THE LANGUAGE OF REFLECTION: A LINGUISTIC EXPLORATION OF REFLECTION WRITTEN BY DESIGN STUDENTS

Master Graduation Project

Strategic Product Design

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PREFACE

As I approach the end of my master's journey at TU Delft, it is with great satisfaction that I present to you my graduation project. The title, "The Language of Reflection: A Linguistic Exploration of Reflection Written by Design Students," captures the essence of my exploratory venture into the field of reflection and linguistic analysis.

As part of my Master's degree in Strategic Product Design, this project finds its place within TU Delft's esteemed Faculty of Industrial Design Engineering. In this report, I delve into the nuances of reflection, seeking to illuminate its intricacies as expressed by fellow design students. I've been fortunate to receive the steady guidance of my graduation chair and mentor, Peter Lloyd and Senthil Chandrasegaran, whose expertise has been instrumental in shaping the trajectory of this endeavor.

Expressing gratitude feels inadequate given the profound impact certain individuals have had on this journey. My supervisors, Peter Lloyd and Senthil Chandrasegaran, have provided constant support and invaluable insights, enriching both my project and my growth as a designer.

The enduring encouragement by my family and my parents has been my bedrock of strength. Their unwavering support, not only throughout this project but throughout my educational journey, has been a cornerstone of my success. Their belief in my abilities fueled my determination, and I dedicate the outcome of this project to them.

A special mention is reserved for my friends from IDE, who've shared in both the academic challenges and the lighter moments in my journey of masters in TU Delft. Your friendship has been a lifesaver giving me a much-needed break during this challenging individual project.

As this preface marks the start of sharing my final work, I earnestly hope that readers find resonance within these pages. Beyond the academic endeavor, this project symbolizes my personal journey of exploration and growth during my time at TU Delft.

With heartfelt gratitude for the shared journey,

Nupura Kulkarni

EXECUTIVE SUMMARY

Reflective writing plays a vital role in the development of designers, enabling them to evaluate their experiences, enhance their learning, and foster professional growth. However, traditional methods of assessing reflective writing have limitations in terms of reliability and objectivity. To address this gap, this research project aims to analyze the reflections of design students in the Design Theory and Methodology (DTM) course using linguistic analysis. By exploring the linguistic elements and patterns within these reflections, the study seeks to facilitate a comprehensive analysis to understand and assess students' reflective practices (Ullmann, 2019; Tausczik & Pennebaker, 2009).

The research project utilizes the Linguistic Inquiry and Word Count (LIWC) tool for linguistic analysis. This tool allows for the examination of linguistic patterns, word categories, and cognitive processes present in the reflective writings of design students (Tausczik & Pennebaker, 2009). Building upon Ullmann's model of reflection detection, which encompasses eight categories (components) including experience, belief, difficulty, perspective, feeling, learning, intention, and descriptive (Ullmann, 2019), the study provides a comprehensive framework for evaluating reflective writing and serves as a basis for the analysis.

The key insights of this explorative research project are twofold. Firstly, the analysis of LIWC categories reveals that specific linguistic features are associated with different components of reflection. The study identifies two types of high-quality reflections: "Holistic narrators" that emphasize personal experiences, learning, intention, and positive outcomes, and "In-depth explorers" that focus on critical assessment, multiple perspectives, and descriptive text. These findings shed light on the diverse ways in which individuals engage in reflective writing and highlight the multidimensional nature of high-quality reflections.

Secondly, the research project explores the feasibility of using LIWC analysis as a tool for identifying high-quality reflections. While LIWC analysis provides valuable insights into certain linguistic features associated with reflection components, it has limitations in capturing the complexity and nuances required for accurate grading. Therefore, a comprehensive and multi-dimensional approach that integrates quantitative measures with qualitative assessments, expert judgment, and a well-defined rubric is crucial for a robust evaluation of reflection quality.

The implications of this research project are significant for design researchers and education. The identification of specific linguistic features associated with high-quality reflections can guide the development of interventions and instructional strategies aimed at fostering critical thinking skills, self-reflection, and diverse perspectives among design students. Additionally, the insights gained from this research can inform the development of automated tools or natural language processing techniques to assist educators in assessing and providing feedback on reflections, thereby enhancing the efficiency and effectiveness of reflective practice in educational settings.

In conclusion, this research project contributes to our understanding of reflective writing in the context of design. By analyzing the linguistic elements and patterns within the reflections of design students, the study provides insights into their reflective practices. The findings highlight the diverse nature of reflective writing and emphasize the need for a comprehensive assessment approach that considers contextual factors, qualitative aspects, and individual variations in reflection quality. The implications of this research extend to the development of instructional strategies and automated assessment tools, promoting the growth and development of design students' reflective skills.

THE LANGUAGE OF DESIGNER'S REFLECTION

NATURE OF QUALITY REFLECTIONS

Diverse ways in which individuals engage in reflective writing

HOLISTIC NARRATORS

Weaving personal experiences into reflections, emphasizing learning and positive outcomes.

- Describe Multiple Experiences
- Brief Yet Critical Assessment
- Incorporate Beliefs and Other Perspectives
- Multiple Clear Intentions or Specific Learnings

IN-DEPTH EXPLORERS

Thriving on critical assessment, multiple perspectives, and detailed descriptions in reflections.

- Focus on Few Experiences
- In-Depth Critical Assessment
- Consideration of Multiple Perspectives
- Few Specific Intentions or Contextual Learnings

SHARED LINGUISTIC FEATURES OF REFLECTION COMPONENTS

RELEVANCE OF THE RESEARCH INSIGHTS

DESIGNERS

Guiding designers in adopting diverse reflective styles for personal growth and navigating design challenges

DESIGNER EDUCATORS

Using linguistic insights for tailored reflection guidelines to the students which enables personalized feedback

RESEARCHERS

Conducting longitudinal studies and linguistic exploration to deepen understanding of the evolution of reflective writings of designers

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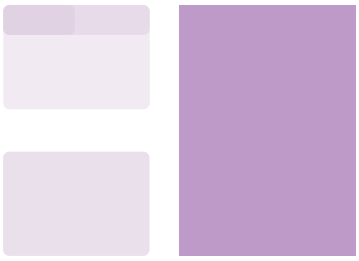
READING GUIDE

This reading guide has been made to help the readers in comprehending the organization and substance of this report. It offers visual indicators, topic-focused chapter markings and abbreviation explanations. Its intent is to facilitate efficient navigation for both quick readers and those seeking specific content within this report.

VISUAL INDICATORS

START OF A MAIN CHAPTER

The report consists of six main chapters.



CONCLUSIVE INSIGHTS

Conclusive key insights of a section are presented in light purple cards (left).
A detail overview of some key insights might also be presented on a purple background (right).

Purple highlighted text are concise summaries of some important sections for quick readers.

Research questions and qualitative coding criteria is presented in these light blue cards.

SELECTED RELEVANT CHAPTER FOR SPECIFIC TOPICS

Relation between components of reflection and LIWC categories (linguistic features)

CHAPTER 2: 2.2 > MODEL OF REFLECTION DETECTION

CHAPTER 3: 3.2 > RESEARCH: PHASE 1

CHAPTER 4: 4.2

CHAPTER 5: 5.1, 5.4, 5.5

Relation between quality of reflection and components of reflection

CHAPTER 2: 2.2 > MODEL OF REFLECTION DETECTION

CHAPTER 3: 3.2 > RESEARCH: PHASE 2

CHAPTER 4: 4.3

CHAPTER 5: 5.2, 5.4, 5.5

Relation between quality of reflection and LIWC categories (linguistic features)

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CHAPTER 4: 4.3

CHAPTER 5: 5.3, 5.4, 5.5

ABBREVIATIONS

DTM	Design Theory and Methodology course
LIWC	Linguistic Inquiry and Word Count tool
ID #	Student Identification for their reflections

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INTRODUCTION

This section lays the groundwork for the research project, starting with the initial assignment that sets the context, scope, and focus. It further explores the overall approach of the project, highlighting the research goals, methods, and tools utilized during different phases of the study, providing a clear roadmap to understand the progression of the research.

1.1 INITIAL ASSIGNMENT

CONTEXT

Reflective practice is a fundamental aspect of professional development, especially within the dynamic and creative field of design. Designers leverage reflective thinking to critically analyze their work, evaluate their decision-making processes, and continuously improve their skills (Schön, 1983). This reflective process allows them to gain deeper insights into their experiences and enhances their ability to create innovative and effective design solutions. Gillie Bolton (2010) further emphasizes that reflective practice involves a mindful examination of the practical values and theories that inform everyday actions, fostering developmental insights. Through reflection-in-action and reflection-on-action, designers engage in a conscious exploration of their emotions, experiences, behaviors, and responses, contributing to their existing knowledge base and promoting a higher level of understanding (Paterson & Chapman, 2013).

Understanding the reflective practices of design students holds immense value in design education and professional growth. Novice designers, as well as experienced practitioners, can benefit from a better understanding of their own reflective behaviors, leading to more informed decision-making and continuous improvement in their design processes. By reflecting on their design experiences, students can identify areas for growth, enhance their design thinking, and develop a deeper awareness of their design principles and values (Schön, 1983).

However, the process of manual content analysis, which has traditionally been employed to assess reflective practice, comes with several limitations. It can be time-consuming, subject to bias, and challenging to scale for larger datasets. Therefore, there is a growing interest in leveraging technological advancements, such as machine learning and linguistic analysis, to gain deeper insights into the cognitive processes and linguistic aspects of reflective writing (Ullmann, 2019).

In recent years, the rapid developments in machine learning and artificial intelligence have paved the way for innovative approaches to understanding human behavior through linguistic analysis of text data (Tausczik & Pennebaker, 2009; Fast et al., 2016). Linguistic analysis tools, such as the Linguistic Inquiry and Word Count (LIWC) and Empath, have emerged as powerful assets in exploring patterns and themes within textual content. Researchers can now efficiently analyze text data and uncover linguistic elements that may influence reflective practice, offering a comprehensive understanding of designers' thought processes and decision-making strategies.

The integration of linguistic analysis into the study of reflective practice provides a promising opportunity to gain a more profound understanding of design students' reflections. By exploring linguistic markers within their written reflections, this research project aims to shed light on the diverse dimensions of reflective writing, identify indicators of high-quality reflections, and illuminate factors that contribute to effective reflective practices in design. This in turn can in shaping design education and fostering the growth of reflective practitioners within the design industry.

How can linguistic analysis contribute to a comprehensive understanding of design students' reflective practices and facilitate the identification of high-quality reflections?

SCOPE AND FOCUS

The scope of this research project is to thoroughly examine design students' reflective practices within the context of the Design Theory and Methodology (DTM) course. Utilizing linguistic analysis tools, particularly the Linguistic Inquiry and Word Count (LIWC), the study aims to gain insights into the linguistic elements and patterns present in the students' final reflections. By leveraging Ullmann's model of reflection detection, which includes eight distinct categories (components of reflection), such as experience, belief, difficulty, perspective, feeling, learning, intention, and descriptive, the research provides a comprehensive framework for evaluating reflective writing in the design domain.

Through a combination of quantitative and qualitative analyses using LIWC, the study will identify specific linguistic indicators associated with high-quality reflections. By integrating these approaches, the research seeks to offer valuable insights into the complexities of reflective writing in the design field. The visual representation of the research scope, as depicted in Figure 1, showcases the interconnected nature of the study's components, highlighting the integration of design students' reflective writings, linguistic analysis using LIWC, and Ullmann's model of reflection detection. The ultimate goal is to enhance our understanding of reflective practices in design and inform the development of educational strategies to foster reflective learning experiences for design students, thus contributing meaningful insights to the field of design education and reflective learning.

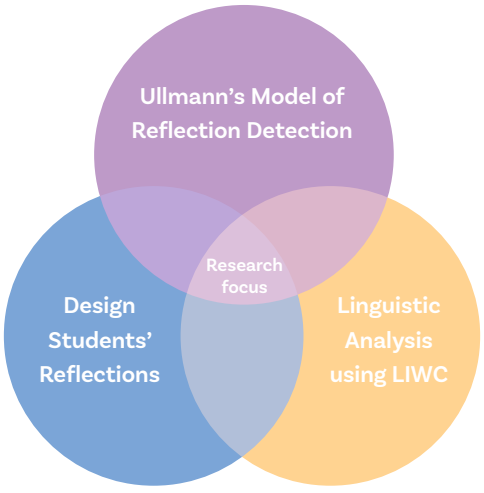

Figure 1: Scope of this research

INITIAL QUESTIONS AND PROJECT GOAL

The goals of this research project are to gain a comprehensive understanding of design students' reflective practices, analyze the linguistic elements present in their reflections, and identify indicators of high-quality reflective writing. By achieving these goals, the research aims to contribute to the field of design education by informing the development of effective instructional strategies and interventions that promote reflective learning experiences for design students.

Some initial questions were formulated which aimed to explore existing knowledge and research gaps related to reflective practices and linguistic analysis in the context of reflective writing. The initial questions that guided the literature survey include:

1. What are the key theories and models related to reflective practice in the field of design?
2. How has linguistic analysis been utilized in the analysis of reflective writing, particularly in design education?
3. What are the existing frameworks and approaches for assessing the quality of reflective writing?
4. What are the potential implications of reflective practice and linguistic analysis in design education and professional development?

PERSONAL AMBITIONS

Throughout this research project, my personal ambitions were driven by a desire to develop and refine my research skills, particularly in the realm of exploratory research. I aimed to gain expertise in both qualitative and quantitative research techniques to effectively explore and analyze the data. Additionally, I sought to enhance my ability to manage time constraints and plan the individual research project in an efficient and organized manner. By actively engaging in this project, I aimed to cultivate a strong foundation in research methodology and build valuable skills that would contribute to my growth as a researcher in the field of design.

1.2 PROJECT APPROACH

APPROACH AND METHODOLOGY

This section outlines the approach and methods employed in this research project to explore the reflections written by the design students and examine the linguistic elements of these reflections. The research journey involved a dynamic and iterative process, combining both qualitative and quantitative methods to gain a comprehensive understanding of the complexities of reflective writing in the design domain.

Divergent Exploration

The initial phase of the research embraced a divergent exploration of the data. Through qualitative coding and quantitative analysis, I aimed to gain a comprehensive understanding of the various reflection categories and the linguistic elements associated with each category.

Qualitative Coding

Qualitative coding is a systematic technique used to analyze textual data and identify recurring themes or categories within the dataset. In this research, I applied qualitative coding, guided by Ullmann's model of reflection detection, to categorize the design students' reflections according to the components of reflection such as experience, belief, difficulty, perspective, feeling, learning, intention, and descriptive.

Quantitative Analysis

Quantitative analysis involved the use of correlation statistics to examine the relationships between reflection components, linguistic elements and grades of the design students' reflections. This method allowed for the identification of statistical associations between specific linguistic features, different components and quality of reflection, providing valuable quantitative insights. To enhance the interpretation of the quantitative findings and gain a deeper understanding of the identified patterns, scatter plots and graphs were utilized. These visual representations allowed for a visual examination of the relationships between the components of reflection and linguistic elements. By plotting the data points and observing the patterns and trends, the connections between the linguistic features and components of reflection became more apparent.

Convergent Investigation

Following the divergent analysis, the research adopted a convergent approach, where specific relations and patterns were selected for in-depth investigation. Visualizations, such as scatter plots and graphs,helped in selecting certain patterns that could be further analyzed. To gain a more nuanced understanding of the identified relations and outliers, small-scale case studies were conducted. By selecting representative examples from the design students' reflections, these case studies provided valuable qualitative insights into the linguistic features contributing to effective reflective practices.

The iterative nature of this approach for different phases of the research allowed for a dynamic exploration of the data, moving between divergent analysis to understand the data and convergent selection of specific relations for in-depth study. By combining both qualitative and quantitative perspectives, this research project achieved a comprehensive and nuanced analysis of design students' reflective practices. The use of these methods ensured a rigorous and systematic exploration of the research questions and provided valuable insights into the complex relationship between reflective practices and linguistic elements in the design domain.

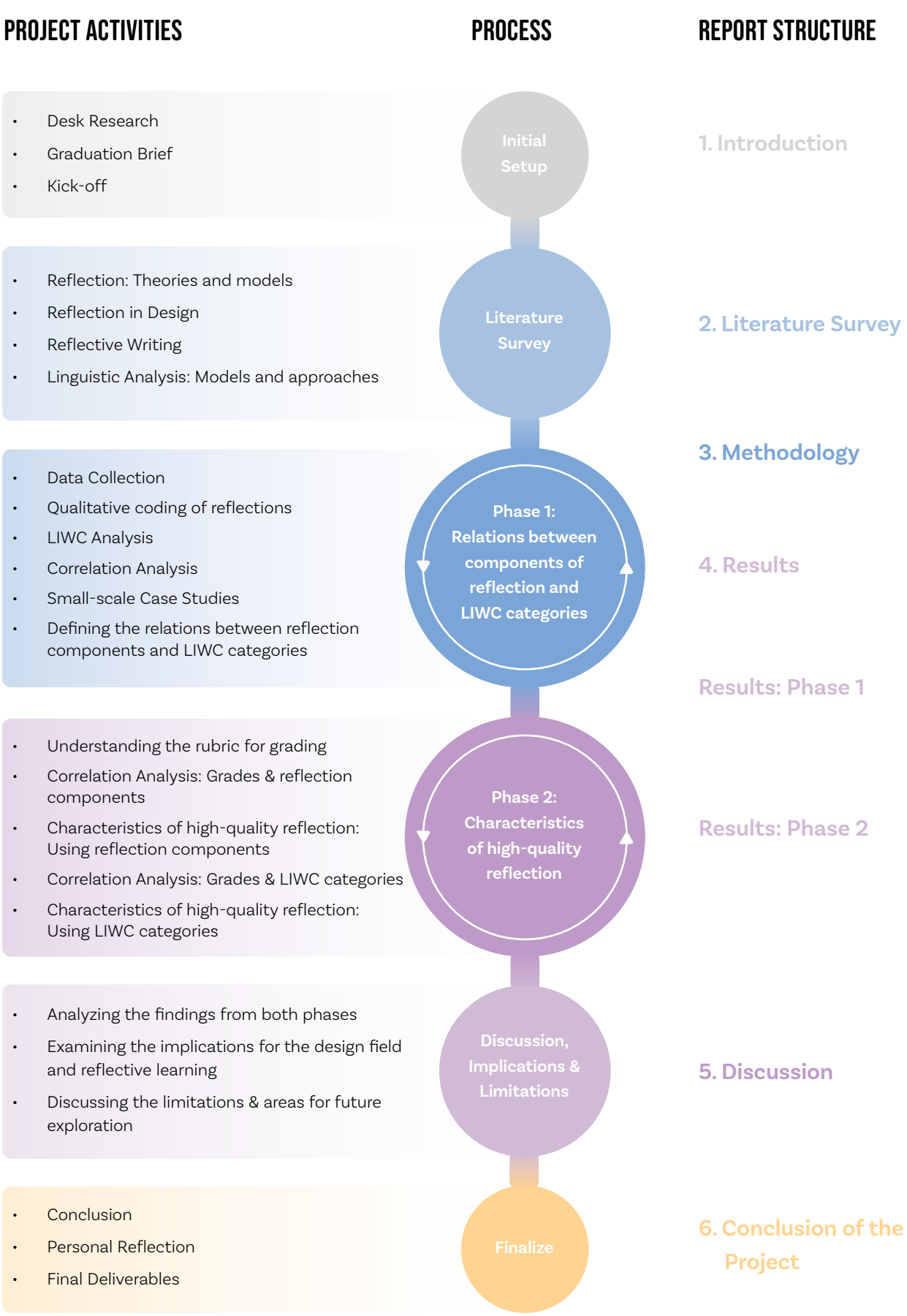

Figure 2: Project process, activities and report structure

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LITERATURE SURVEY

This section of the literature review is dedicated to a comprehensive exploration of reflection as a concept. It delves into the theories and models that revolve around reflection and its utilization in various domains, notably in the fields of design and writing. The significance of assessing reflective writing is also discussed, shedding light on the rationale behind this research. This section also explores the field of linguistic analysis, shedding light on various methods and tools used for this purpose. It highlights the significance of linguistic analysis in revealing the subtleties of reflective writing, emphasizing how it can help to uncover deeper insights and enhance the understanding of reflection.

2.1 REFLECTION

REFLECTION: A MULTIFACETED CONCEPT

With roots in ancient Greece, the idea of reflection has been around for ages. The origins of reflection can be traced back to Socrates and his philosophy of critical self-examination. He is noted for his emphasis on self-reflection and his famous saying, "The unexamined life is not worth living." Instead of trusting what others say or what one considers to be true out of hand, Socrates thought that true wisdom came from confronting and questioning oneself. Throughout the ages, this concept of self-reflection has been transmitted and developed into a pillar of Western philosophy (Schlosser, 2014).

Scholars from a variety of disciplines, including philosophy, psychology, and education, have studied and conceptualized the concept of reflection. Despite the diversity of perspectives, some commonalities emerge, providing a foundation for comprehending reflection within the context of design education.

Reflection is an important cognitive activity that involves looking back on events, analyzing and evaluating them, and forming conclusions for future action. It is fundamentally an intentional and conscious act of introspection, self-evaluation, and critical thinking (Schlosser, 2014; Dewey, 1933; Boud & Garrick, 1999). Reflection includes investigating one's basic assumptions and ideas as well as one's thoughts, feelings, and behavior. Design students have the chance to strengthen their professional practice, pinpoint areas for growth, and gain a deeper understanding of their own design processes through engaging in reflection.

THEORIES AND MODELS OF REFLECTION: BRIDGING SIMILARITIES AND DIFFERENCES

Several theories and models have been proposed to explain the process and outcomes of reflection. While every theory or model has its own special insights, they all have some commonalities that can be combined to give a thorough grasp of reflection.

Dewey (1933), Schön (1983), and Moon (2004) all give viewpoints on reflection that are diverse, while also sharing some commonality. The value of critical thinking and active experimentation in the learning process is emphasized by Dewey's idea of reflective thinking (Dewey, 1933). Reflection, according to Dewey, is a continual cycle of experience, observation, conceptualization, and experimentation. The foundation of Dewey's theory of reflection is the notion that reflection is an intentional, active process that takes into account both one's experiences and thoughts. This aligns with Schön's theory of the reflective practitioner (Schön, 1983), which focuses on reflective practice in professional domains, emphasizing reflection-in-action and reflection-on-action to improve professional performance. Reflective practice is a key component of Schön's theory of "thinking while doing something". Moon's theory (2004) highlights the significance of reflection in experiential learning, emphasizing the integration of experience and reflection to make sense of experiences and develop new insights. Moon (2004) emphasizes the cyclical nature of learning, where experience leads to reflection, which, in turn, informs further action and experience. This holistic approach acknowledges that reflection is not simply a cognitive exercise but also an emotional and embodied process.

While these theories differ in their academic contexts and unique emphases, they all acknowledge the importance of reflection in the learning and professional development processes. They emphasize the active and intentional nature of reflection, its role in deriving meaning from events, and its capacity to develop new knowledge and enhance practice. These theories, when considered together, provide complementary viewpoints that contribute to a holistic understanding of reflection, spanning both educational and professional domains.

The theory of reflection as a social process that Boud and Garrick (1999) developed complements the individual-focused approaches. They argue that reflection is a social activity that benefits from discourse and interaction with others and is not just an individual activity. They highlight the importance of group discussions, feedback, and teamwork in enhancing the reflective process. This social dimension of reflection is consistent with Mezirow's transformative learning theory, which emphasizes reflection as a driving force for personal and social development. According to Mezirow's transformative learning theory (1990), critical reflection extends beyond individual progress to the broader social

context. Critical reflection involves a deep and thorough examination of one's assumptions, beliefs, values, and actions, as well as an exploration of the underlying societal and cultural influences that shape them.

While Boud and Garrick (1999) highlight the social dimension of reflection and the need for discourse and interaction with others, Schön's ladder (1983) and Mezirow's theory (1991) provide additional insights into the reflective practice process and stages. Schön's reflective ladder, described in his book "The Reflective Practitioner: How Professionals Think in Action," (Schön, 1983) illustrates the several stages of reflection that professionals go through. The ladder is divided into two stages: reflection in action and reflection on action. Reflection in action involves quick and intuitive thinking, in which experts think on their feet and make decisions in the moment. Reflection on action, on the other hand, happens retrospectively, as individuals step back from their experiences to examine and learn from them. Schön's reflective ladder is consistent with Mezirow's theory of critical reflection (1990). Professionals go up the reflective ladder, achieving increasing levels of critical reflection. This theory is consistent with Mezirow's emphasis on premise reflection, which involves examining why we believe, see, feel, or behave the way we do. Reflection, according to Mezirow's approach, provides three fundamental functions: guiding action, providing coherence to the unknown, and reevaluating existing knowledge. Mezirow emphasizes reflective thinking's characteristics (Mezirow, 1991), such as content reflection (focused on what we see, think, feel, or act upon), process reflection (concerned with how we carry out actions), and premise reflection (analyzing the underlying reasons for our perceptions, thoughts, feelings, and behaviors).

