CHAPTER I
INTRODUCTION

A. Introduction

Multimodal elements in academic writing are essential for enhancing both comprehension and engagement. Academic texts often involve complex information that can be challenging for readers to process through text alone. According to Mayer's et al. (2009) cognitive theory of multimedia learning, combining textual and visual elements can lead to more effective learning by reducing cognitive load and facilitating deeper understanding.

Mayer also argued that the dual-channel approach where visual and verbal information are processed in separate channels enables readers to better absorb and retain information, thus improving learning outcomes. In addition, Visual modes, such as charts, tables, and diagrams, play a significant role in supporting and extending the textual narrative, allowing readers to better grasp relationships, trends, and abstract concepts (Roth, 2021).

Jewitt (2015) also emphasizes the role of multiple semiotic resources in meaning-making, arguing that multimodal approaches are necessary for a comprehensive understanding of the communicated ent. The use of different semiotic resources, including visual, iistics, and spatial modes, allows for more nuanced and layered

meanings, which are especially important in academic discourse where complex concepts need to be communicated effectively (Rowley-Jolivet, 2004). In academic writing, the integration of visuals with text helps present data more clearly, supports argumentation, and enhances overall readability.

The role of visual elements extends beyond merely supporting comprehension; they also influence how readers navigate and interact with academic texts. Van Leeuwen (2006) highlighted the importance of visual design in guiding reader attention and structuring the flow of information. Elements such as headings, bullet points, and visual hierarchies help readers locate key information quickly, enhancing the navigability of the text. The use of visual cues, therefore, contributes to the overall usability of academic articles, making them more accessible to a broader audience (Garcia-Retamero & Cokely, 2017; Lindgaard et al., 2011). This aspect of multimodality is particularly relevant in an era where digital publication formats are becoming the norm, allowing for more dynamic and interactive visual elements that further support reader engagement.

The integration of visual and textual modes in academic writing is closely linked to the concept of coherence. Coherence refers to the logical connection between different parts of a text, which is crucial for ensuring readers can follow the author's argument. According to Lemke (1998),

visual elements contribute to the coherence of academic texts by providing a parallel narrative that complements the written content. For example, a diagram might illustrate a process described in the text, allowing readers to visualize each step and understand the sequence more clearly. This complementary relationship between text and visuals helps to create a cohesive and unified message, which is essential for effective academic communication.

The effectiveness of multimodal elements in academic writing is influenced by their design quality and integration. Dagron & Tufte (2006) argues that well-designed visuals are characterized by clarity, precision, and efficiency. Poorly designed visuals, on the other hand, can lead to misinterpretation and confusion, undermining the overall effectiveness of the text (Clark & Lyons, 2010). Therefore, the integration of visual elements must be done thoughtfully, with careful consideration of how they complement and enhance the textual narrative. Authors must ensure that visuals are not only accurate and relevant but also designed in a way that supports the reader's understanding of the content. This highlights the importance of visual literacy for academic writers, who need to be skilled in both creating and interpreting visual information.

In academic writing, scientific articles are not merely composed of ıal information; they also incorporate visual elements such as figures,

tables, diagrams, and images. These components work together to construct meaning for readers, which extending beyond what is conveyed solely through text. Multimodality theory, which examines how multiple modes of communication contribute to meaning-making, offers a valuable lens to explore the integration of visual and textual elements in academic discourse. The integration of text and visuals plays a significant role in enhancing the overall communicative value of academic work (Huang & Xia, 2024). As the complexity of scholarly communication grows, there is an increasing reliance on multimodal approaches to effectively convey intricate ideas and data.

