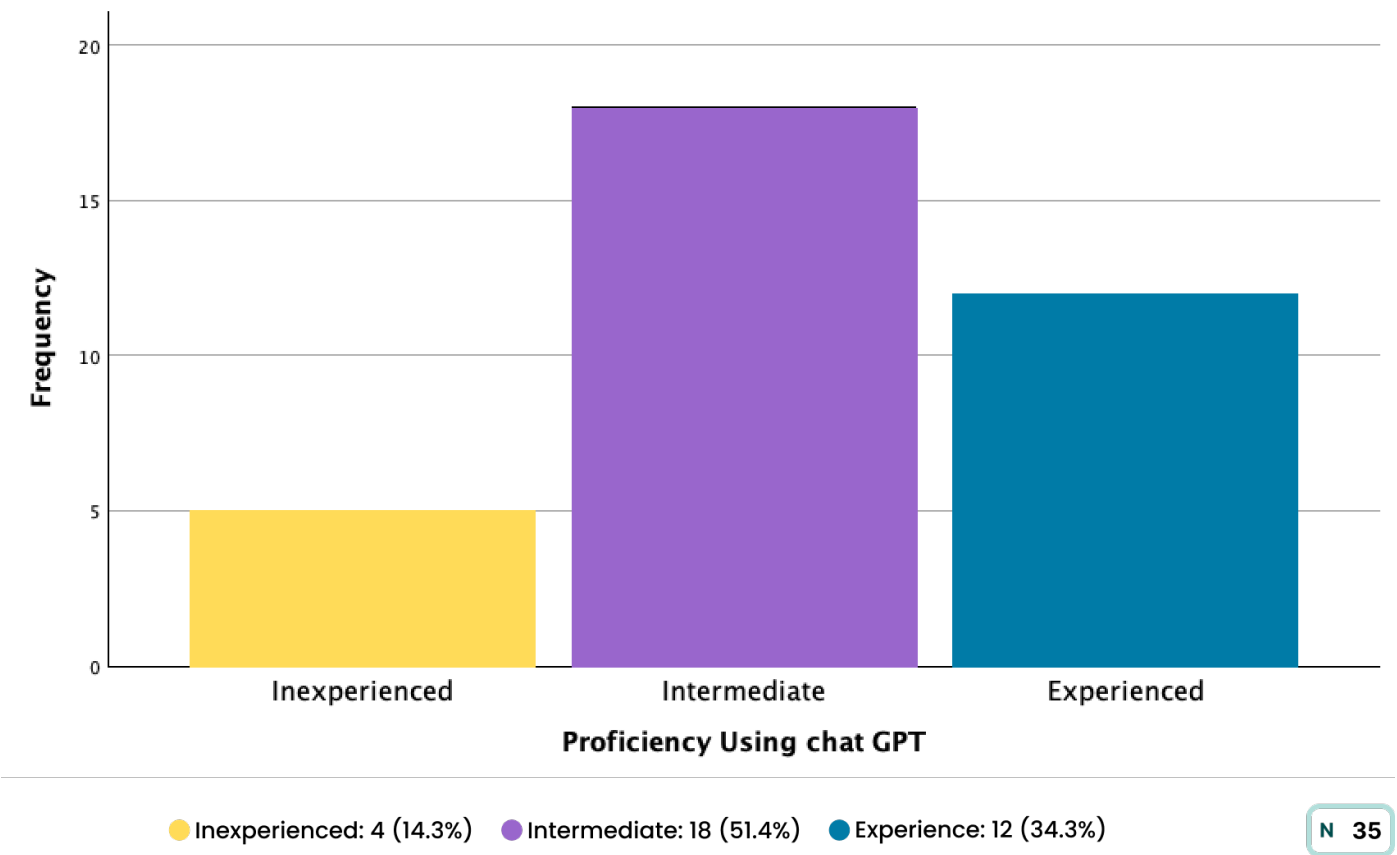● Inexperienced: 4 (14.3%) ● Intermediate: 18 (51.4%) ● Experience: 12 (34.3%) [N 35]

FIGURE 21: FREQUENCY OF PROFICIENCY LEVEL WITH CHAT GPT. ALL PARTICIPANTS HAVE SOME KNOWLEDGE ON USING CHATGPT, WITH ONLY 14.3% CONSIDERING THEMSELVES INEXPERIENCED (KNOW CHATGPT'S POTENTIAL USES, BUT RARELY APPLIED IT IN PRACTICE, ESPECIALLY FOR IDEATION.

In addition to proficiency, participants were also asked how they used ChatGPT in their ideation process. The most common use (62.9%) was for generating initial ideas or brainstorming, followed by 57.1% using it for content creation (text, design, or code). Over 40% indicated that they used it to overcome creative blocks, explore concepts without a specific project, or conduct research. Fewer participants used it for obtaining feedback (28.6%) or learning new skills (14.3%). Figure 22 provides an overview of the prior usage of ChatGPT by participants.

50   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   51
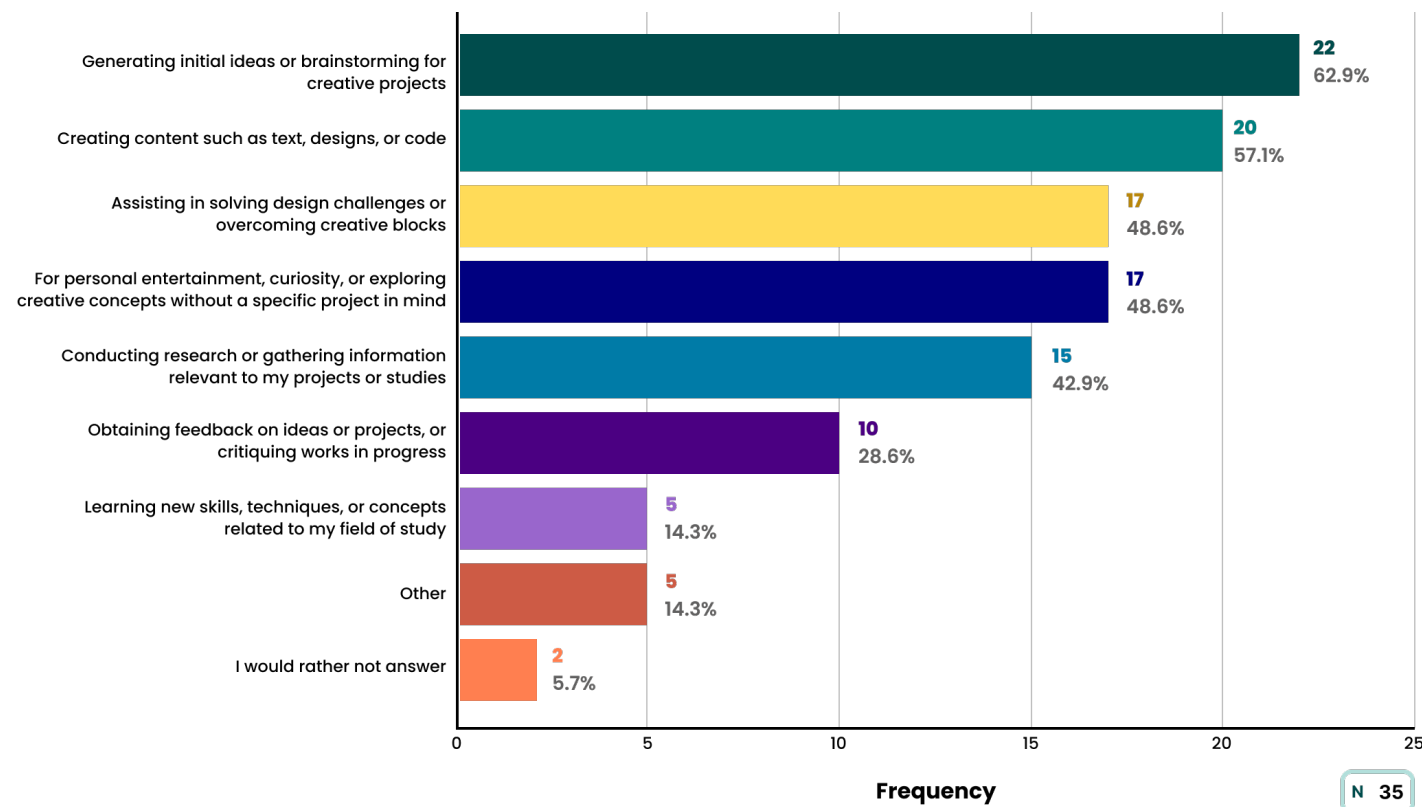
FIGURE 22: FREQUENCY OF WAYS PARTICIPANTS USED CHATGPT WITHIN IDEATION PRIOR TO EXPERIMENT.
MAIN USE INCLUDED THE GENERATION OF IDEAS, TEXT AND DESIGN CONTENT, AND HELPING TO KICKSTART IDEATION OR OVERCOME CREATIVE BLOCKS.

3.4.2. Design concepts creativity

A Wilcoxon Signed-Rank Test was conducted to compare design concepts creativity scores ideated without GenAI and those generated using chatGPT, Table 13 show the results. The test revealed no statistically significant difference $(Z=-0.281, p=.779)$. However, the sum of ranks for negative differences (sum of ranks = 2606.50) was slightly higher than for positive differences (sum of ranks= 2443.50), suggesting a weak, non-significant tendency for creativity scores to be higher in the first condition when no GenAI was used. There were 50 positive ranks, 50 negative ranks, and 7 ties.

TABLE 13: WILCOXON SIGNED-RANK RESULTS FOR COMPARING CONCEPTS CREATIVITY BETWEEN EXPERIMENT CONDITION.
TEST SHOWS POSITIVE TREND WITH NO STATISTICAL SIGNIFICANCE IN CONCEPTS CREATIVITY OF CONCEPTS CREATED WHEN USING CHATGPT IN COMPARISON WITH NO GEN AI USE.

	N	Asymp. Sig (2-tailed	Z	Negative Ranks (a)	Ties	Positive Ranks (b)	Sum of Ranks (a X b)
Concepts creativity comparison between experiment conditions.	107	.779	-.281	50	7	50	(a) 2564.5 (b) 2385.5

*b. based on positive ranks

We also analyzed if there was any creativity difference between conditions across the six different briefs, the results are summarized in Table 11. A statistically significant difference was observed only for Brief 3

$(p = .050)$, where concepts creativity scores when using chatGPT outperformed creativity scores for the first experiment condition, when no genAI was used. For the remaining briefs, no significant differences were found $(p > .05)$, though tendencies varied: Briefs 1, 4 and 5 suggested higher creativity scores for the first experimental condition (no GenAI use) while Briefs 3 and 6 showed a tendency for higher creativity scores on second condition (using chatGPT).

TABLE 14: WILCOXON SIGNED-RANK RESULTS FOR COMPARING CONCEPTS CREATIVITY PER BRIEF BETWEEN EXPERIMENT CONDITIONS.
ONLY BRIEF 3 SHOWED POSITIVE STATISTICAL TENDENCY IN CREATIVITY IN THE CONCEPTS CREATED WHEN USING CHATGPT VS WITH NO GEN AI USE.

Brief	N	Asymp. Sig (2-tailed	Z	Negative Ranks (a)	Positive Ranks (b)	Sum of Ranks (a X b)
Brief 1: A citizens' assembly space for the future	20	.747	-.323[b]	10	9	103.0 X 87.0
Brief 2: Classroom Datafictions	33	.948	-.065[b]	15	14	214.5 X 220.5
Brief 3: Physical Framework for Visually Presenting Local Data	12	.050	-1.958[b]	3	8	11.0 X 55.0
Brief 4: Focusing on the experiential knowledge of amateurs, club members, and volunteers in mobile heritage communities	18	.097	-1.659[b]	11	6	111.5 X 41.5
Brief 5: Taalexplorium - new times need new languages; the library as playground for inventing new ways of expression through language	12	.099	-1.647[b]	8	4	60.0 X 18.0
Brief 6: experience centre in the innovation playground - Paris Proof Camp	12	.146	-1.453[b]	3	9	20.5 X 57.5

*b. based on positive ranks   ☐ ideation with chatGPT < ideation with no GenAI   ☐ ideation with chatGPT > ideation with no GenAI

52   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   53

We also wanted to check the impact on the individual creativity of the designers. Therefore, a Wilcoxon Signed-Rank Test was conducted to compare participant's mean creativity scores generated within each experiment condition (ideating without using GenAI versus using chatGPT), results are shown in Table 15. The test revealed no statistically significant difference between the two conditions (Z=−0.418, p=.676). Descriptive results showed 19 negative ranks (sum of ranks = 340.50) and 16 positive ranks (sum of ranks = 289.50), with no ties. These results suggest a weak, non-significant tendency for creativity scores to be higher in the first condition when no GenAI was used.

	N	Asymp. Sig (2-tailed	Z	Negative Ranks (a)	Ties	Positive Ranks (b)	Sum of Ranks (a X b)
Participant's mean creativity score between experiment conditions.	35	.676	-.418	19	0	16	(a) 340.5 (b) 289.5

*b. based on positive ranks

TABLE 15: WILCOXON SIGNED-RANK RESULTS FOR COMPARING PARTICIPANT'S CREATIVITY MEAN SCORE BETWEEN EXPERIMENT CONDITION. RESULT SUGGEST THERE IS NO STATISTICAL SIGNIFICANT DIFFERENCE BETWEEN CONDITIONS.

We also analyzed whether there were participant's mean creativity differences between conditions across the six different briefs. The results are summarized in Table 13. A statistically significant difference was observed for Brief 4 (p=.028), where participant's mean creativity score for the first experimental condition (no GenAI use) outperformed those for the second condition (using chatGPT). For the remaining briefs, no significant differences were found (p>.05), though tendencies varied: Briefs 1 and 2 showed a slight trend favoring the first experimental condition, while Briefs 3, 5, and 6 suggested higher overall creativity scores when using chatGPT.

TABLE 16: WILCOXON SIGNED-RANK RESULTS FOR COMPARING PARTICIPANT'S CREATIVITY MEAN SCORE PER BRIEF BETWEEN EXPERIMENT CONDITIONS. TEST SHOWS POSITIVE TREND WITH NO STATISTICAL SIGNIFICANCE IN PARTICIPANT'S MEAN CREATIVITY WHEN USING CHATGPT IN COMPARISON WITH NO GEN AI USE.

Concepts creativity comparison between experiment conditions.	N	Asymp. Sig (2-tailed	Z	Negative Ranks (a)	Ties	Positive Ranks (b)	Sum of Ranks (a X b)
Brief 1: A citizens' assembly space for the future	7	.612	-.507[b]	3	0	4	(a) 17.00 (b) 11.00
Brief 2: Classroom Datafictions	11	.623	-.491[b]	7	0	4	(a) 38.50 (b) 27.50
Brief 3: Physical Framework for Visually Presenting Local Data	3	.109	-1.604[b]	0	0	3	(a) .00 (b) 6.00
Brief 4: Focusing on the experiential knowledge of amateurs, club members, and volunteers in mobile heritage communities	6	.028	-2.201[b]	6	0	0	(a) 21.00 (b) .00
Brief 5: Taalexplorium - new times need new languages; the library as playground for inventing new ways of expression through language	4	.273	-1.095[b]	3	0	1	(a) 8.00 (b) 2.00
Brief 6: experience centre in the innovation playground - Paris Proof Camp	4	.0.68	-1.826[b]	0	0	4	(a).00 (b) 10.00

*b. based on positive ranks   ☐ ideation with chatGPT < ideation with no GenAI   ☐ ideation with chatGPT > ideation with no GenAI

3.4.3.   Experiment Conditions questionnaires results comparison

The purpose of the online questionnaires was to evaluate participants' experiences under the two experimental conditions. Specifically, we aimed to determine how the use of ChatGPT influenced students' perceptions of the creative process by analyzing differences in responses to Likert scale statements common to both conditions. Additionally, user perceptions of ChatGPT were explored through Likert scale statements specific to the second condition. This section presents the results of the descriptive statistics and Wilcoxon signed-rank tests conducted for the questionnaire items corresponding to each research question.

54   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   55

RQ1 (How do designers approach the ideation process and inspiration search with ChatGPT's assistance?) was assessed based on the comparison of results of two statements present in both conditions and three statements that were specific to the use of chatGPT.

The results of the Wilcoxon signed-rank test (Table 14) indicate a negative non statistically significant difference between the two experiment conditions in their ability to articulate needs (Z = -0.766, p = 0.444) or find relevant inspiration (Z = -1.103, p = 0.270). These results indicate there was no significant difference in the perception of the ease and effectiveness in the inspiration seeking between conditions only a weak tendency for ratings to be higher when using not using genAI .

TABLE 17: WILCOXON SIGNED-RANK RESULTS FOR COMPARING PARTICIPANT'S LINKERT SCALE RATINGS BETWEEN EXPERIMENT CONDITIONS RELATED TO RQ1. A NEGATIVE TREND IS OBSERVED WITH NO STATISTICAL SIGNIFICANCE.

Linkert scale statement rated in both conditions.	N	Asymp. Sig (2-tailed)	Z	Negative Ranks (a)	Ties	Positive Ranks (b)	Sum of Ranks (a X b)
I found inspiration that was relevant to the problem or to my goal.	35	.270	-1.103[b]	18	7	10	(a)249.50 (b) 156.50
It was easy to convey my needs and intentions when seeking inspirational materials.	35	.444	-.766[b]	15	8	12	(a) 219.00 (b)159.00

*b. based on positive ranks

Participants also evaluated ChatGPT's performance on three key aspects: the intuitiveness of incorporating it into the ideation process, communication effectiveness, and the relevance of its suggestions. While nearly half of the participants provided positive ratings, a substantial portion expressed neutral or negative responses, resulting in a median of 3.0 for all statements. This neutral central tendency suggests that in average ChatGPT was neither perceived as clearly advantageous nor disadvantageous for inspiration seeking and ideation. However, the standard deviations (1.039, 1.078, and 0.910) reveal variability in participant experiences, indicating that while some found ChatGPT effective, others encountered challenges. Despite these results, the ratings when asked about the usefulness of chatGPT as a tool for the ideation process indicate a more positive attitude with a median of 4.0 and only 3 participants (8.6%) rating it negatively. Detailed results are presented in Table 15.

TABLE 15: MEDIANS AND FREQUENCY FOR LINKERT SCALE STATEMENTS ASSOCIATED TO RQ1 THAT ARE EXCLUSIVELY TO THE SECOND EXPERIMENT CONDITION. PARTICIPANTS WERE IN MAJORITY POSITIVE, HOWEVER THERE WAS SUBSTANTIAL NEUTRAL AND DISAGREEMENT RATINGS, WHICH IS IN LINE WITH THE NEUTRAL MEDIAN AND MODERATE STANDARD DEVIATION.

Linkert scale statement exclusive to chatGPT use (2nd experiment condition)	N	Median	Std. Deviation (No GenAI)	Agree/ Strongly Agree	Undecided	Disagree/ Strongly Disagree
Communicating what I intended or wanted to the chatbot was easy.	35	3.0	1.078	17 (48.6%)	11 (31.4%)	7 (20.0%)
Incorporating the use of chatGPT in my ideation process was intuitive.	35	3.0	1.039	16 (45.7%)	11 (31.4%)	8 (22.8%)
The chatbot provided suggestions that were relevant to the problem or to my goal.	35	3.0	.910	16 (45.7%)	10 (28.6%)	9 (25.8%)
I would recommend chat GPT as a useful tool for ideation process.	35	4.0	1.027	18 (51.4%)	14 (40.0%)	3 (8.6%)

☐ Negative central tendency ☐ Positive central tendency ☐ Neutral central tendency

RQ2 (How does the use of ChatGPT influence designers' creative confidence, exploration of problem and solution space, and the quality of their outcomes?) was assessed based on the comparison of results of statements rated for both experiment conditions related to relevant themes to this RQ : creative exploration, quality of creative outputs, creative engagement and creative confidence.

The results associated with participant's creative exploration and perceived (Table 16) indicate a decrease in problem space exploration when using chatGPT, since ratings for the statement " My knowledge on the problem increased throughout the process" were significantly worst in this experiment condition. Furthermore, participants perceived their creative outcome ideated with the aid of chatGPT as significantly less useful. All other statements for both themes show a similar negative tendency, however they are not statistically significant.