In addition to the previously mentioned theories, two other frameworks, Kolb's experiential learning cycle (Kolb, 1983) and Gibb's reflective cycle (Gibbs, 1988) as cited in Paterson & Chapman (2013), provide systematic ways for reflection in professional practice. Kolb's cycle, in which individuals participate in concrete experiences, reflect on those experiences, produce abstract concepts, and actively experiment with applying those concepts in new contexts, emphasizes the iterative nature of learning. This circular process allows for constant learning and adaptation based on input from experience. Gibb's reflective cycle, on the other hand, consists of six stages: describing the scenario, expressing thoughts and feelings, evaluating the experience, analyzing the problem, drawing conclusions, and developing an action plan. This model emphasizes the significance of self-awareness, emotional expression, critical thinking, and the development of action plans based on reflection. It motivates practitioners to do a comprehensive review of their experiences, which leads to significant insights and actionable outcomes. Both Kolb's experiential learning cycle and Gibb's reflective cycle provide well-established frameworks for encouraging reflective practice and evidence-based learning in professional contexts. These frameworks provide different perspectives on the reflection process and are useful tools for practitioners who want to engage in systematic and intentional reflection. Professionals can improve their practice, make informed judgments, and continuously improve their learning and development by using these frameworks.

Finally, reflection is a multifaceted concept that has been extensively examined and hypothesized in the learning and professional practice literature. Several scholars, including Dewey, Boud, Schön, Moon, and Mezirow, have provided various perspectives and definitions of reflection, emphasizing its importance in the learning process and its various functions, such as guiding action, providing coherence to the unfamiliar, and reassessing existing knowledge. In particular, Mezirow's transformative theory of reflection highlights the importance of reflection in generating transformative and emancipatory learning experiences. Important characteristics of reflective thinking include the concepts of content, process, and premise reflection.

These theoretical frameworks give a solid foundation for comprehending the concept of reflection and its use in several fields, including design. The following part will go further into the specific use of reflection in the context of design, investigating how it is practiced and its importance in improving design processes and outputs.

REFLECTION IN DESIGN

Reflection is an important part of design education and practice because it allows designers to critically analyze their work, evaluate their decision-making processes, and improve their design skills. Scholars and practitioners have investigated different aspects of design reflection, such as its integration into design education, techniques, typologies, and ideologies, and its impact on design results. The research of Sengers et al. (2005), Lousberg et al. (2020), Coorey (2012), and Tonkinwise (2004) has aided in the understanding of reflection in design education and research, providing vital insights into the role and significance of reflection in the field of design. We will go further into the concept of reflection in design in this section, building on the findings of these studies and other related literature.

Sengers et al. (2005) wrote "Reflective Design", which provides a framework for integrating reflection into design practice. They highlight the significance of critical reflection (Mezirow, 1991) in design because it allows designers to critically analyze their assumptions, values, and biases, as well as consider the social and ethical ramifications of their design decisions. Reflection in design is divided into four stages: pre-design reflection, in-process reflection, post-design reflection, and reflection in use. This study explores the process and importance of reflection in design, emphasizing how reflective practices can improve design processes and outputs.

In contrast to Donald Schön's theory of reflective practice, which focuses on the reflective practitioner engaging in reflection-in-action and reflection-on-action during problem-solving, Sengers et al. (2005) propose a broader framework that includes reflection at various stages of the design process. Their framework covers a broad spectrum of reflective practices in design, including pre-design, in-process, post-design, and reflection-in-use. While Schön's theory (1983) focuses on individual reflection during the problem-solving process, Sengers et al. (2005) advocate for a more holistic approach to reflection that covers the entire design process, from problem framing to evaluating design outcomes in real-world contexts.

Lousberg et al. (2019), in their study on reflection in design education, highlighted the importance of reflection in design as a crucial component of the design process. They emphasize the importance of reflection in helping students critically review their design choices, perform self-evaluation, and draw lessons from their design experiences. They propose a framework for incorporating reflection into design education, which includes, among other things, the use of reflective journals, peer feedback, and self-assessment. Students can evaluate their design process, pinpoint strengths and weaknesses, and adjust in subsequent iterations by reflecting on their work. This reflective action promotes a deeper understanding of the design process and encourages a more thoughtful and intentional approach to design.

Coorey (2012) focuses on reflective pedagogy methods and offers suggestions for how reflection might be incorporated into design curricula. The author explores several reflective techniques, including dialogue, critique, and reflective writing, and how they might be applied to help students reflect on their design work. Coorey argues that reflective methods might improve students' ability to solve problems creatively, critically assess their design choices, and get a deeper understanding of their design processes. To develop reflective practitioners, this study emphasizes the value of reflection as an active and intentional action that may be incorporated into design pedagogy.

Tonkinwise (2004) goes further into the idealist practice of reflection in design research, examining many typologies, methodologies, and philosophies for reflective practice among design researchers. According to Tonkinwise, reflection is an essential component of design research because it enables researchers to review their results, critically analyze their design process, and think about the broader implications of their work. Designers are urged by reflection to question their presumptions, consider their beliefs and ideologies, and choose their design strategy wisely. It makes it possible to comprehend the social, cultural, and ethical facets of design in greater depth, which produces more responsible and significant design solutions.

Reflective practice is a key component of teaching competent engineering designers, according to Adams et al. (2003). They argue that reflection encourages students to develop their critical thinking, problem-solving skills, and self-awareness, which enhances the quality of their design work. Adams et al. emphasize the value of integrating reflective practice into the teaching of engineering design by giving students the chance to consider their design choices, assess their design solutions, and gain knowledge from their mistakes. Reflection helps students get a better understanding of the design process, which includes taking restrictions, trade-offs, and ethical implications into account.

In conclusion, reflection in design is an essential component that improves designers' ability to learn, think critically, and be aware of themselves. It facilitates self-evaluation, builds a deeper comprehension of the design process, and encourages a more deliberate and careful approach to design. Designers may enhance design outcomes and create more responsible and effective design solutions by reflecting on their design choices, evaluating the results, and learning from their experiences. Designers are encouraged to integrate reflective practice into their design process for ongoing improvement and progress. Guided reflection, feedback, reflective writing, and structured reflection assignments are essential tactics for encouraging reflective practice in design education.

REFLECTIVE WRITING

Usher et al. (1999) highlights reflective writing as a significant technique for supporting conceptual learning and fostering critical inquiry. It includes active participation in the process rather than focusing just on the outcome and has been dubbed the "writing-to-learn" paradigm (Allen et al., 1989). Writing is also linked to analytical thinking and cognitive growth since it allows the formation of a cognitive stance similar to the theoretical attitude in the social sciences (Manen, 1990). As a result, writing is a useful strategy for reflective practice since it provides a medium for developing and refining these skills.

Reflective writing is a valuable tool for improving critical thinking and learning in a variety of domains, including design education. It involves thoughtful reflection on one's experiences, ideas, and actions. Writing in a reflective manner encourages self-awareness, self-evaluation, and self-directed learning, which results in improved understanding and sense-making.

Bolton (2010) provides a thorough theoretical foundation for reflective writing in the context of professional development. According to Bolton, the four stages of the reflective writing process are description, feelings, evaluation, and analysis. In the description phase, the author explains the circumstance or experience objectively. The writer considers their feelings and reactions to the experience in the feelings stage. In the evaluation phase, the author critically assesses the experience while taking its benefits, drawbacks, and consequences into account. The writer then conducts a critical analysis during the analysis stage, making connections between the experience and any relevant ideas, concepts, or frameworks.

Bolton's reflective writing framework provides a structured approach that may be implemented in a variety of design contexts, such as reflecting on design projects, design processes, and design decisions. It encourages designers to critically evaluate their thoughts, feelings, and actions, as well as engage in self-reflective discussion. Designers can improve their design methods, problem-solving abilities, and overall understanding of their work by engaging in reflective writing.

Jasper (2005) provides a theoretical framework for using reflective writing in research, specifically in nursing. By emphasizing the value of reflection in developing insights and knowledge from personal experiences, Jasper's approach mirrors Schön's reflective practice. According to Jasper, reflective writing combines subjective and objective knowledge, matching Schön's emphasis on combining theory and practice. Reflective writing is depicted as a cyclical process in Jasper's framework, with three stages: reflection-in-action, reflection-on-action, and reflection-for-action. Jasper's framework, interestingly, extends Schön's concepts by incorporating the concept of reflection-for-action. This phase examines how the insights gained via reflection might be used to inform future actions and decisions, with an emphasis on the active and transformative components of reflection. By explicitly incorporating reflection-for-action, Jasper's work builds upon Schön's theories and offers an expanded perspective on the role of reflective writing in research.

NEED TO ASSESS REFLECTIVE WRITING

Reflective writing is an effective method for fostering critical thinking and self-awareness in a variety of settings, including education, healthcare, design, and research. However, to assure the effectiveness of reflective writing as a reflective practice, the reflective writing process and outcomes need to be analyzed. Several academics have underlined the importance of analyzing reflective writing to assess its quality, rigor, and impact on learning and professional growth.

Reflective writing is a powerful tool for developing critical thinking and self-awareness in a range of contexts, including education, healthcare, design, and research. It is critical to analyze reflective writing to ensure its effectiveness as a reflective practice.

We can assess the contribution of reflective writing to critical thinking and self-awareness by analyzing its quality, rigor, and impact. The analysis may include assessing the structure, coherence, and depth of reflection in the writing, as well as its impact on personal and professional progress. Through systematic analysis, educators and practitioners can identify areas for improvement and enhance the efficacy of reflective writing as a powerful tool for learning and development.

Reflective writing, according to Bolton (2010), should be viewed as a type of professional development that requires rigorous evaluation rather than just personal expression. The author highlights the importance of examining reflective writing for relevance, coherence, and depth of reflection for a variety of reasons. Firstly, reflective writing evaluation indicates the writer's ability to critically analyze their experiences, thoughts, and behaviors, providing insights into their professional progress and learning process. This evaluation helps the writer by increasing self-awareness, improving reflective abilities, and guiding future practice. Moreover, examining reflective writing allows educators and practitioners to provide constructive feedback, identify areas for improvement, and offer specific assistance for the writer's ongoing development. Evaluators can examine the success of reflective writing and contribute to the writer's ongoing learning journey by assessing the writing process, including methods used, clarity of expression, and organization.

Similarly, Jasper (2005) proposes that reflective writing within research be subjected to analysis to assure its credibility and rigor. Jasper presents an approach for studying reflective writing that includes examining the reflective piece's context, content, and process. This method enables researchers to assess the quality and validity of reflective writing as well as its contribution to the research findings. According to Jasper, evaluating reflective writing can assist researchers in identifying patterns, themes, and insights, as well as improving the overall quality of the research.

Furthermore, Adams et al. (2003) emphasize the importance of assessing reflective writing in engineering education to foster good engineering design. They underline the importance of assessing reflective writing for its capacity to display critical thinking, problem-solving skills, and reflection on design processes and outcomes. In engineering education, assessing reflective writing can help educators discover areas for growth, measure students' progress, and improve their design thinking skills.

In conclusion, assessing or analyzing reflective writing is critical to ensuring its success as a reflective activity. It enables the evaluation of the quality, relevance, and rigor of reflective writing and provides feedback for development. Assessing reflective writing in education, design, or research can assist individuals in improving critical thinking skills, increasing self-awareness, and fostering professional development.

2.2 LINGUISTIC ANALYSIS

HISTORY

Text analysis has a rich history that includes various methodologies and approaches. Linguistic analysis, in particular, has sparked the curiosity of scholars across other disciplines. It is crucial to highlight that not all types of text analysis fall under the scope of computational linguistics or natural language processing (NLP). Initially, researchers utilized manual coding and content analysis to assess and classify text data using well-established coding schemes (Pennebaker, 2011). These methodologies, which were used across fields such as linguistics and philology (Crossley, 2020), were labor-intensive and time-consuming.

The development of computer technology transformed text analysis, resulting in the creation of automated approaches. In the 1960s and 1970s, the General Inquirer (Stone & Hunt, 1963) served as an early computerized text analysis tool, giving a complete lexicon of words and phrases classified by psychological and social phenomena . This was a big step forward in the discipline, revealing the possibilities of computer techniques for text data analysis. In recent years, advances in machine learning and statistical algorithms have driven the spread and evolution of computational techniques (Mertens & Toh, 2019; Eichstaedt et al., 2021). These technologies make text analysis more efficient and scalable, allowing researchers to analyze massive amounts of textual data and derive relevant insights. Text mining techniques have also evolved as a helpful tool for analyzing textual data, aiding in the understanding of language patterns and structures (Hotho et al., 2005).

It is essential to acknowledge the various approaches used throughout the history of text analysis, such as manual coding, computational linguistics, and text mining. Over time, these methodologies have evolved and affected one another, defining the area of linguistic analysis and opening up new possibilities for examining and understanding text data.

NEED FOR LINGUISTIC ANALYSIS

Linguistic analysis, a subfield of text analysis, is concerned with the analysis of language in text data. There are various reasons why researchers might use linguistic analysis in their research.

First and foremost, language is a strong tool for reflecting our thoughts, emotions, and social connections. Language structure and the words we use can convey information about our personality, cognitive processes, emotional state, and social behavior (Pennebaker, 2011). Researchers can acquire insights into the psychological significance of words and how language connects to human behavior by studying the language used in text data.

Second, linguistic analysis can provide a systematic and objective approach to text data analysis. While manual content analysis is still employed in some research, it is prone to biases and inaccuracies, as well as being time-consuming and impractical for vast amounts of text data. Automated linguistic analysis tools, such as Pennebaker and colleagues' Linguistic Inquiry and Word Count (LIWC), provide a more efficient and reliable way to examine language in text data (Tausczik & Pennebaker, 2009).

Finally, linguistic analysis can be used in a wide range of research fields, from psychology and social sciences to engineering and design. For instance, the use of linguistic analysis in the field of design engineering has revealed insights into the cognitive processes and information consumption of novice designers during the early design process (Mertens & Toh, 2019). Linguistic analysis can also be used to analyze language patterns and their implications in marketing, political science, design, healthcare, and other fields.

In conclusion, linguistic analysis is an important approach in text analysis because it helps researchers acquire insights into the psychological meaning of words and how language is related to human behavior. It offers a systematic and objective method for analyzing language in text data and has applications in a variety of academic fields.

MANUAL METHODS OF ANALYZING REFLECTION

Manual approaches for evaluating reflection often entail qualitative content analysis, in which researchers or analysts manually evaluate reflective texts to uncover patterns, themes, or essential topics. These methods have been widely employed to generate insights into the reflecting content of texts in a variety of domains, including psychology, linguistics, and design research. Some common manual methods to analyze reflection (Vaismoradi et al., 2013) include:

Thematic Analysis:

This method involves finding and categorizing recurring themes or patterns in reflective texts. Researchers can choose between a deductive strategy, in which themes are predefined based on existing ideas or literature, and an inductive approach, in which themes arise from the data itself. Thematic analysis enables a more complete and nuanced comprehension of the content and meaning of reflections.

Content Analysis:

This method includes systematically coding and categorizing the content of reflective texts using established categories or coding techniques. Researchers may code for specific words, phrases, or concepts in order to find patterns or trends in the reflecting material. Content analysis can provide a quantitative and structured technique to understanding reflections.

Narrative Analysis:

This method examines the structure and content of narratives in reflective literature. To get insights into the reflecting content, researchers may examine storytelling strategies, plot structures, character development, and other narrative elements. Through storytelling, narrative analysis can provide a thorough knowledge of how people form their reflections.

Limitations of manual methods:

Manual methods to analyze reflection also have some limitations (Ullmann, 2019), including:

Subjectivity and Bias:

Because manual procedures rely on human interpretation and judgment, subjective biases may influence the analysis. The same reflective texts may be interpreted differently by different analysts, resulting in variation in the findings. Bias can also originate from the researchers' prior beliefs, expectations, or theoretical viewpoints, which might influence how the reflecting content is interpreted.

Time and Resource Intensive:

Manual approaches can be time- and labor-intensive, especially when working with huge amounts of text data. The process of reading, coding, and evaluating reflective texts can be time-consuming, involving significant human work and resources.

Limited Scalability:

Manual approaches may not be suitable for evaluating large-scale or diversified datasets since the process of manual coding and analysis may become impractical or impossible. Manual approaches may also be unable to capture minor patterns or trends in reflective content, especially when dealing with complicated or nuanced reflections.

Incomplete Analysis:

Because analysts may only focus on specified categories or coding systems, manual approaches may not capture all the reflected material, thereby missing key information or insights. Manual approaches may also have difficulty recognizing subtle or implicit reflections that require further investigation or comprehension.

Lack of Privacy and Confidentiality:

This restriction can be overcome by using automated reflective writing tools that provide a sense of privacy, as students may be reluctant to discuss private thoughts related to their reflections while sharing their works with a teacher in manual text analysis (Richman et al., 1999).

Manual approaches for studying reflection provide unique advantages that should not be overlooked. Manual analysis, as compared to automatic or computational methods, provides for context sensitivity and the disambiguation of polysemic terms, allowing for a more nuanced comprehension of the content and meaning of reflective writings (Crossley, 2020). These manual approaches are still commonly used in academic fields, providing useful insights into reflective processes and experiences (Hotho et al., 2005). Researchers should be aware of the possible limitations of manual analysis and take steps to eliminate biases, maintain rigor and consistency, and explore complementing findings with automated or computational methodologies (Eichstaedt et al., 2021).

AUTOMATED METHODS OF ANALYZING REFLECTION

The approaches that have been used to automatically analyze reflective writing can be broadly categorized according to three approaches: dictionary-based, rule-based, and machine-learning-based (Ullmann, 2019). First, the two approaches that use manual construction of a "vocabulary" and "rule set" are described. Then, the research that uses a "machine learning" method to automatically get the key "vocabulary" and "rules" to classify text from a set of samples is described.

Dictionary Based Approach

The use of manually compiled dictionaries (concept dictionaries) or vocabulary, or word lists that represent categories for which the words in the list are representative, was one of the earliest methods for annotating texts (Ullmann, 2015). A dictionary is a collection of terms connected with a given category or topic in the field of automated methods. Experts who have a particular interest in a subject frequently define a group of terms for these dictionaries. Computer systems may then use these dictionaries to find instances of dictionary words in text. The primary goal of employing dictionaries for text analysis is to turn text into numerical representations by calculating the frequency of dictionary words. This allows for text quantification and the application of statistical tools for data analysis (Ullmann, 2019). The emphasis of dictionary-based research is frequently not on developing high-performing classifiers, and most researchers do not generally examine performance indicators. There are some exceptions, since some research (e.g., (Ullmann, 2017)) investigates the performance of dictionary-based techniques. Despite this, dictionary-based techniques for automatic reflection detection are extensively utilized because of their advantages. One of the key advantages is that, as compared to rule-based or machine learning-based systems, dictionaries can be set up quickly, making them excellent for testing automation ideas. Furthermore, dictionaries are frequently used in combination with rules in rule-based techniques, and they may even be used to inform the construction of features for machine learning models.

The General Inquirer (Stone & Hunt, 1963), the Textbank System (Mergenthaler & Kächele, 1991), Linguistic Inquiry and Word Count (LIWC) (Pennebaker & Francis, 1996; Tausczik & Pennebaker, 2009) and the Empath tool (Fast et al., 2016) are some examples of dictionary-based systems for automated linguistic analysis. The early examples show the extensive usage of dictionary-based techniques in the field of reflection detection, and they served as the foundation for later research in this area.

LIWC (Tausczik & Pennebaker, 2009) is a widely used software for analyzing the psychological significance of words in text data. It takes a similar approach to that of a dictionary, where words are sorted into predetermined linguistic and psychological categories (such as positive and negative emotions, cognitive processes, and social categories). Using LIWC, researchers may objectively and systematically analyze language use due to quantitative assessments of the frequency and proportion of distinct word categories in a document. LIWC (Linguistic Inquiry and Word Count) stands out among other dictionary-based approaches due to its specialized focus on analyzing the psychological significance of words in text data. LIWC categorizes words into predetermined linguistic and psychological categories, enabling systematic and quantitative assessments of language use. Unlike general dictionaries, LIWC offers specific insights into emotions, cognitive processes, and social categories within a text. This targeted approach allows researchers to analyze language use objectively and comprehensively, providing numerical indicators for comparative studies.

Fast et al. (2016) created Empath, another dictionary-based linguistic analysis tool that evaluates text based on its emotional and empathic content. For academics to evaluate a text's emotional tone and empathetic qualities, they can use Empath, which employs a wide set of lexical categories that capture various emotions, sentiments, and social signs. To further help researchers understand the emotional content of text data, it gives quantitative assessments of the prevalence of different emotional categories in the text.

Both LIWC and Empath make it possible to conduct standardized and automated analyses of sizable text collections. They facilitate the methodical and effective examination of text data, giving researchers access to numerical indicators useful for comparative studies. These methods rely on predetermined dictionaries, which cannot account for the nuances and complexity of language use in all settings and among all groups. Moreover, the quality and depth of the dictionaries utilized may affect the accuracy and reliability of the analysis, necessitating further human verification and validation. Besides these limitations, LIWC and Empath have been widely employed in research domains like psychology, social sciences, and human-computer interaction to obtain insight into language use and emotional content in text data.

When used in combination with other text analysis techniques, they can help researchers gain a more in-depth knowledge of the linguistic and psychological foundations of writing. However, these dictionary-based systems have limitations in detecting complex and nuanced reflections, which led to the development of more advanced approaches such as machine learning and natural language processing techniques. These newer methods have shown promising results in improving the accuracy and efficiency of reflection detection.

Rule Based Approach

Rule-based systems offer methods that expand the potential of forming inferences from texts, whereas dictionary-based techniques focus mostly on pattern matching the dictionary items with the text (Ullmann, 2019). A rule-based system relies on rules to encode domain expertise. Formal reasoning is possible over the rule base due to the logic provided in these rules. As a result, rules may be chained in a knowledge-based system's inference engine to derive facts from a variety of situations. When compared to a dictionary-based method, this strategy increases the automated detector's expressiveness. The rule-based approach is newer to this field than the dictionary-based one. The rule-based approach allows for more flexibility and customization in detecting specific patterns and nuances in language, while the dictionary-based method may miss certain variations or context-dependent uses of words. However, the rule-based approach may require more initial development and fine-tuning to achieve optimal performance.

An example of an automated technique is the rule-based approach, which does text analysis by applying a predefined set of rules in the form of conditional statements to classify the text into predetermined categories or identify predefined notions. The inclusion of specific cue words from a dictionary influences the classification of a text into a specific category; hence, a dictionary-based method may be thought of as a mini rule-based system. Discourse analysis, and more specifically, the study of scientific articles, is one area where rule-based systems have been used. For instance, Sandor (2007) presented a method for identifying scientific discourse in texts by tying meta-discourse indicators to specific rhetorical functions. Meta-discourse is the use of reflective language inside a book to negotiate interactional meaning and include readers as active participants (Hyland, 2005).

Markers are concrete examples of a component idea in Sandor's model of concept matching for meta-discourse (Sandor, 2007). Rhetorical functions are composed of many constituent ideas. Sandor detailed a three-stage process that specialists may follow to build the system. At first, a large corpus is examined to find a handful of keywords that correspond to individual ideas. Second, a more comprehensive vocabulary list for each component notion is compiled. In a final step, rules are developed and evaluated based on the constituent concepts, with the rules combining the constituent concepts to achieve a rhetorical function (Sandor, 2007).

The advantages of rule-based techniques include the ability to construct rules based on expert knowledge in a way that is both clear and interpretable. In cases where dictionaries or word lists can be swiftly generated, they can be quite helpful. To further enhance the precision and efficacy of automated systems, rule-based approaches are often employed in combination with dictionaries or other methodologies. The richness and variation of natural language may be lost with rule-based techniques, and the effectiveness of such systems may be highly dependent on the quality of the rules and the knowledge of the rule designers. Consider a rule-based system designed to categorize movie reviews as positive or negative based on preset rules. While it might accurately identify explicit sentiments, like "great" or "awful," it could misinterpret subtler phrases. For instance, a review stating, "The film wasn't terrible, but it didn't meet my expectations," might be wrongly classified as positive due to the words "wasn't terrible," even though the overall sentiment leans negative. This showcases how the intricacies and nuances of natural language can elude rule-based methods, particularly when handling complex or ambiguous expressions, emphasizing the pivotal role of well-crafted rules and expert design in such systems. Besides these limitations, rule-based systems continue to be a key strategy for automated reflection detection in text analysis research, and they have been utilized in many other areas, including discourse analysis, sentiment analysis, and information extraction.

Ullmann et al. (2012) suggested a rule-based method for classifying texts as reflective or non-reflective in their research. The strategy involved linking information obtained from dictionaries with a set of principles to infer the reflectiveness of texts. Both the rule-based system and the dictionary-based approach depended on the human development of dictionaries and rules, respectively. Software might do automated text analysis after dictionaries or rules are modeled. These

guidelines were hand-built using domain experts' knowledge to identify patterns and traits specific to reflective writing. The rules were implemented in a chain, with each rule's output feeding into the following rule's input. The reflectiveness of texts might be determined using an inferential method that follows a logical sequence of rules.