The study focuses on understanding how visual and textual elements are used collaboratively to convey complex ideas and how these elements contribute to knowledge construction. By exploring the interplay between different modes, this research will shed light on effective academic writing practices, potentially guiding authors on optimizing their use of multimodal features to improve the readability and impact of their articles. Multimodality theory, which examines how multiple modes of communication contribute to meaning-making, provides a valuable framework for understanding this phenomenon. Van Leeuwen (2001) describe multimodality as the use of several semiotic modes in the design communicative artifact, where each mode contributes distinct aspects

of meaning. In academic scientific articles, multimodality refers to the interaction between text, visuals, and sometimes other semiotic elements that work together to construct and convey knowledge. The value of multimodal elements in academic writing has been increasingly recognized, as scholars seek to communicate their findings to a diverse audience in a clear and engaging manner (Reid et al., 2016).

Visual elements such as graphs, tables, and diagrams are not merely supplementary components but essential elements that contribute to the reader's understanding and engagement. Tufte (2006) highlights the importance of visual elements in simplifying complex data and enhancing the interpretability of information. For instance, well-designed visuals can summarize large datasets, illustrate trends, and offer a visual representation of abstract concepts, making them accessible to readers who might otherwise struggle with purely textual descriptions. This interplay between text and visual modes is crucial in scientific disciplines where data complexity often demands a multimodal approach to ensure effective communication.

Despite the widespread use of visual elements in academic articles, there has been limited research focusing on how these visual and textual modes interact from a multimodal perspective. The traditional emphasis on linguistic aspects of academic writing often overlooks the significant

role that visual components play in constructing meaning (Lea et al., 1998). As Jewitt (2014) points out, multimodal analysis provides a more comprehensive understanding of how knowledge is communicated by considering all the available semiotic resources. In the context of scientific articles, this approach allows for an exploration of how visuals are integrated into the textual narrative and how they contribute to the overall argument or explanation presented by the author.

The importance of multimodal elements in academic writing is also underscored by their impact on reader comprehension. Mayer's (2009) cognitive theory of multimedia learning suggests that people learn more effectively when information is presented through multiple channels visual and verbal rather than through a single mode. In scientific articles, the use of visuals alongside text can help readers build a more complete mental model of the content, as visuals can provide concrete representations of abstract concepts, facilitate comparisons, and highlight relationships that might be less apparent in text alone. This theory supports the idea that visual and textual elements should be considered as co-constructors of meaning, working together to enhance the reader's understanding.

The effectiveness of visual elements in academic writing is influenced by how well they are integrated with the textual content. Hyland 9) argues that the strategic use of visuals in conjunction with text can

significantly enhance the clarity and persuasiveness of an argument. For example, a well-placed graph can provide immediate evidence to support a claim made in the text, while a diagram can help explain a complex process that would be cumbersome to describe verbally. However, the success of this integration depends on the coherence between the text and visuals, as disjointed or poorly explained visuals can confuse readers rather than aid their understanding. This underscores the need for a systematic approach to analyzing the role of multimodal elements in academic writing.

This research is particularly relevant in the context of scientific communication, where the complexity of the subject matter often necessitates the use of multiple modes to convey information effectively. Fields such as natural sciences, engineering, and social sciences frequently use tables, graphs, and images to present data, illustrate relationships, and support arguments. The integration of these visual elements with the textual narrative is crucial for effective communication, as it allows for a more nuanced and comprehensive presentation of the research findings. By examining how these elements are used collaboratively to convey complex ideas, this study aims to shed light on the broader implications of multimodality for academic writing and vledge construction.

In recent years, there has been a growing interest in understanding how different modes of communication contribute to the construction of knowledge in academic settings. Researchers such as Bateman (2008) and Lemke (1998) have emphasized the importance of considering the interplay between different semiotic modes in academic texts. Bateman's genre and multimodality approach, for instance, provides a framework for analyzing how different modes contribute to the overall structure and meaning of a text. Lemke (1998) further argues that the integration of multiple modes is essential for constructing complex scientific explanations, as each mode offers distinct affordances that contribute to the overall communicative goal.