56   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   57

Linkert scale statements	N	Asymp. Sig (2-tailed)	Z	Negative Ranks (a)	Ties	Positive Ranks (b)	Sum of Ranks (a X b)
Problem and solution space exploration							
My knowledge on the problem increased throughout the process.	35	.029	-2.182[b]	17	13	5	(a) 191.50 (b)61.50
I generated a lot of ideas.	35	.167	-1.382[b]	17	6	12	(a) 277.50 (b) 157.50
I approached the problem and ideas from multiple perspectives.	35	.648	-.456[b]	13	11	11	(a) 165.00 (b)135.00
I explored unconventional design inspirations.	35	.722	-.356[b]	15	10	10	(a) 175.00 (b)150.00
Quality of outputs							
The ideation resulted in the development of useful concepts.	35	.003	-2.976[b]	18	12	5	(a) 231.00 (b)45.00
The ideation resulted in the development of novel concepts.	35	.103	-1.631[b]	11	20	4	(a) 87.00 (b)33.00

*b. based on positive ranks   ☐ ideation with chatGPT < ideation with no GenAI   ☐ ideation with chatGPT > ideation with no GenAI

Linkert scale statements	N	Asymp. Sig (2-tailed)	Z	Negative Ranks (a)	Ties	Positive Ranks (b)	Sum of Ranks (a X b)
Creative engagement							
The ideation process stimulated creative thinking.	35	<.001	-3.615[b]	22	9	4	(a) 311.00 (b)40.00
I felt in the flow during concept ideation.	35	<.001	-3.345[b]	19	14	2	(a) 209.50 (b) 21.50
My energy level was high throughout the process.	35	.003	-2.974[b]	19	11	5	(a) 251.00 (b) 49.00
I felt engaged throughout the process of creating the concepts.	35	.025	-2.249[b]	17	11	7	(a) 226.50 (b) 73.50
Creative Confidence							
I feel confident with my design choices.	35	.036	-2.097[b]	16	13	6	(a) 189.00 (b) 64.00
I am confident I came up with a creative ideas to solve my design challenge for PS1.	35	.021	-2.301[b]	11	21	3	(a) 88.50 (b) 16.50

*b. based on positive ranks   ☐ ideation with chatGPT < ideation with no GenAI   ☐ ideation with chatGPT > ideation with no GenAI

Furthermore, RQ2 results indicate that creative engagement and creative confident are the two aspects that seemed to have been significantly harmed when participants used ChatGPT. Specifically, there was a decline in creative thinking (Z=-3.615, p<.001), participants were less likely to experience flow (Z=-3.345, p<.001) and reported lower energy (Z=-2.345, p<.001) during concept ideation, feeling less engaged in the process of creating the concepts (Z=-2.249, p=0.25). Similarly, a decline in confidence on their design choices (Z=-2.097, p=0.36) and on the creativity of their ideas for the design challenge (Z=-2.301, p=.021) is observed when introducing the use of ChatGPT. Table 17 show all statements per theme, ordered from higher to lower statistical significance.

Since participant's creative confidence was also measured pre-experiment, a Wilcoxon Signed-Rank Test was performed to compare their confidence in their ability to generate creative solutions for their design challenge pre-experiment versus after each experiment condition (Table 18). No significant difference was found between pre-experiment and after ideation without the use of GenAI. However, there was a statistically significant decrease when comparing to after the ideation with ChatGPT. These results indicate that the decrease in creative confidence is specifically related to the integration of chatGPT in the ideation process.

Linkert scale statements	N	Asymp. Sig (2-tailed)	Z	Negative Ranks (a)	Ties	Positive Ranks (b)	Sum of Ranks (a X b)
Pre-experiment vs after ideating without GenAI	35	.638	-470[b]	8	18	9	(a) 86.00 (b) 67.00
Pre-experiment vs after ideating with ChatGPT	35	.019	-2.353[b]	13	17	5	(a) 138.50 (b) 32.50

*b. based on positive ranks   ☐ ideation with chatGPT < ideation with no GenAI   ☐ ideation with chatGPT > ideation with no GenAI

RQ3 (How does the use of ChatGPT affect designers' critical appraisal of ChatGPT outputs and their own ideas?), similarly to RQ1, was assessed based on the comparison of results of two statements present in both conditions and one statement that were specific to the use of ChatGPT.

TABLE 19: WILCOXON SIGNED-RANK RESULTS FOR COMPARING PARTICIPANT'S LIKERT SCALE RATINGS BETWEEN EXPERIMENT CONDITIONS RELATED TO RQ3. A NEGATIVE TREND IS OBSERVED WITH NO STATISTICAL SIGNIFICANCE.

Linkert scale statement rated in both conditions.	N	Asymp. Sig (2-tailed)	Z	Negative Ranks (a)	Ties	Positive Ranks (b)	Sum of Ranks (a X b)
I thoroughly re-examined and challenged my own ideas.	35	.937	-0.79[b]	11	12	12	(a) 140.50 (b) 135.50
I found it easy to evaluate and critique my ideas effectively.	35	.124	-1.539[b]	12	16	7	(a) 130.50 (b) 59.50

*b. based on positive ranks

The results of Wilcoxon signed-rank test (Table 19) indicate no significant statistical difference (p>0.05) related to the extent and ease of critical appraisal of ideas reported by participants when using ChatGPT. In addition, to assess their trust on ChatGPT designers were asked to reflect on their confidence in sharing ideas with ChatGPT (Table 20), with 65.8% expressing they felt confident sharing their ideas with the chatbot. This may indicate a lack of awareness regarding how ChatGPT and generative AI tools operate, particularly in terms of concerns around idea ownership and authorship.

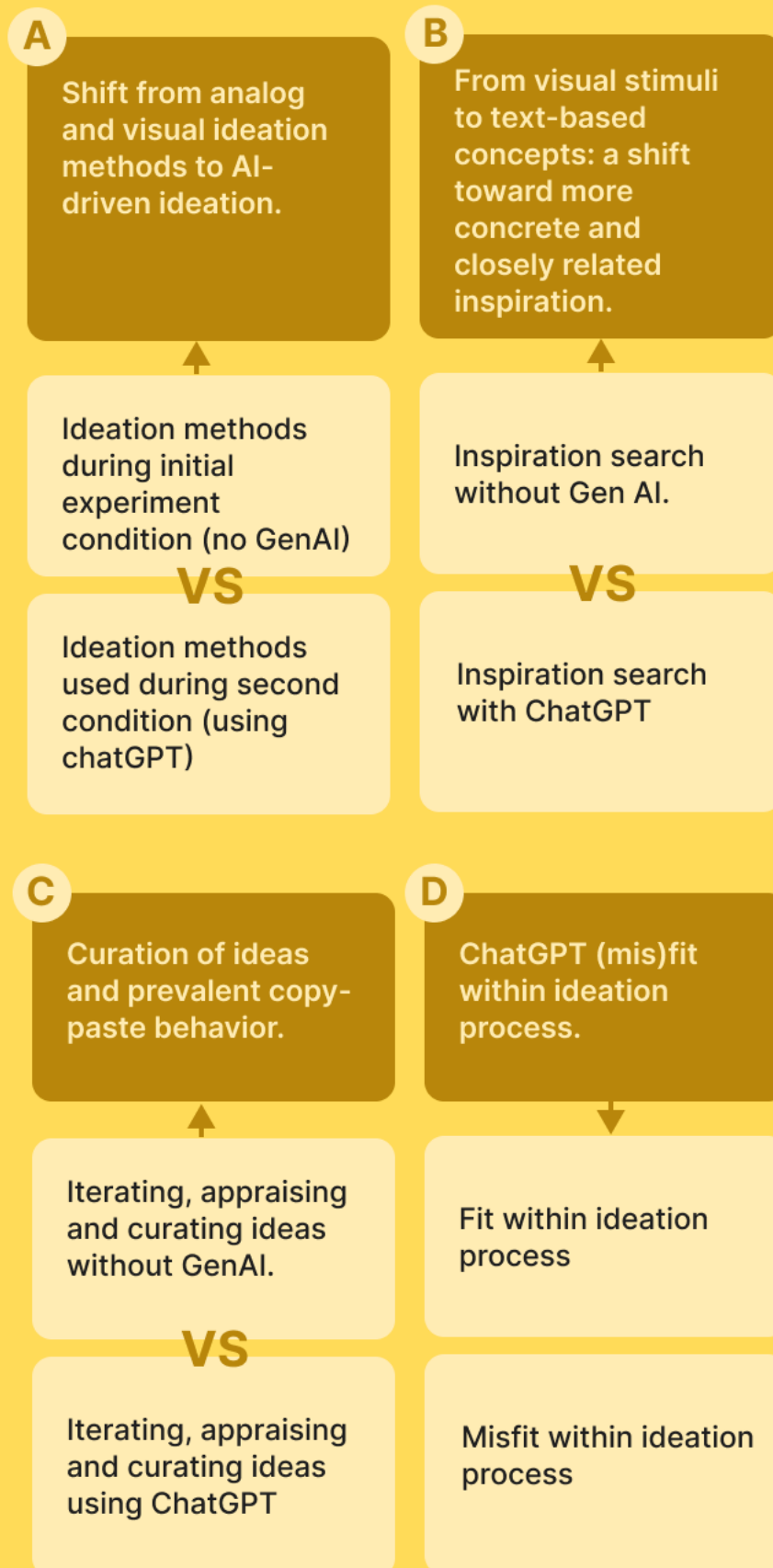| Linkert scale statement exclusive to chatGPT use (2nd experiment condition)	N	Median	Std. Deviation (No GenAI)	Agree/ Strongly Agree	Undecided	Disagree/ Strongly Disagree
I felt confident sharing my ideas with the chatbot.	35	4.0	1.010	23 (65.8%)	8 (22.9%)	4 (11.5%)

☐ Negative central tendency   ☐ Positive central tendency   ☐ Neutral central tendency

3.4.4.   Thematic analysis of qualitative data results

Through the thematic analysis done on the interviews transcripts and open-ended questions we could identify some themes that relate to our research questions. On this subsection we present the themes, sub-themes and categories resulting from the coding process outlined in the data analysis section (3.3.3.). Figure 23, in the following page, show an overview of the themes and sub-themes per Research Questions, we will later detail each of them.
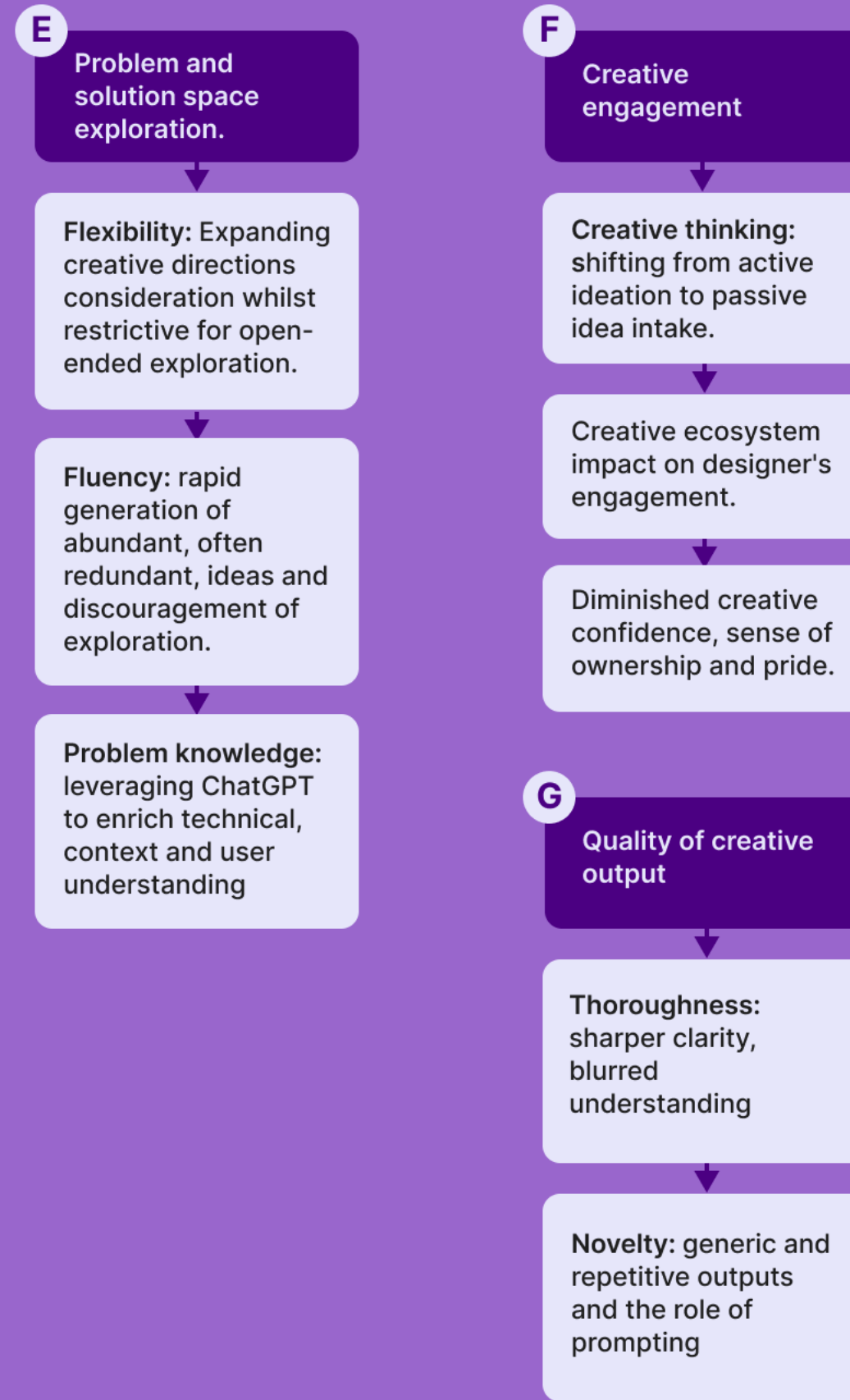
RQ1

How do designers approach the ideation process and inspiration search when using ChatGPT?

A
Shift from analog and visual ideation methods to AI-driven ideation.

↑

Ideation methods during initial experiment condition (no GenAI)

VS

Ideation methods used during second condition (using chatGPT)

B
From visual stimuli to text-based concepts: a shift toward more concrete and closely related inspiration.

↑

Inspiration search without Gen AI.

VS

Inspiration search with ChatGPT

C
Curation of ideas and prevalent copy-paste behavior.

↑

Iterating, appraising and curating ideas without GenAI.

VS

Iterating, appraising and curating ideas using ChatGPT

D
ChatGPT (mis)fit within ideation process.

↓

Fit within ideation process

Misfit within ideation process

RQ2

How does the use of ChatGPT influence designers' creative confidence, exploration of problem and solution spaces, and the quality of their outcomes?

E
Problem and solution space exploration.

↓

Flexibility: Expanding creative directions consideration whilst restrictive for open-ended exploration.

↓

Fluency: rapid generation of abundant, often redundant, ideas and discouragement of exploration.

↓

Problem knowledge: leveraging ChatGPT to enrich technical, context and user understanding

F
Creative engagement

↓

Creative thinking: shifting from active ideation to passive idea intake.

↓

Creative ecosystem impact on designer's engagement.

↓

Diminished creative confidence, sense of ownership and pride.

G
Quality of creative output

↓

Thoroughness: sharper clarity, blurred understanding

↓

Novelty: generic and repetitive outputs and the role of prompting

RQ3

How does the use of ChatGPT affect designers' critical appraisal of chat outputs and their ideas?

H
Critical Appraisal

↓

Ideation context impact on critical appraisal

↓

Human-like and matter-of-fact chat language impact on critical appraisal.

↓

Personal attitude to the use of ChatGPT impact on critical appraisal.

↓

Output appraisal actions.

FIGURE 23: OVERVIEW OF THEMES AND SUB-THEMES PER RESEARCH QUESTION

Regarding **RQ1** (How do designers approach the ideation process and inspiration search with ChatGPT's assistance?) the thematic analysis identified multiple themes and sub-themes that give some insight on how the use of chatGPT influence designers' creative processes, idea selection, iteration, and inspiration search during the experimental conditions.

A. Shift from analog and visual ideation methods to AI-driven ideation

Comparing ideation methods across experimental conditions reveals a significant shift from traditional, non-digital techniques to AI reliance. When working without generative AI, designers engaged in hands-on methods that facilitated visualization and interaction with ideas. However, in the condition with ChatGPT, these traditional methods diminished or adapted to a digital format (Figure 24).
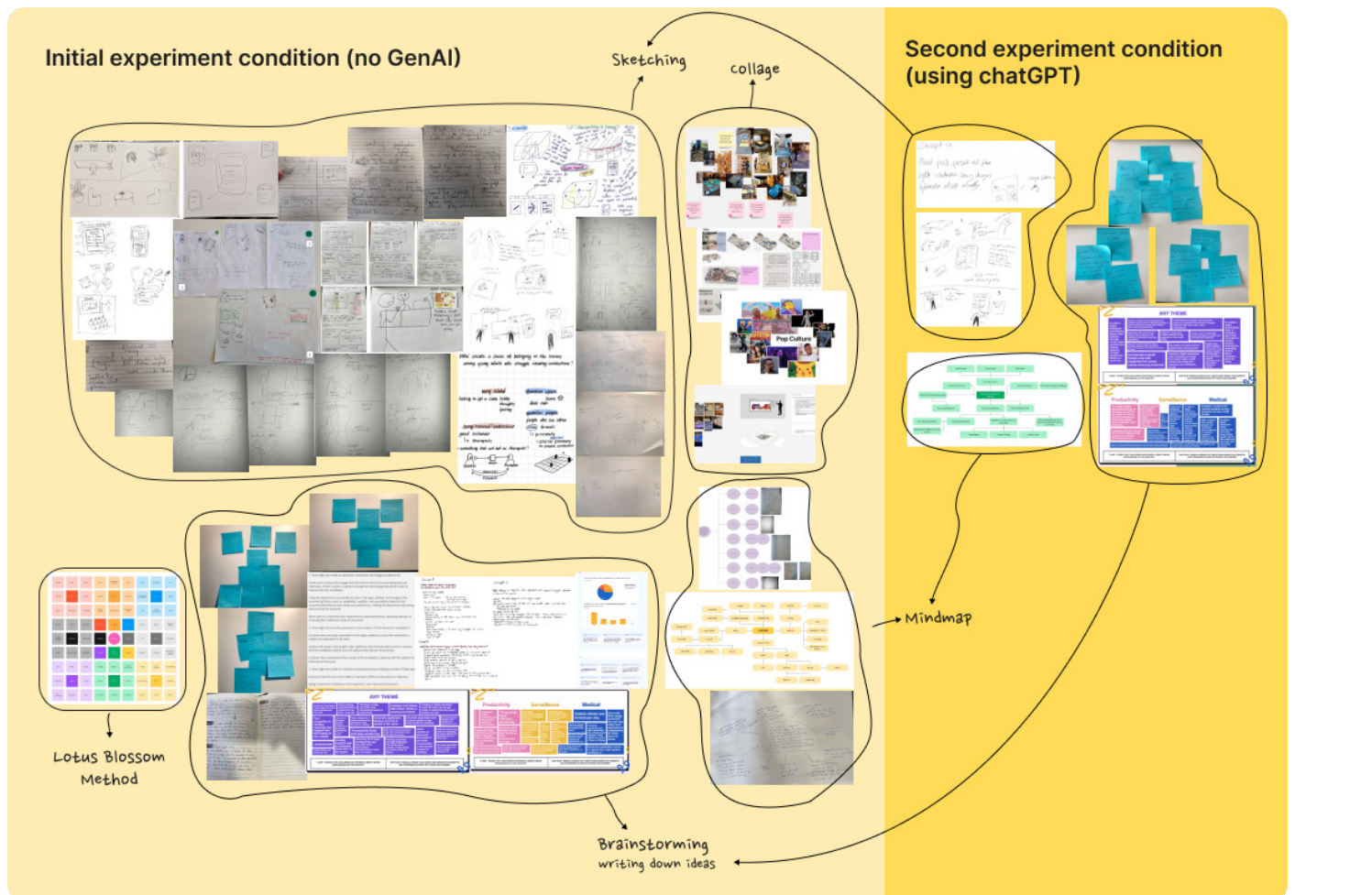
FIGURE 24: OVERVIEW OF DIVERGING METHODS ARTIFACTS IN BOTH EXPERIMENT CONDITIONS. IT IS VERY CLEAR HOW THOSE WERE LESS PRESENT WHEN DESIGNERS WERE USING CHATGPT IN IDEATION.

In the initial condition, designers frequently turned to non-digital and visually focused techniques that facilitated a hands-on, interactive quality to ideation:

Collage/visual boards: Designers utilized visual collages to inspire new concepts. Participant 27 remarked:

"I just kind of went on Pinterest and looked for images that kind of inspired that.[...] Sometimes I just saw an image and I immediately had an idea, so I just didn't even write it down but I immediately started concepting from that."

(EXCERPT FROM INTERVIEW)

FIGURE 25: COLLAGE FROM PARTICIPANT 27

Sketching: Designers used sketching as a foundational activity to visualize ideas, grounding them in quick, initial drawings. Participant 20 described:

"This is like my initial kind of ideation of me just kind of looking at like our problem, what we kind of came up with and just me just sketching some rough things out."