The rules in a rule-based approach are interpretable because they are well-defined and can be readily understood and updated by subject-matter experts. The rule-based method also has the potential to be flexible and adaptive, allowing for the addition of new rules or the alteration of current ones considering new information or insights. Performance may be dependent on the quality of the rules and the skill of the rule designers, as is the case with other rule-based techniques, and it may have difficulties capturing the variety and complexity of natural language.

Machine Learning Based Approach

The topic of automated analysis of reflective writing has seen rising interest in methods grounded in machine learning in recent years. The sentences are categorized as reflective or non-reflective based on human evaluations, and the machine learning models are trained on this labeled data. After the models have been trained, they may use the patterns they've learned to automatically label new texts as reflective or non-reflective.

There are several benefits to using machine learning rather than a dictionary or rules-based system. Firstly, they can recognize intricate linguistic patterns and complexities that traditional dictionaries and rules can miss. The performance of machine learning models may be enhanced by providing them with additional data and more efficient algorithms. Secondly, the models may be retrained and updated with fresh data to further refine the accuracy of machine learning-based techniques. Finally, techniques based on machine learning can be scalable since they can process massive volumes of data and automatically evaluate texts in real time.

Reflection detection in texts was suggested by Ullmann (2015a) and verified by Ullmann (2015b) both of which use machine learning (Ullmann, 2019). These methods involve annotating texts with human-judged labels to train machine learning models on labeled data. The machine learning method usually entails a multi-stage process. To begin, a labeled dataset is constructed, in which sentences are manually marked as reflective or non-reflective. A machine learning model, whether a supervised classifier or a deep learning model, is trained using this dataset. The model is trained on the labeled data and eventually becomes capable of using the features it has learned to categorize texts as reflective or non-reflective. The trained model may then be utilized to do automatic text analysis. The trained model receives the texts as input and, using the patterns it has discovered from the labeled data, predicts the texts' level of reflection. Predictions made by the model can be compared to expert opinions or other standards to see how well it performs.

One of the benefits of a machine learning-based method is that it may pick up on nuances and complicated patterns in language that traditional approaches like dictionaries and rules may miss. Models trained with machine learning data can adjust to new forms of expression, new situations, and new languages. As a result, they are applicable to the analysis of texts in the real world, despite the presence of noisy or confusing data. The use of machine learning has its advantages, but it also has its drawbacks. While the model's effectiveness is dependent on the precision and breadth of the annotations, the quality of the labeled data used for training is crucial. In addition, machine learning models may need regular updates and retraining to retain accuracy since they have trouble generalizing to data that is different from the training data.

The machine learning-based approach to automated analysis of reflective writing has proven effective, and it provides a scalable, versatile, and malleable means of identifying reflective moments in written works. Its accuracy and relevance to real-world scenarios can be improved with more research into its educational potential and limits.

MODEL FOR REFLECTION DETECTION

The datasets used for keyword extraction were created based on a common distinction found in research on reflective writing: the distinction between descriptive (non-reflective) and reflective texts. Descriptive writing is a type of writing that focuses mostly on description without explicit reflection, whereas reflective writing includes texts with a higher level of reflection. There are several subcategories within the category of reflective writing that capture different aspects or dimensions of reflection. These variances in writing types serve as key differentiators among the various models used to assess reflective writing. Although these models use different approaches, they all attempt to capture the breadth and depth of reflection. While doing manual content analysis of reflective writing, researchers frequently adopt coding category schemes that incorporate both the breadth and depth of reflection. Despite the variety of models, there is some similarity in the categories used to classify them.

Ullmann (2015a) analyzed over twenty-four different reflection detection models before deriving their own. Both characteristics are included in the composite model that resulted from this research. In the paper, they referred to this model as the model of reflection detection. In all, there are eight categories in the model: reflection, experience, feeling, belief, difficulty, perspective, learning, and intention. Many separate models can be seen as generalizations of the research model used in this study. For example, Wong et al. (1995) described their model to analyze reflective writings with categories, such as attending to feelings, validation, and outcome of reflection. Prilla and Renner (2014) analyzed reflection according to categories such as describing an experience, mentioning and describing emotions, and challenging or supporting assumptions.

Although the model categories vary from research to research, they do share some commonalities. The model categories have the potential to represent a standard set of rubrics for assessing introspection or reflection. Ullmann (2015a) analyzed more than 24 models of reflection detection to finally derive their own model. The synthesis of all these models led to a model of common constituents containing both qualities. They referred to this model as the model for reflection detection. In total, the model consists of eight categories (referred as 'components of reflection' henceforth): Reflection, Experience, Feeling, Belief, Difficulty, Perspective, Learning, Intention. The categories in this model will provide a comprehensive framework for the analysis of reflective writing in the design field. This research aims to explore how design students use reflection as a tool for learning and professional development.

2.3 KEY TAKEAWAYS

Understanding Reflective Writing: Leveraging the Model of Reflection Detection and Linguistic Analysis

According to the reviewed literature, reflective writing is a common method of gaining knowledge and developing skills in many academic disciplines, including design. Previous studies have presented a wide variety of models for reflection detection, with varying categories to represent the components of reflective writing. There is, however, a clear distinction between descriptive (non-reflective) writings and reflective texts, the latter of which may be broken down even further into subcategories based on the depth or breadth of the reflection they feature.

Ullmann (2015a) developed an extensive model for reflection detection that comprises eight categories: reflection, experience, feeling, belief, difficulty, perspective, learning, and intention. These basic components may be able to capture the depth and breadth of reflection in reflective writing. Manual content analysis of reflective writings has made extensive use of the model, which provides a coding category structure.

This research aims to gain an understanding of design students' reflection by using the categories of the model of reflection detection as a main basis and a rule-based approach with the Linguistic Inquiry and Word Count (LIWC) tool. The LIWC program is widely known because it can analyze text and determine linguistic patterns, including word categories, emotions, and cognitive processes. The purpose of this research is to develop a scalable rule-based technique for detecting reflection in the writings of design students using LIWC with the help of the keywords and patterns discovered through the model of reflection detection.

In this study, I will use LIWC to automatically assess the reflective writing of design students based on the components of reflection in the model of reflection detection. Reflective writing will be recognized and classified based on markers such as experience, feeling, belief, difficulty, perspective, learning, and intention-related keywords.

By using the model of reflection detection as a guiding framework and a rule-based approach using LIWC for linguistic analysis, this research aims to contribute to a better understanding of how design students write their reflections. Additionally, the research findings may have significance for developing reflective writing interventions and educational approaches in the design area with the objective of improving students' reflective practice and professional growth.

In conclusion, the analysis of relevant literature demonstrates that the model of reflection detection with its eight categories provides a thorough framework for evaluating reflective writing. Using the model of reflection detection as a starting point and a rule-based approach using LIWC for linguistic analysis, this study aims to comprehend the reflective writings of design students. Reflective writing is an important skill for designers, and this research has the potential to shed light on the processes and tactics that design students use in this area.

03

METHODOLOGY

This section outlines the methodology employed in the study to examine the reflections of design students within the context of the Design Theory and Methodology (DTM) course at the faculty of Industrial Design Engineering (IDE) at TU Delft. The research process was structured into two distinct phases, each contributing to the comprehensive exploration of the reflection data. The first phase focuses on understanding relations between components of reflection and LIWC categories, Building upon the findings from the first phase, the second phase focuses on understanding characteristics of high-quality reflections.

3.1 Introduction

3.2 Process and Method

Data Collection

Research Process: Phase 1

- Coding Reflections Based on Ullmann's Model of Reflection Detection
- Frequency Extraction of Reflection components
- Conducting LIWC Analysis
- Correlation Analysis

Research Process: Phase 2

- Understanding the Rubric and Its Alignment with Reflection components
- Analyzing Patterns and Relations Between Grade Range and Components of reflection
- Comparing Grade Ranges Based on LIWC categories

3.1 INTRODUCTION

The reflections provided by design students serve as valuable resources for gaining insights into how they reflect on their own experiences. This study aims to analyze the reflections that design students completed for the Design Theory and Methodology (DTM) course in the faculty of Industrial Design Engineering (IDE) at TU Delft. The objective of this research is to explore the linguistic elements of these reflections to facilitate a comprehensive analysis to understand and assess students' reflective practices.

Reflective thinking, as stated in the literature study, is considered an important aspect of the design process since it allows designers to evaluate their efforts, make improvements, and further enhance their design skills. Manual content analysis has traditionally been the most common method for evaluating reflective thinking through self-reported reflections. Nevertheless, this method lacks reliability and can be biased. The human element in manual procedures introduces subjectivity, which can lead to variations in interpretation, ultimately affecting the consistency and dependability of the findings. There is a growing interest in using machine learning and linguistic analysis tools to overcome these limitations and gain a deeper knowledge of reflective thinking (Ullmann, 2019).

To address the concerns of time, effort, and consistency, it is prudent to leverage the scalability and (relative) objectivity offered by psycholinguistic dictionaries such as LIWC. Manual analysis, exemplified by the qualitative coding performed, is characterized by its time-intensive nature and inherent subjectivity. By adopting LIWC, this study seeks to mitigate these challenges and provide a systematic and quantitative analysis that facilitates an in-depth investigation of reflective thinking. While methods for linguistic analysis such as the Linguistic Inquiry and Word Count (LIWC) and Empath have been created, their capacity to capture the complex linguistic aspects of reflection in design approaches is limited. These tools were designed primarily to examine the psychological significance of words and emotions in text (Tausczik & Pennebaker, 2009). As a result, there is a need to investigate alternate ways of gaining a more comprehensive understanding of design students' reflections.

The primary focus of this research project is on using linguistic analysis, specifically LIWC, to study design students' reflection on their own design practice based on their learnings from the essay they wrote for the assignment in the DTM course. The study intends to reveal linguistic elements and patterns within the reflections by utilizing linguistic analysis. The insights gained from this analysis will help to better understand the cognitive processes, decision-making strategies, and general reflective practices employed by the design students.

Research Goals

01

To understand the components and dimensions of reflection within the design students' final reflections in the DTM course

02

To explore the linguistic elements and patterns present in the reflections using LIWC

03

To identify the characteristics of high-quality reflections and determine the linguistic categories associated with such reflections

To achieve these research goals, the project builds on Ullmann's model of reflection detection. The model provides a thorough framework for analyzing and understanding different aspects of reflective writing. It includes eight distinct and measurable components of reflection: reflection, experience, difficulty, belief, feeling, perspective, learning, and intention. Each component captures a different aspect of the author's thoughts, experiences, and cognitive processes, allowing for a more in-depth exploration of design students' reflective writings.

By utilizing Ullmann's model of reflection detection and applying LIWC for linguistic analysis, this research project aims to gain insights into the various components and dimensions of reflection present in the design students' final reflections for the DTM course. Through the analysis of linguistic characteristics, patterns, and correlations, the study seeks to identify indicators of high-quality reflection and explore the factors that contribute to effective reflective practices.

The findings of this research project have the potential to provide valuable insights into the components and characteristics of design students' reflections. By understanding how students construct their reflections, the different components they include, and the patterns observed in higher-graded (good quality) reflections, this research aims to enhance our understanding of reflective practices in design education. These insights can inform design educators and practitioners about effective approaches to teaching and assessing reflective thinking, ultimately improving design processes and outcomes. Additionally, the research outcomes may contribute to the development of new tools and methodologies that support and enhance the reflective design process.

3.2 PROCESS AND METHOD

DATA COLLECTION

The data collection process for this research project involved obtaining the reflections written by design students who participated in the Design Theory and Methodology (DTM) course. The reflections were a mandatory part of an assignment that required students to write an essay on a selected topic and then reflect on how, in the light of their essay, their future practice as designers could change. The reflections were limited to a maximum of 300 words, ensuring a concise and focused assessment. The length of the reflections submitted by the students ranged between 162 and 415 words (M=299; SD=44), providing a substantial amount of textual data for analysis.

The assignment's primary goal was to assess the students' theoretical understanding of their own design practice. To collect the data, the course coordinators gathered the reflections from the students. Prior to the analysis, the reflections were anonymized by assigning each student a unique ID number. This anonymization process ensured the confidentiality and privacy of the students' identities. Along with the reflections, the collected data also included the associated grades, the coach who graded each reflection, and the coach's comments. This additional information proved valuable for conducting a comprehensive analysis of the collected reflections. The grades given to the reflection samples ranged from 6 to 10 on a scale of 10, with further subdivisions into grade ranges: Excellent (E) for grades 9 to 10, Good (G) for grades 8 to 8.5, Moderate/Sufficient (M) for grades 7 to 7.5 and Poor (P) for grades 6 to 6.5. This categorization facilitated the efficient analysis and examination of specific groups of reflections, enabling a more detailed exploration of their different components and linguistic elements.

In total, 56 unique reflections written by the design students were included in the data analysis. These reflections were a diverse and representative sample of the students' reflective practices in the DTM course. This made it possible to do a thorough analysis of the collected data's linguistic features and patterns. The subsequent sections will further delve into the methodologies and techniques employed to analyze and interpret the collected reflection data, with the aim of gaining a deeper understanding of the students' reflective practices and identifying key linguistic elements associated with high-quality reflections.

RESEARCH PROCESS

The research process undertaken in this study involved a systematic and comprehensive analysis of the collected data to gain insights into the components and linguistic elements of design students' reflections. The research process can be divided into two distinct phases: Phase 1 focused on understanding the relationship between components of reflection and LIWC dictionary categories (referred as 'LIWC categories' henceforth), while Phase 2 aimed to uncover the components of a good reflection using components of reflection and associated LIWC categories.

The following visual (Figure 3) represents the approach taken for each phase of the research.

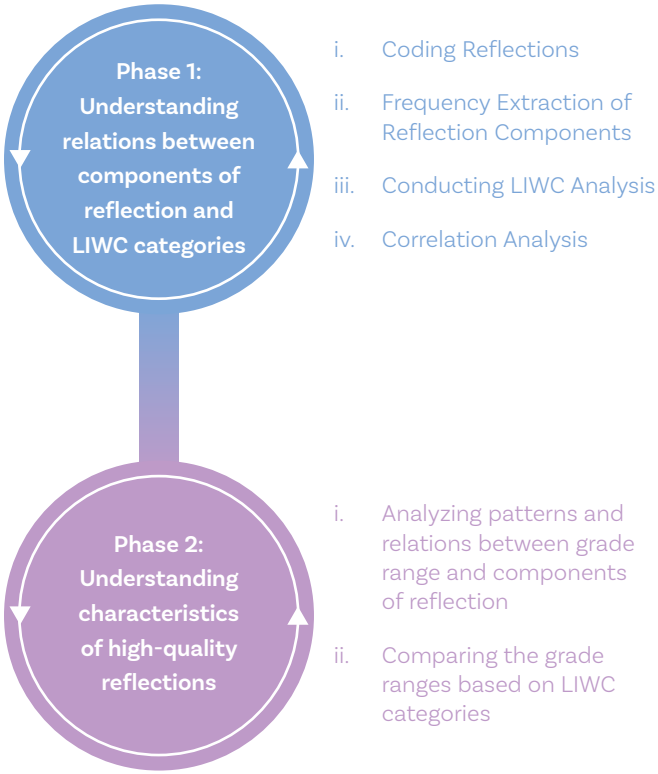


Figure 3: Research process explaining the approach taken in the phases

RESEARCH PROCESS: PHASE 1

In Phase 1, a qualitative coding approach was employed using Atlas.ti[1] to analyze the reflections based on predefined criteria for reflection categories. This coding process facilitated the categorization of the reflection content, providing a foundation for further analysis. The frequency of occurrence for each reflection category was then extracted, offering quantitative data on the prevalence of different categories within the collected dataset. To delve deeper into the linguistic aspects of the reflections, a basic LIWC analysis was performed on all the collected reflections. The LIWC analysis allowed for the examination of linguistic patterns, word categories, emotional tone, and cognitive processes present in the reflections. A correlation analysis was then conducted to identify any significant relationships between the reflection categories and the linguistic features captured by LIWC.

Coding Reflections Based on Ullmann's Model of Reflection Detection

In Phase 1 of the research process, I used the Atlas.ti to conduct qualitative coding. The researcher personally coded all 56 samples of reflections written by design students, ensuring accuracy and consistency through three iterations.

First Iteration: Initial Test with 10 Samples

In the first iteration, a small test set of 10 reflection samples was used. The main purpose of this initial test was to gain an understanding of the nature of the data and to explore how the coding process could be effectively implemented. It served as a trial run to identify any challenges or issues that might arise during the full-scale coding. This initial test was based on my understanding of the model of reflection detection. During the coding process, it was observed that coding just a phrase of the sentence as one component of reflection meant losing some of the linguistic elements related to this component of reflection. Hence, for the next iteration of coding, it was determined that the complete sentence will be coded as one/multiple components of reflection based on definitions given by Ullmann (2019).

Second Iteration: Coding for 30 Samples

For the second iteration, a larger set of 30 reflection samples was selected. During this phase, the coding was solely based on the predefined definitions of the components of reflection. The aim was to systematically categorize each sentence in the reflection samples according to the appropriate component of reflection. However, it was observed that certain sentences could fit into multiple codes, leading to ambiguity in coding decisions. The main challenge faced during this iteration was to decide which code (component of reflection) has a higher priority for a sentence. This was due to lack of more rules to distinctly relate a specific code to a sentence or part of the sentence.

Third Iteration: Coding for 56 Samples with Adopted Criteria

To address the ambiguity faced in the second iteration, the criteria for coding were adopted from Ullmann's models of reflection detection. This involved using the indicators and guidelines provided by Ullmann's work to ensure a more precise categorization of the sentences. The third iteration of coding was performed on a total of 56 reflection samples, encompassing a more diverse range of content and language.

By employing the criteria from Ullmann's models, the coding process became more structured and allowed for consistent decision-making regarding the appropriate category for each sentence. This ensured that sentences were appropriately assigned to the relevant categories, reducing ambiguity and enhancing the accuracy of the coding process.

The coding process was based on predefined criteria derived from the components of reflection in the "model of reflection detection" developed by Ullmann. Ullmann's work, encompassing a series of papers published in 2012, 2015, and 2019, provided valuable insights and approaches for analyzing reflective writing. These guidelines provided a framework for systematically identifying and classifying the reflection content based on the relevant categories.

1 Atlas.ti tool: https://atlasti.com/atlas-ti-desktop

Predefined Criteria for Coding

In the coding process, predefined criteria were employed based on Ullmann's model of reflection detection to categorize the reflections written by design students. Each category (component) in the model represented a distinct aspect of reflection, allowing for a comprehensive analysis of the students' written reflections.

A fundamental rule followed during the coding process was the consideration of the complete sentence as a meaning unit (Lindgren et al., 2020) to be coded as a component of reflection. In most cases, a sentence was coded as belonging to a single component based on its overall content and intention. However, there were instances where a sentence exhibited an overlap of codes, indicating that it could be interpreted as containing elements of multiple reflection components. In such special cases, where a sentence was larger and could be distinctly seen as two separate sentences with different components of reflection, the coding considered the distinct components and assigned the appropriate categories accordingly. This approach allowed for a nuanced analysis of the reflections and ensured that the coding accurately captured the different aspects of the students' reflective writing.

By adhering to this rule, the coding process maintained consistency and accuracy in categorizing the reflections based on the predefined criteria, while also accounting for potential complexities or overlaps that might arise in the sentence structure or content.

The following are the definitions of the categories and their corresponding criteria used in the coding process as mentioned by Ullmann (2012; 2019). For a meaning unit to be coded as a components, it should be noted that at least one of each criteria about the pronouns should be satisfied along with one of any other criteria mentioned for a specific component.

01 EXPERIENCE

Author's description and recounting of personal experiences, highlighting their subjective encounters and narratives

1. Past tense sentences with self-related pronouns as subjects.
2. Present tense sentences with self-related pronouns as subjects.
3. Sentences with surprise keywords and self-related pronouns as subjects.

02 BELIEF

The expression of the author's personal beliefs, perspectives, or opinions on various topics or issues

1. All sentences that implicitly cover the element of "personal experience" through self-related pronouns.
2. All indicators based on self-related pronouns.
3. Question sentences where the subject is a self-related pronoun.

03 DIFFICULTY

Author's critical assessment of their own actions or experiences, where they analyze challenges, obstacles, or struggles encountered

1. Sentences with premise, conclusion, and causation keywords.
2. Sentences with certainty or discrepancy as keywords and using self-related pronouns as subjects.
3. Sentences with self-related pronouns as subjects and reflective verbs as governors.

04 PERSPECTIVE

Author's consideration of alternative viewpoints or perspectives, indicating their ability to understand different sides of an issue or situation

1. Sentences with "pronoun others" as subjects and self-related pronouns as objects.
2. Sentences with self-related pronouns as subjects and pronouns others as objects.

05 FEELING

Author's emotional experiences and expressions, capturing their feelings and affective states

1. Feelings often associated with reflection, such as concern, doubt, uncertainty, frustration, surprise, or excitement.

06 LEARNING

Author's reflections on what they have learned or gained from their experiences, indicating their acquisition of knowledge, insights, or lessons

1. Sentences with self-related pronouns as subjects.
2. Sentences with self-related pronouns as subjects and keywords expressing insights.

07 INTENTION

Author's expressed intentions or plans for future actions or behaviors

1. Sentences with self-related pronouns as subjects.
2. Future tense sentences with self-related pronouns as subjects.

08 DESCRIPTIVE

Text written by the author that is purely descriptive or non-reflective; a straightforward description without any critical assessment

1. No use of use of self-related pronouns

Note: The component of 'Reflection' from Ullmann's model was not used in this research due to its difficulty in practical coding. Instead, the component of 'Descriptive' was employed to identify sentences that were non-reflective or purely descriptive in nature. Hence, the criteria for descriptive component is solely based on it's definition and the understanding of the definition.

Table 1: Components of Reflection and Corresponding Coded Examples

Component of Reflection	Coded Example
Experience	"During my minor Education I had to write down a lot of my reflection on paper so you will not forget the recommendations that you wrote to yourself." *ID 8: Quotation 4*
Belief	"If we do not have design options to analyze and reflect on, how can we be expected to conduct this at a faster and more efficient rate in industry where deadlines are strict?" *ID 11: Quotation 7*
Difficulty	"Even though my design process has been close to the co-evolution model, I have been fixated on the conception that design is about rational problem solving so its process should also follow rational steps of analyzing and synthesizing." *ID 5: Quotation 4*
Perspective	"I do notice, like Nordby & Schønheyder tell in their paper, that it is very useful to tweak the design methods a little bit to your own design problem." *ID 24: Quotation 7*
Feeling	"This was very refreshing as this was something I often unconsciously did as a designer, but would get frustrated at not finding the right solution." *ID 9: Quotation 6*
Learning	"Writing the essay helped me realize that personal leans and a particular uncommon way of framing the problems, which is an imprint of a lived experience, is a strong factor in building expertise." *ID 16: Quotation 7*
Intention	"I hope that in my next design practice, in the stage of analyzing problems, I will take myself as an observation sample, introduce the design vision and observe what it brings to me." *ID 48: Quotation 9*
Descriptive	"Design visions should be a way of expressing your personality through design and to create unique solutions." *ID 44: Quotation 2*

By applying these predefined criteria during the coding process using Atlas.ti, the reflections were systematically categorized into these distinct reflection components.

The subsequent sections will elaborate on the coding methodology and provide insights into the findings derived from the analysis of the coded data.

RESEARCH PROCESS: PHASE 1

Frequency Extraction of Reflection components

Once the coding of the reflection samples was completed, the next step involved extracting the frequency of occurrence for each component of reflection. This process aimed to quantify the presence and prevalence of each reflection component within the collected samples.

For each reflection sample, the frequency of occurrence was determined by counting the number of instances where a specific component code (e.g., experience, belief) was assigned during the coding process. These frequencies were then normalized across all 56 samples, ensuring a fair comparison and analysis across the entire dataset.

To establish a consistent unit of measurement, the frequency of words within the reflection samples was utilized as the basic unit for analysis. The need for comparability with the LIWC analysis, which also uses word counts rather than sentence-level analysis, served as the driving force behind this decision.

By extracting and normalizing the frequency of occurrence for each component of reflection, valuable quantitative data was obtained. These frequency values served as crucial information for conducting correlation analyses with the LIWC categories. The goal was to uncover potential relationships and connections between the identified components of reflection and the linguistic features captured by the LIWC analysis.

Conducting LIWC Analysis

To gain further insights into the linguistic aspects of the reflections, a basic LIWC analysis was conducted on all 56 samples. The LIWC-22 dictionary was selected for this analysis, which includes various predefined linguistic categories. The primary goal was to explore the relationships between the components of reflection and different LIWC categories.