Moreover, the use of multimodal elements in academic writing is not limited to enhancing comprehension; it also plays a role in shaping the reader's engagement with the text. Visual elements can capture the reader's attention, break up dense blocks of text, and provide a more dynamic reading experience. The visual design of a text can influence how readers navigate and interpret the content, with elements such as layout, color, and imagery contributing to the overall meaning-making process. In the context of scientific articles, the effective use of visuals can make the content more accessible and engaging, particularly for readers who may ɔe specialists in the field. This highlights the importance of considering

not only the informational value of visual elements but also their rhetorical and aesthetic functions.

Despite the recognized importance of multimodality in academic writing, there is still a need for more empirical research on how visual and textual elements are used in practice. Much of the existing literature has focused on theoretical frameworks and case studies, with relatively few studies providing systematic analyses of a larger sample of scientific articles.

The integration of text and visual modes in scientific articles plays a crucial role in enhancing the communicative value of academic writing. Multimodality theory provides a valuable framework for understanding how these elements work together to construct meaning, with implications for both reader comprehension and engagement. The current study aims to investigate the interaction between text and visual elements in scientific articles, with the goal of providing insights into effective practices for integrating multimodal features. By exploring the interplay between different modes, this research will contribute to the existing body of literature on multimodality in academic writing, offering guidance for authors on how to optimize their use of visual and textual elements to improve the readability and impact of their work.

The primary aim of this research is to investigate the interaction between text and visual modes in scientific articles. Specifically, the study seeks to understand how visual elements, such as graphs, tables, and images, complement and extend the textual content, contributing to the overall meaning-making process. The research aims to explore the role of visual modes in enhancing reader comprehension, reducing cognitive load, and improving the rhetorical effectiveness of academic writing.

B. Research Questions

1. How are the text elements and visual modes related to strengthen the clarity of the message in selected scientific articles?
2. How do the text elements and visual modes affect readers' comprehension based on multimodality theory?

C. The Objectives of the Research

1. To analyze how the text elements and visual modes are related to strengthen the clarity of the message in selected scientific articles.
2. To examine how the text elements and visual modes affect readers' comprehension based on multimodality theory.

D. The Significance of the Study

1. Theoretical

a. Students

By improving their academic writing skills and helping them critically analyze and create scientific articles with cohesive text-visual integration.

b. Teachers

By equipping them with tools and frameworks to teach multimodal literacy, enhance feedback quality, and guide students in creating impactful multimodal assignments.

c. Editors and Publishers

By providing guidelines to design articles that enhance reader comprehension.

d. Academic Institutions

By supporting the development of teaching methods that emphasize the importance of multimodality in scientific writing.

2. Practical

a. Students

This study provide students with concrete strategies to enhance the quality of their academic work by integrating both textual and visual ements effectively.

b. Teachers

The study offers applicable pedagogical approaches and instructional resources that can be directly implemented in the classroom. These practices enable more effective guidance in cultivating multimodal literacy, thereby improving student engagement, comprehension, and performance in academic writing.

c. Editors and Publishers

Editors and publishers benefit from practical guidelines derived from the study that support the development of more coherent and reader-friendly academic texts.

d. Academic Institutions

At the institutional level, the study provides a basis for designing academic policies and training initiatives that integrate multimodal approaches into curricula.

E. Scope and Limitations

This study focuses specifically on static visual elements, such as graphs, tables, charts, and images, in published scientific articles. It does not consider dynamic or interactive visual forms, which are increasingly common in digital publications. Additionally, the analysis is limited to a selected sample of articles across disciplines, chosen to provide a diverse

yet manageable dataset for qualitative analysis. While these limitations narrow the scope, they also ensure the study's feasibility and depth.

CHAPTER II

LITERATURE REVIEW

A. Previous Related Studies

This section presents a summary of relevant studies, focusing on their methodologies, findings, and contributions to the field. The table below provides an overview of these studies, highlighting their theoretical foundations and key insights.