(EXCERPT FROM INTERVIEW)
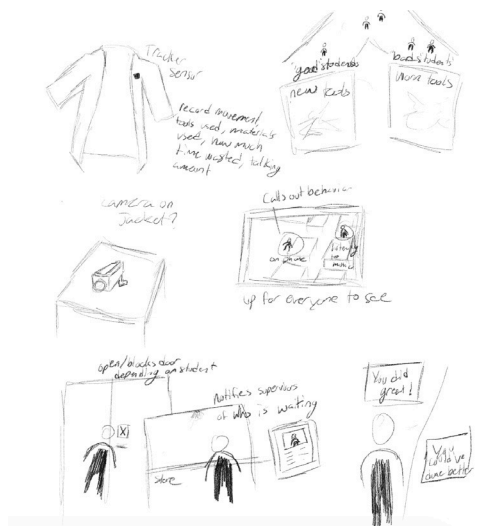
FIGURE 26: SKETCHES FROM PARTICIPANT 20

Brainstorming: This method facilitated rapid idea generation, often utilizing sticky notes for jotting down thoughts.Participant 25 noted:

"I started just brainstorming... I looked at them (referring to HMW questions)... and I was like okay, for that I actually have some ideas I just started to like writing them down on sticky notes [...]"

(EXCERPT FROM INTERVIEW)
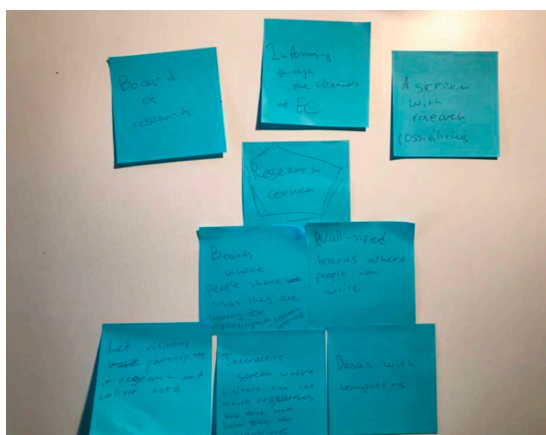
FIGURE 27: POST-ITS WERE USED BY TO BRAINSTORM IDEAS FOR ONE OF THE HMW QUESTIONS. THERE WAS ALSO INSTANCES IN WHICH PARTICIPANT DID THIS DIGITALLY.

64   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   65

Lotus Blossom Method and Mindmapping:
This mapping techniques provided a structured approach to explore ideas around a central theme.

Participant 12 mentioned:

"I sort of started off with a mindmap[...] through the research in general, we found out that they were seeking an escape from their like normal basic lives [...] I started diverging to different keywords"

(EXCERPT FROM INTERVIEW)

FIGURE 28: LOTUS BLOSSOM METHOD AND MINDMAP OUTCOME OF PARTICIPANT 12'S DIVERGING PROCESS.

ii.   **Ideation methods used during second condition (used ChatGPT)**

In the ChatGPT condition, reliance on non-digital methods notably decreased. Designers increasingly relied on ChatGPT for ideation, although some still integrated traditional methods alongside it:

6-3-5 Technique with ChatGPT: Participant 15 requested ChatGPT to execute the structured 635 brainstorming technique to generate ideas; however, they found the AI's responses did not align with their expectations. The participant reflected:

"So I just asked GPT the explanation of what is the research and I gave the 'how might we' question and I asked it to create to do the 635 [...] I realized that it didn't do it very correctly."

(EXCERPT FROM INTERVIEW)

FIGURE 29: SCREENSHOT OF CHAT GPT TRANSCRIPT WITH PARTICIPANT PROMPT. PARTICIPANT GPT TO DO THEIR OWN IDEATION WITH THE METHOD.

ChatGPT as an Evaluation Tool: Participant 12 shifted ChatGPT's role to that of an evaluator rather than a generator, asking it for feedback on ideas rather than using it to create original concepts. The participant noted:

"I sort of asked it to be more of like an evaluation tool instead of an ideation tool"

(EXCERPT FROM INTERVIEW)

FIGURE 30: CHAT GPT TRANSCRIPT WITH PROMPT REQUESTING FEEDBACK.

Mindmapping and the use of sticky notes (Externally to ChatGPT): While some designers still turned to mindmapping or sticky notes to structure and visualize ideas, these methods were noticeably less frequent. As indicated by participant 12:

"I only did one mind mapping compared to the ones before"
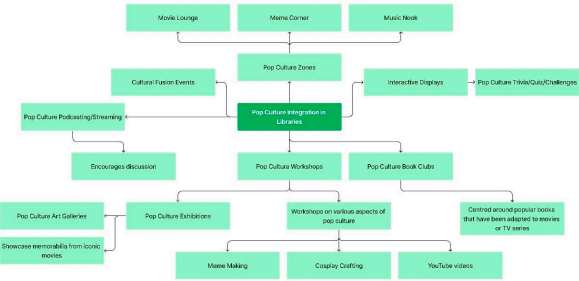

FIGURE 31: MINDMAP FROM PARTICIPANT 12

B.   From visual stimuli to text-based concepts: a shift towards more concrete and closely related inspiration.

In comparing insights between experimental conditions, the qualitative data showcased a shift from external, image-based inspiration to a text-driven inspiration. The data suggests a predominant use of chatGPT for more closely related and detailed inspiration, such as ready-to-use concepts. It also highlights a learning curve in prompting the AI, and some difficulty in conveying intent to get desired results (Figure 32).
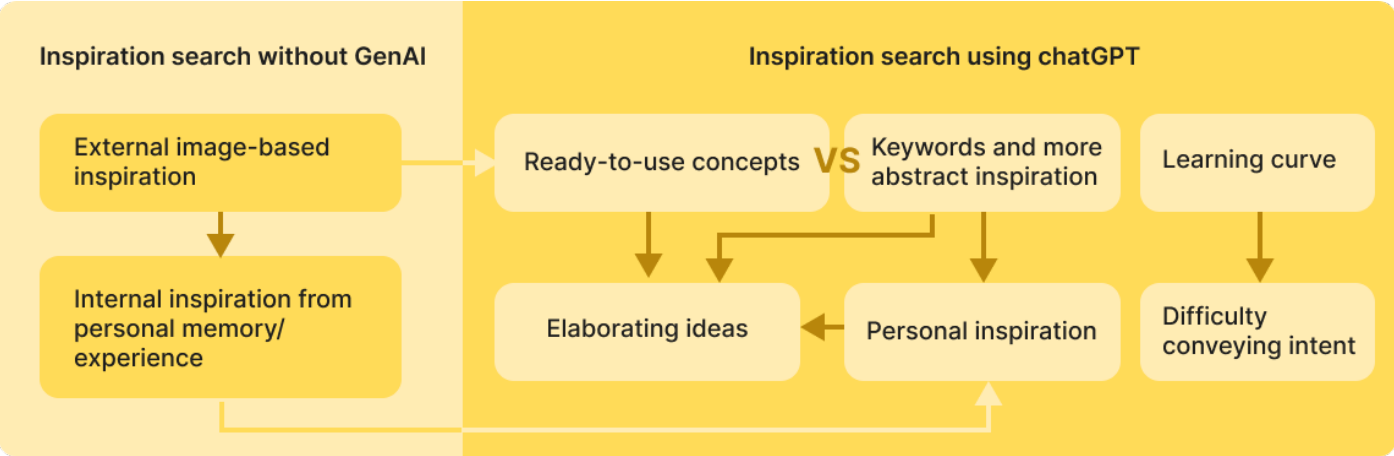

FIGURE 32: SUB-THEMES AND CATEGORIES OVERVIEW. THERE WAS ALSO INSTANCES IN WHICH PARTICIPANT DID THIS DIGITALLY.

i.   **Inspiration search without generative AI**

In the initial condition, designers relied primarily on external visual sources of inspiration, with a report of internal inspiration in the form of personal experiences:

Image-Based Inspiration: Designers sought visual stimuli from platforms like Pinterest. Participant 27, for example, described how browsing images related to pedestrian and street design led to new ideas.

3 QUOTES

"I saw all these really nice pictures [...] maybe we can do something about that as well."

(PARTICIPANT 27, EXCERPT FROM INTERVIEW)

66   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   67

**Internal Inspiration from Personal Memory/
Experience:** Drawing inspiration from personal
memory and experience was less reported, but
mentioned. For instance, Participant 25 cited
inspiration from an experience at an exhibition.

1 QUOTE

"I took a lot of inspiration from there."

(PARTICIPANT 25, EXCERPT FROM INTERVIEW)

ii.   **Inspiration search with chat GPT**

In the ChatGPT condition, designers adopted a predominantly AI-driven approach, where inspiration was
largely shaped by their interactions with chatGPT through prompt adjustments, refinement requests, and
exploration of ChatGPT's capabilities. Number of quotes of each theme reveal a predominance of looking
for more concrete concept ideas instead of more abstract inspiration and a struggle in finding an output
that answered to nuanced design intentions.

Ready-to-Use Concepts: This was the most
common approach, where designers asked
ChatGPT to generate fully developed ideas based
on a brief.

11 QUOTES

"I kind of just asked GPT to create one
concept. Oh yeah, I kind of gave it basically
our design brief in one sentence and then I
looked at what it would give me."

(PARTICIPANT 27, EXCERPT FROM INTERVIEW)

Difficulty Conveying intent: Designers frequently
encountered challenges in communicating design
intentions through prompts. This difficulty highlights
how prompting has a huge impact on achieving
useful outputs from ChatGPT.

9 QUOTES

"Can become a bit too much at
times, and sometimes hard to make it
understand what I wanted."

(PARTICIPANT 52, OPEN-ENDED ANSWER)

Elaborating on Ideas (Groundness: 4): Some
designers used ChatGPT to refine or expand initial
ideas, treating it as an iterative tool. For example,
Participant 25 described asking ChatGPT to
elaborate on their output.

4 QUOTES

"Yeah, I was just asking to like elaborate
like, what do you mean by this or how
that can be used? I think, yeah, I asked it
several times."

(PARTICIPANT 25, EXCERPT FROM INTERVIEW)

Learning Curve: Designers also experienced a
learning curve as they adapted to using ChatGPT.
Adjusting to prompt structures and understanding
the AI's potential required some experimentation.

4 QUOTES

"So, I was a bit like the first time I opened. I was
like, OK, how how do I go about this? So, I kind
of started using it more like a search engine and
then […] in my second concept thing, I started
like really getting into how to maybe use it
more efficiently. But I still feel like I could have
probably used it more creatively, […]."

(PARTICIPANT 27, EXCERPT FROM INTERVIEW)

Personal Inspiration: Although less common, some
designers used ChatGPT as a springboard for
inspiration, integrating AI suggestions with personal
experiences or memories. This approach highlights
ChatGPT's role as an indirect source of inspiration,
sparking ideas that designers personalized or built
upon based on their own experiences.

4 QUOTES

"[…], because it said something about like
feeling welcomed and feeling like belonging.
[…] that made me think of the Central Library
in Helsinki. […]. Maybe I can use that to kind of
bounce off and then chat GPT also gave me a
few different options on how to create that kind
of set of belonging and safety. So I kind of put all
those things together."

(PARTICIPANT 27, EXCERPT FROM INTERVIEW)

**Experimenting with prompts, keywords and
general inspiration:** These approaches were less
frequent, yet they reflect exploratory strategies.
Some designers sought high-level keywords
to guide abstract inspiration, while others
experimented with different prompts to gauge
ChatGPT's range.

4 QUOTES

"I asked Chat GPT to give me keywords in this
case, whereas for the other one I asked it to
give me a whole design concept, and then for
this one with the keywords I had to still like…
Then design myself."

(PARTICIPANT 12, EXCERPT FROM INTERVIEW)

C.   Iteration and curation of ideas and prevalent copy-paste behavior

The comparison between experiment conditions reveals that while many creative processes remained similar across both—such as combining ideas, selection, and refinement—the integration of ChatGPT introduced a distinct shift in designers' engagement (Figure 33). In both conditions, designers curated concepts by blending and refining ideas, but with ChatGPT, a notable "copy and paste" approach emerged. This behavior, marked by directly transferring AI-generated ideas into projects with minimal modification, signals an over-reliance on the tool and a reduction in hands-on creative involvement.

FIGURE 33: SUB-THEMES AND CATEGORIES OVERVIEW. THERE WAS ALSO INSTANCES IN WHICH PARTICIPANT DID THIS DIGITALLY.

i.   Iterating, appraising and curating ideas using without generative AI

In the non-AI condition, designers followed a more personal and hands-on approach for idea appraisal and curation.

Selecting and Combining Ideas: This was the most prominent approach, where designers reviewed their ideas and combined cohesive ones to form concepts.

3 QUOTES

"So it was more like, yeah, seeing what I have and being like, okay, well these things can kind of go together and like create a concept out of it."

(PARTICIPANT 20, EXCERPT FROM INTERVIEW)

Evaluating Ideas for Relevance and Feasibility (Groundness: 1): Designers also engaged in critical evaluation, assessing ideas based on their alignment with the design problem and their feasibility. Participant 12 emphasized filtering ideas for relevance:

1 QUOTE

"I sort of went with the ones where I thought was most feasible, where I thought, oh, okay, this is the most relevant to the actual problem […]"

(PARTICIPANT 12, EXCERPT FROM INTERVIEW)

ii.   Iterating, appraising and curating ideas using chatGPT

In the ChatGPT condition designers relied on AI to quickly generate a wide range of options. Through combining, copying, or selectively refining AI-generated ideas, designers selected, curated and iterated on the creative output.

Combine from List of Ideas: This was the most common approach, with designers using ChatGPT to generate a variety of ideas from which they selected and combined elements. This is in line with their creative process when not using GenAI, as it indicates a shift towards leveraging ChatGPT for rapid ideation, with the AI acting as an initial generator from which designers curated and synthesized their concepts.

11 QUOTES

"ChatGPT gave me lists of ideas that I could easily combine."

(PARTICIPANT 16, OPEN-ENDED ANSWER)

Copy and Paste: Some designers directly transferred ChatGPT-generated ideas into their projects with minimal or no modification. This approach reflects a straightforward reliance on AI content as foundational, showing that some designers opted to use ChatGPT's outputs almost verbatim, perhaps valuing speed and ease over creative engagement.

8 QUOTES

"I think I just took that idea. That's how I just took the idea. This one also I did that, now I realize it."

(PARTICIPANT 15, EXCERPT FROM INTERVIEW)

Select and Refine: A notable approach involved asking ChatGPT for lists of ideas, then selecting and further refining one of them. This approach illustrates a selective engagement with ChatGPT, where designers actively exercised judgment in choosing an idea but relied on AI generating options.

8 QUOTES

"It can generate a lot of ideas in a short time so it helps me skimming what to select and develop more."

(PARTICIPANT 29, OPEN-ENDED ANSWER)

Consistent Evaluation of Ideas (Groundness: 1): Although ChatGPT contributed to the ideation process, designers reported maintaining the same criteria used in the other experiment condition for evaluating ideas based on research and project goals relevance.

1 QUOTE

"[…] I think my thinking process was relatively the same like I was looking at kind of the answer that chat GPT was giving […] what would make sense as a solution which was also what I was doing before."

(PARTICIPANT 27, EXCERPT FROM INTERVIEW)

D.   ChatGPT (mis)fit within ideation process

This final theme addresses the extent to which ChatGPT naturally integrated into designers' ideation workflows, highlighting areas where it both supported and hindered their creative processes (Figure 34).

Fit within ideation process

Helpful in kickstarting and refining ideas.

Misfit within ideation process

Challenges in translating text to visuals

Lonely compared to human collaboration

Convergent rather then divergent thinking

FIGURE 34: SUB-THEMES AND CATEGORIES OVERVIEW. DISCUSS IN WHICH WAYS CHATGPT WAS HELPFUL OR CHALLENGING IN TERMS OF CREATIVE PROCESS.

Overall, while ChatGPT served as a helpful starting point and refinement tool, it introduced notable limitations in alignment with designers' existing workflows and mental models. Its text-based nature created challenges in translating ideas into visuals, and its prompting need constricted designers into convergent thinking, which restricted the breadth of exploration. Additionally, the solitary nature of interacting with ChatGPT contrasted with the dynamic exchange of human collaboration.

Challenges in Translating Text to Visuals:
Designers found it difficult to transform ChatGPT's text-based outputs into visual representations, such as sketches. This challenge points to a mismatch between ChatGPT's textual format and the visual-centric nature of design.

5 QUOTES

"When I tried to draw the concepts on paper so I can see it better, it was very hard to make myself draw from words. I usually prefer the other way around (from sketches to description)."

(PARTICIPANT 15, EXCERPT FROM INTERVIEW)

Lonely Compared to Human Collaboration:
Designers expressed a sense of isolation when using ChatGPT, missing the dynamic back-and-forth typical in human collaboration. Participant 15 described this absence of reciprocal interaction as a barrier.

3 QUOTES

"oh, and most important that I need to do it individually, that was my biggest problem I would say. Usually when I work with someone, even if the dynamic is not that good, you kind of get into this effect of ping pong. So, I say something, you take that, you make it bigger, I take that, I make it bigger, and we build on each other. Here, I was building on myself."

(PARTICIPANT 15, EXCERPT FROM INTERVIEW)

Convergent Rather Than Divergent Thinking:
Designers reported that ChatGPT often forced them toward more focused, narrow solutions rather than supporting open-ended exploration. This shift toward convergent thinking limited their ability to freely brainstorm, which is essential in the early stages of ideation.

2 QUOTES

"Instead of focusing on diverging my thinking process in order to create more ideas, I had to converge my thinking process to make the GPT write something that makes sense."

(PARTICIPANT 29, OPEN-ENDED ANSWER)

Helpful in Kickstarting and Refining Ideas:
Despite its limitations, ChatGPT proved useful for generating initial ideas and refining existing concepts. Designers used it as a springboard to begin the ideation process and as a tool for iterative improvement, making it beneficial for progressing partially developed ideas or overcoming creative blocks.

2 QUOTES

"It provided a good starting point to begin the process and later to further refine the concepts."

(PARTICIPANT 42, OPEN-ENDED ANSWER)

Regarding **RQ2** (How does the use of ChatGPT influence designers' creative confidence, exploration of problem and solution space, and the quality of their outcomes?), through the thematic analysis we identified multiple themes and sub-themes that reflect how designers interaction with ChatGPT during the creative process impact their creative exploration, thinking, confidence, and their perception of the creative output.

E.   Problem and solution space exploration

This theme examines ChatGPT's impact on designers' exploration of problem and solution spaces. ChatGPT supported flexibility by offering diverse directions and acting as a memory aid, supported fluency through rapid idea generation (though often repetitive), and helped broaden knowledge of technical elements and user contexts. However, limitations included a perceived restricted space for open-ended exploration and a lack of motivation to generate ideas beyond the required. The sub-themes (Figure 35) highlights how ChatGPT both expanded and constrained designers' problem-solving and ideation processes.
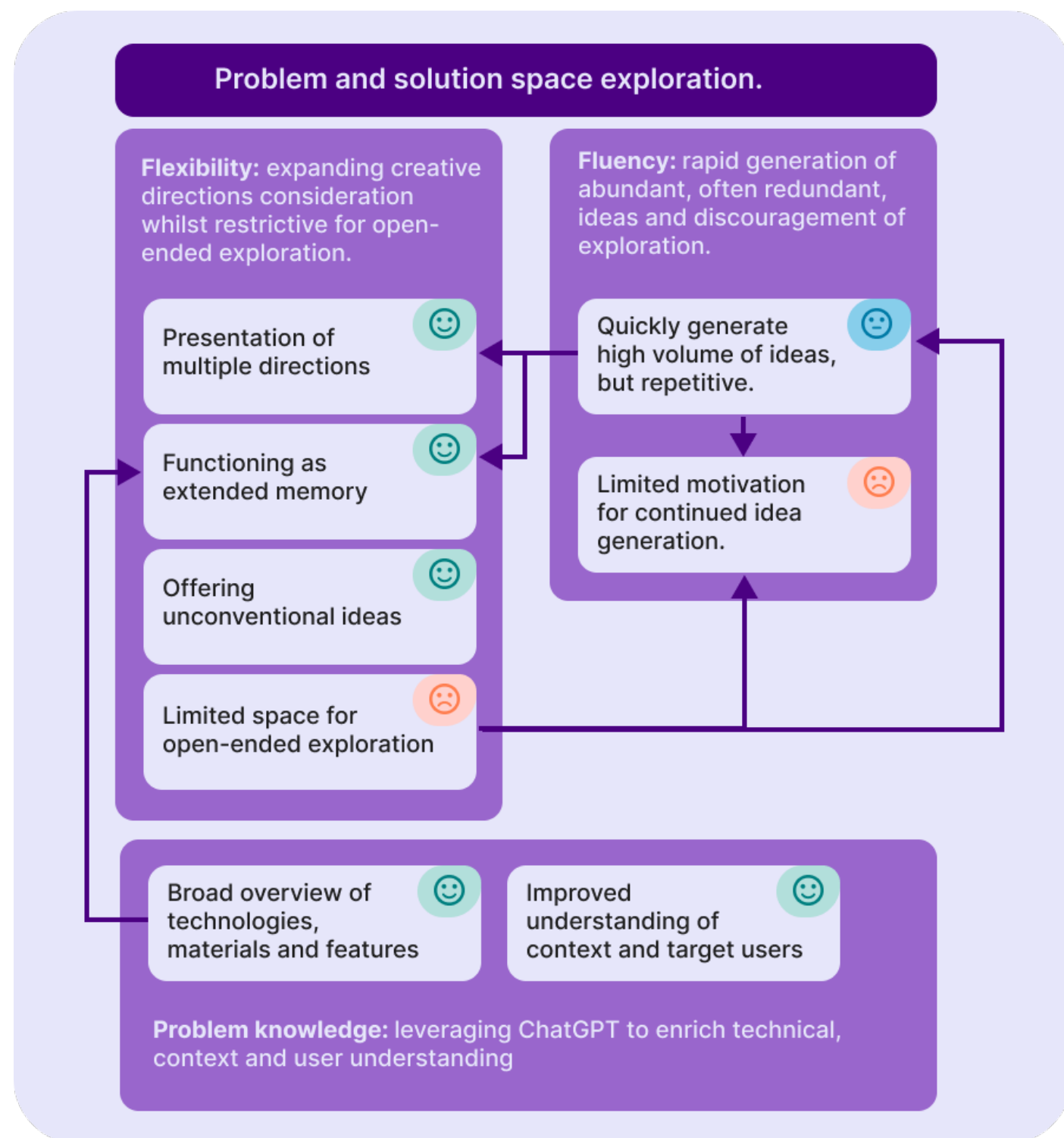
Problem and solution space exploration.