LIWC analysis involves analyzing the text based on word categories and linguistic dimensions. Each word in the reflection samples was matched with the LIWC dictionary to determine its component. The analysis focused on identifying the frequency of occurrence of specific word categories in the reflections.

For this research, the entire text of each reflection sample was used without any segmentation, as the samples were already concise in size, typically containing around 300 words. The resulting numbers obtained from the LIWC analysis formed a significant part of the data that would be used for the subsequent correlation analysis.

LIWC analysis provides valuable insights into the linguistic content of the reflections, allowing for a deeper understanding of the language used by the students. It helps identify patterns and tendencies in word usage, enabling researchers to explore the relationship between linguistic features and the components of reflection in a systematic manner.

Comparing the reflection dataset to the Stream of Consciousness (SOC) corpus:

To further enhance the reliability and representativeness of the analysis, statistics from the “Stream of Consciousness” (SOC) corpus within the LIWC test kitchen corpus (Boyd et al., 2022) were also incorporated as a reference. The SOC corpus consists of essays written by students in an online introductory psychology class, where they were asked to engage in a 20-minute stream of consciousness writing exercise (Vine et al., 2020). This corpus provides a larger dataset with diverse linguistic characteristics captured during unfiltered and spontaneous writing.

The strong correlation observed between the reflection samples of the students in the DTM course and the SOC corpus from the LIWC Test Kitchen corpus suggests a notable similarity in their linguistic characteristics. This similarity provides an opportunity to leverage the statistics of the LIWC analysis from the larger SOC corpus as a representative basis for the reflection data in the DTM course. The SOC corpus consisted of 1,574 essays written by students in an online introductory psychology class, while the reflection samples in the DTM course likely had a smaller number of participants. By using the LIWC statistics from the SOC corpus, which is a much larger data set, we can make the LIWC scores for the reflection samples more reliable and applicable to a wider range of texts.

The statistics derived from the LIWC analysis of the SOC corpus can be considered a reference point or benchmark for understanding the linguistic patterns and characteristics found in the reflection samples. The SOC corpus provides a broader range of linguistic expressions and a more diverse set of topics and contexts compared to the relatively smaller reflection

dataset. Factors that might have contributed to the similarities between the SOC corpus and the reflection samples from the DTM course:

1. **Similar Writing Context:** Both the students in the DTM course and the participants in the SOC corpus were engaged in a writing exercise where they were instructed to express their thoughts, perceptions, and feelings freely and continuously. This similarity in the writing context likely led to comparable linguistic patterns and characteristics in their written expressions. Although it should be noted that reflections exhibited a significantly higher mean 'Analytic' score, indicating a more structured and organized thought process compared to the SOC corpus. This might be due to the nature of the assignment for reflection where the students were required to reflect on their design process while considering the essay they had written.

2. **Personal Reflection and Self-Expression:** The focus of both the DTM course reflections and the SOC essays was on personal experiences, perceptions, and feelings. Participants in both datasets were encouraged to delve into their own subjective experiences and express themselves authentically. This shared emphasis on personal reflection and self-expression may have contributed to similar linguistic patterns related to introspection and self-awareness.

3. **Common Psychological Processes:** Reflection and stream of consciousness writing are both associated with psychological processes such as introspection, self-reflection, and emotional exploration. These processes involve accessing and articulating one's inner thoughts and emotions. The LIWC analysis scores for 'Authentic' were similar, suggesting that the degree to which a person is self-monitoring might be similar for both datasets. The shared psychological underpinnings between the DTM course reflections and the SOC corpus may have resulted in linguistic similarities related to emotions, introspective language, and the expression of subjective experiences.

Note: While these factors provide potential explanations for the observed correlation, further research and analysis would be necessary to gain a deeper understanding of the specific mechanisms driving the linguistic similarities between the two datasets. Additionally, the findings may be influenced by the specific instructions given in the DTM course and the SOC corpus, as well as the characteristics of the participants involved.

By using the representative LIWC scores from the SOC corpus, we can gain insights into the prevalence and distribution of linguistic features associated with various LIWC categories within the reflection samples of the DTM course. This allows us to make meaningful comparisons and analyze how the students' reflections align with or differ from the broader stream of consciousness writing represented in the SOC corpus.

Additionally, the use of the larger SOC corpus as a representative basis helps mitigate potential biases or idiosyncrasies that may arise from analyzing the reflection samples in isolation. It provides a more robust foundation for identifying linguistic trends, patterns, and associations between the components of reflection and LIWC categories.

However, it is important to note that while the statistics from the SOC corpus serve as a valuable reference point, they may not capture the specific nuances and context-specific aspects of the reflection samples in the DTM course. Therefore, it is essential to interpret the results within the context of the DTM course and consider the unique characteristics and objectives of the reflection data being analyzed.

Correlation Analysis: Exploring Relations Between Components of reflection and LIWC categories

In this phase of the research, correlation analysis was conducted to examine the relationships between the components of reflection and LIWC categories. The data obtained from the coding frequencies and the LIWC analysis formed the basis for this analysis. The primary objective was to explore different relations and identify trends within the analyzed data.

The significance of the correlation was not analyzed in this study, as the main focus was on exploring the relationships rather than determining their statistical significance. Instead, the correlation values were considered to assess the strength and direction of the correlations. By examining these values and corresponding graphs, trends were identified, and any outliers were investigated.

During the correlation analysis, the definitions and explanations of each LIWC category were taken into account. This allowed for an evaluation of whether specific LIWC categories helped explain the components of reflection or not. For example, the component of reflection 'Intention' exhibited a

moderate to weak correlation with LIWC categories such as 'polite', 'family', and 'fatigue'. However, it was observed that these LIWC categories might be more related to the topic being discussed in the text rather than specifically indicating whether the text is about intention or not. In other words, the presence of words related to politeness, family, or fatigue in the text did not necessarily contribute to a better understanding of the concept of 'Intention' as defined in the study.

It was important to consider the relevance of the LIWC categories in relation to the specific components of reflection. In this case, the correlation analysis highlighted that certain LIWC categories did not align with the definition or essence of the 'Intention' component, indicating that they were not useful indicators for identifying or characterizing the presence of intention in the reflections.

By scrutinizing these correlations and considering the explanations provided for each LIWC category, the research aimed to discern which LIWC categories were most relevant in explaining and capturing the essence of the different components of reflection. This process of analyzing the correlations and examining the LIWC category definitions served to refine the selection of LIWC categories.

Overall, the correlation analysis in Phase 1 revealed trends and associations that contributed to understanding the relationships between components of reflection and LIWC categories. This foundation serves as a critical basis for Phase 2, where the relationships between grade ranges and components of reflection will be explored. The selected LIWC categories and their relationship with grade ranges will then be investigated, with the ultimate goal of determining whether it is possible to identify high-quality reflections based on these specific LIWC categories from the LIWC-22 dictionary.

RESEARCH PROCESS: PHASE 2

In Phase 2, the focus shifted towards understanding the components of a good reflection. Patterns and relationships between the assigned grade ranges and the components of reflection were analyzed, aiming to uncover any consistent trends associated with higher-graded reflections. Additionally, a comparison was made between the grade ranges, the reflection components, and the LIWC categories associated with each component. This comparison aimed to identify the specific reflection components and linguistic features that contributed to higher-graded reflections.

By undertaking this rigorous research process, the study sought to enhance our understanding of the elements and linguistic characteristics that define a good reflection. The subsequent sections will provide a detailed explanation of each phase, outlining the methodologies employed, the specific analyses conducted, and the significant findings derived from the research process.

Understanding the Rubric and Its Alignment with Reflection components

Before delving into the analysis of grade ranges and reflection components, it is crucial to explain the rubric used for grading the DTM course reflections. The rubric assessed the quality of the reflection in relation to the essay topic and the student's future design practice. The rubric (refer to table 2) explicitly emphasized the need for a theoretical understanding of the student's own design practice and the reflection's connection to the chosen topic.

To align the rubric with the model of reflection detection categories, it becomes apparent that certain components of reflection form the basis of the rubric. Specifically, the "Perspective," "Intention," and "Learning" categories are crucial in meeting the rubric's criteria. According to the rubric, if a reflection mentions different perspectives, demonstrates an excellent connection between these perspectives, intentions, and learning, it is more likely to receive a higher grade. Understanding this alignment provides a foundation for analyzing the grade ranges and reflection components.

Table 2: Rubric for the reflections assignment in the DTM course

Learning Objective	Assessment Criteria	Very Poor (<6)	Poor [P] (6)	Sufficient/ Moderate [M] (7)	Good [G] (8)	Excellent [E] (9-10)
Demonstrate a theoretical understanding of your own design practice	Quality if the reflection on how the student's future design practice might change in the light of the essay.	The reflection does not relate to the chosen essay topic.	The reflection shows some connection to the essay topic but does not go beyond cliché.	The reflection clearly relates to the chosen topic, providing a good description of practice that goes beyond cliché.	The reflection is thoughtful about the chosen essay topic and insightful about future design practice.	The reflection shows an excellent connection to the essay topic along with a nuanced understanding of future design practice.

Analyzing Patterns and Relations Between Grade Range and Components of reflection

To understand the components of a good reflection, an analysis was conducted to examine the patterns and relationships between the assigned grade ranges and the components of reflection. This analysis aimed to uncover consistent trends associated with higher-graded reflections. The following steps were undertaken:

i. Comparing Grade Ranges Based on Occurrence of Components of reflection:

In this step, the occurrence of each reflection component was analyzed across all grade ranges. The goal was to identify distinct patterns that occurred specifically in "Excellent (E)" graded reflections. Additionally, observations were made regarding the occurrence of certain categories being more prevalent in some grade ranges and less common in others. This analysis provided insights into the distribution of reflection components across different grade levels, helping to identify any significant correlations between specific categories and higher grades.

ii. Analyzing Occurrence of Combinations of Components in Specific Grade Ranges

To further describe the characteristics of a good reflection, the analysis focused on examining the occurrence of combinations of reflection components within specific grade ranges. By analyzing correlations within the components of reflection over different grade ranges, it was possible to understand how specific combinations of components contributed to higher grades. This analysis helped uncover the reflection components that were more prevalent in higher-graded reflections and provided insights into the characteristics of a good reflection.

Comparing Grade Ranges Based on LIWC categories

Building upon the relationships between grade ranges and components of reflection established in the previous analysis, a comparison was made between the grade ranges and associated LIWC categories. This step aimed to identify specific LIWC categories whose scores could help distinguish higher-graded reflections. The following steps were taken:

Analyzing LIWC categories Associated with Reflection components

Selected LIWC categories associated with the reflection components were analyzed based on their relationship with the grade ranges. The focus was on identifying LIWC categories that showed consistent patterns or specific scores within certain grade ranges. By examining the linguistic features captured by these LIWC categories, it became possible to understand the specific linguistic characteristics that contributed to higher-graded reflections. This analysis added another layer of insight into the characteristics of a good reflection based on the identified LIWC categories.

By considering the rubric's expectations and exploring the relationships between grade ranges, reflection components, and LIWC categories, the research aims to uncover the characteristics and linguistic characteristics that define a good reflection in the context of the research project. This comprehensive analysis provides valuable insights for understanding and evaluating the quality of reflections in the Design Theory and Methodology (DTM) course.

04

RESULTS

This section presents the findings from both Phase 1 and Phase 2 of the research. Phase 1 focused on analyzing the relationships between components of reflection and linguistic features using correlation analysis. It aimed to uncover patterns and associations between the coded reflection samples and the LIWC categories. The correlations obtained provided insights into how different components of reflection were related to specific linguistic dimensions (LIWC categories). Building upon the findings of Phase 1, Phase 2 explored the connection between the grade range of reflection samples and the selected LIWC categories. This investigation aimed to determine whether specific linguistic features identified in Phase 1 could serve as indicators of high-quality reflections. The results from both phases contribute to a deeper understanding of the linguistic characteristics of student reflections and their potential implications for assessing reflection quality.

4.1 CHARACTERISTICS OF REFLECTION SAMPLES

CHARACTERISTICS OF REFLECTION SAMPLES

The reflections in the dataset exhibited an average word count of 299, with an average of 24 words per sentence. The average word count indicates that the students' reflections were of substantial length, allowing for detailed exploration and analysis of their thoughts and experiences. Additionally, the average number of words per sentence suggests that the students generally expressed their ideas in concise and focused statements.

The results show that participants' reflections commonly addressed different aspects of their experiences. The component "Difficulty" was present in all the reflection samples, indicating that participants frequently analyzed challenges, obstacles, or struggles they encountered. The categories of "Experience," "Intention," "Belief", and "Learning" were also prevalent, present in 89%, 89%, 84%, and 80% of the reflection samples, respectively (refer to figure 4). This suggests that participants heavily relied on their personal experiences, expressed their learnings and future intentions, and shared their personal beliefs and perspectives while reflecting. The categories of "Feeling," "Descriptive," and "Perspective" were also present, albeit to a slightly lesser extent.

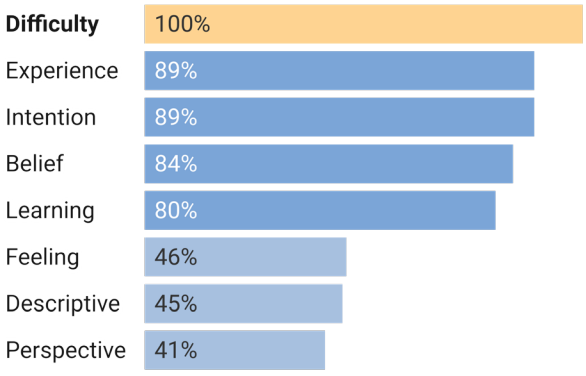


Figure 4: Percentage of reflection samples where the component was found at least once. All the reflections discussed some form of difficulty (represented in 'yellow' in the bar graph) for example, some students discussed the causes of their issues they faced, while some focused on critically assessing their actions or their views. Most students also mentioned their experiences, intentions, beliefs, and learnings (represented in 'blue') whereas only few students mentioned their feelings, different perspectives or descriptions of something (represented in 'light blue')

RESULTS: PHASE 1

Correlations between Components of reflection and LIWC categories

Note: All correlations presented in the following results section are Pearson correlations (r)unless otherwise stated.

Experience

In analyzing the relationships between the component 'Experience' and different LIWC categories, several correlations were observed:

Correlation with 'i' (1st person singular): A weak positive correlation r(54) = 0.2 was found between the use of the pronoun 'i' (1st person singular) and the 'Experience' component. Notably, this correlation was not exclusive to the 'Experience' component and was also present in other categories such as 'Belief', 'Feeling', 'Intention', and 'Learning'.

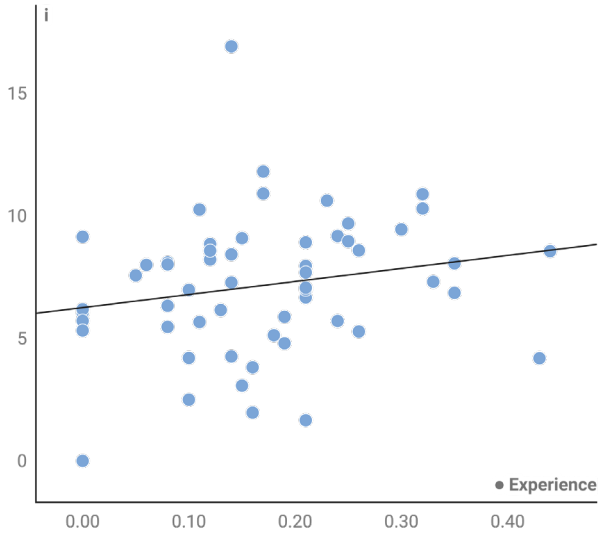


Figure 5: Correlation of LIWC category 'i' with reflection component 'Experience' where a positive trend line can be observed

Correlation with 'time' (time-related words): A weak to moderate positive correlation r(54) = 0.352 was identified between the use of time-related words (e.g., when, now, then, day) and the 'Experience' component. This indicates that individuals who frequently mention their personal experiences also tend to discuss or contextualize those experiences in relation to time.

4.2 RESULTS: PHASE 1

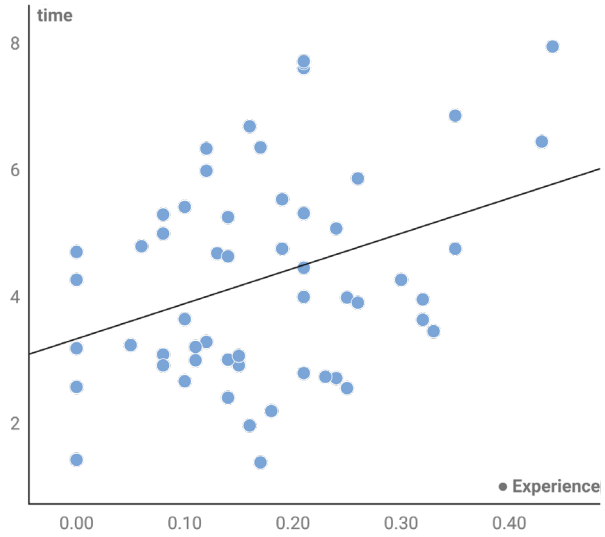


Figure 6: Correlation of LIWC category 'time' with reflection component 'Experience' where a positive trend line can be observed

Correlation with 'focuspast' (Past focus): A weak positive correlation r(54) = 0.259 was observed between the use of past tense words and the 'Experience' component. This suggests that individuals often describe or discuss past events or experiences when reflecting on their personal encounters.

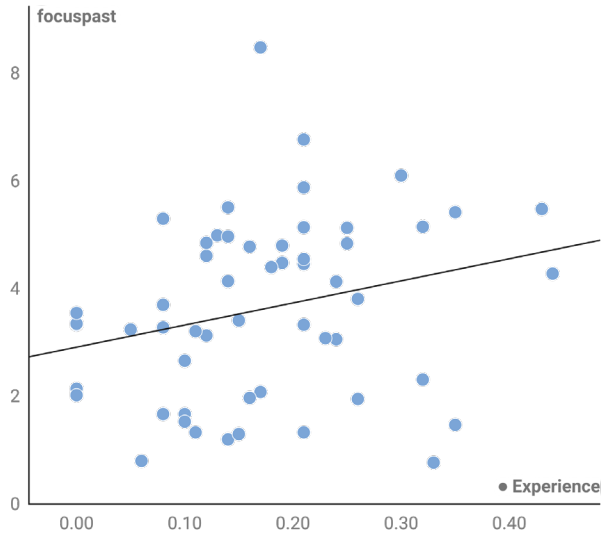


Figure 7: Correlation of LIWC category 'focuspast' with reflection component 'Experience' where a positive trend line can be observed

01
EXPERIENCE

Linguistic Indicators from LIWC categories

The component 'Experience' in the LIWC dictionary refers to the mention or discussion of the author's personal experiences. It is identified by presence of linguistic features like such as the pronoun 'i' (1st person singular), time-related words, and the use of past tense words. This component captures the expression of the author's individual encounters, moments, and temporal aspects related to their personal experiences.

Example:

Table 3: Comparison between ID 23 and ID 60 for 'Experience' component of reflection

ID	Experience	i	time	focuspast
23	6.4	8	4.8	0.8
60	34.66	6.86	6.86	5.42

The comparison between ID 23 and ID 60 highlights notable distinctions in their scores related to the 'Experience' component and associated LIWC categories. ID 23 exhibits lower scores in time, focuspast, therefore, suggesting lower use of experience related words which can also be observed in the lower occurrence of 'Experience' component in the coding, indicating a limited emphasis on personal experiences. In contrast, ID 60 demonstrates higher scores in these measures, suggesting a more substantial inclusion of personal experiences in the reflection. These differences indicate that ID 60 likely contains a richer discussion of personal experiences compared to ID 23, which shows a relatively lower focus on such aspects.

The higher score for the pronoun 'i' in ID 23, compared to ID 60, deviates from the expected pattern. While 'i' is often associated with personal experiences, it should have been lower in ID 23, which displayed lower scores in other fields related to experience. This discrepancy suggests that the use of 'i' in ID 23 may also be linked to categories other than experience, contributing to its higher score.

Refer to Appendix B:01 for the coded reflections and LIWC case study

Belief

The observed correlations between the component 'Belief' and different LIWC categories from the LIWC dictionary provide insights into the linguistic features associated with expressions of belief.

Correlation with 'i' (1st person singular): A weak positive correlation r(54) = 0.146 was found between the use of the pronoun 'i' (1st person singular) and the 'Belief' component. This correlation is not exclusive to the 'Belief' component and is also present in other categories like 'Experience', 'Feeling', 'Intention', and 'Learning'. One possible explanation is that the expression of personal beliefs often involves the author sharing their subjective perspective, which may be accompanied by the use of first-person pronouns.

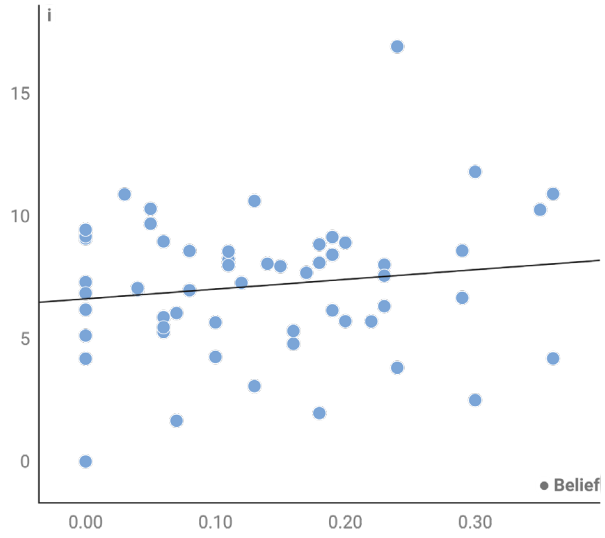


Figure 8: Correlation of LIWC category 'i' with reflection component 'Belief' where a positive trend line can be observed

Correlation with 'ipron' (impersonal pronouns): A weak positive correlation r(54) = 0.247 was observed between the use of impersonal pronouns (e.g., that, it, this, what) and the 'Belief' component. This correlation suggests that when discussing their beliefs, individuals may use impersonal pronouns to provide general or abstract references, creating a sense of objectivity or detachment from personal experiences.

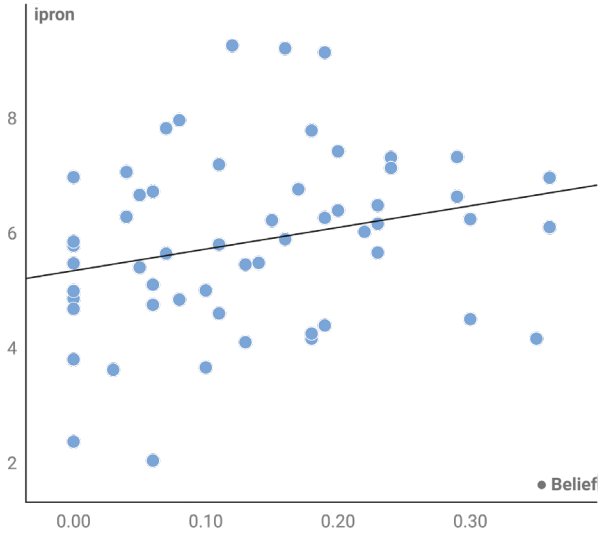


Figure 9: Correlation of LIWC category 'ipron' with reflection component 'Belief' where a positive trend line can be observed

Correlation with 'auxverb' (auxiliary verbs): A weak positive correlation r(54) = 0.287 was identified between the use of auxiliary verbs (e.g., is, was, be, have) and the 'Belief' component. This correlation may be attributed to the fact that expressing beliefs often involves asserting or qualifying statements, where auxiliary verbs play a role in conveying certainty or speculation.

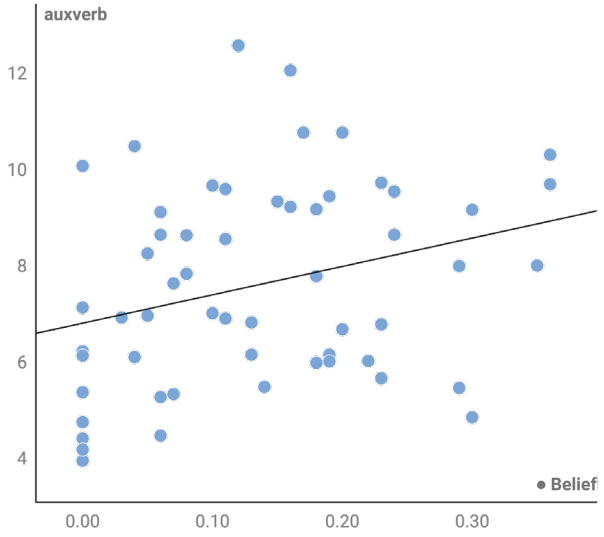


Figure 10: Correlation of LIWC category 'auxverb' with reflection component 'Belief' where a positive trend line can be observed

Correlation with 'focuspresent' (focus on present): A weak positive correlation r(54) = 0.166 was observed between the focus on present-related words and the 'Belief' component. This suggests that individuals discussing their beliefs tend to focus on the current or ongoing aspects of their thoughts, emphasizing their present perspective.