Table 2.1 Previous Studies

Author (Year)	Title	Methods	Results	Conclusion
Lirola (2006)	*A Critical Analysis of the Image of Immigrants in Multimodal Texts*	Systemic Functional Linguistics (SFL) and visual grammar analysis of multimodal texts in newspapers.	Identified biased linguistic and visual elements that portrayed immigrants negatively. Media texts positioned readers to perceive immigrants in a stereotypical manner.	Multimodal texts reinforce dominant ideologies and shape public perceptions through language and visuals.
Fitriana & Wirza (2021)	*An Analysis of Multimodal Texts in Indonesian EFL Textbooks*	Multimodal framework combining Halliday's SFL and Kress &	Found that textbooks used a dominant relational process (42%)	Visual elements assist students' comprehensio n, but

		Van Leeuwen's Grammar of Visual Design.	and a material process (22%) in text. The images often failed to fully align with pedagogical goals, leading to potential confusion.	textbooks need improvements in color and size for better multimodal learning.
Tyrer (2021)	*The Voice, Text, and the Visual as Semiotic Companions: An Analysis of Multimodal Screen Feedback*	Semiotic analysis using "Inquiry Graphics" to examine digital feedback on student assignments.	Multimodal screen feedback (text, visuals, voice) improved student engagement and comprehension. Students struggled to recognize fine details in multimodal elements without explicit focus.	Integrating multimodal feedback practices in education can enhance student learning and assessment communication.
Jewitt et al. (2001)	*Exploring Learning Through Visual, Actional and Linguistic Communication: The Multimodal Environment of a Science Classroom*	Classroom-based multimodal analysis of learning using speech, action, and image.	Learning involved multimodal processes where students transformed information across different modes. The study highlighted the role of gestures,	Learning requires multiple semiotic resources, and education should integrate visual, actional, and linguistic elements.

			visuals, and spoken explanations.	
Serafini (2010)	*Reading Multimodal Texts: Perceptual, Structural and Ideological Perspectives*	Multimodal framework analyzing perceptual, structural, and ideological elements in picture books.	Found that readers required broader interpretive strategies beyond traditional reading methods. Readers engaged with texts through both visual and textual cues.	Visual literacy is crucial for contemporary text comprehension, requiring new interpretive strategies.
Pantaleo (2012)	*Meaning-Making with Colour in Multimodal Texts: An 11-Year-Old Student's Purposeful Doing*	Case study analyzing an 11-year-old student's use of color in multimodal text creation.	Identified that color was purposefully used to convey emotions and meaning in student-created texts. Strategic use of color enhanced narrative impact.	Teaching visual elements like color enhances students' ability to create and interpret multimodal texts effectively.
Colton et al. (2023)	*Readers Matter: Seven Transactions with the Visual, Linguistic, and Material Elements in a Picture Book*	Reader response theory applied to a picture book, analyzing visual, linguistic,	Found that readers' interpretations varied significantly based on personal experiences. Different	Supports the idea that multimodal reading is interactive and influenced by readers' backgrounds.

		and material elements.	readers focused on different multimodal elements.	
Nur Izzati Abdullah et al. (2020)	*Elements of Multimodality in Cartoon through Linguistic Mode and Visual Mode*	Analysis of cartoons using Multimodal Discourse Analysis (MDA) and SFL.	Found that linguistic text enhanced the meaning of visuals by providing context. Visuals alone were often ambiguous without supporting text.	Cartoon-based multimodal analysis can improve education and social awareness.
Ghoushchi et al. (2020)	*A Multimodal Discourse Analysis of Pictures in ELT Textbooks: Modes of Communication in Focus*	Multimodal Discourse Analysis of EFL textbook images using Kress & Van Leeuwen's visual grammar.	Identified a mismatch between images and pedagogical goals, with visuals failing to align with language instruction. Suggested need for cultural representation in visuals.	Recommended improving multimodal resource selection to better support L2 learning and align with pedagogical objectives.
Budi Hermawan (2013)	*Multimodality: Menafsir Verbal, Membaca Gambar, dan Memahami Teks*	Systemic Functional Linguistics (SFL) and image analysis.	Found that text and image must be analyzed together for a full interpretation of meaning. Identified	Multimodal analysis improves understanding of how text and images interact to convey meaning.