Flexibility: expanding creative directions consideration whilst restrictive for open-ended exploration.

Presentation of multiple directions ☺

Functioning as extended memory ☺

Offering unconventional ideas ☺

Limited space for open-ended exploration ☹

Fluency: rapid generation of abundant, often redundant, ideas and discouragement of exploration.

Quickly generate high volume of ideas, but repetitive. 😐

Limited motivation for continued idea generation. ☹

Broad overview of technologies, materials and features ☺

Improved understanding of context and target users ☺

Problem knowledge: leveraging ChatGPT to enrich technical, context and user understanding

FIGURE 35: OVERVIEW OF SUB-THEMES AND CATEGORIES RELATED TO PROBLEM AND SOLUTION SPACE EXPLORATION.

i.   **Flexibility: Expanding creative directions consideration whilst restrictive for open-ended exploration**

This sub-theme examines ChatGPT's ability to support designers in exploring diverse creative directions by quickly providing a range of ideas, from straightforward suggestions to more unconventional approaches. However, designers' prompts and ChatGPT's structured response style sometimes limited the degree of open-ended exploration, curbing the tool's potential for fostering truly expansive thinking.

Presentation of Multiple Design Directions: ChatGPT provided designers with various approaches to the problem, helping them explore alternative paths that they might not have initially considered.

9 QUOTES

"It gave me several directions to the problem which I struggled with myself, so it really helped."

(PARTICIPANT 25, OPEN ENDED ANSWER)

Functioning as Extended Memory: Designers found that ChatGPT served as an "extended memory," reminding them of simple, straightforward ideas or knowledge that they may have overlooked.

7 QUOTES

"It offers interesting ideas that already exist, but maybe I wouldn't have thought of them."

(PARTICIPANT 10, OPEN ENDED ANSWER)

Offering Unconventional Ideas: Certain ChatGPT outputs were recognized by designers as unconventional, adding an unexpected layer of ideation that enriched the design process and introduced fresh perspectives.

4 QUOTES

"I personally don't like using it that much, perhaps because I'm a bit old-fashioned and hesitate to really let it guide the ideation process. However, when I do ask it for ideas, it can sometimes present unexpected ideas, or things I would've never have thought of."

(PARTICIPANT 36, OPEN ENDED ANSWER)

Limited Space for Open-Ended Exploration: Designers noted that the structure of their prompts, combined with ChatGPT's response style, sometimes restricted the potential for imaginative or "crazy" ideas. This limitation made it challenging to fully explore open-ended or highly creative directions.

4 QUOTES

"Also, because the direction was already quite specific due to the client's requirements, I feel that I couldn't give the chatbot enough space to come up with a bunch of random nonsense that I could take inspiration from, so instead I decided to just ask it for a complete concept that I could use smaller parts of."

(PARTICIPANT 47, OPEN ENDED ANSWER)

ii. Fluency: rapid generation of abundant, often redundant, ideas and discouragement of exploration.

This sub-theme focuses on the volume and variety of ideas ChatGPT helped generate, revealing both strengths in speed and limitations in diversity and designer's motivation:

Quickly generate high volume of ideas, but repetitive: ChatGPT was particularly effective in generating a large number of ideas quickly, which helped designers sort and refine their choices. However, designers noted a lack of originality, as the tool often repeated similar concepts.

7 QUOTES

"It can generate a lot of ideas in a short time so it helps me skimming what to select and develop more,"

(PARTICIPANT 29 , OPEN ENDED ANSWER)

"It kind of was a little bit repetitive."

(PARTICIPANT 25 , OPEN ENDED ANSWER)

Limited motivation for continued idea generation: Designers noted a tendency to stop generating ideas once they met assignment requirements, as ChatGPT's rapid output made it easy to meet specified targets. Suggesting that ChatGPT's efficiency sometimes discouraged extended exploration beyond initial needs.

2 QUOTES

"I wouldn't stop at the six. I don't know why I stopped at the six,"

(PARTICIPANT 15 , EXCERPT FROM INTERVIEW)

iii. Problem Knowledge: leveraging ChatGPT to enrich technical, context and user understanding.

This sub-theme examines how interacting with ChatGPT contributed to designers' understanding of the design problem, enhancing their ability to define, contextualize, and evaluate potential solutions. ChatGPT seemed particularly helpful in technical areas and understanding project contexts, aiding in informing their approach to problem solving.

Broad Overview of Technologies, Materials, and Features: ChatGPT was particularly useful in providing general knowledge on technologies, materials, and features, which helped designers consider a wider range of options.

6 QUOTES

"It reminded me of possible features that I could miss or forget. [...] chatgpt easily shows the problem and can explain why it would or wouldn't work."

(PARTICIPANT 35 , OPEN-ENDED ANSWER)

Improved Understanding of Context and Target Users: Some designers used ChatGPT to gain insights into user needs and contextual information, helping them refine their solutions.

2 QUOTES

"We didn't get too much like User research. [...] maybe I can kind of trying to get an understanding through ChatGPT. So I asked it why people would feel out of place [...]".

(PARTICIPANT 27 , OPEN-ENDED ANSWER)

F. Creative Engagement and Confidence

This sub-theme explores how ChatGPT impacted designers' engagement in the creative process, examining both the cognitive involvement in ideation and the factors that influenced their active participation (Figure 36). While ChatGPT offered assistance in overcoming creative blocks, it also led to a more passive role for designers, reducing their critical thinking and motivation to engage deeply with ideas.
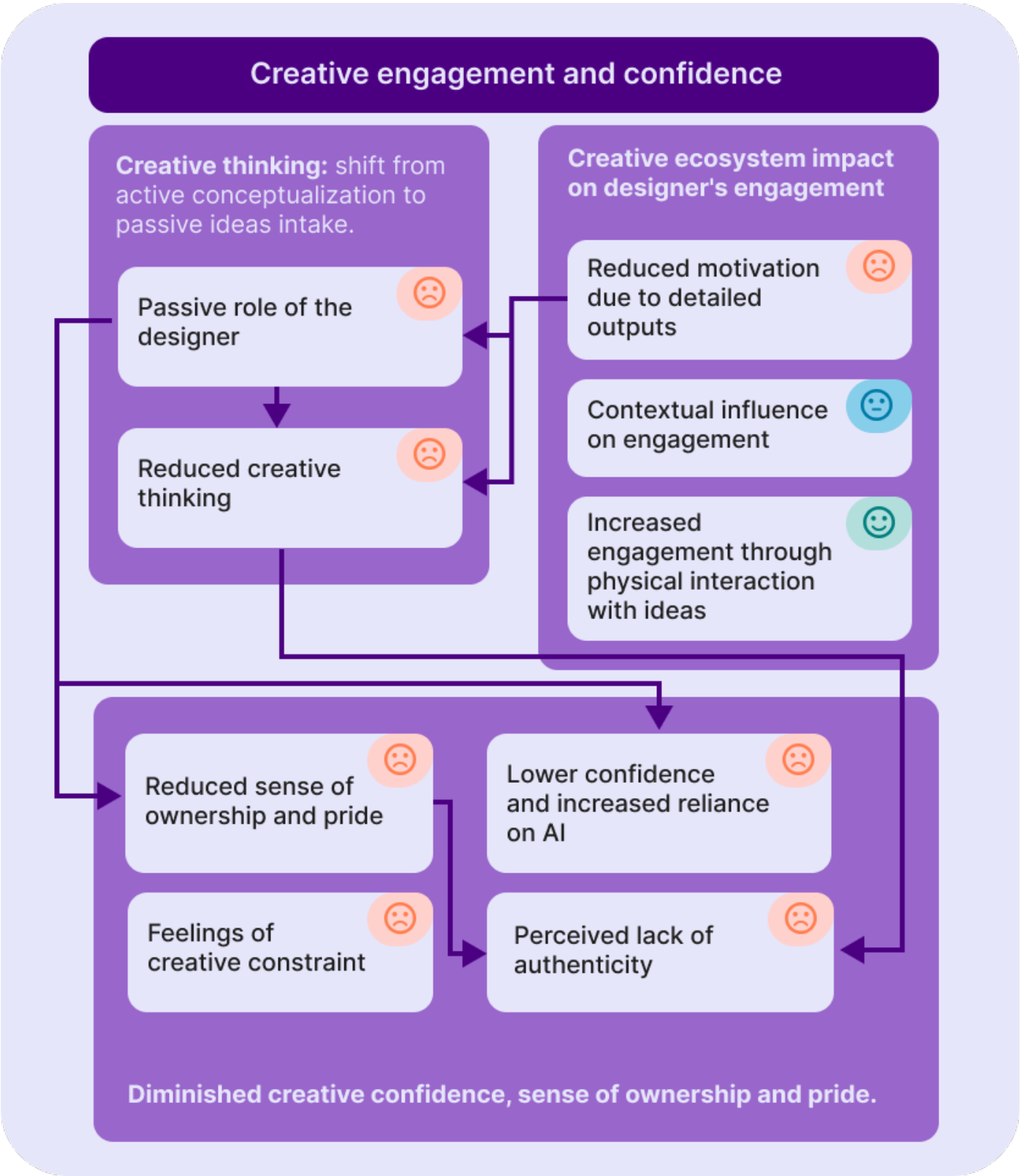

FIGURE 36: OVERVIEW OF SUB-THEMES AND CATEGORIES RELATED TO CREATIVE CONFIDENCE AND ENGAGEMENT.

i. Creative thinking: shift from active conceptualization to passive ideas intake.

This theme examines the impact of ChatGPT on designers' creative processes, highlighting both enhancements and limitations to their cognitive engagement during ideation. ChatGPT influenced creative thinking by reducing the active role of the designer, leading to a more passive and less critical engagement.

Passive Role of the Designer: Designers often took a back seat as ChatGPT generated fully formed ideas, limiting their opportunity for personal ideation. This reliance on AI outputs reduced the designers' engagement in actively shaping ideas. This passive role diminished their sense of involvement.

17 QUOTES

"It's hard for me to be creative when I'm using chat GPT since it already does everything for me."

(PARTICIPANT 6 , OPEN-ENDED ANSWER)

Reduced Creative Thinking: ChatGPT's ready-made suggestions sometimes bypassed stages that would normally require deeper thought, diminishing designers' need for creative thinking. Indicating that the tool's comprehensive outputs lessened the cognitive effort designers typically apply during ideation.

11 QUOTES

"Did not get motivation to think myself."

(PARTICIPANT 67 , OPEN-ENDED ANSWER)

ii. Creative ecosystem impact on designer's engagement

This sub-theme explores the level of active Involvement designers maintained In the creative process when using ChatGPT, examining how the tool influenced their motivation and the contextual factors affecting their engagement.

Reduced Motivation Due to Detailed Outputs: Designers reported feeling less motivated to further develop ideas when ChatGPT provided detailed concepts. The completeness of ChatGPT's outputs reduced the need for active refinement, diminishing their involvement in the creative process.

11 QUOTES

"Some of the ideas were already relatively good by themselves, so it was a little tricky to not use them directly."

(PARTICIPANT 5 , OPEN-ENDED ANSWER)

Contextual Influence on Engagement: External factors, such as the research setup or collaborative environment, also shaped designers' engagement with ChatGPT-generated ideas. Participant 20 explained how she decided to try diferente approaches with chatGPT per concept, because she knew it was for a research.

3 QUOTES

"I know this is for a research thing, I want to help produce more results, so I'll start with different things."

(PARTICIPANT 20 , EXCERPT FROM INTERVIEW)

Increased Engagement Through Physical Interaction with Ideas: Designers felt more engaged with ideas when they took ChatGPT's suggestions out of the digital environment and worked with them physically, such as by sketching or using sticky notes. This hands-on approach fostered a stronger sense of ownership and connection to the creative process.

1 QUOTE

"[…] I was like, okay, this actually cool, and I just took it and wrote it down, and combined it on sticky notes."

"So it's not exactly what chat GPT said. So it's still my, I feel like it's still my idea."

(PARTICIPANT 25 , EXCERPTS FROM INTERVIEW)

iii. Diminished creative Confidence, sense of ownership, and pride

This theme examines how ChatGPT affected designers' sense of pride, ownership, and personal connection to the ideas generated (Figure. While ChatGPT facilitated idea generation its influence on designers' creative confidence was largely negative, as it diminished their sense of ownership and pride in their work. The tool's detailed suggestions and the resulting reliance on AI contributed to a feeling of creative constraint, reducing designers' confidence in their own abilities and leading them to view the AI-driven process as less authentic. This theme underscores the importance of personal engagement and ownership in nurturing creative confidence within the design process.

Reduced Sense of Ownership and Pride : Designers frequently experienced a disconnect from ideas generated by ChatGPT, feeling that these outcomes were not truly their own. This led to diminished pride and engagement.

16 QUOTES

"I felt less proud of my ideas and felt less engagement with them. It felt more like my teammate in my group created an idea and I had to ideate on it further. Even when asking to not finish the idea completely ChatGPT still provides very detailed responses which can hinder creativity."

(PARTICIPANT 44 , OPEN-ENDED ANSWER)

78   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   79

Feelings of Creative Constraint : ChatGPT's rapid, detailed suggestions sometimes left designers feeling creatively constrained, as they felt unable to fully explore or add their unique flair to ideas. Participant 22 noted:

8 QUOTES

"I don't think I could be extra creative in terms of the amount of craziness I put on my ideas with ChatGPT."

(PARTICIPANT 22 , OPEN-ENDED ANSWER)

Lower Confidence and Increased Reliance on AI: Some designers reported a reduced confidence in their own skills, particularly in writing, due to their reliance on ChatGPT. They found themselves depending on the AI to articulate ideas, which led to doubts about their own abilities. Participant 15 shared:

5 QUOTES

"I think I have to write some words. It was so hard to explain the design without chat GPT. Yes, like recently me and my friend realized that the only piece of writing that we have that is our own words is something that we wrote in late November, late October 22. After that everything is AI. It's touched by AI in some percentage."

(PARTICIPANT 15 , EXCERPTS FROM INTERVIEW)

Perceived Lack of Authenticity (Groundness: 2): The process of using ChatGPT made some designers feel that their creative process was less authentic compared to when creating ideas independently. This perception affected their creative confidence, as Participant 12 stated:

2 QUOTES

"I don't feel as creative or proud of my results when using AI during my creative process either. Personally, it's as though the authenticity of the process has been removed."

(PARTICIPANT 12 , OPEN-ENDED ANSWER)

G.   Quality of outputs

This theme assesses the impact of ChatGPT on the quality of designers' outputs, focusing on the thoroughness and novelty of ideas generated (Figure 37). While ChatGPT contributed to clearer, more concise descriptions, it often produced generic and repetitive ideas, limiting the originality of the outputs. The findings reveal both perceived strengths and weaknesses in the depth and creativity of ChatGPT-assisted designs.
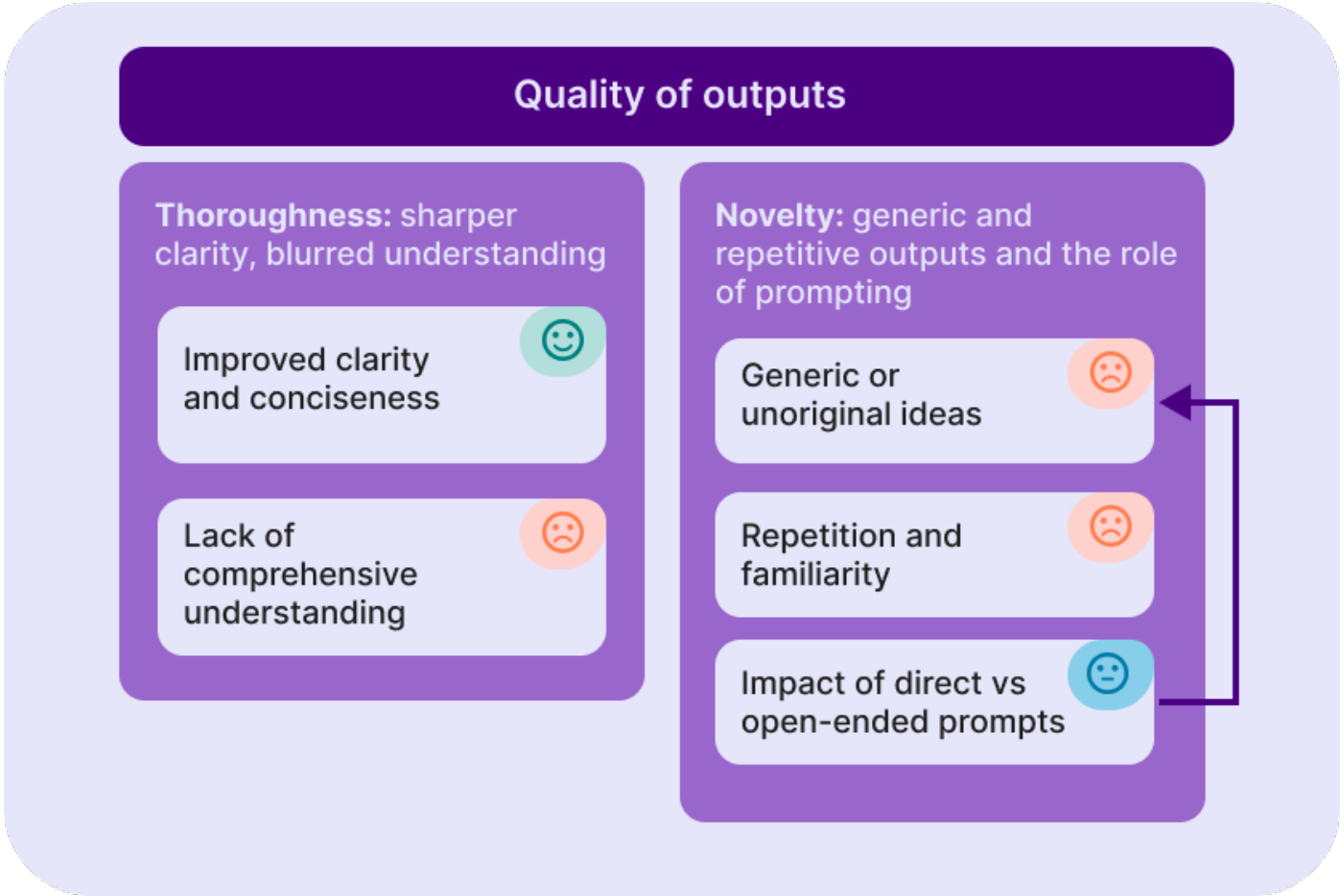

FIGURE 37: OVERVIEW OF SUB-THEMES AND CATEGORIES RELATED TO PERCEPTION OF OUTPUT CREATIVITY.

i.   **Creative output thoroughness**

ChatGPT influenced the thoroughness of creative outputs, contributing positively to clarity but occasionally resulting in a lack of depth and comprehensive understanding of the design.

Improved Clarity and Conciseness : Designers noted that ChatGPT often produced clear and concise descriptions, effectively articulating ideas in a structured manner. ChatGPT's command of language helped designers communicate their concepts more clearly and efficiently.

4 QUOTES

"It described the concepts and the ideas well, whereas I usually lack the skills to do it concisely."

(PARTICIPANT 15 , OPEN-ENDED ANSWER)

Lack of Comprehensive Understanding: Important aspects such as context, purpose, and detailed breakdowns were sometimes missing, and difficult for the designer to explain resulting in an incomplete understanding of the idea. Participant 15 indicated this gap by his uncertainty when questioned about his concept.