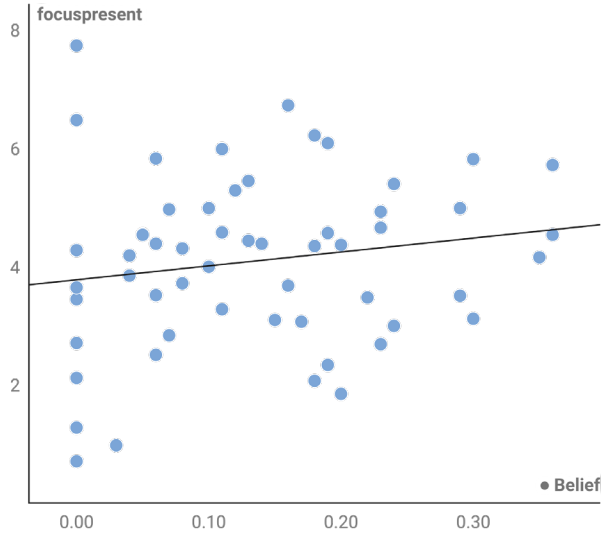


Figure 11: Correlation of LIWC category 'focuspresent' with reflection component 'Belief' where a positive trend line can be observed

Correlation with 'discrep' (discrepancy-related words) and 'tentat' (tentative language): Weak positive correlations r(54) = 0.238 and r(54) = 0.133 were found between the 'Belief' component and the 'discrep' and 'tentat' LIWC categories, respectively. This implies that expressing beliefs may involve discussing discrepancies, alternative possibilities, or expressing a level of tentativeness in one's language. When individuals reflect on their beliefs, they may explore different perspectives, weigh contrasting viewpoints, or consider inconsistencies in their own beliefs. These discussions of discrepancies can contribute to a deeper understanding of one's own beliefs and foster critical thinking. Individuals expressing their beliefs may also employ tentative language in their reflective writing. Tentative language often includes words such as "if", "or", "anything" or "something" that convey a sense of uncertainty or openness to different possibilities. This reflects the nuanced nature of belief formation and expression, where individuals may acknowledge the potential for alternative viewpoints or acknowledge the limitations of their own beliefs.

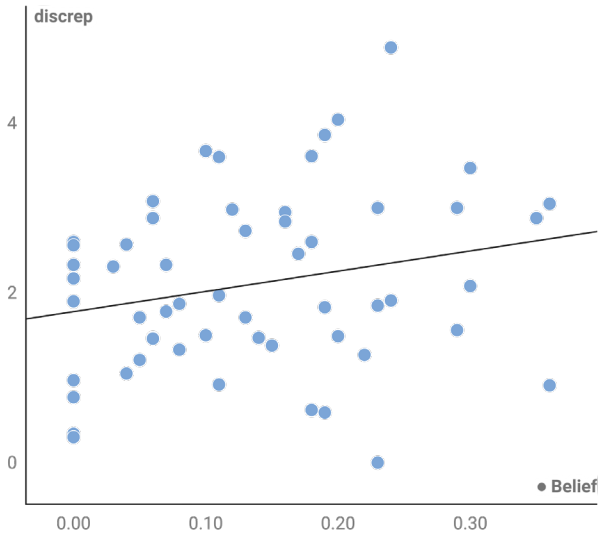


Figure 12: Correlation of LIWC category 'discrep' with reflection component 'Belief' where a positive trend line can be observed

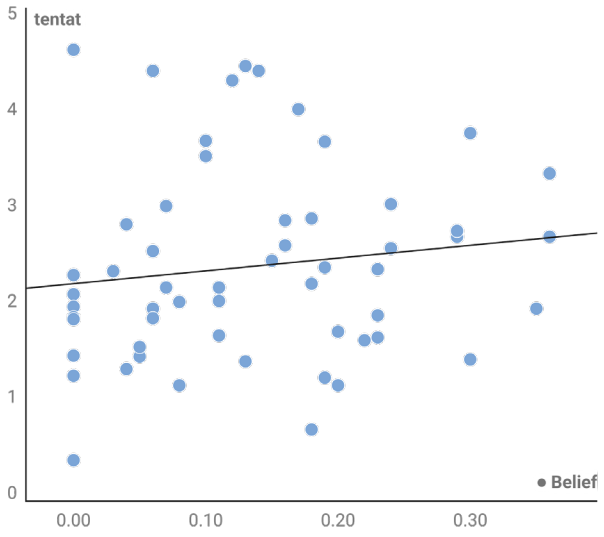


Figure 13: Correlation of LIWC category 'tentat' with reflection component 'Belief' where a positive trend line can be observed

02

BELIEF

Linguistic Indicators from LIWC categories

The component 'Belief' in the context of LIWC categories represents the author's expression of personal beliefs, assumptions, and convictions within their reflections. It is characterized by the presence of linguistic features such as the use of first-person pronouns ('i'), impersonal pronouns ('ipron'), auxiliary verbs ('auxverb'), a focus on present-related words ('focuspresent'), and discussions of discrepancies ('discrep') and tentative language ('tentat'). The presence of these linguistic indicators in the text can help identify if the reflections mention the author's beliefs and assumptions, contributing to a deeper understanding of their personal experiences and perspectives.

However, it is worth noting that similar correlations were observed for the categories 'Perspective' and 'Descriptive' as well. This suggests that the usage of words related to discrepancy is not specific to the 'Belief' component alone but may be a common linguistic pattern in expressing various aspects of personal experiences, perspectives, or descriptive accounts. Therefore, while the correlation provides some insight into the relationship between belief expression and the use of words related to discrepancy, it should be interpreted in conjunction with the broader linguistic context and the presence of similar patterns in other categories.

Difficulty

The difficulty component in the reflections showed a consistent pattern of being preceded by the experience component. This suggests that some authors often discussed challenges, obstacles, or struggles in the context of their personal experiences. It indicates a tendency to reflect on the difficulties encountered during their learning journey and to explore the impact of those experiences on their overall development. However, it is important to note some authors also critically assessed their beliefs and considered alternative perspectives in relation to the difficulties they faced. This reflects a deeper level of introspection and an analytical approach to understanding the underlying causes and implications of the challenges encountered.

These examples highlight the instances where authors reflected on difficulties in relation to their experiences, beliefs, and perspectives.

Example 1:

> To overcome this, I often used to use design methods that forced myself into seeking for alternatives. [Experience]
>
> But what I can do more of is asking myself high-level questions. Changing the level of abstractness in previous design processes often led to new opportunities. This can also be an effect of asking high-level questions, which is something I would like to do more in the future. [Difficulty]
>
> *ID 9: Quotations 13 to 16*

Example 2:

> If we do not have design options to analyze and reflect on, how can we be expected to conduct this at a faster and more efficient rate in industry where deadlines are strict? Moving forward, a way that I can use the time available to improve on my reflection skills is by keeping my design outcomes simple. [Belief]
>
> I often overcomplicate the design by trying to fix everything instead of focusing on one element. I am wasting time that could instead be used to build on my iteration through reflection skills. [Difficulty]
>
> *ID 11: Quotations 7 to 10*

Example 3:

> Especially the five key factors of the basic method have given me insight into the fact that not every method is suitable for every problem (Cash & Daalhuizen, 2021). That many small factors that seem unimportant do have an impact on how a method works. [Perspective]
>
> So that you really have to choose which method you're going to use carefully. Until now, I've never really done that. I did start doing it a little more recently, because we were given the freedom to do so. [Difficulty]
>
> *ID 30: Quotations 6 to 10*

The observed correlations between the component 'Difficulty' and different LIWC categories shed light on the linguistic features associated with expressions of difficulty.

Correlation with 'ipron' (impersonal pronouns): A weak positive correlation r(54) = 0.138 was found between the use of impersonal pronouns (e.g., that, it, this, what) and the 'Difficulty' component. This correlation suggests that when individuals discuss difficulties, they may utilize impersonal pronouns to provide a sense of detachment or objectivity, emphasizing the challenging nature of the situation rather than personal involvement.

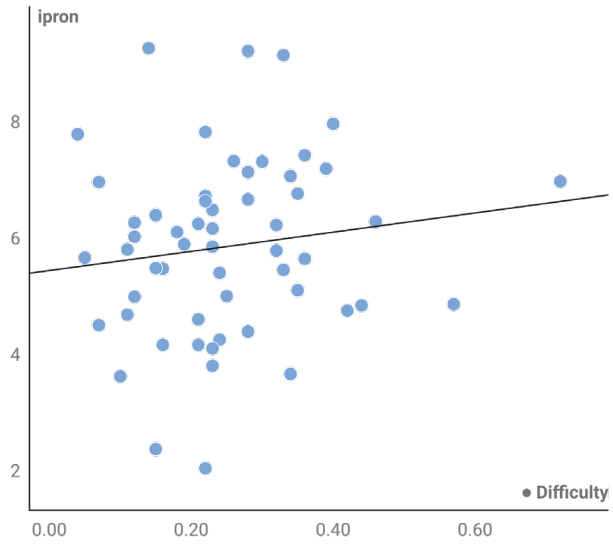


Figure 14: Correlation of LIWC category 'ipron' with reflection component 'Difficulty' where a positive trend line can be observed

Correlation with 'auxverb' (auxiliary verbs): A weak positive correlation r(54) = 0.231 was observed between the use of auxiliary verbs (e.g., is, was, be, have) and the 'Difficulty' component. This correlation can be attributed to the fact that expressing difficulties often involves conveying actions, states, or conditions that are challenging or require effort. Auxiliary verbs are commonly employed to describe such situations and amplify the understanding of the difficulty being discussed.

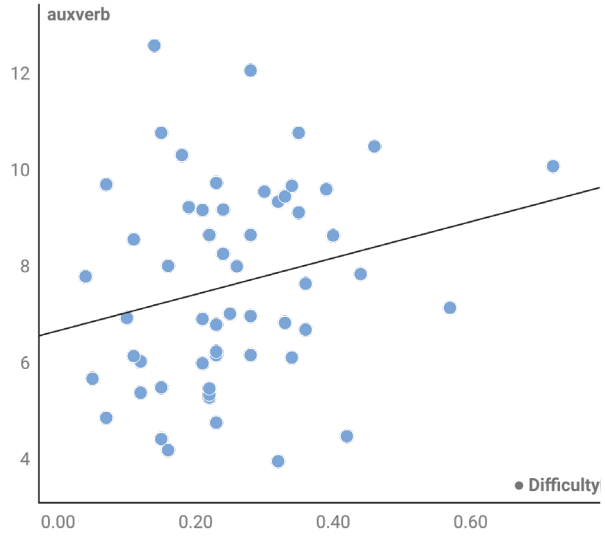


Figure 15: Correlation of LIWC category 'auxverb' with reflection component 'Difficulty' where a positive trend line can be observed

Correlation with 'negate' (negations): A weak to moderate positive correlation r(54) = 0.336 was identified between the presence of negations (e.g., not, no, never, nothing) and the 'Difficulty' component. This correlation suggests that individuals discussing difficulties tend to utilize negations to emphasize the absence or negation of desired outcomes or expectations, reinforcing the challenging nature of the situation.

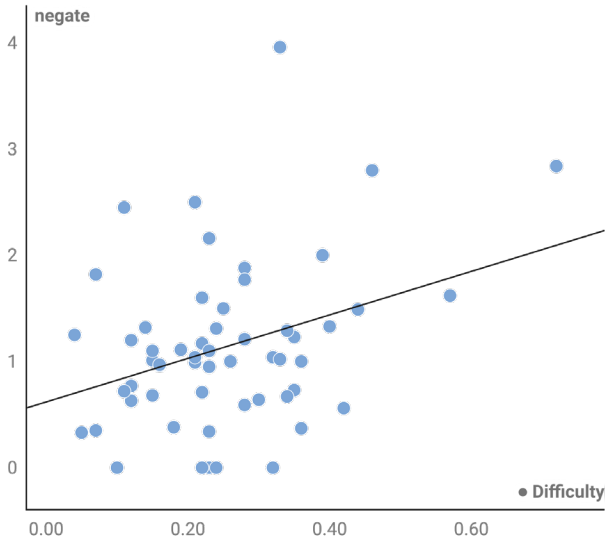


Figure 16: Correlation of LIWC category 'negate' with reflection component 'Difficulty' where a positive trend line can be observed

Correlation with 'focuspresent' (focus on present): A weak to moderate positive correlation r(54) = 0.360 was observed between the focus on present-related words and the 'Difficulty' component. This correlation indicates that individuals discussing difficulties often focus on the present aspects of the challenges they face, highlighting the immediate or ongoing nature of the difficulties.

Refer to the graph on the next page.

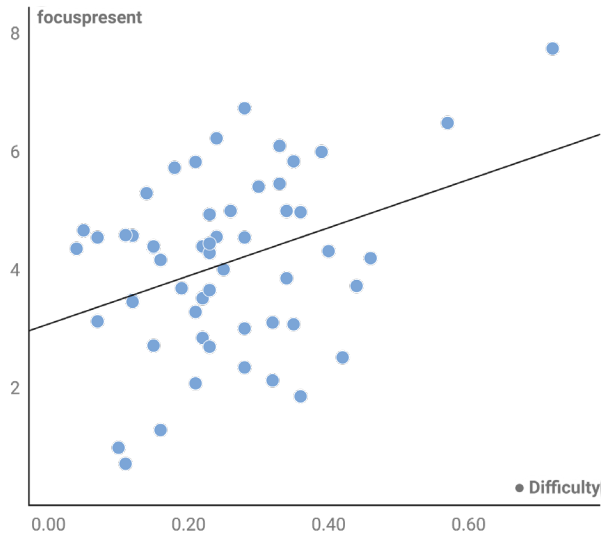


Figure 17: Correlation of LIWC category 'focuspresent' with reflection component 'Difficulty' where a positive trend line can be observed

Correlation with 'cause' (causation-related words) and 'differ' (differentiation-related words) from the Cognition group: Weak to moderate positive correlations r(54) = 0.302 and r(54) = 0.295 were found between the 'Difficulty' component and the 'cause' and 'differ' LIWC categories, respectively. This suggests that expressing difficulties involves discussing causation, understanding the reasons behind challenges (cause), and acknowledging differentiation or contrasting factors in relation to the difficulties (differ).

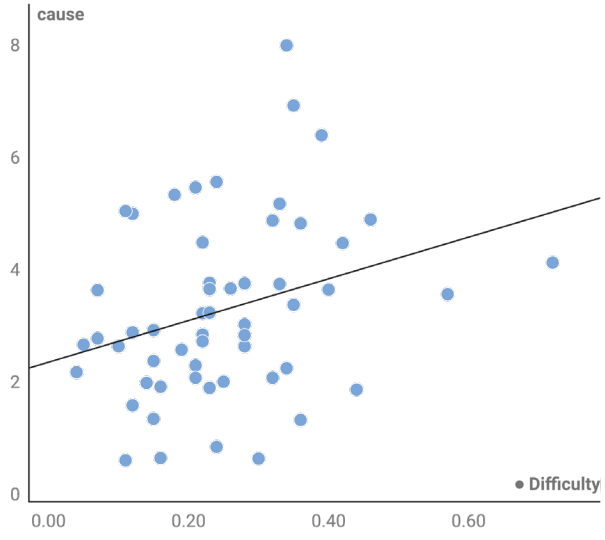


Figure 18: Correlation of LIWC category 'cause' with reflection component 'Difficulty' where a positive trend line can be observed

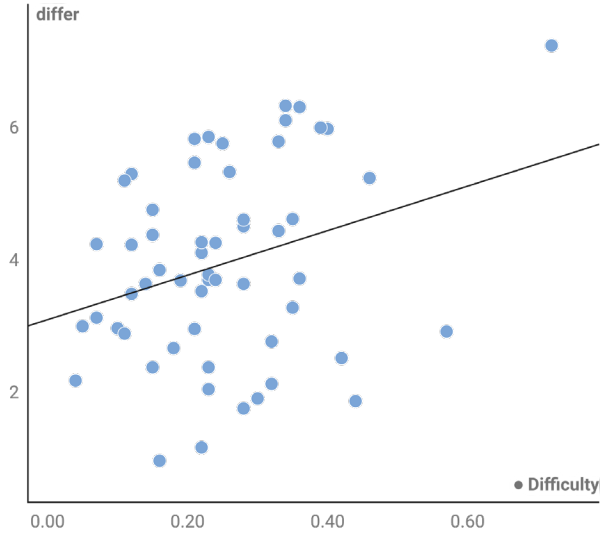


Figure 19: Correlation of LIWC category 'differ' with reflection component 'Difficulty' where a positive trend line can be observed

03

DIFFICULTY

Linguistic Indicators from LIWC categories

The component 'Difficulty' in the context of LIWC categories represents the author's discussion and critical assessment of challenges, obstacles, or struggles encountered within their reflections. It is characterized by the presence of linguistic features such as the use of impersonal pronouns ('ipron'), auxiliary verbs ('auxverb'), negations ('negate'), a focus on present-related words ('focuspresent'), causation-related words ('cause'), and differentiation-related words ('differ'). The presence of these linguistic indicators in the text helps identify if the reflections mention the author's experiences of difficulty, allowing for a deeper understanding of the challenges they have faced and their critical analysis of those experiences.

Perspective

The observed correlations between the component 'Perspective' and different LIWC categories provide insights into the linguistic features associated with expressing alternative viewpoints and considering different perspectives.

Correlation with 'shehe' (3rd person singular) and 'they' (3rd person plural): A weak to moderate positive correlation r(54) = 0.310 was found with the use of 3rd person singular pronouns ('shehe') and a weak positive correlation r(54) = 0.108 was observed with the use of 3rd person plural pronouns ('they'). These correlations suggest that when individuals discuss different perspectives or alternative viewpoints, they may refer to specific individuals (3rd person singular) or a broader group (3rd person plural). This linguistic pattern helps establish a distinction between the author's perspective and other viewpoints being considered.

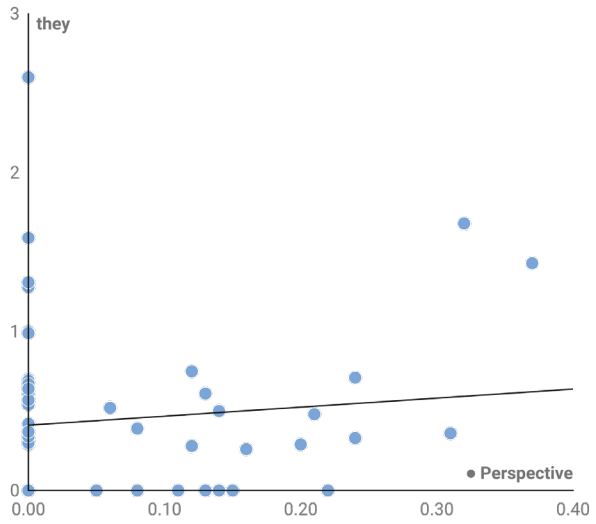


Figure 20: Correlation of LIWC category 'they' with reflection component 'Perspective' where a positive trend line can be observed

Correlation with 'quantity' (quantity-related words): A weak positive correlation r(54) = 0.260 was identified between the presence of quantity-related words (e.g., all, one, more, some) and the 'Perspective' component. This correlation indicates that individuals discussing perspectives tend to use words that convey quantity, which can be linked to the consideration of various degrees, ranges, or numbers of viewpoints or perspectives being discussed.

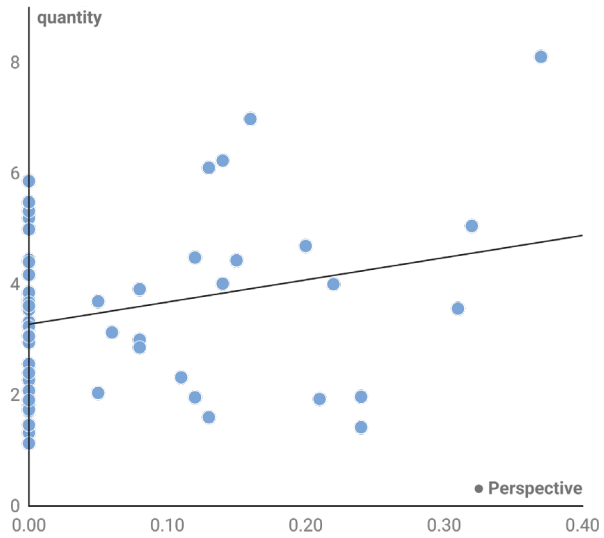


Figure 21: Correlation of LIWC category 'quantity' with reflection component 'Perspective' where a positive trend line can be observed

Correlation with 'focuspresent' (focus on present): A weak positive correlation r(54) = 0.145 was observed between the focus on present-related words and the 'Perspective' component. This correlation suggests that individuals exploring different perspectives often focus on the present aspects of the viewpoints or perspectives being discussed, emphasizing their current relevance or immediate context.

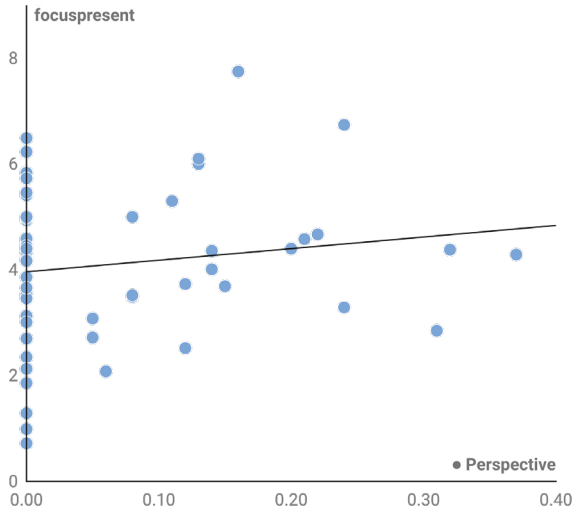


Figure 22: Correlation of LIWC category 'focuspresent' with reflection component 'Perspective' where a positive trend line can be observed

Correlation with 'discrep' (discrepancy-related words) from the Cognition group: A weak positive correlation r(54) = 0.208 was found between the 'Perspective' component and the 'discrep' LIWC category. This suggests that expressing alternative viewpoints or considering different perspectives involves discussing discrepancies, contradictions, or variations. By acknowledging and exploring these discrepancies, individuals can provide a more comprehensive analysis of the multiple perspectives being considered.

Refer to the graph on the next page.

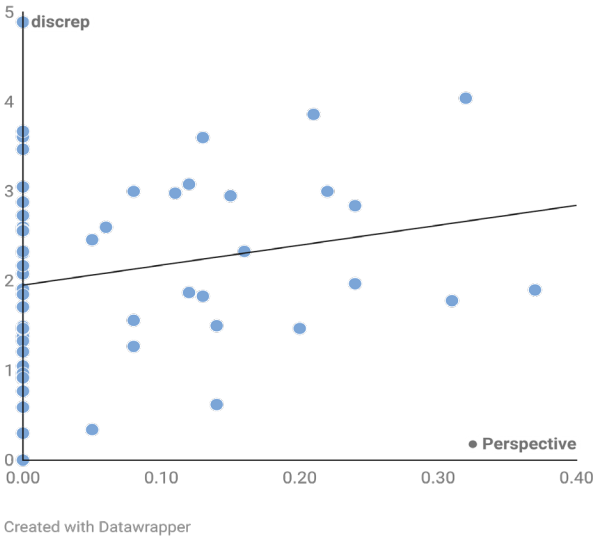


Figure 23: Correlation of LIWC category 'discrep' with reflection component 'Perspective' where a positive trend line can be observed

However, it is important to note that these correlations alone are not sufficient to distinctly identify the component of 'Perspective' based on the LIWC categories. They provide insights into the nature of the component, but the presence of similar correlations in 'Descriptive' component indicates that these linguistic patterns are not specific to 'Perspective' alone. The interpretation of the component should consider the broader context of the reflection and the interplay of various linguistic features to gain a comprehensive understanding.

04

PERSPECTIVE Linguistic Indicators from LIWC categories

The component 'Perspective' in the context of LIWC categories represents the author's consideration and exploration of alternative viewpoints and perspectives within their reflections. It is characterized by the presence of linguistic features such as the use of 3rd person singular pronouns ('shehe'), 3rd person plural pronouns ('they'), quantity-related words ('quantity'), a focus on present-related words ('focuspresent'), and discussions of discrepancies ('discrep'). The presence of these linguistic indicators in the text helps identify if the reflections mention the author's analysis of different perspectives, providing insights into their ability to understand and consider alternative viewpoints and contribute to a more comprehensive and well-rounded discussion.

Feeling

The correlations between the component 'Feeling' and different LIWC categories provide insights into the linguistic features associated with the expression of emotions and affective states within reflections.

Correlation with 'i' (1st person singular): The weak positive correlation r(54) = 0.16 between 'Feeling' and the use of 1st person singular pronouns ('i') indicates that the expression of feelings is not exclusive to the 'Feeling' component alone. It is observed in other categories like 'Belief', 'Experience', 'Intention', and 'Learning' as well. The use of 1st person pronouns might be due to the fact that individuals intimately convey their emotional experiences, emphasizing their personal involvement and providing a sense of authenticity and genuineness in their reflections.