			intersemiotic relationships between verbal and visual elements.	
Julianingsi (2023)	*A Multimodal Discourse Analysis of Text and Images Interplay in the 2021 Cinderella Movie*	Multimodal Discourse Analysis (MDA) using Kress & Van Leeuwen's (2006) theory and Halliday's (2013) Systemic Functional Linguistics (SFL).	Identified how text and images in *Cinderella 2021* interact to convey interpersonal and interactive meanings. Found that camera angles, gaze, and text-image relations shaped viewer perception.	Multimodal elements in film enhance narrative interpretation, offering deeper insights into social and cultural themes.

The reviewed studies collectively explore the role of multimodal discourse analysis in various domains, including education, media, literature, and film. These studies employ different theoretical frameworks, with the most common being Systemic Functional Linguistics (SFL) by Halliday and Matthiessen (2013) and the visual grammar approach by Kress and Van Leeuwen (2006). The studies focus on understanding the interaction between multiple semiotic modes, such as text, images, color, and gestures, and how they contribute to meaning-making.

Most of the studies analyze multimodal texts within specific contexts, such as educational materials (Fitriana & Wirza, 2021; Ghoushchi et al., 2020), classroom interactions (Jewitt et al., 2001), media portrayals (Lirola, 2006), and literature (Serafini, 2010; Pantaleo, 2012; Colton et al., 2023). Additionally, some research investigates multimodal discourse in films (Julianingsi, 2023), cartoons (Abdullah et al., 2020), and digital communication (Tyrer, 2021). These studies highlight the increasing importance of multimodal literacy in both academic and real-world applications.

A recurring theme among these studies is the crucial role of multimodal elements in shaping meaning. Research on educational materials (Fitriana & Wirza, 2021; Ghoushchi et al., 2020) found that images often fail to align with pedagogical goals, potentially leading to misunderstandings among learners. Studies in classroom interactions (Jewitt et al., 2001) emphasized that learning is a multimodal process, where students use speech, gestures, and visuals to construct knowledge.

In the media and literature context, Lirola (2006) demonstrated how multimodal texts in newspapers reinforce biased ideologies, while Serafini (2010) and Pantaleo (2012) revealed the need for broader interpretive strategies to decode multimodal texts effectively. Research on film and digital (Julianingsi, 2023; Tyrer, 2021) highlighted how text, image, and sound

interact to create meaning, with particular emphasis on how camera angles, gaze, and typography influence audience interpretation.

While these studies provide valuable insights, several gaps remain, which justify the need for the present research. While multimodal discourse analysis has been applied to education, literature, and media, very few studies have explored its role in scientific communication. Scientific articles rely heavily on both textual and visual elements (graphs, charts, figures), yet their interaction remains underexplored. Most existing research on multimodal analysis is qualitative, focusing on interpretations rather than measurable impacts. The present study aims to bridge this gap by providing systematic insights into how text and visual elements function together in scientific discourse.

By addressing these gaps, this research contributes to a deeper understanding of how scientific knowledge is conveyed through multimodal elements and offers practical implications for academic writing, research dissemination, and scholarly communication.

B. Theoretical Background

1. Multimodality Theory

Multimodality theory is a framework within the field of semiotics that stigates how multiple modes of communication interact to create and

convey meaning. Rooted in the idea that communication is not limited to verbal language alone, this theory recognizes the importance of other modes, such as visuals, spatial arrangements, gestures, and sound, in shaping human understanding. Scholars in this field argue that meaning is co-constructed through these diverse semiotic resources, each contributing unique affordances to the communicative act.

As modern communication increasingly relies on visual and multimedia elements, the application of multimodality theory has grown in relevance. Scientific articles, which are traditionally text-heavy, now frequently incorporate visual elements like charts, tables, and diagrams. These additions reflect an implicit acknowledgment of the power of multimodal representation in enhancing comprehension, but their integration and interaction with textual elements are seldom analyzed systematically.