3 QUOTES

"I think you don't interact from what I learned."

(PARTICIPANT 15 , EXCERPTS FROM INTERVIEW)

80   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   81

ii.   Creative output novelty

This sub-theme considers the originality of the idea, emphasizing its uniqueness and whether it represents a new, unexpressed concept. ChatGPT often produced generic and repetitive ideas, which limited the originality of the outputs. The tool's tendency to generate conventional responses (based on its generation of the most likely answer) underscored the importance of using open-ended prompts to encourage greater creativity from the tool and designer.

Generic or Unoriginal Ideas: Designers frequently perceived ChatGPT responses as generic and lacking innovation, leading to frustration with ChatGPT's inability to produce unique insights.

18 QUOTES

"It made me frustrated when it kept generating super generic ideas."

(PARTICIPANT 15 , OPEN-ENDED ANSWER)

Repetition and Familiarity: ChatGPT often repeated similar ideas across multiple prompts, generating outputs that designers felt were redundant, which limited the diversity of concepts and restricted novel exploration.

11 QUOTES

"I saw that there were some ideas that were coming back such as comfortable seating, so chat gpt was using similar database all the time."

(PARTICIPANT 16 , OPEN-ENDED ANSWER)

Impact of Direct vs. Open-Ended Prompts: Designers found that straightforward prompts often led to predictable, conventional answers, while more open-ended prompts sometimes resulted in more creative responses. Highlighting the role of prompt design in achieving more unique outputs.

3 QUOTES

"Because I was really straightforward, it also gave me quite straightforward answers [...]"

(PARTICIPANT 25 , EXCERPTS FROM INTERVIEW)

Regarding our **RQ3** (How does the use of ChatGPT affect designers' critical appraisal of chat outputs and their ideas?). The thematic analysis identified multiple themes and sub-themes that reflect how ChatGPT influences the evaluative judgments crucial to the creative process.

H.   Critical Appraisal

This theme explores how designers critically assessed ChatGPT's outputs, highlighting how factors like project context, ChatGPT's language style, personal attitudes, and designers' appraisal practices influenced their evaluations (Figure 38). While some designers carefully scrutinized and filtered ChatGPT's responses, others were less critical due to contextual and personal factors, affecting the degree to which they engaged in selective and cautious evaluation.
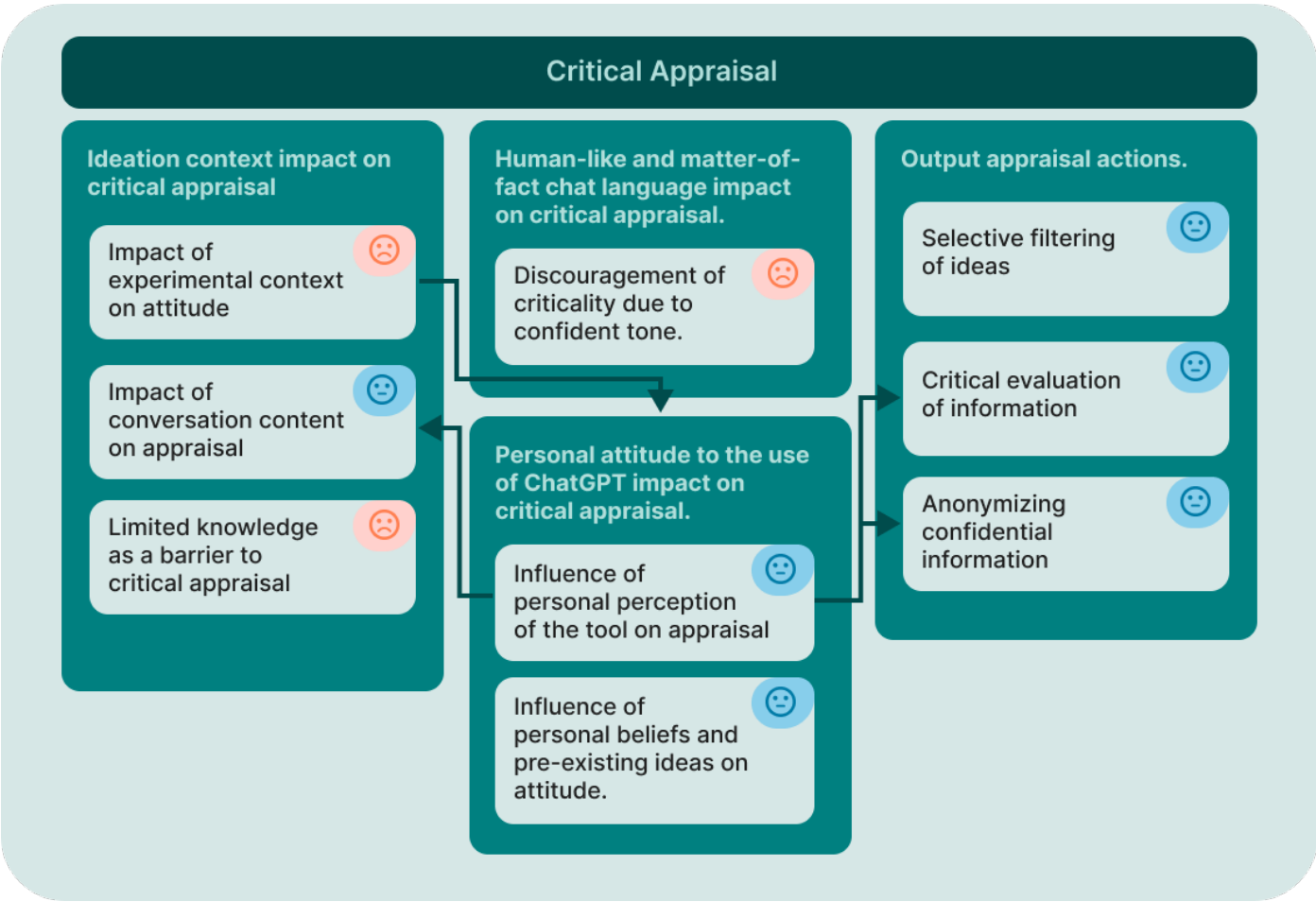

FIGURE 38: OVERVIEW OF SUB-THEMES AND CATEGORIES RELATED TO CRITICAL APPRAISAL

82   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   83

i. Ideation context impact on critical appraisal

This sub-theme explores how specific project contexts and the nature of the interaction with ChatGPT influenced designers' critical evaluation of the tool's outputs and suggestions.

Impact of Experimental Context on Attitude: The designer's interpretation of the research context influenced designers' interactions with ChatGPT. Some participants felt they shouldn't critically engage with the tool, interpreting that the research wanted to compare the raw AI output, even though that was never mentioned as a requirement.

3 QUOTES

"If it was for outside the research, I would probably do a lot more to see how can this tie into more outside of my perspective [...]. But because it was the research, I really tried to step away from changing it so much or adding in my own ideas into it. [...]"

(PARTICIPANT 20, EXCERPTS FROM INTERVIEW)

Impact of Conversation Content on Appraisal: Designers' critical assessment varied depending on the nature of their requests. Participant 20 expressed some trust in ChatGPT but noted a lack of complete confidence, especially in requests involving factual accuracy or data verification.

2 QUOTES

"[...] it wasn't like anything that I was like I think it's providing me false information because [...] I don't think anything that I asked would require, like, I don't know I don't think there's any question for that, but if I asked it like oh what's like the statistics on this I don't think I would really trust [...]."

(PARTICIPANT 20, EXCERPTS FROM INTERVIEW)

Limited Knowledge as a Barrier to Critical Appraisal: Designers with limited knowledge or expertise on the design problem found it more challenging to critically evaluate ChatGPT's responses. This lack of background information made it harder to judge the accuracy and relevance of the suggestions, affecting their ability to discern high-quality outputs from less suitable ones.

2 QUOTES

"I was so lost myself, so I trusted completely."

(PARTICIPANT 15, EXCERPTS FROM INTERVIEW)

ii. Human-like and matter-of-fact language

ChatGPT's authoritative tone and confident language style affected designers' willingness to question its outputs, often discouraging further exploration.

Discouragement of criticality due to confident tone: Designers observed that ChatGPT's matter-of-fact language sometimes led them to accept its suggestions without further questioning. The confident tone gave the impression of reliability, which reduced their instinct to critically evaluate or explore alternative ideas.

4 QUOTES

"Chat GPT tends to present information in a comprehensible and confident way, that makes me believe that this is the best idea for the specific project, therefore leading me to hang on to one idea for a long time."

(PARTICIPANT 12, OPEN-ENDED ANSWER)

iii. Personal Attitude to the Use of ChatGPT

Designers' individual beliefs, preferences, and ethical considerations influenced their engagement with and evaluation of ChatGPT's outputs.

Influence of Personal Perception of the Tool on Appraisal: Designers' trust in ChatGPT based on their pre-existing impression of the tool significantly impacted their critical appraisal. Those who had a positive attitude towards the tool were more likely to accept its outputs without rigorous scrutiny, while those with a more skeptical view approached it with more caution.

6 QUOTES

"How do I say it? I don't know if you should completely trust it though, it's like I think, I don't know, I heard about this black box technique thing. No, not technique, but it's like it's using AI in a creative process. It's very black box, you don't know where the information is coming from and that's also why you shouldn't completely trust it."

(PARTICIPANT 12, EXCERPT FROM INTERVIEW)

Influence of Personal Beliefs and Pre-existing Ideas on Attitude: Designers' pre-existing ideas, ethical concerns, and personal biases also affected their engagement with ChatGPT. Some were resistant about integrating AI-driven suggestions due to personal beliefs, while others allowed their pre-existing design direction to influence their openness to ChatGPT's outputs.

6 QUOTES

"It does not follow any moral rules and human values such as religion, grey topics etc."

(PARTICIPANT 21, OPEN-ENDED ANSWER)

"I might have actually been biased by doing the same, HMW question for both. For both. For both, yeah. Because it's like, when I was already done with the first part without the chat GPT and for that I already had inspiration and I already had a specific direction I was going towards."

(PARTICIPANT 12, EXCERPT FROM INTERVIEW)

Designers used various strategies to appraise ChatGPT's outputs, demonstrating selective filtering, validation, and caution regarding confidentiality.

Selective Filtering of Ideas : Designers exercised discretion in selecting ChatGPT's suggestions, retaining only the ideas that aligned with their design goals. Participant 27 described this selective approach:

4 QUOTES

"But I do think I was doing it kind of more like looking through the answers and then sorting out what was relevant and irrelevant for this other than just kind of. Looking at all of it and being like hmm, this could be interesting. What if I look at it from this perspective? "

(PARTICIPANT 27, EXCERPT FROM INTERVIEW)

Critical Evaluation of Information: Some designers actively evaluated the accuracy of ChatGPT's outputs by cross-checking information or seeking additional validation.

2 QUOTES

"It depends on the process itself, because I would use chat GPT, for example, as I mentioned, with the chair. I looked at materials, I saw them, I started ideating right after. But then I would go on Google once again to prove that. Usually, I need to do this proofreading. To make sure that... By proof research. I don't know how to call it."

(PARTICIPANT 15, EXCERPT FROM INTERVIEW)

Anonymizing Confidential Information: To protect sensitive data, designers were cautious about sharing confidential information with ChatGPT, opting to anonymize details to safeguard privacy. This same cautious was not expressed in sharing their ideas with the tool.

2 QUOTES

"[...] if there are names of people and stuff, I always replace that or I never even write it. [...] Maybe nothing will happen. Maybe something will happen. But I think what I'm still cautious about is the names and also confidential stuff, because it's a good thing to know."

(PARTICIPANT 12, EXCERPT FROM INTERVIEW)

"Yeah, I was definitely comfortable, like I wasn't sharing anything personal, so it was fine. Well, trustworthiness. I haven't thought about it from that perspective, to be honest. I was just, okay, it just gave me ideas."

(PARTICIPANT 25, EXCERPT FROM INTERVIEW)

4. Discussion

This study explored how the use of ChatGPT in the ideation process influences designers' creativity and workflow. Specifically, we addressed the following research questions:

RQ1

How do designers approach the ideation process and inspiration search when using ChatGPT?

RQ2

How does the use of ChatGPT influence designers' creative confidence, exploration of problem and solution spaces, and the quality of their outcomes?

RQ3

How does the use of ChatGPT affect designers' critical appraisal of chat outputs and their ideas?

Through our experiment and the analysis of quantitative and qualitative data, we explored how the use of ChatGPT in early ideation influences creativity, engagement, confidence, and critical appraisal during the design process. In the discussion, we interpret these findings in the context of the research questions and existing literature, aiming to have a more clear insight on the effect of ChatGPT in design creativity.

4.1. Designers approach the creative process and inspiration search when using chatGPT

According to our quantitative analysis majority of the experiment participants would recommend chatGPT as a useful tool for ideation. According to our qualitative analysis they found the tool particularly helpful in kickstarting ideation and helping with creative block. That is inline with two of the main reported uses they had of the tool prior to the experiment: generating initial ideas or brainstorming (62.9%), and to overcome creative blocks (40%), which could indicate that their prior experience in using ChatGPT for this, might have had some influence in their positive perspective, perhaps because they have more experience and consequently knowledge on how to use it in this way. The tools capability to generate a large amount of ideas quickly, was also appreciated by the participants, making it be perceived as very convenient and less energy consuming.

Furthermore, quantitative data revealed that majority of designers reported they found easy to communicate with ChatGPT when searching for inspiration and rated its suggestions as relevant. However, the qualitative data suggests otherwise, one of the most common themes out of the data was a sense of frustration on the output from the software, either due to it's generic nature, or lack of relevance or usefulness to their design goal.

Possibly, the user experience of inputting the prompts was experienced as straightforward, as it mimics a known social (conversational) and digital (chat) pattern, which might be what led to the positive ratings. However, communicating the more nuanced intents effectively to the chatbot seemed to have been challenging based on the qualitative data. Designers noted that time and experimentation were needed to craft prompts that would yield useful and inspirational outputs.

The need to articulate such nuanced details from their design challenge was significant due to the type of output most designers searched. In their approach to seeking inspiration, designers showed a preference for concrete stimuli, often using ChatGPT to generate complete ideas rather than abstract stimuli.

Ray (2023) acknowledges that achieving precise outputs with ChatGPToften requires defining detailed and specific prompts, which frequently will require some iterations. The iterative prompting process, necessary to refine vague or incomplete initial outputs, can exacerbate user frustration, especially when the expectation is for immediate and precise results. However, this requirement for precision can clash with the exploratory and open-ended nature of divergent thinking, which is essential during ideation. By forcing designers into a convergent thinking mode it could hinder flexibility, fluency, and the generation of novel concepts, reducing creative stimulation.

Furthermore, according to Gonçalves et al. (2016), using stimuli that are too concrete or closely related to the design problem can limit creativity by promoting "design fixation" (Jansson & Smith, 1991b). Moderately abstract stimuli can encourage more flexible and original thinking. Some designers reported integrating concepts or words from ChatGPT's suggestions with their internal inspirations, which helped mitigate limitations associated with relying solely on the AI for inspiration. However, this practice was minimal, and the overall impact on inspiration search remained negative overall.

As result of the overly related and detailed

outputs a "copy and paste" approach emerged, with many designers directly transferring AI-generated ideas into their projects with minimal modification. In an educational context, this is particularly concerning. Igo et al. (2005) found that unrestricted "copy and paste" practices lead to shallow cognitive processing and reduced engagement, possibly affecting the quality of their design formation. Thus, heavy reliance on ChatGPT for ready-made ideas could similarly limit creativity, critical thinking, and engagement, which align with the results we found for RQ2, that we will detail further in this discussion.

Another consequence on the overreliance on ChatGPT for detailed was a decrease in the use of analog methods such as sketching and mind mapping during the ideation process. Regarding sketching, students reported finding challenging to translate the text-based outputs into visual representations. According to Purcell and Gero (1998), sketching aids working memory by allowing designers to manipulate and reinterpret complex ideas without cognitive overload, supporting iterative visual experimentation crucial for creativity. The detail-heavy outputs from ChatGPT likely increased cognitive load, as students had to mentally parse and hold complex textual information, making it harder to visualize the concepts.

Additionally, designers experienced a sense of isolation stemming from the lack of reciprocal interaction with ChatGPT. Traditional design processes often involve collaborative brainstorming, where ideas are shared and developed collectively. Students experienced ChatGPT's as a one-way interaction which does not replicate this dynamic, potentially leading to a less engaging and stimulating environment for creativity.

These challenges, highlighted some differences

between participant's preference or expected creative process versus the affordances of the tool. These mismatches with the creative process along with the frustration with inspiration search might explain some of the causes for the significant negative impact of chatGPT on designer's flow, as demonstrated in our quantitative analysis. On the other hand, there was also some patterns of their creative process that was consistent with creativity literature that were present in both conditions, such as: evaluation of ideas (Runco, 2004) based on relevance; selection and combination of ideas (Cash et al., 2023), internal inspiration (Gonçalves et al., 2016c).

4.2. Influence of the use of ChatGPT in designers' creative confidence, exploration of problem and solution spaces, and the quality of their outcomes

4.2.1. Creative engagement and confidence

Quantitative results revealed that using ChatGPT significantly impacted designers' creative confidence and engagement. Qualitative data supported these findings, shedding light on potential causes.

Ray (2023) raised concerns that overreliance on AI systems like ChatGPT could reduce engagement in critical thinking and creativity. Our findings align with this concern, demonstrating a tendency for designers to depend on the chatbot for most, if not all, ideation. This reliance often led to a more passive role for the designer, exemplified by the "copy-paste" pattern.

The approach of seeking detailed, fully-formed concepts, rather than abstract inspiration, limited designers' opportunities to contribute meaningfully to the creative process. This approach often resulted in a sense of creative constraint or a lack of stimulation for critical thinking. Notably, participants reported a significant decrease in creative engagement when using ChatGPT. Some participants also highlighted how their specificity in prompts constrained the AI, further underscoring the role of prompting in molding the stimuli.

This lack of engagement, in turn, resulted in a decreased sense of ownership and pride over the ideas generated, as they feel (in the words of a participant) "as if it is not your idea". ChatGPT's ready-made suggestions sometimes bypassed stages that would normally require deeper thought, diminishing the need for critical thinking.

Participants that reported feeling like the idea was more ownership and pride in the interviews, also reported engaging more with the theme and/or ideas within and outside of chatGPT.

Karwowski et al. (2019) emphasized that active involvement in creative processes is essential for maintaining a strong creative self-concept. Our findings suggest a causal relationship between low engagement and the significant decrease in students' creative confidence. This also extend to feeling of ownership; as participants expressed greater confidence in ideas generated without ChatGPT.

Another concern from the theoretical background was whether designers, feeling outperformed by AI in specific areas, might lose confidence in their abilities. This concern was evident in the context of writing, as participants reported diminished confidence in their writing skills without the tool, and shared:

> "[...] recently me and my friend realized that the only piece of writing that we have that is our own words is something that we wrote in late November, late October 22. After that everything is AI. It's touched by AI in some percentage."

This quote highlights how a low creative self-concept in comparison to AI performance can lead to over-reliance, creating a cycle where one problem reinforces the other (Figure 39).
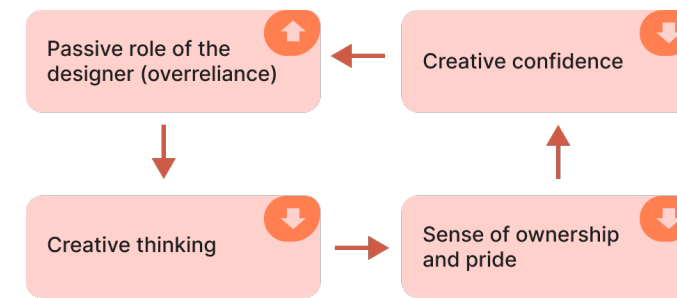
FIGURE 39: NEGATIVE OVERRELIANCE CYCLE . DEPICTS HOW RELIANCE ON CHATGPT REDUCES CREATIVE THINKING, LEADING TO DIMINISHED OWNERSHIP, PRIDE, AND CONFIDENCE, WHICH FURTHER REINFORCES RELIANCE ON THE TOOL.

Our research does not suggest that students currently believe ChatGPT outperforms them overall. In fact, they expressed greater confidence in their ideas from the first, non-ChatGPT condition. However, this aspect warrants attention as AI tools continue to improve.

Finally, external factors such as the research setup, academic context, and collaborative environment also influenced designers' engagement levels. For instance, one designer explored diverse prompting techniques to obtain varied data, while another cited a negative collaborative experience with a group member as a demotivating factor in creative exploration.