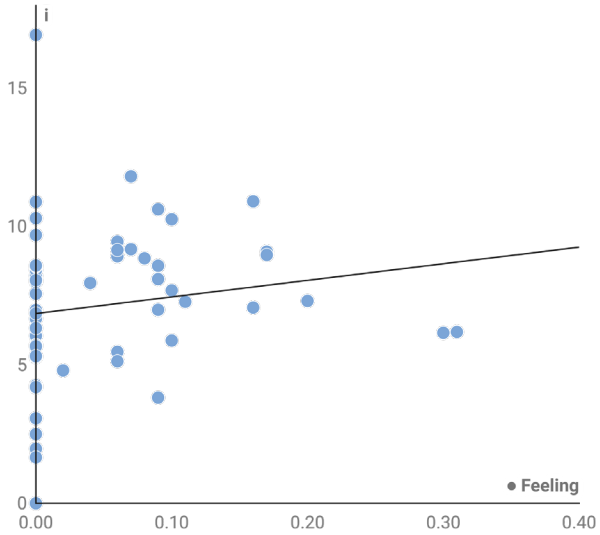


Figure 24: Correlation of LIWC category 'i' with reflection component 'Feeling' where a positive trend line can be observed

Correlation with 'quantity' (quantity-related words): The weak positive correlation r(54) = 0.187 between the presence of quantity-related words (e.g., all, one, more, some) and the 'Feeling' component suggests that individuals expressing their feelings may utilize these words to convey the degree, intensity, or range of their emotional experiences. The use of quantity-related words allows for a nuanced and descriptive representation of emotions.

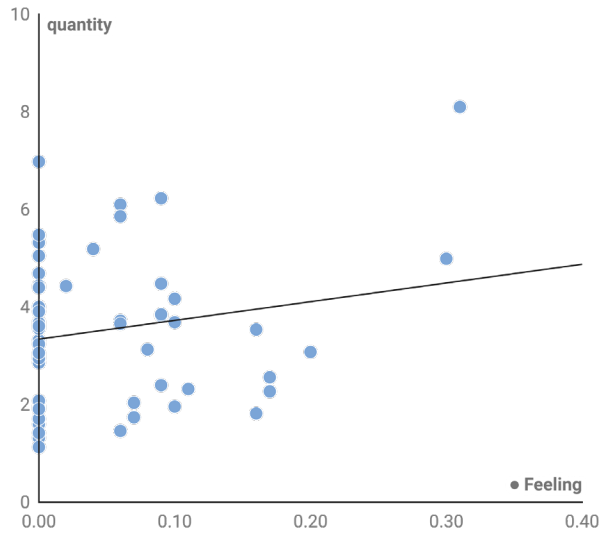


Figure 25: Correlation of LIWC category 'quantity' with reflection component 'Feeling' where a positive trend line can be observed

Correlation with 'focuspast' (focus on the past): The weak positive correlation r(54) = 0.249 between the focus on past-related words and the 'Feeling' component suggests that individuals reflecting on their feelings often discuss past experiences or emotions. By focusing on the past, individuals may provide contextual information and reflect upon the progression or impact of their emotional states over time.

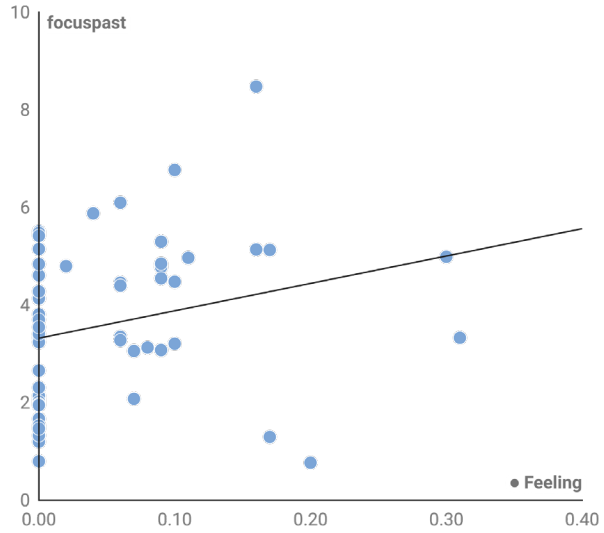


Figure 26: Correlation of LIWC category 'focuspast' with reflection component 'Feeling' where a positive trend line can be observed

Correlation with 'Affect' (including tone and emotion) and 'feeling' (in the Perception group): The weak to moderate positive correlations r(54) = 0.337 and r(54) = 0.525 between 'Feeling' and the 'Affect' and 'feeling' LIWC categories, respectively, indicate the presence of a rich emotional content within the component. These correlations suggest that individuals expressing their feelings in reflective writing use words related to tone, emotion, and perception to convey and describe their affective experiences in a comprehensive manner.

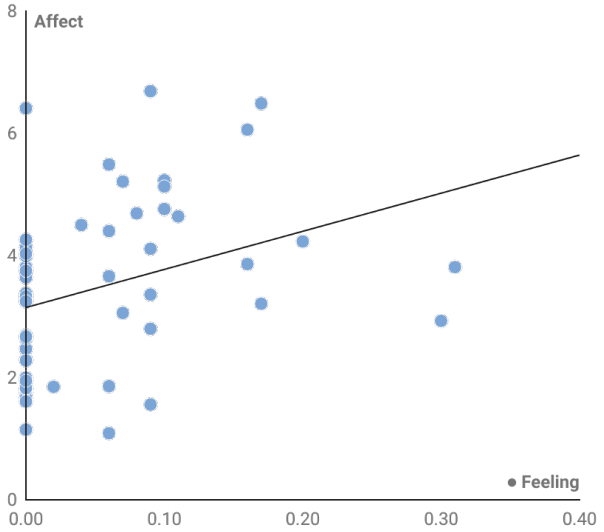


Figure 27: Correlation of LIWC category 'Affect' with reflection component 'Feeling' where a positive trend line can be observed

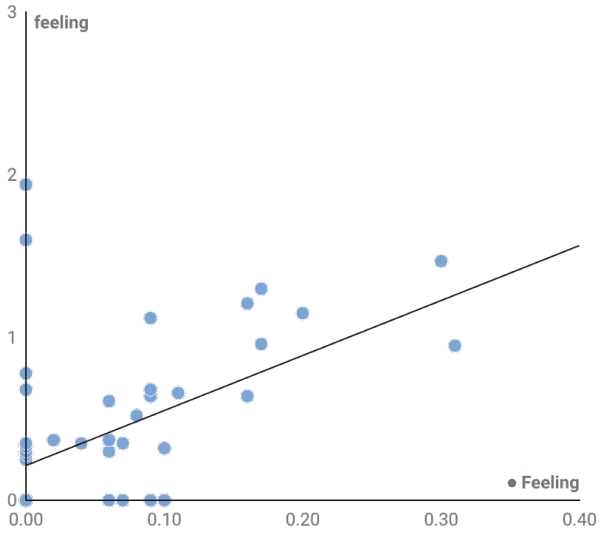


Figure 28: Correlation of LIWC category 'feeling' with reflection component 'Feeling' where a positive trend line can be observed

05

FEELING

Linguistic Indicators from LIWC categories

The component 'Feeling' in the context of LIWC categories represents the author's expression and discussion of emotions and affective states within their reflections. It is characterized by the presence of linguistic features such as the use of 1st person singular pronouns ('i'), quantity-related words ('quantity'), a focus on past-related words ('focuspast'), the inclusion of affect-related fields ('Affect'), and the presence of feeling-related words within the Perception group ('feeling'). The presence of these linguistic indicators in the text helps identify if the reflections mention the author's subjective experiences and emotional responses, providing insights into their affective engagement and the emotional dimensions present within their reflective writing.

Learning

The observed correlations between the component 'Learning' and different LIWC categories shed light on the linguistic features associated with the expression of knowledge acquisition, insights, and the learning process within reflections.

Correlation with 'i' (1st person singular): The weak positive correlation r(54) = 0.208 between 'Learning' and the use of 1st person singular pronouns ('i') The use of 1st person pronouns might be due to the fact that individuals intimately convey their emotional experiences, emphasizing their personal involvement and providing a sense of authenticity and genuineness in their reflections.

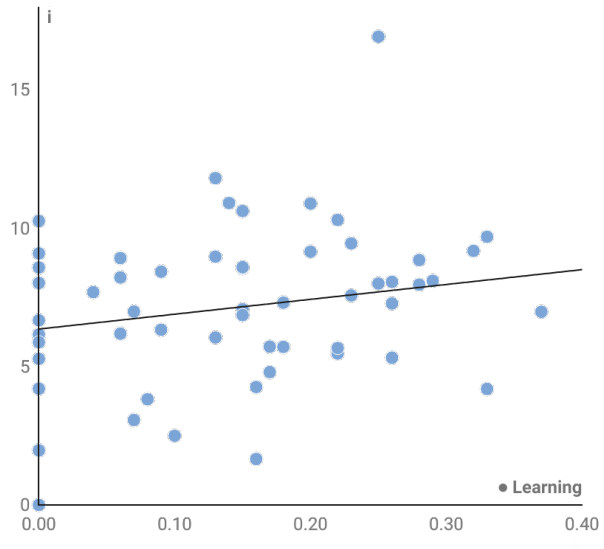


Figure 29: Correlation of LIWC category 'i' with reflection component 'Learning' where a positive trend line can be observed

Correlation with 'focuspast' and 'focusfuture': The very weak positive correlations r(54) = 0.093 and r(54) = 0.165 between 'Learning' and the focus on past-related words ('focuspast') and future-related words ('focusfuture'), respectively, suggest that individuals reflecting on their learning experiences may touch upon both past and future aspects. However, it is worth noting that 'focuspast' demonstrates comparatively stronger correlations with the 'Experience' and 'Feeling' categories, while 'focusfuture' exhibits a strong correlation with the 'Intention' component. This indicates that the past-focused reflections may be more closely associated with experiences and emotional aspects, while the future-focused reflections may be linked to intentions and plans.

Correlation with 'insight' from the Cognition group: The weak to moderate positive correlation r(54) = 0.332 between 'Learning' and the 'insight' LIWC component suggests that individuals discussing their learning experiences often incorporate words associated with knowledge acquisition, understanding, and self-reflection. Within the context of design reflections, it is important to consider that some words in the 'insight' dictionary, such as decision, decision-making, and feedback, may align with the topic of the sentence or the design process itself. However, it is crucial to note that the presence of these words does not necessarily indicate that the author has gained new insights or learned something specific.

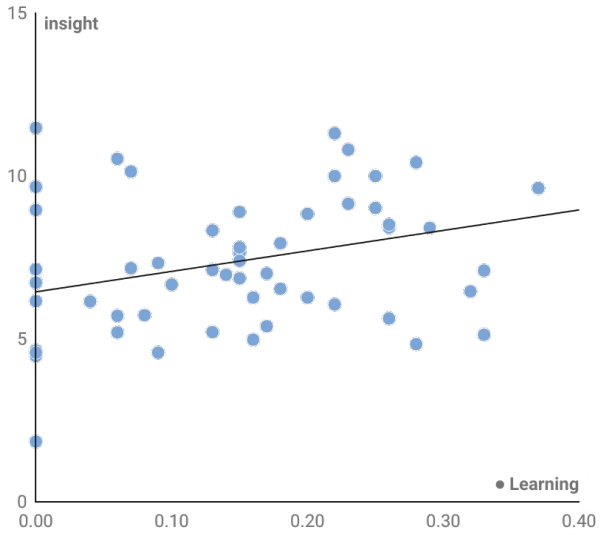


Figure 30: Correlation of LIWC category 'insight' with reflection component 'Learning' where a positive trend line can be observed

06

LEARNING

Linguistic Indicators from LIWC categories

The component 'Learning' in the context of LIWC categories encompasses the author's reflections on the process of acquiring knowledge, insights, and lessons from their experiences. It is characterized by the presence of linguistic features such as the use of 1st person singular pronouns ('i'), the consideration of past and future aspects ('focuspast' and 'focusfuture'), the inclusion of words related to knowledge and understanding ('insight' from the Cognition group), and the overall focus on personal growth and development. The presence of these linguistic indicators within the text helps identify if the reflections mention the author's active engagement in learning, the acquisition of new insights, and the integration of newfound understanding within their reflective writing.

Intention

The observed correlations between the 'Intention' component and different LIWC categories shed light on the linguistic features associated with expressing future plans, goals, and intentions within reflections.

Correlation with 'i' (1st person singular): The weak positive correlation r(54) = 0.229 between 'Intention' and the use of 1st person singular pronouns ('i') suggests that individuals discussing their intentions often express personal involvement and ownership of their future plans and goals. This correlation is not exclusive to the 'Intention' component alone but is also observed in other categories such as 'Belief', 'Experience', 'Learning', and 'Feeling'. It indicates that individuals draw on their personal perspectives and experiences when expressing their intentions, emphasizing their active engagement in shaping their future trajectories.

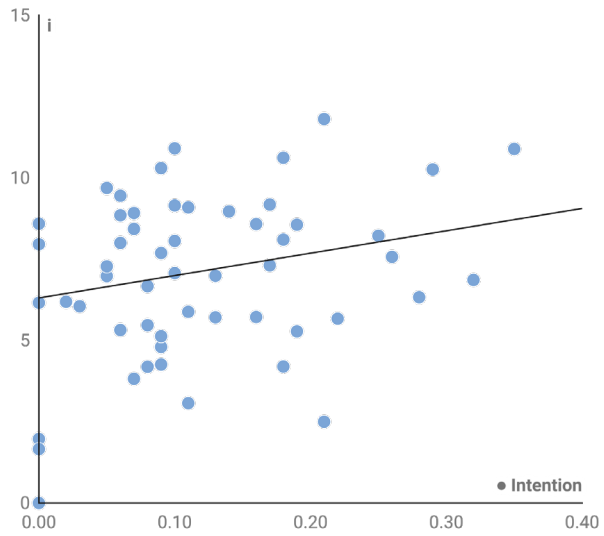


Figure 31: Correlation of LIWC category 'i' with reflection component 'Intention' where a positive trend line can be observed

Correlation with 'focusfuture': The moderate to strong positive correlation r(54) = 0.510 between 'Intention' and the focus on future-related words ('focusfuture') indicates that individuals discussing their intentions prominently include language related to future-oriented thoughts, plans, and aspirations. This correlation suggests that reflections on intentions involve a forward-looking perspective, emphasizing the individual's goals, motivations, and anticipated outcomes.

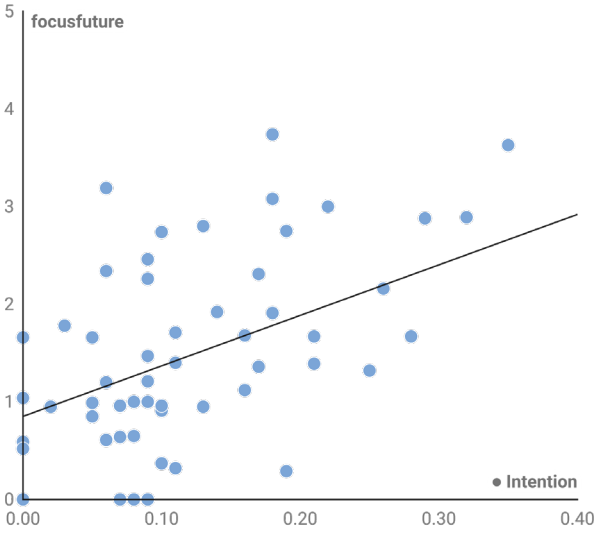


Figure 32: Correlation of LIWC category 'focusfuture' with reflection component 'Intention' where a positive trend line can be observed

Correlation with 'achieve' from the Drive group: The weak positive correlation r(54) = 0.114 between 'Intention' and the 'achieve' LIWC component suggests that individuals discussing their intentions may incorporate words related to achievements, productivity, and striving for improvement. The presence of these words reflects the proactive mindset associated with setting goals and working towards their realization.

Refer to the graph on the next page.

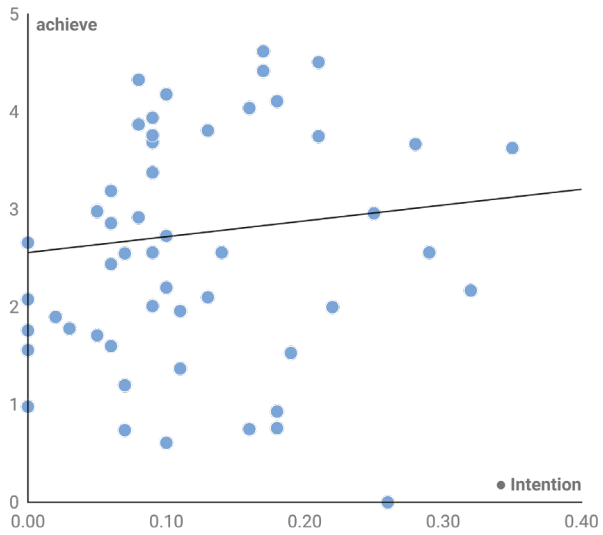


Figure 33: Correlation of LIWC category 'achieve' with reflection component 'Intention' where a positive trend line can be observed

07

INTENTION

Linguistic Indicators from LIWC categories

The component 'Intention' in the context of LIWC categories pertains to the author's expressed intentions, plans, and goals for future actions or behaviors within their reflections. It is characterized by the presence of linguistic indicators such as the use of 1st person singular pronouns ('i'), a focus on future-oriented language ('focusfuture'), and the inclusion of words associated with achievement and productivity ('achieve' from the group 'Drives'). The presence of these linguistic features within the text helps identify if the reflections mention the author's proactive mindset, their aspirations and motivations, and their conscious consideration of future actions and outcomes. It signifies the intentional and forward-looking nature of the author's reflections as they articulate their plans and goals for personal growth and development.

Descriptive

The observed correlations between the 'Descriptive' component and different LIWC categories provide insights into the linguistic features associated with conveying non-reflective, descriptive text within the reflections.

Correlation with 'shehe' (3rd person singular): The weak positive correlation r(54) = 0.258 between 'Descriptive' and the use of 3rd person singular pronouns ('shehe') suggests that individuals expressing descriptive content often refer to other people or entities in their narratives. This correlation indicates that descriptive passages may involve discussing the actions, experiences, or characteristics of others, providing objective accounts or descriptions of events or situations.

Correlation with 'focuspresent': The weak positive correlation r(54) = 0.297 between 'Descriptive' and the focus on present-related language ('focuspresent') suggests that descriptive text tends to emphasize the depiction of current or ongoing events or situations. This correlation indicates that individuals engaging in descriptive writing often focus on describing elements of the present moment rather than reflecting on past experiences or future intentions.

Correlations with 'discrep', 'cause', and 'differ' from the Cognition group: The weak positive correlations observed with these LIWC categories suggest that individuals employing descriptive language may utilize words associated with discrepancy, causation, and differentiation to provide additional details or nuances within their descriptions. These words may help convey contrasts, reasons, or distinctions within the descriptive passages, enriching the level of detail and comprehensiveness.

It is noteworthy that the trends observed in the Descriptive component are similar to those observed in the Perspective component. This could be due to the nature of the assignment given to the students, where they were required to reflect on their design practice based on the essay the wrote using reference papers, which inherently involves trying to use the theories and considering different perspectives from the reference papers.

08

DESCRIPTIVE

Linguistic Indicators from LIWC categories

The component 'Descriptive' within the LIWC framework pertains to the presence of non-reflective, descriptive text in the author's reflections. It is characterized by the use of linguistic indicators such as 3rd person singular pronouns ('shehe'), a focus on present-related language ('focuspresent'), and the inclusion of words associated with discrepancy, causation, and differentiation ('discrep', 'cause', 'differ' from the Cognition group). The presence of these linguistic features in the text helps identify if the reflections primarily involve objective descriptions of events, situations, or the actions and characteristics of others. It signifies that the author's writing focuses on providing detailed, non-reflective accounts without engaging in personal introspection or subjective analysis of their own experiences.

IDENTIFYING REFLECTION COMPONENTS USING LIWC CATEGORIES

01 EXPERIENCE

- i
- time
- focuspast

02 BELIEF

- i
- ipron
- auxverb
- focuspresent
- discrep
- tentat

03 DIFFICULTY

- ipron
- auxverb
- negate
- focuspresent
- cause
- differ

04 PERSPECTIVE

- shehe / they
- quantity
- focuspresent
- discrep

05 FEELING

- i
- quantity
- focuspast
- Affect
- feeling

06 LEARNING

- i
- focuspast or focusfuture
- insight

07 INTENTION

- i
- focusfuture
- achieve

08 DESCRIPTIVE

- shehe
- focuspresent
- discrep
- cause
- differ

4.3 RESULTS: PHASE 2

The analysis encompassed a total of 56 reflections, with varying distribution across different grade ranges. Four coaches were involved in the evaluation of these reflections. Coach 1 graded 33 reflections, coach 2 graded 12 reflections, coach 3 graded 6 reflections and coach 4 graded 5 reflections. The majority of the reflections fell within the poor grade range ('P'), comprising 21 samples. The sufficient/moderate grade range ('M') had 17 reflections, while the good grade range ('G') consisted of 10 samples. The excellent grade range ('E') had the smallest number of reflections, with a total of 8 samples. These observations lay the foundation for further exploration and comparison of the reflection components within each grade range, shedding light on potential trends and patterns associated with higher-graded reflections.

Analysis of Reflection Components: Individual Patterns Across Grade Ranges

No notable patterns or trends were observed in the distribution of occurrence for the categories 'Experience', 'Difficulty', 'Learning', 'Intention', and 'Descriptive' across different grade ranges. The occurrence of these categories alone did not consistently differentiate between higher and lower grades. However, it is important to note that combinations of certain categories might play a role in higher grades for a reflection.

It is worth noting that the lack of significant patterns may be attributed to the specific characteristics of the sample size and the nature of the reflections analyzed. The current sample size may limit the generalizability of the findings. Further analysis with a larger sample size and potentially additional variables could provide more insights into the relationship between these categories and the grades.

Belief

The component 'Belief' showed an interesting pattern across the different grade ranges. The mean occurrence of 'Belief' was lowest for the excellent grade range (E) and highest for the good grade range (G), with moderate (M) and poor (P) grade ranges falling in between. There was a weak negative correlation ($r(54) = -0.159$) between the occurrence of 'Belief' and the grades. This suggests that as the grade level increased, the frequency of mentioning beliefs tended to decrease slightly.

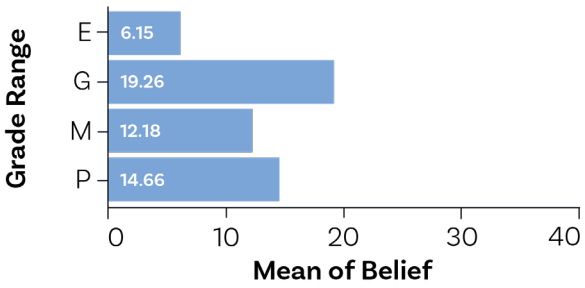


Figure 34: Presence of Belief component for grade range 'E' is notably lower than for other components. Also, it should be noted that presence of Belief component for all the E graded samples is less than overall mean M = 13.54)

Notably, in the 'E' grade range, all the reflections had occurrences of belief below the overall mean. On the other hand, in the 'P' grade range, more than two-thirds of the reflections had occurrences of belief higher than the mean. This observation suggests that for poor reflections, the absence of belief was often accompanied by a lack of connection to other perspectives discussed in the essay. This can be exemplified by the comment from the examiner on reflection ID 59, stating that the reflection focused mainly on the methods used without connecting them to the different themes and theories covered in the essay and reference material.

In contrast, for excellent reflections, while some did not mention beliefs, they compensated by incorporating other perspectives and demonstrating a strong connection to the theme of the essay. These reflections were appreciated by examiners, as mentioned in their comments.

This observation suggests that the inclusion of beliefs, along with connecting to different perspectives and themes, is an important factor in achieving higher grades. The absence of beliefs alone does not necessarily result in a lower grade, as long as the reflection demonstrates a strong understanding and integration of other perspectives.

Perspective

Interpretation of the component 'Perspective' reveals interesting patterns across different grade ranges. The mean occurrence of perspective was highest in the 'Excellent' grade range (11.52), indicating that a majority of the reflections in this component mentioned some form of perspective. This aligns with the rubric's emphasis on connecting reflections to the themes in the essay.

However, there were cases of exceptions observed. In some 'Excellent' reflections, perspective was absent, but these reflections compensated by focusing more on outcomes such as learnings and intentions. Examples include ID 21 and ID 16, where perspective occurrence was lower than the overall mean, but the outcomes were emphasized. Another exception was ID 47, where perspective was absent but the presence of descriptive text linking the reflection to the essay theme was appreciated by the examiner.