Multimodality theory, as articulated by Kress and van Leeuwen, (2001) posits that communication is not limited to linguistic modes but instead encompasses multiple semiotic resources, such as visual, spatial, and gestural modes. Kress & van Leeuwen (2001), posits that communication is not limited to linguistic modes but instead encompasses multiple semiotic resources, such as visual, spatial, and gestural modes. ss and van Leeuwen argue that meaning is constructed through the

integration of these modes, each contributing unique affordances to the communication process. In the context of academic writing, multimodality refers to how visual and textual elements work in tandem to construct meaning. argue that meaning is constructed through the integration of these modes, each contributing unique affordances to the communication process. In academic writing, multimodality refers to how visual and textual elements work together to construct meaning. According to Kress (2010), different modes emphasize different aspects of content, which can significantly enhance reader comprehension.

According to Kress (2010), different modes are used to emphasize different aspects of the communicated content, which can significantly enhance the reader's understanding. The theory of multimodality provides a framework for analyzing how text, visuals, and other elements are combined in academic scientific articles to create a more cohesive and effective presentation of information. Kress and van Leeuwen (2006) also emphasize that visual modes are not simply supplementary but are integral to the meaning-making process, functioning alongside text to convey complex ideas and relationships. For example, visual representations, such as diagrams and charts, offer an alternative but complementary way to understand information that may be challenging to articulate purely ugh text.

a. Principles of Multimodality Theory

1) Modes and Semiotic Resources

Modes are fundamental to multimodality theory, representing socially and culturally shaped semiotic resources used for communication and meaning-making. According to Kress (2010), modes function as systems of representation, enabling individuals to express and interpret ideas through various means. These systems are shaped by social conventions and cultural practices, influencing how information is structured and conveyed. Common modes include linguistic (text), visual (images, diagrams), auditory (sound), gestural (body language), and spatial (arrangement).

a) Affordances of Modes

Each mode has unique affordances, or specific capabilities, that determine how it can be used effectively in communication. These affordances are tied to the physical, social, and cultural characteristics of the mode. Scholars such as Jewitt (2009) and O'Halloran (2011) emphasize that understanding these affordances is essential for analyzing multimodal texts.

b) Text (Linguistic Mode)

Text is often linear and precise, making it ideal for conveying detailed information, building arguments, and explaining abstract

concepts. In scientific articles, text functions as the primary vehicle for argumentation, often structured into sections such as introduction, methods, results, and discussion (IMRAD). The linguistic mode's strength lies in its capacity for elaboration and logical sequencing, which is crucial for scientific discourse.

c) Visuals (Visual Mode)

Visuals offer a holistic and immediate representation of information, making them particularly effective for summarizing data, illustrating relationships, and highlighting patterns. Diagrams, charts, and images allow readers to grasp complex concepts quickly, complementing the detailed explanations provided by text. According to Tufte (2001), the visual mode’s ability to reveal patterns and trends in data makes it indispensable in fields such as science and engineering.

d) Spatial Arrangements (Spatial Mode)

The layout and organization of content on a page, often referred to as the spatial mode, influence how readers navigate and understand information. In scientific articles, elements such as headings, subheadings, and whitespace guide readers through the text, ensuring logical flow and accessibility. Bezemer and Kress (2008) argue that spatial arrangements are critical in multimodal documents, as they dictate the relationships between text and visuals.

b. Relationship Between Text and Visuals

Hyland (2009) discusses the strategic use of visuals in conjunction with textual content, emphasizing their role in strengthening arguments and facilitating understanding. Visuals and text often work in tandem to create a cohesive narrative, with visuals simplifying or elaborating on information that might be challenging to convey through text alone. The interplay between these elements is crucial for effective communication, particularly in disciplines that rely heavily on data presentation.