4.2.2.   Creative Exploration

The integration of ChatGPT influenced designers' creative exploration in various ways. Quantitative data revealed that participants' problem knowledge increased more significantly when they were not using ChatGPT. Interestingly, qualitative data highlighted some positive aspects of ChatGPT's role in problem space exploration. Participants noted that the tool provided an overview of technologies, materials, and features, and helped them understand the context and target users. However, the lower increase in problem knowledge when using ChatGPT might be linked to reduced engagement. Some

participants struggled to explain their own ideas, indicating a lack of attention to and understanding of the information generated by the AI.

Another notable finding was that participants perceived the artifacts created with ChatGPT as less useful. While creativity evaluations conducted during the research did not show significant differences in overall creativity, this perception aligns with the challenges participants faced in obtaining outputs tailored to the nuanced aspects of their design challenges. Conversely, participants felt more confident in their ideas as they believed these were more effective and relevant to their design challenges.

ChatGPT supported flexibility by offering diverse directions and acting as a memory aid. Although the stimuli generated by ChatGPT were often not novel, they occasionally highlighted overlooked ideas, functioning as a form of extended memory. However, it was dependent on how participants crafted their prompts. Straightforward prompts often produced predictable and conventional answers, whereas open-ended prompts were more likely to yield creative responses, providing greater space for exploration.

Although the stimuli from ChatGPT was often not novel, it presented ideas they sometimes overlooked, helping as a type of extended memory.

ChatGPT also facilitated fluency by enabling rapid, high-volume idea generation. However, this approach was not always effective, as many of the AI's suggestions were repetitive or generic, which limited the originality of the outputs. Additionally, designers often stopped generating ideas once they met assignment requirements. ChatGPT's quick outputs made it easy to satisfy these targets, potentially stifling deeper exploration and innovation

4.2.3. Creative Outcomes

We found no statistically significant difference in the overall creativity of concepts and participants when using ChatGPT compared to when not. Our sample included only novice designers, which may have influenced this outcome. Novices may lack expertise to critically evaluate, guide or refine the outputs of generative tools, leading to a bigger reliance on the tool's suggestions without deeper exploration or adaptation (Saadi and Yang, 2023). In contrast, more experienced designers might be better equipped to leverage AI-generated outputs, using them to expedite ideation while integrating their own expertise, potentially resulting in more creative outcomes.

When examining creativity on a per-design-brief basis, only two briefs produced significant yet opposing results:

- **Brief 3:** This brief, which involved developing an interactive installation to present local government data in a multi-sensory way, resulted in significantly more creative concepts when using ChatGPT.

- **Brief 4:** The mean creativity of the three concepts ideated per participant for this brief, which focused on designing a platform for sharing knowledge of mobile heritage, was negatively impacted when using ChatGPT.

TThese opposing effects on creativity may stem from differences in the characteristics of the briefs, which in turn shape the effectiveness of prompts. Brief 4 focused on a niche topic (experiential knowledge) with a narrowly defined scope (designing a platform). This specificity likely guided ChatGPT to produce concise and focused outputs. In contrast, Brief 3 featured a broader topic (data visualization) and scope (interactive installation), allowing for greater interpretative freedom and fostering exploratory

tasks or ideation, which often lead to diverse and unexpected insights.

Given that participants had already generated some concepts for the briefs, they might have benefited from abstracting the narrower briefs to obtain stimuli that were more semantically distant and creatively stimulating (Chan et al., 2017).

4.3. Effect of ChatGPT on Designers' Critical Appraisal of Outputs and Ideas

The study explored how using ChatGPT influences designers' critical appraisal of both AI-generated outputs and their own ideas. Quantitative analysis revealed no significant statistical differences in reflection statements related to critical appraisal between conditions with and without ChatGPT.

Qualitative findings, however, provide deeper insights into critical appraisal practices. Designers employed a strategy of selectively filtering ChatGPT's output, prioritizing ideas that aligned with their design goals. This approach was consistent with the criteria they applied when evaluating ideas without generative AI. Nonetheless, individual beliefs, preferences, and ethical considerations significantly shaped their engagement with and evaluation of ChatGPT's suggestions.

Designers with a positive attitude toward ChatGPT were more inclined to accept its suggestions without rigorous scrutiny, while skeptical designers approached the outputs more cautiously. Attitudes toward ChatGPT are influenced by perceived risks, anxiety, and social influence (Sallam et al., 2024). These findings emphasize the need to foster critical AI literacy, enabling users to navigate and evaluate AI-generated outputs effectively while mitigating overreliance or unwarranted rejection stemming from personal biases.

TThe ability to critically appraise outputs was also influenced by designers' subject matter expertise. A lack of domain knowledge hindered their ability to assess the accuracy and relevance of ChatGPT's suggestions, making it difficult to distinguish high-quality ideas from less suitable

ones. Additionally, ChatGPT's matter-of-fact language can led designers to accept suggestions without further questioning. The AI's confident tone conveys an impression of reliability, dampening their instinct to critically evaluate or consider alternative ideas.

Furthermore, the research context may have also influenced interactions with ChatGPT. One participant noted they refrained from critically engaging with the tool because they believed the study required them to use it as-is, despite clear instructions that they could use ChatGPT as they saw fit to aid their ideation. This misunderstanding led them to accept ChatGPT's suggestions without modification, further diminishing critical appraisal.

Interestingly, while designers expressed concerns about protecting confidential information, such as anonymizing names, they were less apprehensive about sharing their ideas with ChatGPT. A substantial 65.8% reported feeling comfortable sharing ideas with the AI. This suggests that although they are cautious about safeguarding sensitive data, they may not fully grasp the implications of sharing intellectual property with AI tools.

Ethical concerns regarding authorship and ownership of AI-generated content introduce challenges for intellectual property rights (Anderson, 2022). Designers may lack awareness of how their inputs are used or stored by AI systems. After previously emphasizing the value of their own ideas, a participant reacted with surprise upon learning that their inputs could be used to train the AI unless configured otherwise, stating:

"I never thought of it like this"

4.4. Practical Recommendations

Drawing upon the insights gained from our findings, as well as established guidelines on AI tool usage in educational contexts (e.g., TU Delft's guidelines), we propose a series of recommendations from three complementary perspectives: educational, user, and product. These recommendations are designed to enhance critical engagement with generative AI tools like ChatGPT, foster creativity, while mitigating the potential risks identified in our research.

4.4.1. Encourage a Balance Between AI and Traditional Ideation Methods

The study highlighted a significant shift in ideation approaches when designers used ChatGPT, transitioning from hands-on, exploratory methods to text-based processes. While this shift enabled efficiency and rapid idea generation, it constrained exploration and led to more repetitive or generic outputs. Designers also struggled with crafting nuanced prompts to elicit context-specific and innovative results. To address these challenges, it is essential to encourage a balance between AI tools and traditional ideation methods. Below are some ideas of how that could be achieved within education, product, and individual (designer) perspective.

A.   Educational Perspective

- Educators can teach students how to design prompts that elicit broader or more abstract responses, emphasizing creativity over precision.

- Encourage combining AI outputs with traditional methods, such as starting with ChatGPT-generated creative prompts and refining them through sketching or brainstorming.

- Facilitate group ideation sessions where students critically engage with AI-generated outputs and build on each other's contributions.

B.   Product Perspective

- Add features to translate AI outputs into visual formats like mind maps or diagrams, bridging the gap between textual and visual ideation.

- Integrate capabilities that allow multiple users to engage with ChatGPT in real time, simulating traditional brainstorming environments.

- Provide templates for common design techniques that users can adapt to their specific goals.

C.   Designer Perspective

- Designers should actively combine AI-generated suggestions with hands-on methods, such as using ChatGPT for initial ideas and iterating through sketching or mood boards.

- Focus on obtaining abstract or moderately related stimuli during early ideation stages to maximize

creativity and explore them outside ChatGPT.

- Reflect on how AI outputs align with design goals and expand them manually to ensure depth and originality.

4.4.2. Foster intentional use of AI, creative engagement and sense of ownership

The structured nature of ChatGPT's outputs often reduced designers' engagement and sense of ownership, contributing to a decline in creative confidence and energy. Participants expressed feeling less connected to their ideas and struggled to maintain flow during the AI-supported ideation process. Broadly, efforts should focus on fostering reflective and intentional use of AI tools to ensure that designers remain active agents in the creative process. Below are some ideas of how that could be achieved within education, product, and individual (designer) perspective:

A.   Educational Perspective

- Implement guidelines that discourage copy-paste behavior and promote active manipulation of AI outputs.

- Train students to see AI as a tool to support their creativity, not replace it. Assign tasks that require active curation and justification of AI-generated ideas.

- Train student to use ChatGPT as a metacognition tool that help them think about their ideas, instead of having the tool create the concepts.

- Include exercises where students critique AI outputs, identify their limitations, and propose modifications.

- Educate students about how AI tools work, their biases, and their limitations to foster informed and reflective use.

B.   Product Perspective

- Enhance the tool's ability to facilitate creative flow, such as adding modes that dynamically adjust to user feedback and engagement levels

- Limit the amount of copying allowed

- Ask the user questions to help them get involved in the process, for example: "What aspects of this suggestion resonate with your goals?" or "What changes would make this idea more effective?"

- Develop interface designs that adapt to the user's creative stage, such as toggling between inspiration, ideation, and refinement phases, to maintain engagement and momentum.

C.   Designer Perspective

- Treat AI suggestions as starting points, making manual adjustments or elaborations to ensure the final output reflects personal creativity and vision.
- Have ChatGPT be a creative facilitator to help you with creative problem solving techniques (Heijne & Van Der Meer, 2019) to help you actively generate creative solutions.
- Be mindful of when to use ChatGPT, leveraging it during moments of creative block or refinement rather than as the sole driver of ideation.

4.4.3. Promote broader exploration through intentional AI use

The predominant approach of asking for concepts to the design challenge resulted in concrete and closely related outputs, which hindered participant's creative thinking and reduced opportunities for deep exploration. Participants expressed frustration with its inability to get more creative and relevant outputs. Therefore, it is important to use ChatGPT in a more intentional way in order to promote broader exploration. Below are some ideas of how that could be achieved within education, product, and individual (designer) perspective:

A.   Educational Perspective

- Create tasks that encourage the deliberate use of AI for both abstract and concrete ideation, teaching students to toggle between these modes strategically.
- Offer prompt templates for the different phases of ideation and goals (diverging, converging, problem exploration, solution exploration, etc.)

B.   Product Perspective

- Provide options to adjust the abstraction level of text outputs (e.g., summaries or creative ideas), enabling users to explore broader themes or detailed specifics.
- Provide tools to suggest or refine prompts based on the ideation stage, such as divergent versus convergent thinking.
- Add features to introduce randomness or tangential suggestions, encouraging users to consider less obvious or unexpected directions.

C.   Designer Perspective

- Start broad, then narrow down. Abstract your HMW into more abstract concepts or themes that you can explore with ChatGPT before diving into specific details. For example, instead of asking, "How can I design a more comfortable chair?" ask, "What makes people feel comfortable in a space?"
- Craft prompts that ask ChatGPT to reinterpret the problem, such as "How would this issue be approached in a different cultural or historical context?"

4.4.4. Strengthen Critical Appraisal Skills to Mitigate Over-Reliance on AI

The study identified a tendency for designers to rely heavily on AI-generated outputs, often adopting them with minimal modification. This over-reliance led to reduced understanding, engagement, and critical appraisal of concepts. Reinforcing the need for strategies to improve designers' ability to evaluate and refine ChatGPT outputs thoughtfully.

A.   Educational Perspective

- Assign exercises where students analyze the assumptions, limitations, and biases in AI-generated outputs.
- Teach students about data ownership, authorship, and intellectual property implications and concerns when using AI tools.

B.   Product Perspective

- Embed reflective questions directly into the interface, prompting users to critique outputs. The tool could ask, "What part of this idea excites you? What could be improved?" or "Does this align with the end-user's needs?

C.   Designer Perspective

- Question outputs, focusing on their assumptions, logic, and gaps.
- Understand how the tool uses inputed data and ensure that intellectual property and privacy are safeguarded during use.

4.5. Limitations and Future Directions

The findings of this study must be interpreted in light of several limitations. First, the integration of the experiment within an educational course, while reflective of real-world usage, limited the ability to observe the ideation process under controlled experimental conditions. Additionally , the experiment sample lacked diversity in terms of gender and age distribution, with 77,1% of the participants identifying as female and 76,5% of the participants in their early 20's. While this imbalance does not inherently invalidate the findings, it may limit the generalizability of the results to broader designer populations, particularly those with more balanced demographic characteristics. Additionally, the sample was second-year design students, therefore its results mays not apply to more experienced professionals whose approaches to AI use may differ significantly.

Future research should address these limitations by employing more diverse and controlled

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methodologies. Expanding participant demographics to include a broader range balanced representation across genders, ages, and levels of design expertise and researching other design contexts t(e.g., professional settings) can provide richer insights into how AI tools are utilized across different contexts and expertise.

Longitudinal studies that track sustained interactions with generative AI over time could shed light on its long-term impacts on creativity, particularly on divergent thinking, iterative exploration, and problem-solving. Furthermore, investigating contextual factors, such as the complexity of design briefs and task constraints, can help uncover the conditions under which ChatGPT tools are most effective or where they may inadvertently hinder the creative process. The same applies to the different phases of the creative process. Our research focused on the initial stages of ideation following problem definition, researching the use of ChatGPT within other phases could also be interesting, in providing more complete guidelines to the creative process in general, since each phase has different needs.

Another important limitation pertains to the study design itself. Participants were aware of the study's purpose and conditions, and in some case that have influenced their behavior and approach to ideation tasks. There were reports of being more explorative and trying different approaches and just copy-pasting GPT ideas as they are, because they thought that was the most appropriate for the research. Employing independent participant groups for each condition in future studies could mitigate this bias and produce more reliable valid insights.

Different analysis could still be done with the data we collected. Future research could also calculate rarity of the concepts, given that repetitive ideas was a considerate theme, it would be something interesting to explore. Another promising direction for future work involves performing a qualitative and quantitative analysis of the ChatGPT transcripts collected during ideation sessions. By examining how designers prompted the system and how they responded to the tool's outputs, we could identify new insights, and observe how the now know insights relate to the prompting approaches.

Finally, further research should also be done to determine how the use of different prompts, GPT configurations that align more closely with natural creative workflows and different ideation phases would perform in comparison to our findings. This would allow to more precisely recommend how to improve it's use for creative means. In the following section we will discuss some of these possible recommendations.

5. Conclusion

This study investigated the influence of ChatGPT on the ideation processes of design students, examining its effects on creativity, confidence, and critical appraisal. Utilizing a mixed-methods approach embedded within an educational setting, the research provides a nuanced understanding of how generative AI impacts creativity in practice.

The methodology included a within-group experimental design with 35 design students tasked with generating concepts in two conditions: with and without ChatGPT. Data collection spanned multiple methods, including quantitative evaluation of design outcomes, pre- and post-experiment questionnaires, and qualitative analysis of reflections, interviews, and ChatGPT transcripts. Creativity was assessed through expert evaluations of concept dimensions such as novelty, relevance, and clarity, while thematic coding of qualitative data provided deeper insights into designers' experiences and ideation approaches.

The results revealed both benefits and challenges in using ChatGPT during ideation.

Regarding our first research question, designers exhibited a significant shift in their ideation methods when using ChatGPT compared to traditional, non-digital techniques. Without AI, participants employed hands-on methods like sketching, brainstorming, and visual tools (e.g., mood boards and mind maps), fostering divergent thinking and abstract exploration. With ChatGPT, designers leaned toward text-based ideation, often requesting concrete, ready-to-use concepts. While this approach facilitated rapid idea generation, it also limited deeper exploration. The search for more closely related responses, required more narrow prompts, which led to challenges in crafting effective prompts to convey nuanced design intentions. Furthermore, with it resulted in more repetitive and generic ideas.

Addressing our second research question, the integration of ChatGPT resulted in a noticeable decline in creative confidence and engagement, as supported by both quantitative and qualitative findings. Participants reported feeling less confident in their ideas and decisions when using ChatGPT, with a significant drop in energy, creative thinking, engagement and flow during ideation. Qualitative insights highlighted similar trends, as participants described a reduced sense of ownership and agency over their creative outcomes, which contributed to their decreased confidence. They also reported feeling less engaged in the process, as the tool's structured and concrete outputs often diminished opportunities for personal input and exploration.

Furthermore, ChatGPT's tendency to provide concrete and closely related outputs constrained broader exploration of problem and solution spaces, reducing creative thinking. Participants expressed frustration with the difficulty of achieving nuanced or context-specific results, which hindered their ability to balance abstraction and relevance. While some participants successfully leveraged ChatGPT to refine or elaborate on initial ideas, these instances were less common. Overall, the findings indicate that while ChatGPT can streamline certain aspects of ideation, it risks undermining deeper engagement and consequently harming creative thinking and confidence.

With respect to our third research question, participants' idea evaluation approach appeared consistent across both conditions, though important challenges emerged in the ChatGPT condition. A notable "copy-paste" behavior was observed, where designers often directly integrated AI-generated outputs with minimal modification. This over-reliance on ChatGPT led to a lack of deeper engagement with their concepts, with some participants demonstrating limited understanding of the details or rationale behind the ideas they submitted.

The level of critical appraisal was found to be influenced by participants' beliefs and prior knowledge and attitudes in relation to ChatGPT. Furthermore, ChatGPT's human-like responses occasionally led participants to see it as more reliable and superior, reducing the rigor of their evaluation. This highlights the need for educational strategies that not only strengthen designers' technical skills but also cultivate reflective attitudes and critical thinking, ensuring that AI-generated ideas are thoughtfully evaluated and adapted to their creative intent.

The study underscores critical implications for integrating generative AI into design education and practice. While tools like ChatGPT provide valuable support in speeding ideation, they also introduce challenges that must be addressed to preserve essential aspects of the creative process. Designers need to balance the efficiency offered by AI with their own creative agency, ensuring that the tool serves as a complement rather than a replacement for human input. Strategies that encourage deeper engagement with ideas, foster critical appraisal of AI outputs, and maintain a sense of ownership over creative decisions are essential. Educational frameworks should incorporate modules that teach designers how to interact with AI reflectively, emphasizing the development of prompts to best support different ideation needs such as diverging vs converging thinking and creative problem solving techniques, critical evaluation skills, and an understanding of the limitations and biases inherent in AI systems. Additionally, product designers should focus on features that actively support cognitive demands of prompting, exploration, abstraction, and iterative refinement to better align with designers' natural creative workflows.

Future research could explore long-term impacts of generative AI on designers' designers' ability to engage in divergent thinking, iterative exploration, and problem-solving over time. Contextual factors such as the nature of the design brief, user expertise, and task constraints should also be examined to better understand when and how generative AI tools are most effective. Furthermore, the development and testing of adaptive AI features tailored to creative workflows—such as tools that dynamically adjust to user input, provide context-aware suggestions, or better support abstraction and critical reflection— represent an important avenue for exploration.

The study's findings must also be interpreted within its limitations, which present additional opportunities for future research. The integration of the experiment within a course limited the ability to observe the ideation process in controlled conditions, and the reliance on self-reported data may have introduced biases in participants' reflections. Additionally, the small sample size and the focus on novice designers may limit the generalizability of the findings to more experienced professionals or broader design contexts. Future research should address these limitations by expanding participant demographics, incorporating more controlled experimental setups, and exploring the perspectives of experienced designers.

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Appendices

Appendix A: Kick off overview

Kick-Off 25/03

i. Presentation (30 min)

- Hand-in consent form, checklist and workshop material.

I will briefly mention the different material and what they are for, and say I will indicate when is time to use each of them during the presentation.

- Who am I?

Briefly present myself and the researchers in the group, and explain that the research is for my Master Graduation project, and will also be shared with their university's research group.

- What the research is about
  - Explain why we are focusing on GPT and creativity.
  - Benefits on participating in the study.

- What we ask of them (Instructions)
  - General Overview
  - Highlight it is individual
  - Highlight how they ideate vs create concepts is up to them (one big ideation for all three concepts or one ideation process per concept).
  - Concept Generation Instructions (Show checklist)
  - Explain how word template fit within steps.
    - Explain what to do there in each step of the checklist
    - Make clear they can use AI to make the concept images, as long as they do that after filling the concept description.
    - Show reflection questionnaires and highlight when they are supposed to be filled.
    - Ask if there are any questions

- Interviews
  - I will explain that we are also looking for some volunteers to make some post-interviews, why that would be helpful to the study, and how to volunteer.

- Data Management
  - Go through the consent form points with them and explain how their data is gonna be used.
  - Explain participant ID and how it will be used
  - Give them time to ask questions and fill.
  - Explain we will keep the signed consent form. But they can keep the checklist with the summary of what the experiment entails.
  - If people are done filling it in go to next step.