In the 'Poor' grade range, 60% of the reflections did not mention other perspectives, supporting our interpretation that lower grades have less emphasis on perspective. However, for the remaining 40% of reflections that had higher occurrences of perspective, it was observed that they mentioned theories from different papers without effectively linking them to their own experiences. These reflections provided generic learnings and intentions without deeper engagement with the specific concepts and themes introduced in the essay. Notably, these reflections also had belief scores similar to or higher than the mean (M = 13.51).

Examiner comments for reflections such as ID 24, ID 6, and ID 19 highlighted the need for a deeper engagement with the essay's themes and concepts. These reflections failed to connect the mentioned theories with their own experiences and missed the opportunity to categorize their reflections under specific types.

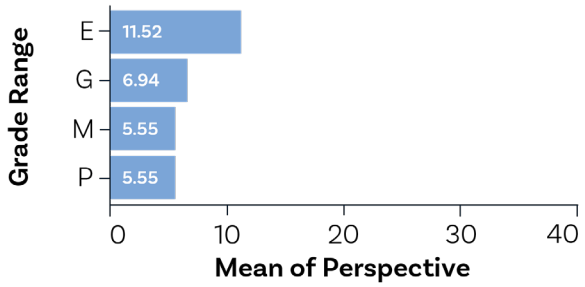


Figure 35: Overall higher mean for presence of Perspective component in the grade range 'E' can be observed (M = 11.52)

Overall, the patterns observed in the 'Perspective' component suggest that while a majority of 'Excellent' reflections mention perspective, exceptions can occur where reflections compensate for the absence of perspective by focusing on outcomes. In the 'Poor' grade range, a higher occurrence of perspective alone does not guarantee higher grades unless it is effectively connected to the essay's themes and concepts and integrated with the student's own experiences.

Feeling

The interpretation of the 'Feeling' component reveals interesting patterns across different grade ranges. The mean occurrence of Feeling component was lowest in the 'Excellent' grade range (M = 2.09). Also, a majority of the reflections (75%) in this component did not mention any feelings. Similarly, in the 'Good' grade range, a lower occurrence of feelings was observed along with lower mean of Feeling component (M = 3.36). This suggests that higher-graded reflections may not place as much emphasis on explicitly mentioning feelings. In contrast, the 'Moderate' and 'Poor' grade ranges showed a higher presence of feelings in the reflections (M = 6.46 and M = 6.19, respectively). However, it is important to note that the presence of feelings alone does not guarantee higher grades. The weak negative correlation observed between feelings and grades (r(54) = -0.219) suggests that there might be a relationship between feelings and reflection quality, but is complex and may require further analysis.

In the 'Excellent' grade range, most reflections did not mention feelings, but there were exceptions. For example, ID 17 included one sentence about feelings while critically assessing a described experience. On the other hand, in the 'Poor' grade range, while many reflections mentioned more feelings, some did not mention any. In these cases, the absence of feelings was not explicitly commented on by the examiners, but they did highlight the lack of other perspectives. This suggests that the absence of feelings alone may not negatively impact the grade if other important components, such as incorporating multiple perspectives, are present.

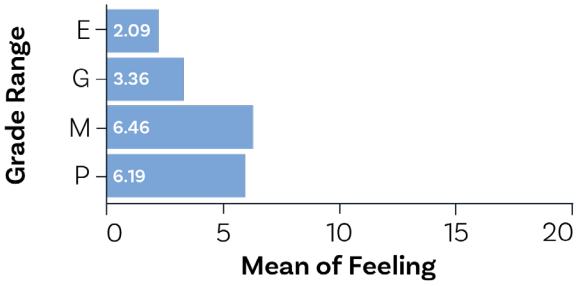


Figure 36: Overall lowest mean for presence of Feeling component in the grade range 'E' can be observed (M = 2.09)

Overall, while a trend of lower occurrence of feelings in higher-graded reflections was observed, further analysis is required to fully understand the role of feelings in reflection quality, as it is not explicitly mentioned in the rubric.

Analysis of Reflection Components: Combination of Reflection Components Across Grade Ranges

Nature of Excellent Graded Reflections

Upon further analysis, it became evident that the excellent grade range comprised two distinct types of reflections, each contributing to higher grades but with different emphases and characteristics.

The first type of reflection, which emphasized personal experiences, learning, intention, and positive outcomes, demonstrated strong positive correlations between the component of experience and learning ($r(6) = 0.454$), intention ($r(6) = 0.772$), and outcome ($r(6) = 0.732$). These correlations indicate that when students incorporated their experiences into their reflections and showcased their ability to derive meaningful learning and intention from those experiences, it resulted in higher grades. The positive relationships between experience, learning, intention, and outcome highlight the importance of integrating personal insights and growth within the reflection process.

Example:

The reflection provided by ID 16 (figure 37) aligns with the conclusions drawn regarding the type 1 of excellent graded reflections that focus more on personal experiences, learnings, and intentions. The reflection demonstrates a clear shift in the student's understanding and expectations of the design process. They express a willingness to trust their intuition more and explore a directed creative exploration model. The reflection also highlights the importance of experience, the development of schemata and gambits, and the influence of previous experiences in shaping their design process. The author adeptly intertwines personal experiences, critical analysis, and learning moments throughout the reflection. They introduce past experiences, providing concise yet precise descriptions, followed by a brief thoughtful analysis and the presentation of an alternative perspective. This pattern repeats as the author seamlessly transitions from one critical analysis or difficulty to another, promptly offering accompanying insights and intentions. This consistent structure and content arrangement contribute to the overall coherence and depth of their reflection which might have contributed to the higher quality of the reflection along with the other factors.

On the other hand, the second type of reflection focused more on critical assessment, multiple perspectives, and descriptive text. It was observed that this type of reflection showed positive correlations between the component of difficulty and perspective ($r(6) = 0.237$) as well as descriptive ($r(6) = 0.432$). These correlations suggest that when students engaged in critical assessment, considered various perspectives, and provided descriptive explanations, it contributed to a higher emphasis on the challenges and complexities encountered in their design practice.

Figure 37: Coded Reflection of ID 16 (Grade 10)

Although these reflections showed lower correlations with learning, intention, and outcomes, they excelled in evaluating the design process from diverse perspectives, resulting in higher grades based on their ability to critically analyze and articulate different viewpoints.

Example:

In the reflection from ID 17 (figure 38), the author frequently mentions the categories of 'difficulty' and 'perspective'. They reflect on their past projects and acknowledge the challenges they faced, such as making assumptions and avoiding uncertainty. The author engages in critical analysis by referencing scholarly work, such as the avoidance of uncertainty described by Tracey and Hutchinson (2016) and the preference effect mentioned by Nikander et al. (2014). This demonstrates a conscious effort to explore the difficulties and complexities of their design practice. Moreover, the author consistently incorporates different perspectives into their reflection. The author's writing style showcases a thoughtful and analytical approach to reflection. They begin by recounting their past experiences, providing context for their analysis. Subsequently, the author delves deeply into critically examining these experiences, demonstrating a keen ability to evaluate them from different perspectives. Notably, the author incorporates their personal beliefs while discussing alternative viewpoints, enriching the reflection with a nuanced understanding. Towards the conclusion, the author succinctly articulates their overall intention, drawing upon the insights gained through their critical analysis. This type of reflection exhibits a focused exploration of challenges ('difficulty') and alternative perspectives ('perspective'), concluding with concise and precise insights and/or learnings.

One limitation is the small sample size of only 8 reflections in the excellent grade range. While this restricts the generalizability of our findings, it serves as a starting point for future investigations with larger datasets. Despite this limitation, the observed correlations provide a preliminary understanding of the relationships between reflection components and higher-graded reflections. Further research with a larger sample size can build upon these initial insights and provide a more comprehensive analysis.

In summary, the excellent grade range encompassed two types of reflections. The first type emphasized personal experiences, learning, intention, and positive outcomes, while the second type focused on critical assessment, multiple perspectives, and descriptive text. Both types exhibited unique strengths, and their correlation patterns shed light on the specific aspects that contributed to their higher grades. By recognizing and understanding these distinctions, it becomes evident that achieving a high grade is not limited to a singular approach, but rather a combination of different reflection components that demonstrate critical thinking, personal growth, and the ability to consider diverse perspectives.

Figure 38: Coded Reflection of ID 17 (Grade 10)

Nature of Poor Graded Reflections

The combinations of categories in the poor graded reflections suggest several factors that may contribute to their lower quality compared to the excellent graded reflections. Firstly, the weak negative correlation between difficulty and perspective (r(19) = -0.307) indicates that poor reflections tend to lack the incorporation of multiple perspectives while critically analyzing their experiences or beliefs. This suggests a potential limitation in their ability to consider alternative viewpoints and engage in comprehensive reflection.

Additionally, the weak positive correlation of experience with learning (r(19) = 0.110) and weak negative correlation with intention (r(19) = -0.135) in the poor graded reflections suggest an imbalance in the incorporation of these categories. In contrast to the type 1 excellent graded reflections, the poor reflections may not effectively strike a balance between discussing their experiences and deriving meaningful learnings, as well as setting clear intentions for their future design practice. This lack of balance may hinder the depth and coherence of their reflections.

Furthermore, the strong negative correlation between belief and experience (r(19) = -0.655) and moderate negative correlation with difficulty (r(19) = -0.245) in the poor graded reflections highlight a potential issue in connecting beliefs to personal experiences and engaging in critical analysis. While the poor reflections may mention more beliefs, the absence of in-depth analysis and connection to experiences may diminish the overall quality of their reflections.

Example 1:

The reflection of ID 45 (figure 39) might be graded as poor due to several factors related to the components of reflection. Firstly, the reflection predominantly focuses on personal beliefs without critically analyzing them using another perspective. The author expresses their belief in the importance of reflection, but there is a lack of depth in examining this belief through the lens of different perspectives or theories. This limited analysis may result in a shallow and less comprehensive reflection. Furthermore, the reflection directly transitions to discussing intentions without providing a proper analysis of past experiences or engaging with different perspectives. The author jumps from expressing their belief to talking about implementing reflection-in-action without adequately exploring the connections between their beliefs, experiences, and the practical implications for their future design practice. This lack of in-depth analysis and contextualization may lead to a less coherent and substantive reflection.

The examiner's comment reinforces these points,

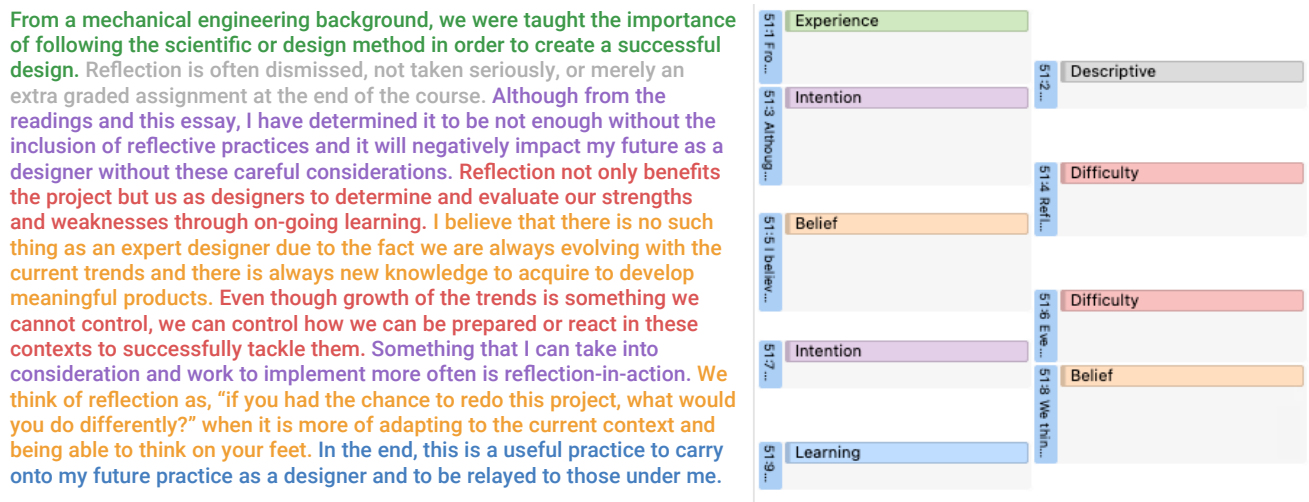


Figure 39: Coded Reflection of ID 45 (Grade 6.5)

COACH'S COMMENT

The language used here (and also in the essay) is quite difficult to follow. Try and state what you mean more clearly. There is some reflection and thoughts about future practice.

suggesting that the language used in the reflection, as well as in the essay, is difficult to follow. This indicates a need for clearer communication and a more explicit expression of ideas. While there is some evidence of reflection and thoughts about future practice, the lack of clarity and coherence in the reflection might contribute to its lower grade. To improve the reflection, the author should strive for greater clarity in their writing, clearly stating their ideas and ensuring that the reflection includes more thorough analysis of past experiences, critical examination of beliefs through multiple perspectives, and a coherent connection between beliefs, experiences, and future intentions.

Example 2:

The reflection from ID 19 (figure 40) may be graded as poor due to several factors related to the components of reflection. While the structure of the reflection follows the pattern seen in type 1 excellent graded reflections, there are shortcomings in connecting the theories to the author's practice and critically analyzing them. In the reflection, the author briefly mentions concepts such as framing and fixation from the literature without delving into a deeper engagement with these concepts or exploring their implications for their own design practice. Instead of critically analyzing the theories and relating them to their own experiences, the author merely acknowledges their applicability without providing substantial analysis or insights. This lack of in-depth engagement with the themes and concepts that should have been addressed in the reflection, indicates a limited exploration and analysis, which may contribute to the poor grade.

This deficiency is highlighted in the examiner's comment, which suggests that the reflection only engages somewhat with the concepts of framing and fixation, and that a greater level of engagement was expected. The examiner points out the need for a more thorough examination of the themes and theories in the essay, indicating that the reflection falls short in providing the required depth and analysis. To improve the reflection and potentially achieve a higher grade, the author should strive for a more comprehensive and critical analysis of the theories presented. This can be done by connecting the theories to their own experiences, reflecting on the implications for their design practice, and offering deeper insights and reflections based on these connections.

In summary, the lower quality of the poor graded reflections compared to the excellent graded reflections may be attributed to the insufficient incorporation of multiple perspectives, an imbalance between experience, learning, and intention categories, and a lack of connecting beliefs to personal experiences and critical analysis.

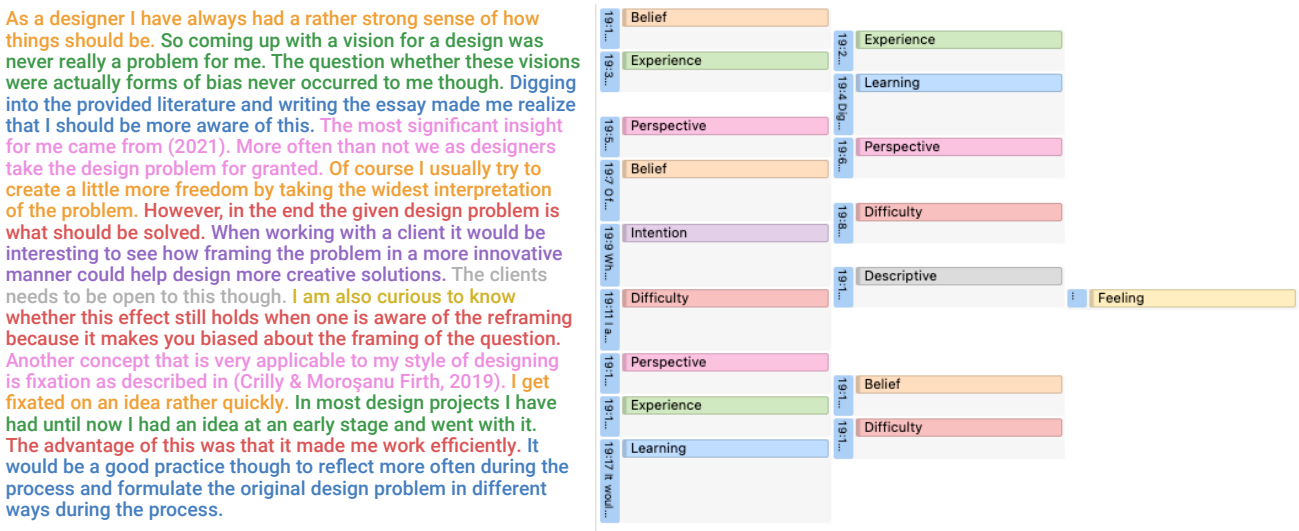


Figure 40: Coded Reflection of ID 19 (Grade 6)

COACH'S COMMENT

The reflection engages somewhat with concepts of framing and fixation. It would have been better to show a greater engagement with the themes that should have been addressed in the essay.

Analysis of LIWC Categories: Combination of LIWC Categories Across Grade Ranges

The correlation analysis of the specific LIWC categories with the grades yielded several interesting findings.

achieve

The LIWC category "achieve" showed a weak to moderate positive correlation (r(54) = 0.339) with the grades. This field is associated with the component of "Intention" in our research. One possible explanation for this correlation is that reflections that express a higher degree of intention or goal-oriented language may be perceived as more focused and purposeful, which could contribute to a higher grade. It is intriguing to note that the LIWC category "focusfuture," also associated with the component of Intention, did not show a significant correlation. This could suggest that the specific linguistic cues captured by "achieve" are more closely aligned with the evaluative criteria used by the examiners.

feeling

The LIWC category "feeling" exhibited a weak negative correlation (r(54) = -0.288) with the grades. This field is linked to the component "Feeling," where a general trend of negative correlation with grades was observed. However, it is important to acknowledge that the rubric for grading did not explicitly mention feelings as a criterion. Therefore, the reasons for this occurrence may not be easily explained solely based on the grading criteria. Further investigation and analysis are required to understand the relationship between feelings expressed in the reflections and their impact on grades.

ipron and auxverb

The LIWC categories "ipron" and "auxverb" demonstrated weak to moderate negative correlations with the grades (r(54) = -0.363 and r(54) = -0.288, respectively). These fields are associated with the categories "Belief" and "Difficulty." It is worth noting that poor graded samples had a higher occurrence of the component "Belief," which could contribute to the negative correlation. However, it is intriguing that these fields show negative correlations with grades, even though the component "Difficulty" had a positive correlation. One plausible explanation is that these fields do not uniquely identify a specific component of reflection. Therefore, it becomes challenging to attribute a certain correlation between LIWC categories and grades solely to a particular component of reflection.

Other LIWC categories

The remaining LIWC categories, including "i," "shehe," "quantity," "cause," "differ," "discrep," "focuspast," "focuspresent," and the other shortlisted fields, either demonstrated no correlation or very weak negative correlations with the grades. These LIWC categories do not independently point out to a specific component of reflection, which could explain the unclear association between these fields and the grades. It is possible that the evaluation of reflections involves multiple dimensions and criteria that extend beyond the scope of the individual LIWC categories analyzed in this study.

Possible reasons for these observations could include the subjective nature of grading, the complexity of capturing reflection components accurately through LIWC categories alone, and the limitations of using a smaller sample size for analysis. It's important to note that the correlation analysis provides insights into potential associations but does not establish causality.

The limitations of this analysis include the small sample size, which may limit the generalizability of the findings. Additionally, the reliance on LIWC categories alone to capture the complexity of reflection components may overlook important contextual nuances and linguistic features. Further research with a larger and more diverse dataset, incorporating additional qualitative analysis methods, could provide a more comprehensive understanding of the relationship between LIWC categories and grading in reflection assessments.

Due to the limitations and challenges encountered in using LIWC analysis as the sole method for predicting grades and the need for a more comprehensive and nuanced approach, the research was concluded at this stage. While the analysis provided valuable insights into the linguistic elements and associations with reflection components, it became evident that additional factors and assessments are necessary to accurately predict grades for reflections.

Additionally, it was recognized that a comprehensive analysis of reflection quality requires the integration of multiple assessment methods, beyond the scope of this research. These findings serve as a foundation for future research to explore and refine the methods of analyzing and evaluating student reflections, facilitating a more comprehensive understanding of their reflective writing abilities.

05

DISCUSSION

This section encapsulates key findings and insights from the study. It delves into LIWC category indicators for reflection components, revealing linguistic intricacies. It introduces two reflection types – Holistic Narrators and In-depth Explorers – shedding light on their distinct qualities. The discussion navigates through limits of assessing reflection quality using LIWC categories, underscoring the importance and constraints of linguistic analysis. Implications for design education showcase the practical relevance of these discoveries. Lastly, the section touches on limitations and future research, underscoring the ongoing potential for advancements in reflective thinking assessment within design education.

5.1 LIWC CATEGORY INDICATORS FOR REFLECTION COMPONENTS

The analysis of LIWC categories in relation to reflection components yielded valuable insights into the linguistic elements of reflective writing. By examining specific LIWC categories, I was able to identify certain linguistic patterns associated with different reflection components. In this subsection, the focus is on the discussion of these findings and their implications.

Within the linguistic domain, the use of first-person singular pronouns ("I") exhibited a weak positive correlation with multiple reflection components, including Experience, Belief, Feeling, Learning, and Intention. This suggests that individuals tend to express their personal experiences, beliefs, feelings, learning processes, and intentions using first-person language. On the other hand, the presence of third-person singular pronouns ("shehe") and third-person plural pronouns ("they") showed relatively weak correlations with perspective and descriptive, indicating that their presence alone may not strongly differentiate specific reflection components. Further analysis, incorporating other linguistic features and contextual cues, is necessary for accurate identification.

Impersonal pronouns, such as "that," "it," "this," or "what," demonstrated a weak positive correlation with the Belief and Difficulty categories. The use of these pronouns may indicate a focus on abstract ideas or concepts rather than personal experiences within reflective writing. Similarly, the presence of auxiliary verbs like "is," "was," "be," or "have" showed a weak positive correlation with the categories of Belief and Difficulty. This suggests that individuals may employ these verbs to express their beliefs, perspectives, or critical assessment of challenges and struggles encountered in their reflections.

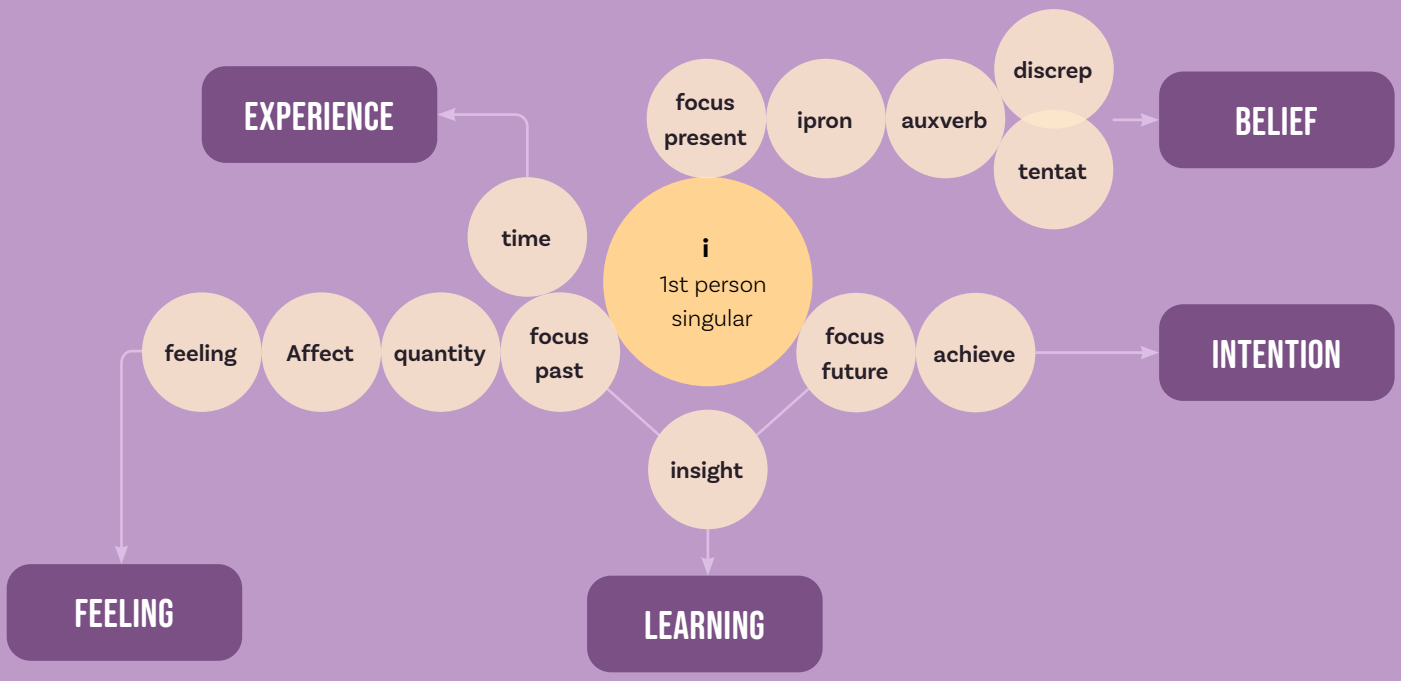
Negations, such as "not," "no," "never," or "nothing," exhibited a moderate correlation with the Difficulty component. The presence of negations may suggest a critical analysis of challenges and obstacles experienced by the author. However, it is important to consider other linguistic features and contextual cues to accurately distinguish the Difficulty component from other reflective domains.