- Fill Online Form (5 min)
  - If people are done filling consent form, they can already start filling online form

- Chat GPT
  - Interactive Explanation (I made interactive slides using Mentimeter)
    To make the explanation a bit more interesting, we will have a quiz on basic chat GPT knowledge. We will cover:
    - What is chat GPT
    - How it generate answers
    - Privacy concerns
    - Bias
    - Prompt-Engineering
  - Practical Stuff
    - How to make a account
    - Show how to ensure they are using the free version
    - How to share your GPT chat anonymously.

- Prompt-Engineering

Explain different prompt types and form and how it influence GPT outcomes.

ii. Workshop (30 min)

- Introduction (5 min)
  - Explain the goal of the workshop is to experiment and learn using chat GPT.
  - Explain how workshop will work
  - Introduce Brief : Design for life in Mars
    (Since we do not want to ideate for the PS1 brief yet, since it would influence the ideation without AI that is suppose to happen first, for this workshop we have a new brief)

- Introduce rules
  - We will use a timer, so that every 2 minutes we make them try something new of what chat GPT can do for them.
  - Try to create as many ideas as possible use the workshop papers provided to them for sketching/note taking.
  - In the last 5 min build a final concept direction with GPT help.
  - Write your concept information use the printed template provided to them,
  - Introduce what GPT says it can help with ideation. The order in which the capabilities is up to them, and they can also try something that is not on the list instead.

(Due to constraint of time we had to shorten the workshop, and could not include printed template due to problems with the printer).

- Workshop execution (15 min)
  - Diverging (10 min)
  - Converging Final Concept (5 min)
  - Reflection (10 min)

- Have a short discussion where people can share their ideas, approaches.
  - Were their ideas useful, novel?
  - Did they took a particular approach in prompting?
  - What went well or bad?
  - Were there any question in filling the questionnaire or in the procedure?
  - Ask if there are any adittional questions or comments.

- Explain what I hoped they got from this exercise
  - being more familiar with chat GPT its capabilities and limitations.
  - get a better understanding of how what you input influence what chat GPT gives you back.
  - being more familiar on different ways the tool could be used in your creative process.
  - having more clear how the research procedure go, and how chat GPT use is integrated.

iii.   **Final Considerations**

- Please do not use chat GPT or any other generative AI for your PS1 brief ideation until you are finished with part 1 of the study.
- They can keep the research checklist and refer to it when needing participant ID, and when not sure what step to do next.
- Please hand-in your signed consent forms before leaving. I will stay a couple of minutes in case there are still questions.
- I will be in their class on Thursday, in case there are any questions or need for help with chat GPT or the research materials.
- Making sure they know they can contact me in case of questions through e-mail.

Appendix B: Pre-experiment questionnaire

Participant Background Questionnaire

* Obrigatória

Background Information

What is your date of birth? *

> Insira a data (dd/MM/yyyy)

What is your gender? *

- ○ Male
- ○ Female
- ○ Non-binary
- ○ Prefer not to say
- ○ Outra

Please select the option that best represents your region of origin. *

- ○ Africa
- ○ Asia
- ○ Europe
- ○ Middle East
- ○ North America
- ○ Oceania
- ○ South and Central America
- ○ Prefer not to say

Voltar   Avançar   Página 2 de 4

Prior experience with chat GPT

How often have you used Chat GPT in the last Month?

- ○ I haven't used it
- ○ A couple of days in the month
- ○ At least once a week
- ○ Several times a week
- ○ Everyday in the last month
- ○ Prefer not to say

Which of the options below best represent your proficiency using chat GPT for creative activities ? *

- ○ **Novice:** I'm unfamiliar with its functionalities or how to use it for ideation.
- ○ **Inexperienced:** I know its potential uses, but I've rarely applied it in practice, especially for ideation.
- ○ **Intermediate:** I have some experience applying it to creative workflows, but I wouldn't consider myself an expert.
- ○ **Experienced:** I'm comfortable leveraging its capabilities to enhance my workflow.
- ○ **Advanced:** I use it regularly as a tool in my creative process and have explored and utilized many features for ideation and other purposes.
- ○ Prefer not to say

For what purposes have you used chat GPT? (Select all that apply) *

- ☐ I would rather not answer
- ☐ Generating initial ideas or brainstorming for creative projects.
- ☐ Creating content such as text, designs, or code
- ☐ Conducting research or gathering information relevant to my projects or studies.
- ☐ Learning new skills, techniques, or concepts related to my field of study
- ☐ Assisting in solving design challenges or overcoming creative blocks
- ☐ Obtaining feedback on ideas or projects, or critiquing works in progress.
- ☐ For personal entertainment, curiosity, or exploring creative concepts without a specific project in mind
- ☐ Outra

Voltar | **Avançar**

Página 3 de 4

Participant Background Questionnaire

* Obrigatória

Creative Confidence

Since our study is about creativity, we are also interested in exploring your creative confidence. Rate the following statements according to how much you agree with it.

I am creative. *

1	2	3	4	5

Strongly Disagree   Strongly Agree

I know I can efficiently solve even complicated problems *

1	2	3	4	5

Strongly Disagree   Strongly Agree

I know I can efficiently solve even complicated problems *

1	2	3	4	5

Strongly Disagree   Strongly Agree

I trust my creative abilities *

1	2	3	4	5

Strongly Disagree   Strongly Agree

Compared with my friends, I am distinguished by my imagination and ingenuity. *

1	2	3	4	5

Strongly Disagree   Strongly Agree

I have proved many times that I can cope with difficult situations.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

I am sure I can deal with problems requiring creative thinking
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

I am good at proposing original solutions to problems.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

I am confident I can come up with a creative way (i.e., original and useful) to solve my design challenge for PS1. *

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

| Voltar | **Enviar** | Página 4 de 4 ━━━━━━━━━━

Appendix C: Procedure Checklist (concept template cover)

Chat Assisted Ideation: A study on creativity in AI-designer collaboration

| Participant ID |

Creating concepts with and without chat GPT

*This activity should be done individually.

Please perform activities in the order below.

1. Start with Part 01: Ideation **without using Generative AI**

   [ ] Diverge-ideate take picture of your sketches/ideas and upload in this file.
   [ ] Define three concept directions and fill descriptions.
   [ ] Fill Online Reflection on Part 1 (should only take < 5 min)

2. After, repeat **using chat GPT** as ideation tool for Part 2.

   [ ] Diverge-ideate if there is sketches/notes take picture and upload in this file.
   [ ] Define three new concept directions and fill descriptions.
   [ ] Fill Online Reflection on Part 2 (should only take around 5 min)

3. Save this file as PDF with the naming: Firstname_Lastname_concepts. (Researcher will anonymize file before processing data)
4. Make one folder in the Teams Channels of your group named 'Concepts'. Each team member upload the PDF and you are all done 😊

🚨   We ask you not to delete the GPT conversation(s) until 15/04/24

114   **ChatGPT and ideation** a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   115

Appendix D: Concept template

Part 1 Diverging without using Generative AI

Please take a picture of the sketches you made during the process of diverging and upload.

If you had separate ideation sessions per concept, you can identify what concept they relate to by adding the concept number (1,2,3).

Take a picture of your ideas sketches and notes

Replace with an image of your concept

Replace with concept title

Quote
What was said in your research that inspired this direction.
"Replace with quote"

Design Challenge
The current state of things and the problem you are trying to solve.
Replace with design problem description

Design direction
Please explain the goal of this concept compared to the current state. Briefly describe the design's appearance, form, function and the user interaction.
Replace with design direction description.

External Inspiration
If applicable (e.g., I searched for [ ] on [ ] and saw this [image, information, etc] of [ ] and thought [ ]).
Replace with inspiration.

**Replace with an image
of your concept**

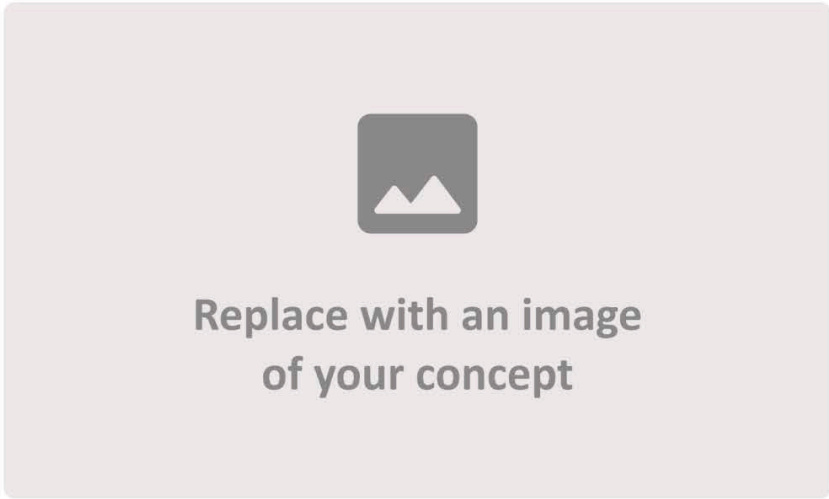# Replace with concept title

Quote
What was said in your research that inspired this direction.
"Replace with quote"

Design Challenge
The current state of things and the problem you are trying to solve.
Replace with design problem description

Design direction
Please explain the goal of this concept compared to the current state. Briefly describe the design's appearance, form, function and the user interaction.
Replace with design direction description.

External Inspiration
If applicable (e.g., I searched for [ ] on [ ] and saw this [image, information, etc] of [ ] and thought [ ]).
Replace with inspiration.

**Replace with an image
of your concept**

Replace with concept title

Quote
What was said in your research that inspired this direction.
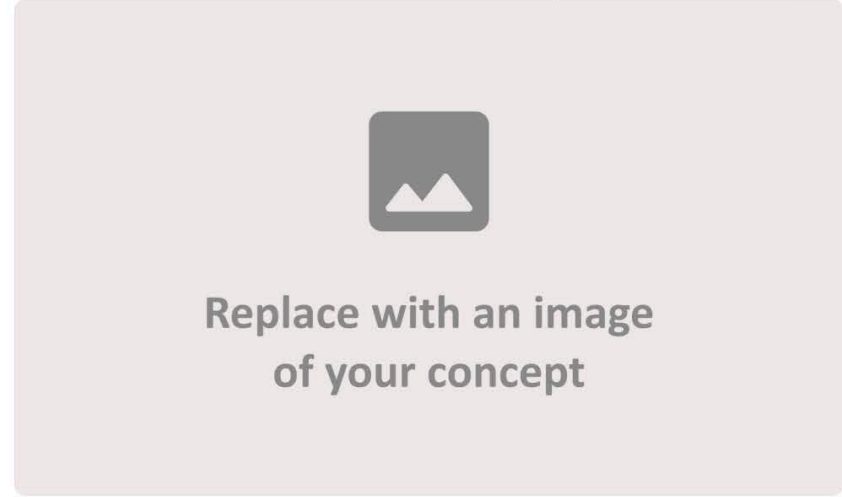"Replace with quote"

Design Challenge
The current state of things and the problem you are trying to solve.
Replace with design problem description

Design direction
Please explain the goal of this concept compared to the current state. Briefly describe the design's appearance, form, function and the user interaction.
Replace with design direction description.

External Inspiration
If applicable (e.g., I searched for [ ] on [ ] and saw this [image, information, etc] of [ ] and thought [ ]).
Replace with inspiration.

Have you completed the three concepts? Please reflect on "Part 1: Ideation without Generative AI" before continuing. Scan the QR Code or click here.

Part 2 Diverging using chat GPT

If you also made sketches during the process of diverging, please take picture and upload.

If you had separate ideation sessions per concept, you can identify what concept they relate to by adding the concept number (1,2,3).

Take a picture of your ideas sketches and notes

Replace with an image of your concept

Replace with concept title

Quote
What was said in your research that inspired this direction.
"Replace with quote"

Design Challenge
The current state of things and the problem you are trying to solve.
Replace with design problem description

Design direction
Please explain the goal of this concept compared to the current state. Briefly describe the design's appearance, form, function and the user interaction.
Replace with design direction description.

Use of chat GPT and how it led to this concept
Describe any specific GPT interaction that inspired you to come up with this concept (e.g., After doing [ ], GPT's [response, suggestion, question] made me think of [ ]).
Replace with answer

Chat GPT Conversation Link
Select share on the top right of the conversation interface, select "copy link" and paste below.
Replace this with the chat link

Replace with an image
of your concept

Replace with concept title

Quote
What was said in your research that inspired this direction.
"Replace with quote"

Design Challenge
The current state of things and the problem you are trying to solve.
Replace with design problem description

Design direction
Please explain the goal of this concept compared to the current state. Briefly describe the design's appearance, form, function and the user interaction.
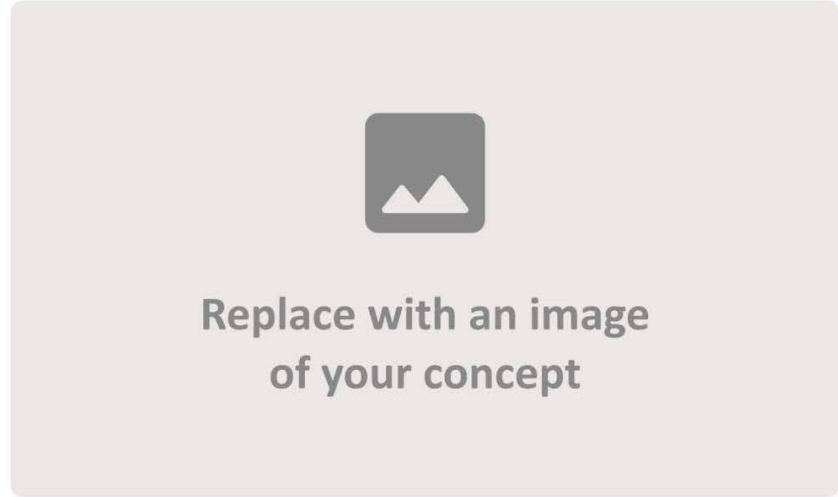Replace with design direction description.

Use of chat GPT and how it led to this concept
Describe any specific GPT interaction that inspired you to come up with this concept (e.g., After doing [ ], GPT's [response, suggestion, question] made me think of [ ]).
Replace with answer

Chat GPT Conversation Link
Select share on the top right of the conversation interface, select "copy link" and paste below.
Replace this with the chat link

Replace with an image
of your concept

Replace with concept title

Quote
What was said in your research that inspired this direction.
"Replace with quote"

Design Challenge
The current state of things and the problem you are trying to solve.
Replace with design problem description

Design direction
Please explain the goal of this concept compared to the current state. Briefly describe the design's appearance, form, function and the user interaction.
Replace with design direction description.

Use of chat GPT and how it led to this concept
Describe any specific GPT interaction that inspired you to come up with this concept (e.g., After doing [ ], GPT's [response, suggestion, question] made me think of [ ]).
Replace with answer

GPT conversation link
Replace this with the chat link

Please reflect on "Part 2: Ideation using chat GPT" after finishing the concepts. Scan the QR Code or click here.

Appendix E: Reflection Questionnaire

A. First experiment condition (no Gen AI use)

Reflection Part 1: ideation WITHOUT the use of chat GPT

* Obrigatória

Overall Ideation Experience

Rate the following statements according to how well they represent your experience ideating the first three ideas:

The ideation process stimulated creative thinking. *

1	2	3	4	5

Strongly Disagree   Strongly Agree

I generated a lot of ideas.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I explored unconventional design inspirations.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I approached the problem and ideas from multiple perspectives.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

Voltar   Avançar   Página 2 de 5

Concept Development and evaluation of ideas

Rate the following statements according to how well they represent your experience ideating the first three ideas:

The ideation resulted in the development of useful concepts.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

The ideation resulted in the development of novel concepts.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I thoroughly re-examined and challenged my own ideas. *

1	2	3	4	5

Strongly Disagree   Strongly Agree

I found it easy to evaluate and critique my ideas effectively. *

1	2	3	4	5

Strongly Disagree   Strongly Agree

Voltar   Avançar   Página 3 de 5

124   **ChatGPT and ideation** a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   125

Personal Engagement and Confidence

Rate the following statements according to how well they represent your experience ideating the first three ideas:

I feel confident with my design choices.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I felt engaged throughout the process of creating the concepts.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I felt in the flow during concept ideation.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

My energy level was high throughout the process.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

My knowledge on the problem increased throughout the process.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I am confident I came up with a creative ideas to solve my design challenge for PS1.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

Voltar   Avançar   Página 4 de 5

Seeking Inspiration

Rate the following statements according to how well they represent your experience ideating the first three ideas:

It was easy to convey my needs and intentions when seeking inspirational materials.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I found inspiration that was relevant to the problem or to my goal.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

Voltar   Enviar   Página 5 de 5

126   **ChatGPT and ideation** a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   127

B.   Second experiment condition (using ChatGPT)

Reflection Part 2: Ideation USING chat GPT

* Obrigatória

Overall Ideation Experience

Rate the following statements according to how well they represent your experience ideating the last three ideas with the help of chat GPT.

The ideation process stimulated creative thinking. *

1	2	3	4	5

Strongly Disagree   Strongly Agree

I generated a lot of ideas.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I explored unconventional design inspirations.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I approached the problem and ideas from multiple perspectives.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

Voltar   Avançar   Página 2 de 7

Concept Development and evaluation of ideas

Rate the following statements according to how well they represent your experience ideating the last three ideas with the help of chat GPT.

The ideation resulted in the development of useful concepts.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

The ideation resulted in the development of novel concepts.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I thoroughly re-examined and challenged my own ideas. *

1	2	3	4	5

Strongly Disagree   Strongly Agree

I found it easy to evaluate and critique my ideas effectively. *

1	2	3	4	5

Strongly Disagree   Strongly Agree

Voltar   Avançar   Página 3 de 7

Personal Engagement and Confidence

Rate the following statements according to how well they represent your experience ideating the last three ideas with the help of chat GPT.

I feel confident with my design choices.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

I felt engaged throughout the process of creating the concepts.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

I felt in the flow during concept ideation.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

My energy level was high throughout the process.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

My knowledge on the problem increased throughout the process.
*

| 1 | 2 | 3 | 4 | 5 |

I felt in the flow during concept ideation.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

My energy level was high throughout the process.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

My knowledge on the problem increased throughout the process.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

I am confident I came up with a creative ideas to solve my design challenge for PS1.
*

| 1 | 2 | 3 | 4 | 5 |

Strongly Disagree   Strongly Agree

Voltar   Avançar   Página 4 de 7

130   **ChatGPT and ideation** a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   131

Seeking Inspiration

Rate the following statements according to how well they represent your experience ideating the last three ideas with the help of chat GPT.

It was easy to convey my needs and intentions when seeking inspirational materials.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I found inspiration that was relevant to the problem or to my goal.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

Voltar   Avançar   Página 5 de 7

Chat GPT as a creative partner/tool

Rate the following statements according to how well they represent your experience ideating the last three ideas with the help of chat GPT.

Incorporating the use of chat GPT in my ideation process was intuitive.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

Communicating what I intended or wanted to the chatbot was easy.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

The chatbot provided suggestions that were relevant to the problem or to my goal.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I felt confident sharing my ideas with the chatbot.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I would recommend chat GPT as a useful tool for ideation process.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

I would recommend chat GPT as a useful tool for ideation process.
*

1	2	3	4	5

Strongly Disagree   Strongly Agree

Voltar   Avançar   Página 6 de 7

Impact of chat GPT on your creative process

To what extent do you feel using chat GPT impacted your creative process? *

1	2	3	4	5

Not at all   Extremely

In which ways did Chat GPT supported your creative process? *

Insira sua resposta

In which ways did Chat GPT harmed your creative process? *

Insira sua resposta

Voltar	Enviar

Página 7 de 7 ━━━━━━━━━━━━━

Appendix F: Follow-up interview script

Thank for volunteering and taking some time to participate on this interview. I really appreciate as it is really helpful for our research. I don't have access yet to the concepts you delivered, do you have them with you, and could share them through your screen, so we can use them within the interview?

i. **About Part 1: without generative AI**

- Can you guide me through your process designing without the generative AI using your sketches and concepts?
  - Can you guide me through the process of creating the sketches?
    - What was your initial ideas?
    - What inspired each one of them?
  - How was your process for moving from these sketches to your three concepts?
    - How was your decision process on what to keep, or combine from your initial ideas?
    - Why did came up with this specific directions?
    - How did you refine and develop these concepts further after generating them?

ii. **Part 2: using chat GPT in comparison.**

- Can you guide me through your process designing your sketches/concepts using chat GPT?
  - What differences did you notice in your creative process when using Chat GPT compared to when you didn't?
  - Were there any similarities in your approach regardless of using Chat GPT?
- How did you defined what to prompt chat GPT to find inspiration?
  - How did it differ from searching for inspiration in part 1?
    - Was it easier? In what way?
  - Were there specific keywords you used ?
  - Were there a specific interaction with chat GPT that you found particularly inspiring?
  - Were there a specific interaction with chat GPT that you found particularly frustrating or constraining creatively?
- How did you refined and develop your concepts further after generating them?
  - How did you evaluate GPT suggestions ?
  - How did you built over GPT suggestions?

iii. **Overall Experience:**

- Looking back on the entire process, what are your overall thoughts and feelings?
- What are your thought in incorporating Chat GPT into the ideation process?
  - How does it differ on how you saw it before this experiment?

134   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   135

- How would this change your ideation process in the future?
    - How would you change your use of AI in the future?
- How did it affect your sense of ownership of the ideas?
- Are there any suggestions or improvements you would recommend for future projects involving the use of AI in creativity?

Appendix G: themes/ categories/codes

RQ1: How do designers approach the ideation process and inspiration search when using ChatGPT?

Categories/Codes	Description
1. Creative approach	Captures how designers integrate ChatGPT into their creative ideation, focusing on strategies like combining existing ideas, generating new concepts, or using ChatGPT for inspiration.
a. Combine from list of ideas	Designer asks ChatGPT to generate a list of ideas and selects multiple items to combine into a new concept, highlighting the synthesis of different inspirations.
b. Copy and Paste	Designer directly transfers ideas or concepts generated by ChatGPT without significant modification or personalization.
c. Select idea from list and refine it	Asked chatGPT for a list of ideas, chose one and refine it to better fit problem.
d. Come up with own idea inspired by part of GPT output	Designer uses ChatGPT's suggestions as a starting point but generates a unique idea based on their own interpretation and inspiration from part of the output.
2. Creative thinking	Evaluates how the use of ChatGPT influenced the designer's creative process, either by enhancing their thinking or by imposing limitations.
a. Designer takes a passive role as chat GPT does everything	Designers felt or was passive as ChatGPT generated fully formed concepts, as it left little room for their own ideation.
b. No thinking	The tool's suggestions reduced the need for active problem-solving or critical thinking.
c. Helpful during creative block or struggle	Designers found ChatGPT useful in overcoming creative blocks, particularly when they struggled to generate ideas or felt a lack of inspiration.
d. Lonely compared to the back and forth collaboration between people	Designers noted the absence of iterative back-and-forth exchanges with ChatGPT, found in human collaboration, which limited the tool's ability to stimulate ongoing creativity.

Categories/Codes	Description
3. ChatGPT (mis)fit within ideation process	Evaluates how the use of ChatGPT influenced the designer's creative process, either by enhancing their thinking or by imposing limitations.
a. Hard to go from GPT textual output to visual (e.g., sketches)	Hard to go from GPT textual output to visual (e.g., sketches)Designers faced challenges when attempting to translate text-based ideas generated by ChatGPT into visual formats, such as sketches or images.
b. Converged instead of diverged	Designers expressed frustration that ChatGPT encouraged convergence toward specific ideas, limiting the exploration of diverse, divergent possibilities.
c. Good for kickstarting and refinement of ideas	ChatGPT proved useful for generating initial ideas and enhancing existing concepts.
d. Evaluation of the ideas followed the same basis as in Part 1(research-based)	Designers reported that their method for selecting stimuli was unchanged by the use of ChatGPT, suggesting a consistent approach regardless of the tool's influence.
4. Inspiration search approach	Explores the different ways designers approached ChatGPT for inspiration, focusing on methods such as searching for abstract ideas or seeking out specific concepts.
a. Asked chatGPT to create a concept	Designers used ChatGPT to generate fully developed concepts, seeking ready-to-use ideas rather than rough inspirations.
b. Asked chatGPT to elaborate	Designers requested that ChatGPT expand on its initial suggestions, refining or building on partial ideas to develop more complete concepts.
c. Asked chatGPT for keywords or other more distant and general inspiration	Designers looked for more abstract inspirations rather than fully detailed concepts, leveraging ChatGPT for high-level ideas rather than finished outputs.
d. Use of different chats to try different prompt approaches	Designers experimented with various prompts and started new chats to reset ChatGPT's context.

Categories/Codes	Description
5. Inspiration search ease	Explores the different ways designers approached ChatGPT for inspiration, focusing on methods such as searching for abstract ideas or seeking out specific concepts.
a. Difficulty conveying nuances and frequent adjustments needed for getting useful GPT responses.	Designers struggled to frame prompts in a way that consistently yielded relevant or useful responses from ChatGPT.
b. Learning curve	Designers encountered a learning curve in effectively communicating their design goals to ChatGPT
6. Search output format	Designers found that the outputs generated by ChatGPT sometimes failed to fully address their search goals or design intentions, leaving gaps to fill.
a. Do not target problem precisely	Designers found that the outputs generated by ChatGPT sometimes failed to fully address their search goals or design intentions.
b. Vague and confusing output	Some designers found ChatGPT's responses to be vague or difficult to interpret, which limited their practical use.
c. Too much text	Designers noted that ChatGPT occasionally produced excessive or irrelevant text, which complicated the process of extracting useful insights.
d. Provide input on multiple concept aspects (functionality, appearance, etc)	ChatGPT served as a source of inspiration, providing fragmented ideas and information that designers could incorporate into different aspects of their project.
e. Worked well for more straightforward/logical solution in comparison with when requiring creative thinking.	Designers observed a discrepancy in ChatGPT's output quality, with better performance on straightforward tasks compared to more open-ended or creative challenges.

Categories	Description
7. Fluency	Refers to the total number of ideas produced with ChatGPT during the ideation process, emphasizing both volume and variety.
a. Generate a lot of ideas in a short time although can be repetitive	Although ChatGPT produced content quickly, designers noticed that it often repeated similar ideas without introducing significant novelty.
b. Lack of motivation to continue diverging beyond the number of directions asked for the assignment	Because the assignment specified a exact number of directions as output, students limited their ideation to that.
c. Constricts exploration (diverging) leading to less ideas in total	Designers found that prompting GPT required converging, limiting the number of divergent ideas generated.
8. Flexibility	Describes how well ChatGPT was able to provide a range of ideas from different perspectives, supporting designers in exploring diverse creative directions.
a. Present multiple directions and approaches that might not have been considered	ChatGPT encouraged designers to explore alternative directions in their work, helping them identify possibilities they hadn't previously considered.
b. Functions as extended memory reminding of simple and straightforward overlooked ideas, knowledge.	ChatGPT highlighted familiar but previously overlooked ideas, prompting designers to reconsider simple concepts they might have ignored.
c. Chat GPT offered some interesting more unconventional ideas	Designers recognized certain outputs from ChatGPT as creative or unconventional.
d. Lack of space for both chat and designer to create crazy ideas	Designers found that both the structure of their prompts and ChatGPT's responses could leave little space for imaginative or open-ended exploration.
e. Non-sense output	Reflects instances where ChatGPT's output was irrelevant or lacked coherence, failing to contribute meaningfully to the design process.

Categories	Description
9. Knowledge on the problem	Explores how interacting with ChatGPT expanded or enhanced the designer's understanding of the design problem and its potential solutions.
a. Offer a broad idea of different technologies, materials and features that could be incorporated.	ChatGPT offered general information that helped designers clarify or specify certain aspects of their design concepts, contributing to more precise solutions.
b. Helped get a better understanding of context and/or target user	Designers engaged ChatGPT to inquire about specific contextual factors or user insights, broadening their knowledge for more targeted design solutions.
c. ChatGPT could help evaluate and explain if and why an idea would work	Designers used ChatGPT to gather feedback on the feasibility and practicality of their ideas, helping them refine concepts.
10. Creative outcome throughness	Explores the different ways designers approached ChatGPT for inspiration, focusing on methods such as searching for abstract ideas or seeking out specific concepts.
a. Improved clarity and conciseness of descriptions	Highlights how effectively the idea is conveyed, considering clarity in language, grammar, and overall communication with chat GPT.
b. Lack of complete understanding or exploration of the idea	Indicate a incompleteness of concept, lacking some coverage with regard to who, what, where, when, why, and how.
11. ChatGPT output novelty	Considers the originality of the idea, emphasizing its uniqueness and whether it represents a new, unexpressed concept.
a.Generic (not new) ideas	Describes ideas that lack innovation, instead recycling familiar or previously expressed concepts without offering new perspectives.
b. Repetitive	Reflects frustration when ChatGPT repeatedly generated similar or identical ideas, even when explicitly prompted to provide new or alternative concepts.

Categories	Description
c. Ideas previously thought by the designer	Highlights instances where ChatGPT generated ideas that mirrored thoughts or concepts already discussed by the designer or their team.
d. Ouput is affected by prompt (straightforward or technical questions get straightforward and logical answers)	Observes how the uniqueness or novelty of the output from ChatGPT varies based on the phrasing and structure of the prompt provided by the designer.
12. Creative confidence, ownership and pride	Explores the level of pride and personal connection designers feel toward ideas generated with ChatGPT, particularly in terms of how creative they perceive the outcome to be.
a. Negative effect on sense of ownership and pride of ideas	Designers expressed a sense of disconnection or reduced pride in ideas generated by ChatGPT, perceiving them as less personally meaningful.
b. Feeling creatively constrained	Designers felt that ChatGPT hindered their creativity by suggesting ideas too quickly or limiting their personal exploration of concepts.
c. Low confidence in writing and reliance on AI	Designers may doubt their own writing abilities in comparison to ChatGPT's output, possibly over-relying on the tool in the process.
d. Can be helpful when there is a struggle to be creative	Designers noted that ChatGPT was particularly helpful when they experienced creative blocks or had difficulty coming up with ideas on their own.
e. Design process feels less authentic	Describes how some designers felt the ideation process was less authentic or credible when using ChatGPT, as opposed to creating ideas independently.
13. Engagement in the creative process	Examines how engaged the designer remained in the creative process while using ChatGPT, particularly whether the tool enhanced or reduced their active involvement.
a. No motivation to engage due to detailed ideas provided by GPT	Designers felt less motivated to develop ideas themselves when ChatGPT generated nearly complete concepts, reducing the need for their engagement.

Categories	Description
b. Engagement is affected by context (research setup, collaboration with group, etc)	Identifies external influences, such as project context or collaborative settings, that impacted the designer's level of engagement with ChatGPT-generated ideas.
c.Engage more with ideas by taking ideas out of GPT, for example, by sketching or using post-its.	Describes efforts to transform or adapt ideas generated by ChatGPT into more tangible or actionable forms outside of the digital realm.
14. Energy level	Explores how the designer's energy level influenced and was influenced by engagement with ChatGPT, particularly in terms of relying on the tool to streamline ideation.
a. Ideating with GPT is quick and require less energy	Designers experiencing low energy found ChatGPT's fast-paced output more appealing than manually working through the problem-solving process.
b. Lack of motivation to explore problem and solution space	Low energy make the quickness of chat GPT more enticing than personally exploring problem and solution space
c. Intense text content and communication struggle affect energy	Designers reported that reading through ChatGPT's responses could sometimes be mentally exhausting, decreasing their energy and engagement.

Categories	Description
15. Context impact critical appraisal	Reflects how the specific project context or the nature of the interaction with ChatGPT shaped the designer's level of critical evaluation of its output and suggestions.
a. Personal perception of GPT influence critical appraisal of output	Designers' overall perception of ChatGPT's trustworthiness affected how skeptical or accepting they were of the tool's outputs.
b. Content of conversation influence critical appraisal	Designers' goals for their ChatGPT interaction (e.g., a straightforward task vs. a highly creative request) influenced how critically they evaluated the tool's responses.
c. Limited knowledge on the problem make it harder to be critical about GPT output	Designers knowledge or expertise on the topic impacted ease to critically evaluate the accuracy and relevance of ChatGPT's responses.
16. Personal attitude to the use of chat GPT	Captures the designer's personal feelings, preferences, and attitudes toward using ChatGPT in their creative process. and how these attitudes influence their overall engagement with and reliance on the tool.
a. Personal beliefs and ideas have influence on attitude in relation to output	Designers evaluated ChatGPT from an ethical or moral perspective, which impacted their comfort level and attitude with using the tool.
b. Experiment context have influenced attitude to chat interaction	Designers noted that using ChatGPT in a research context shaped their approach to the interaction.
17. Human-like and matter-of-fact language	Designers commented on the tone of their exchanges with ChatGPT noting how that influenced their engagement with the output.
a. GPT language and framing discourages exploration	Designers observed that ChatGPT's confident, matter-of-fact tone led them to not question the accuracy of the information or prompt them to double-check or further explore its suggestions.

Categories	Description
18. Trust and critical appraisal	Indicated a level of distrust and critical appraisal through action taken
a. Filter ideas	Designers selectively used ChatGPT's suggestions, choosing only those that were directly relevant to their design goals and discarding the rest.
b. Evaluate GPT information	Designers acknowledged that they critically appraised the information provided by ChatGPT, assessing its relevance and accuracy before incorporating it into their work.
c. Anonimyzing confidential information	Designers were cautious about the information they shared with ChatGPT, avoiding confidential details to protect sensitive project data.

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TUDelft

IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:
- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME
Complete all fields and indicate which master(s) you are in

Family name	Fernandes Krajcer	7115
Initials		
Given name	Louise	
Student number	5516285	

IDE master(s) IPD ☐ DfI ✓ SPD ☐
2nd non-IDE master
Individual programme (date of approval)
Medisign ☐
HPM ☐

SUPERVISORY TEAM
Fill in he required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

Chair	Milene Guerreiro Gonçalves	dept./section	DOS
mentor	Pan Wang	dept./section	DOS
2nd mentor	Alice Schut		
client:	Alice Schut		
city:	Den Haag	country:	Netherlands

optional comments: Chair and mentor skills and knowledge are complementary and directly related to the theme of my project: Creativity and AI.

❗ Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.

❗ Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.

❗ 2nd mentor only applies when a client is involved.

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in **by the Chair** of the supervisory team

Sign for approval (Chair)

Milene Guerreiro Goncalves
Digitally signed by Milene Guerreiro Goncalves
Date: 2024.03.21 14:32:33 +01'00'

Name	Milene Gonçalves	Date	21 Mar 2024	Signature	

CHECK ON STUDY PROGRESS
To be filled in **by SSC E&SA** (Shared Service Centre, Education & Student Affairs), after approval of the project brief by the chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total _____ EC
Of which, taking conditional requirements into account, can be part of the exam programme _____ EC

★	YES	all 1st year master courses passed
	NO	missing 1st year courses

Comments:

Sign for approval (SSC E&SA)

Robin den Braber
Digitaal ondertekend door Robin den Braber
Datum: 2024.04.09 12:13:02 +02'00'

Name	Robin den Braber	Date	9 apr 2024	Signature	

APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team comply with regulations?

YES	★	Supervisory Team approved
NO		Supervisory Team not approved

Based on study progress, students is …

★	ALLOWED to start the graduation project
	NOT allowed to start the graduation project

Comments:

Comments:

Sign for approval (BoEx)

Monique von Morgen
Digitally signed by Monique von Morgen
Date: 2024.04.09 15:06:19 +02'00'

Name	Monique von Morgen	Date	9 Apr 2024	Signature	

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Personal Project Brief – IDE Master Graduation Project

Name student Louise Fernandes Krajcer   **Student number** 5,516,285

Project title Chat-Assisted Ideation: A study on how to enhance creativity in AI-Designer Collaboration

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

ChatGPT has seen an exponential adoption with a reported 100 million users within two months of launch (Reuters, 2023). Despite its popularity, and the trend for its increased adoption within creative workflows, its impact on designer's workflow and creativity remains unclear.

As a text-based AI tool, Chat GPT produce content, mimicking creativity, but lack human creativity's intentionality and originality, as noted by Runco (2023). In contrast, Research by De Peuter et al. (2021) suggest AI can enhance creative processes serving as an assistant for creativity and problem-solving. Designers leverage AI for inspiration speeding up ideation while integrating their own expertise to guide and assess AI-generated solutions (Saadi & Yang, 2023), pointing to the value of AI within creativity being on AI-designer collaboration.

Gonçalves (2016) highlighted the importance of keyword definition in the inspiration process but noted that while existing computational tools aid stimuli retrieval, they lack in supporting problem framing and keyword formulation. Chat GPT, on the other hand, claims to assist with problem framing, brainstorming, idea evaluation or expansion, prototyping, and creative methods, thus potentially serving as a superior source of inspiration. The AI chat accommodates a wider array of inputs and could prompt broader exploration due to the ambiguity afforded by textual stimuli.

Therefore, exploring AI chatbots like GPT as ideation partner and source of inspiration is relevant. As designers increasingly integrate AI into their creative process, it is essential to understand its influence on creativity.

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image / figure 1   Scope of the Project and Reasoning

References

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3. De Peuter, S., Oulasvirta, A., & Kaski, S. (2023). Toward AI assistants that let designers design. Ai Magazine, 44(1), 85–96. https://doi.org/10.1002/aaai.12077

4. Gonçalves, M., Cardoso, C., & Badke-Schaub, P. (2016). Inspiration choices that matter: the selection of external stimuli during ideation. Design Science, 2. https://doi.org/10.1017/dsj.2016.10

5. Hu, K. (2023, February 2). ChatGPT sets record for fastest-growing user base - analyst note. Reuters. https://www.reuters.com/technology/chatgpt-sets-record-fastest-growing-user-base-analyst-note-2023-02-01/

6. Nielsen, J. (2023, June 18). AI: First new UI paradigm in 60 years. Nielsen Norman Group. https://www.nngroup.com/articles/ai-paradigm/

7. Runco, M. A. (2023). AI can only produce artificial creativity. Journal of Creativity, 33(3), 100063. https://doi.org/10.1016/j.yjoc.2023.100063

8. Saadi, J. I., & Yang, M. C. (2023). OBSERVATIONS ON THE IMPLICATIONS OF GENERATIVE DESIGN TOOLS ON DESIGN PROCESS AND DESIGNER BEHAVIOUR. Proceedings of the Design Society, 3, 2805–2814. https://doi.org/10.1017/pds.2023.281

image / figure 2   References used for the formulation of this brief.

148   ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.

ChatGPT and ideation a study on the effect of the use of the tool on design student's creativity and creative process.   149

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Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

AI introduces the paradigm of intention-based interaction (Nielsen, 2023), where designers specify desired outcomes rather than dictating step-by-step commands, demanding a new mental modal during initial stages of design when problems and solutions are still forming. This leads to RQ1: How do designers approach ideation with GPT assistance?
The project is interested in how the interaction with the AI impacts creativity. GPT looks for patterns, themes and information in its training data associated with the user's prompt to produce its response. However, exposure to predefined solutions may lead to fixation, a phenomenon where designers' exploration of design space is limited by unconcious biases (Crilly & Cardoso, 2017). This raises the concern that the use of GPT might reinforce these biases through its responses. Hence, RQ2 is: To what extent dos GPT fixate designers, influencing creative exploration and outcomes?
The cognitive co-evolution model indicates that uncertainty prompts designers to traverse solution and problem spaces (Cash et al., 2023). Chat GPTs' human-like and matter-of-fact reply style could impact designers' sense of uncertainty, influencing their creative confidence, limiting appraisal of AI outputs and design space exploration. Prompting RQ3: How does AI affect a designer's critical appraisal of ideas and discussion?
The project will address the challenges and opportunities uncovered and propose interventions to improve AI-designer creative interaction.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for.
Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence)
As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Investigate designer's use of chat GPT in the ideation process and its impact on creativity. Based on the insights, I will design a prototype or intervention aimed at enhancing the creative process for designers working with AI tools like GPT.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

This project will employ a mixed method approach. The investigation will happen through a data collection experiment involving 100 students of The Hague University of Applied Sciences (THUAS). Each will develop six concepts for a client brief. The first three concept without and last three with chat GPT. They will describe their concepts and complete questionnaires reflecting on their experience. Analysis will cover the concepts, sketches, chat GPT transcripts and reflection responses, complemented by post-experiment interviews with volunteers.

For the second part, a intervention or prototype based on the investigation insights will be iteratively designed. Proposal will be tested with design students from the THUAS bachelor or TU Delft Master students, using same concept templates and questionnaires used for the investigation phase, to evaluate the intervention's effectiveness in enhancing their creative process.

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a kick-off meeting, mid-term evaluation meeting, green light meeting and graduation ceremony. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	14 Mar 2024
Mid-term evaluation	30 May 2024
Green light meeting	8 Aug 2024
Graduation ceremony	2 Set 2024

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	✓
For how many project weeks	
Number of project days per week	3,0

Comments:
I will be working alongside the graduation project so I will be dedicating three days a week to it, instead of five.

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

In my personal practice I have always been proactive in thinking on how processes and methods could be redesigned to facilitate and improve my personal and my team's design process. With this I developed a keen interest in studying and exploring design process, tools, and methods. My motivation for this project stems from a desire to enhance my effectiveness as a designer in practice, along with my interest in further exploring AI and its capabilities.

This project will allow me:

- to develop my research and analytical skills though the data analysis.
- to deepen my knowledge on creativity and its limitations which are intrinsic to us designers, such as personal and cognitive biases.
- deepen my knowledge of generative AI and build experience in designing with and for it.
- develop my critical and reflective capabilities as a designer in relation to AI, and to the limitations I am bringing to my design process which are normally unconcious, such as fixation and personal biases.