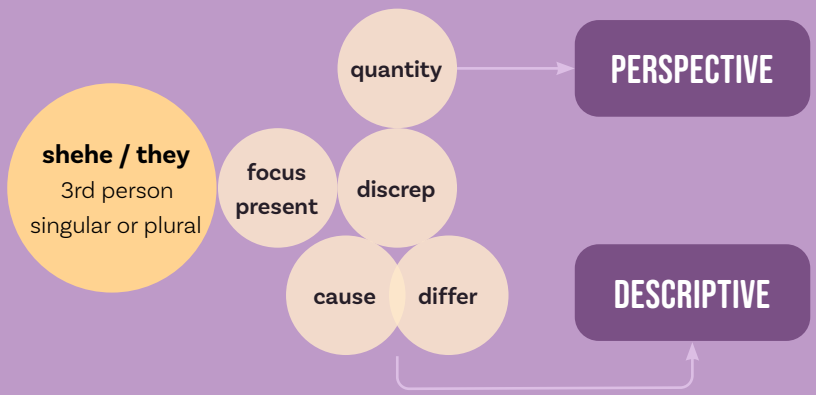
In the cognition domain, words associated with insight, causation, discrepancy, tentative language, and differentiation displayed weak to moderate positive correlations with various reflection components. These linguistic features indicated cognitive engagement in terms of gaining new knowledge, understanding underlying factors, considering alternative viewpoints, expressing tentative thoughts, and analyzing distinctions within reflections. Insights, represented by words like "know," "how," "think," or "feel," are associated with the Learning component, indicating individuals' engagement in reflective practices to gain new knowledge and understanding. Cause-related words, such as "because" and "why," correlate with Difficulty and Descriptive categories, reflecting individuals' reflection on underlying factors and influences. Differentiation-related words, like "but" and "not," indicate cognitive analysis of distinctions and alternatives within reflections, while discrepancy-related words, such as "would" and "could," highlight consideration of alternative viewpoints and possibilities. The presence of these linguistic elements enriched the cognitive dimension of reflective writing.

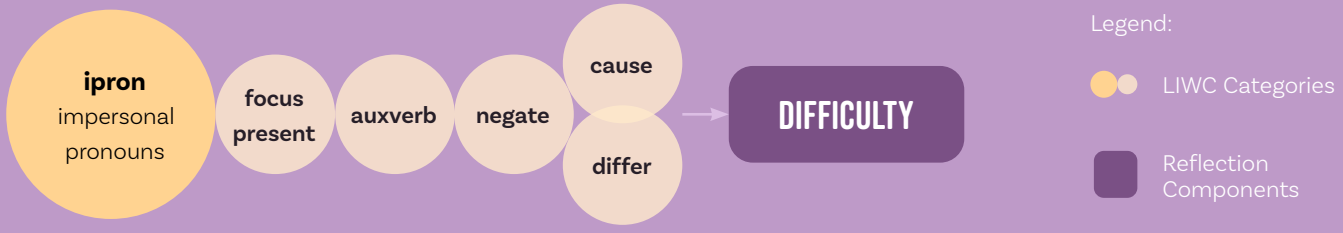
Within the time orientation domain, time-related words exhibited weak to moderate positive correlations with the Experience component. The inclusion of temporal markers allowed individuals to reflect on specific temporal aspects or recount past experiences within their reflections. Additionally, a temporal emphasis on previous events, emotions, or acquired knowledge was observed through the focus on past-related words. The focus on present-related words demonstrated weak positive correlations with multiple categories, suggesting an emphasis on current experiences, beliefs, challenges, perspectives, emotions, or descriptive accounts. Furthermore, the focus on future-related words exhibited a moderate to strong positive correlation with the Intention component, indicating individuals' articulation of their intentions, plans, or goals for future actions or behaviors.

Finally, other LIWC categories, such as achievement-related words and affect-related fields, displayed weak to moderate positive correlations with specific reflection components. These linguistic elements captured the motivational and goal-oriented focus of reflections, as well as the expression of emotions and affective states within reflective writing.

SHARED LINGUISTIC FEATURES AMONG REFLECTION COMPONENTS







It is important to acknowledge that not all reflection components can be uniquely identified by specific LIWC categories. There are overlaps and shared linguistic features among reflection components, requiring consideration of multiple cues for accurate categorization. Additionally, similarities in linguistic patterns between certain components, such as Descriptive and Perspective, were observed, indicating potential overlaps or shared characteristics. Therefore, a comprehensive analysis incorporating multiple linguistic features and contextual information is necessary for precise identification and interpretation of reflection components.

5.2 TYPES OF EXCELLENT REFLECTIONS: HOLISTIC NARRATORS AND IN-DEPTH EXPLORERS

The analysis of the reflection data revealed two distinct types of excellent graded reflections, each with its own unique characteristics and strengths. The first type, referred to as "Holistic Narrators" (5 reflection samples: ID 3, 4, 5, 16, 21), placed emphasis on personal experiences, learning, intention, and positive outcomes. These reflections showed strong positive correlations between the experience component and learning, intention, and outcome categories. This suggests that when students integrated their experiences into their reflections and demonstrated meaningful learning and intention derived from those experiences, it led to higher grades. The holistic narrators displayed the ability to describe multiple experiences, provide a brief yet critical assessment, incorporate beliefs and other perspectives, and articulate multiple clear intentions or specific learnings.

On the other hand, the second type of excellent graded reflections, termed "In-depth Explorers" (3 reflection samples: ID 13, 17, 47) focused more on critical assessment, multiple perspectives, and descriptive text. These reflections showed positive correlations between the difficulty component and the perspective and descriptive categories. This indicates that when students engaged in critical assessment, considered various perspectives, and provided descriptive explanations, it contributed to a higher emphasis on the challenges and complexities encountered in their design practice. While these reflections showed lower correlations with learning, intention, and outcomes, they excelled in evaluating the design process from diverse perspectives, resulting in higher grades based on their ability to critically analyze and articulate different viewpoints.

The in-depth explorers demonstrated characteristics such as a focus on a few experiences, in-depth critical assessment, consideration of multiple perspectives, and few specific intentions or contextual learnings.

It is important to recognize that achieving a high grade in reflections is not limited to a singular approach. The existence of these two distinct types highlights that excellence can be achieved through different reflection components. Both types demonstrate critical thinking, personal growth, and the ability to consider diverse perspectives, albeit with different emphases. This insight provides valuable guidance to students and educators, indicating that a comprehensive reflection encompasses various elements and approaches to showcase a comprehensive understanding of design practice.

The poor graded reflections showed lower quality compared to the excellent graded reflections for a few reasons. Firstly, they lacked the incorporation of multiple perspectives while critically analyzing experiences or beliefs. This suggests a limitation in considering alternative viewpoints and engaging in comprehensive reflection. Additionally, there was an imbalance in the incorporation of categories such as experience, learning, and intention. Unlike the excellent graded reflections, the poor reflections did not effectively strike a balance between discussing experiences, deriving meaningful learnings, and setting clear intentions for future design practice. Moreover, there was a lack of connection between beliefs and personal experiences, resulting in a diminished overall quality of the reflections. These factors contributed to the lower grade assigned to the poor reflections.

HOLISTIC NARRATORS

- Describe Multiple Experiences
- Brief Yet Critical Assessment
- Incorporate Beliefs and Other Perspectives
- Multiple Clear Intentions or Specific Learnings

IN-DEPTH EXPLORERS

- Focus on Few Experiences
- In-Depth Critical Assessment
- Consideration of Multiple Perspectives
- Few Specific Intentions or Contextual Learnings

5.3 LIMITS OF ASSESSING REFLECTION QUALITY USING LIWC CATEGORIES

Specific LIWC categories also revealed associations with reflection quality. The LIWC category “achieve” showed a positive correlation with grades, suggesting that reflections expressing intention and goal-oriented language were associated with higher grades. On the other hand, the LIWC category “feeling” exhibited a negative correlation, indicating that an excessive focus on emotions may not contribute significantly to higher grades. Other LIWC categories, such as “ipron” and “auxverb,” demonstrated negative correlations with grades, although their specific associations with reflection components were less clear.

Despite these correlations, it is important to acknowledge the limitations and feasibility of relying solely on LIWC analysis to identify high-quality reflections. LIWC analysis provides valuable quantitative insights into linguistic features and certain reflection components but may not capture the depth, complexity, and qualitative aspects required for accurate grading. Grading reflections involves evaluating multiple dimensions, such as critical thinking, coherence, depth of analysis, and connection to the essay topic, which may not be fully captured by LIWC analysis alone.

Additionally, the association between LIWC categories and reflection components is not always clear-cut. Some LIWC categories showed negative correlations with grades, but their specific associations with reflection components were not well-defined. This indicates the challenge of attributing a particular correlation between LIWC categories and grades solely to a specific component of reflection. The overlapping dictionaries and multiple associations within LIWC analysis further complicate the interpretation of results.

Considering these limitations, it is important to adopt a holistic approach when assessing reflection quality. Integrating multiple assessment methods, such as expert judgment, examiner feedback, and a well-defined rubric, can provide a more comprehensive and accurate understanding of reflection quality. While LIWC analysis can offer valuable insights, it should be complemented by qualitative assessments and contextual factors to ensure a robust evaluation process.

5.4 IMPLICATIONS FOR DESIGN EDUCATION

Future research on the linguistic elements of reflections holds immense potential for advancing the field of design and providing valuable insights for educators and students alike. Building upon the findings of this study, researchers can focus on several key areas to further explore the implications and applications of linguistic analysis in reflective writing.

Recommendations for Reflective Writing Practices

For Educators

The current research provides a strong foundation for developing evidence-based guidelines and recommendations for writing effective reflections. By identifying linguistic patterns associated with higher grades or more comprehensive reflections, educators can offer specific strategies and practices to guide design students in improving their reflective writing skills. These recommendations may include suggestions for incorporating critical analysis, balancing personal experiences with theoretical perspectives, and enhancing clarity and coherence in written reflections. Such guidelines can serve as valuable resources to support students in crafting more meaningful and impactful reflective narratives. Based on the research findings, a valuable recommendation arises for designers aiming to enhance their reflective practices.

For Designers

The study identified two primary types of high-quality reflections: "Holistic Narrators" and "In-depth Explorers." These types underscore the importance of adopting varied approaches to excel in the process of reflection. For designers, a logical strategy involves selecting the appropriate role based on the content of their reflections. Embracing the role of a "Holistic Narrator" entails incorporating personal experiences, learning, and positive outcomes into reflections. This approach fosters a deeper resonance and enhances the evaluative impact of reflections. On the other hand, aligning with the "In-depth Explorer" path involves focusing on critical evaluation, embracing multiple viewpoints, and providing comprehensive explanations. This strategy empowers designers to navigate the intricacies of challenges and complexities within their design journey.

The overarching insight is that there isn't a one-size-fits-all approach to crafting exceptional reflections. By thoughtfully blending these two roles, designers can enrich personal growth, nurture critical thinking, and expand their capacity to encompass diverse perspectives. This amalgamation enables designers to craft reflections that encapsulate a holistic view of their design process. Ultimately, the best course of action involves crafting reflections that illuminate both personal development journeys and the intricate aspects of the design process. By choosing the role that aligns with their reflective content, designers can establish a robust yet structured approach to composing impactful reflections.

Student Support and Feedback

The insights gained from this research can inform the development of interventions and support systems to assist students in honing their reflective writing abilities. Educators can leverage the identified linguistic elements to provide targeted feedback and guidance to students, helping them refine their reflective writing skills. By highlighting areas where students may need improvement or further development, educators can foster deeper critical thinking, encourage self-reflection, and facilitate students' personal and professional growth as designers. This personalized support can enhance the quality of students' reflective writing and contribute to their overall learning experience.

Integration of Quantitative and Qualitative Approaches

Future research can explore the integration of quantitative linguistic analysis, such as LIWC, with qualitative methods to gain a more comprehensive understanding of reflective writing. By combining linguistic analysis with in-depth qualitative examinations, such as interviews or focus groups, researchers can capture the richness and complexity of students' reflective narratives.

This mixed-methods approach enables a deeper exploration of the contextual factors, motivations, and emotions underlying the linguistic patterns identified in the quantitative analysis. Integrating quantitative and qualitative approaches can provide a holistic perspective on reflective writing, encompassing both the structural aspects and the subjective experiences of students.

Longitudinal Studies

Longitudinal studies tracking students' reflective writing development over time offer a valuable avenue for future research. By examining how linguistic patterns evolve and change with increased experience and expertise, researchers can gain insights into the developmental trajectory of reflective writing skills. Longitudinal studies can also investigate the impact of reflective writing interventions or educational approaches on the growth and refinement of students' reflective writing abilities. Understanding the longitudinal progression of reflective writing can inform the design of targeted interventions and curriculum enhancements that support students' continuous development as reflective practitioners.

Furthermore, future research can explore additional linguistic features beyond the scope of this study, such as syntactic structures, discourse markers, and rhetorical devices, to uncover further insights into the relationship between language and reflective writing. Investigating these linguistic elements can provide a deeper understanding of how different linguistic strategies are employed in reflective writing and how they contribute to the overall quality of reflections.

By pursuing these avenues of research, design educators and researchers can make significant contributions to the field by offering evidence-based recommendations, designing effective support systems, and furthering our understanding of the intricate nature of reflective writing. This research has the potential to empower design students to engage in reflective thinking, enhance their communication skills, and facilitate their personal and professional growth as reflective practitioners.

5.5 LIMITATIONS AND FUTURE RESEARCH

LIMITATIONS AND ALTERNATIVE APPROACHES IN LIWC ANALYSIS FOR GRADING REFLECTIONS

While LIWC analysis provides valuable insights into the linguistic features of reflections and their potential association with grades, it is essential to recognize the limitations inherent in this approach. These limitations are crucial for a comprehensive understanding of the research context and should be considered in the interpretation of the results. The following limitations should be taken into account when using LIWC analysis in grading reflections:

Subjectivity in Coding

The coding of reflections based on Ullmann's criteria was performed by a single researcher, which introduces the potential for subjectivity and bias in the coding process. Multiple researchers should be involved to enhance the reliability and validity of the coding procedure. Additionally, the coding was done at the sentence level, and some sentences may fit into multiple reflection components, leading to potential overlaps and challenges in accurately capturing the intended meaning. Future research could consider using phrase-level coding to provide a more precise categorization of reflections.

Word-Level Analysis

LIWC analysis operates at the word level, while the coding of reflections was done on a sentence level. This difference in granularity may result in discrepancies and limitations when associating specific linguistic patterns with the components of reflection. Future studies could explore ways to integrate word-level and sentence-level analyses to bridge this gap and improve the alignment between LIWC analysis and the coding of reflections.

Overlap of LIWC Categories

Some LIWC categories, such as 'auxverb' and 'focuspresent', may share overlapping words or linguistic features, potentially leading to challenges in attributing specific linguistic patterns to a particular component of reflection. Researchers should exercise caution when interpreting results associated with these overlapping reflection components and consider alternative approaches, such as analyzing combinations of LIWC categories or employing more sophisticated natural language processing techniques.

Complexity of Language and Ambiguity

Human language is complex and can be open to interpretation. The rigidity of LIWC analysis and the use of pre-defined dictionaries may oversimplify the nuances and ambiguity inherent in language use, potentially missing important contextual information. Researchers should be mindful of the limitations of LIWC analysis in capturing the rich layers of meaning embedded in reflections and consider supplementing the analysis with qualitative methods to gain a more comprehensive understanding of the text.

Feasibility of Grade Prediction

While LIWC analysis can offer valuable insights into linguistic features correlated with higher or lower grades, it is important to acknowledge its limitations as the sole determinant of accurate grade prediction. In academic contexts, grades are influenced by a range of factors that extend beyond linguistic patterns, including essay content, structure, critical thinking, and adherence to the topic. To enhance the precision of grade prediction models, researchers could explore strategies such as incorporating LIWC analysis alongside supplementary predictors like essay coherence, organization, or topic-specific metrics. Furthermore, the integration of machine learning algorithms that leverage multiple features can provide a more comprehensive and robust basis for accurate predictions.

Ethical Considerations for Automated Grading

When considering the ethical aspects related to automated grading of subjective writing, particularly in contexts like the evaluation of essays, a significant concern arises. The reliance on automated systems, while efficient, may inadvertently disadvantage students who do not conform to commonly-held ideas or approaches.

This concern is substantiated by the works of Azmi et al. (2019), Bhatt et al. (2020), and Liang et al. (2021), which suggest that existing automated scoring models can exhibit bias and produce scoring disparities when compared to human evaluators. For instance, when essays of varying quality are evaluated by automated systems, the resultant scores may significantly diverge from those provided by human experts.

Wang et al. (2023) emphasize that existing automated scoring models often operate as black box AI systems, which could contribute to scoring bias in subjective assignments. In response to this concern, the authors propose a collaborative approach that involves re-evaluation of essays by human experts.

In essence, while automated grading systems offer efficiency and speed in evaluating subjective writing, their potential to introduce bias and disadvantage certain students cannot be overlooked. Therefore, it is imperative to strike a balance between the advantages of automation and the need for human expertise in grading, ensuring fair and unbiased evaluations that truly reflect the students' efforts and capabilities.

Given these limitations, it is important to view LIWC analysis as a valuable tool within the broader research framework. Integrating LIWC analysis with complementary approaches, such as qualitative coding, expert evaluation, or additional data sources, can provide a more comprehensive and nuanced understanding of the relationship between linguistic features, reflection components, and grades. Researchers should consider employing mixed-method approaches to triangulate findings, validate results, and enhance the reliability and validity of their conclusions.

By acknowledging the limitations of LIWC analysis and considering alternative approaches, researchers can gain a more holistic understanding of the grading process and develop more accurate models for grade prediction in reflection-based assessments.

06

CONCLUSION OF THE PROJECT

This section serves as the culmination of this research journey, encapsulating both the overarching findings and personal reflections on this graduation project. It presents the comprehensive conclusions drawn from the research's empirical exploration, shedding light on the intricate dynamics of reflection within the context of design education. Beyond the research itself, this section presents a personal reflection that echoes the journey undertaken throughout the graduation project. The final chapter of this project encapsulates the academic and personal dimensions that have converged to shape this significant milestone.

6.1 CONCLUSION

Reflective writing is a crucial skill for designers, as it enables them to critically analyze their experiences, enhance their learning, and foster professional growth. By delving into the nature of reflective writing and exploring the relationships between linguistic features and the quality of reflections, this research sought to contribute to a deeper understanding of how design students engage in reflective practice and provide insights for educational approaches and interventions. The research utilized linguistic analysis, specifically the Linguistic Inquiry and Word Count (LIWC) software, to examine the relationship between the linguistic nature of reflections and its quality. Drawing upon the model of reflection detection proposed by Ullmann (2015a), which encompasses eight categories including experience, belief, difficulty, perspective, feeling, learning, intention, and descriptive this research aimed to provide a comprehensive framework for evaluating reflective writing in the context of design.

The key insights from this explorative research are twofold. Firstly, through the analysis of LIWC categories, it was revealed that specific linguistic features are associated with different components of reflection. Two types of high-quality reflections were identified: "Holistic narrators" which emphasized personal experiences, learning, intention, and positive outcomes, and "In-depth explorers" which focused on critical assessment, multiple perspectives, and descriptive text. These findings contribute to our understanding of the diverse ways in which individuals engage in reflective writing and highlight the multidimensional nature of high-quality reflections.

Secondly, the study shed light on the feasibility of using LIWC analysis as a tool for identifying high-quality reflections. While LIWC analysis provided valuable insights into certain linguistic features associated with reflection components, it has limitations in capturing the complexity and nuances required for accurate grading. Grading reflections involves evaluating multiple dimensions, including critical thinking, coherence, depth of analysis, and connection to the essay topic, which may not be adequately captured by LIWC analysis alone. Therefore, a comprehensive and multi-dimensional approach that integrates quantitative measures with qualitative assessments, expert judgment, and a well-defined rubric is crucial for a robust evaluation of reflection quality.

These findings have important implications for design researchers and education. Firstly, the identification of specific linguistic features associated with high-quality reflections can guide the design of reflective writing interventions and instructional strategies. By understanding the characteristics of "Holistic narrators" and "In-depth explorers," educators can provide targeted guidance and support to students, fostering the development of critical thinking skills, self-reflection, and diverse perspectives. Whereas designers can strategically choose roles (Holistic Narrators or In-depth Explorers) while writing reflection to enhance personal growth, critical thinking, and comprehensive reflection. Furthermore, the insights from this research can inform the development of automated tools or natural language processing techniques to assist educators in assessing and providing feedback on reflections, enhancing the efficiency and effectiveness of reflective practice in educational settings.

Moreover, the study emphasizes the importance of a comprehensive and holistic approach to assessing reflection quality. Educators and researchers should not solely rely on LIWC analysis but should integrate other assessment methods, such as expert judgment, examiner feedback, and a well-defined rubric, to ensure a thorough evaluation of reflections. By considering contextual factors, qualitative aspects, and individual variations in reflection quality, a more accurate and comprehensive assessment of reflective writing can be achieved, providing students with meaningful feedback and promoting their growth and development.

6.2 PERSONAL REFLECTION

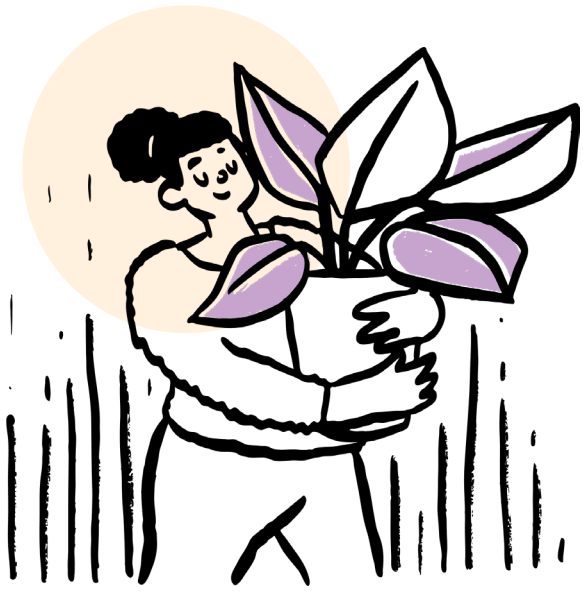
At the start of this year, I began my search for a topic for my graduation project. In light of the current AI boom, exemplified by the prevalent use of tools such as ChatGPT and DALL.E, I found myself drawn to the realm of AI's potential contributions to the field of design. This curiosity was further piqued by the prospect of AI's role in shaping the design process. My supervisors helped me decide on my graduation project topic, and that's when my journey really began.

During my strategic design masters, I was always motivated to reflect on my actions and my design process. This project gave me a chance to explore how technology, especially AI, can influence the way designers think. I knew a bit about reflection, but this topic also led me to learn about something called linguistic analysis. At first, I was a bit overwhelmed, but the more I learned, the more interested I became in the topic. Reading the book 'Secret life of pronouns' by James Pennebaker truly got me into the topic of how people write and how we use this information understand more about them. Honestly, I surprised myself. I didn't expect to dive so deep into a research project, where I had to learn not just about the topic, but also about research methods and using different tools.

Once I started the research, I had some personal goals for this project. I wanted to learn about explorative research and get better at both qualitative and quantitative methods. I got introduced to new ways like exploring the data visually and how it can support the statistical analysis. This really caught my interest, and I want to keep learning how it can help me as a design researcher.

My supervisors played a pivotal role in shaping the trajectory of my graduation project. They told me to stay open-minded while exploring and to be ready for unexpected things. This project was different from others because I had to be flexible in my approach. Each step depended on what I found in the previous one. Throughout this research project, I learned to iterate on exploring the data and testing theories but at the same time making decisions to choose and move to the next phase. I actually like challenges like this as they push me to master new subjects, methods, and tools.

Having not engaged in an extensive research project previously, I often grappled with concerns. Questions lingered: Would the results match my expectations? Could my research genuinely contribute meaningfully to the design field? Towards the end of my journey, I came to realize that research surpassed mere outcomes. It wasn't solely about achieving predefined goals. Instead, it encompassed the process itself—unearthing discoveries and sharing insights. The pivotal aspect lay in articulating these findings and engaging in meaningful discussions about their potential impact. Doing a research project is complex but navigating through this complexity is the role of a designer. Through this project, I've become more confident in managing my time, planning, and doing research. I can see how much I've grown as a design researcher during my time in this program.



Nuturing Reflection - A Designer's Compass to Foster Creativity

Thank you for embarking on this journey through my thesis. Warm Regards, Nupura

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APPENDIX

Appendices are provided in a seperate document. Please refer to that.