Jewitt (2009) extends the discussion of multimodality by highlighting the importance of understanding the affordances of different semiotic modes. Affordances refer to the possibilities and limitations that each mode provides for communication. For instance, while text is well-suited for detailed explanations, visuals can effectively depict spatial relationships or trends. Jewitt argues that a comprehensive analysis of multimodal texts must consider the specific contributions of each mode to the overall communicative goal. This perspective underscores the importance of understanding how different modes interact to create a richer, more nuanced representation of information.

c. Affordances of Multimodal Elements

Jewitt (2009) introduces the concept of affordances in multimodal munication, referring to the possibilities and limitations that each mode

provides. Text is well-suited for detailed explanations, while visuals are effective in depicting trends and spatial relationships. Understanding the affordances of different modes is essential for optimizing their use in academic writing.

Bezemer and Kress (2008) also contribute to the understanding of multimodality by exploring how the shift from print to digital media has transformed the use of different modes in communication. They argue that digital environments offer new opportunities for integrating visual and textual elements, allowing for more dynamic and interactive forms of meaning-making. This shift has significant implications for academic writing, as digital publications increasingly incorporate interactive visuals, hyperlinks, and multimedia elements to engage readers and convey information more effectively. The evolving nature of multimodal communication in digital contexts highlights the need for ongoing research into how these changes affect the construction and interpretation of academic texts.

2. Multimodal Communication in Digital Contexts

Bezemer and Kress (2008) explore how digital media have transformed multimodal communication by offering new opportunities for integrating textual and visual elements. Digital platforms allow for dynamic interactive visuals, which can enhance reader engagement and

understanding. This evolution necessitates ongoing research into how digital contexts influence the construction and interpretation of academic texts.

Lemke (1998) provides further insights into the role of multimodality in scientific communication. He argues that scientific discourse often relies on a combination of text, visuals, and mathematical symbols to construct complex explanations. Lemke's work emphasizes that each mode contributes a distinct type of meaning, and it is the interplay between these modes that allows for the effective communication of scientific concepts. For instance, mathematical symbols can provide precise quantitative information, while visuals can illustrate relationships or processes, and text can offer interpretive context. This multimodal approach is essential for conveying the full complexity of scientific knowledge.

3. Multimodality in Scientific Communication

Lemke (1998) highlights the use of multiple modes text, visuals, and mathematical symbols in scientific communication to convey complex ideas. Each mode offers distinct affordances, and their combination is essential for effectively communicating scientific knowledge. Visuals can illustrate processes and relationships, while mathematical symbols provide precise information, and text offers interpretive context.

Bateman (2008) introduces the concept of genre and multimodality, which examines how different genres of academic writing make use of

multimodal elements. Bateman argues that the conventions of a particular genre influence the ways in which text and visuals are integrated. For example, in research articles, visuals are often used to present data and support arguments, whereas in review articles, they may be used more to summarize and synthesize information. Understanding the genre-specific use of multimodal elements is crucial for analyzing how academic authors make strategic choices about the integration of different modes to fulfill their communicative objectives.

4. Genre and Multimodality

Bateman (2008) examines how the conventions of different academic genres influence the use of multimodal elements. In research articles, visuals are typically used to present data, whereas in review articles, they are more likely to synthesize information. Understanding the genre-specific use of multimodal elements helps in analyzing the strategic choices authors make.

The multimodal approach allows researchers to examine how the interaction between text and visual elements facilitates or impedes the reader's comprehension, offering valuable insights into the design and effectiveness of scholarly communication. This theory emphasizes that no single mode is inherently more important than the others; instead, it is the play between these modes that determines the overall meaning-

making process. Kress and van Leeuwen's framework is particularly useful for analyzing how authors make strategic choices about integrating different modes to fulfill their communicative objectives, thereby enhancing the rhetorical and persuasive aspects of their work. Ultimately, the effectiveness of multimodal communication in academic writing depends on the thoughtful design and integration of these elements, taking into account their affordances and the specific needs of the audience.

C. Conceptual Framework

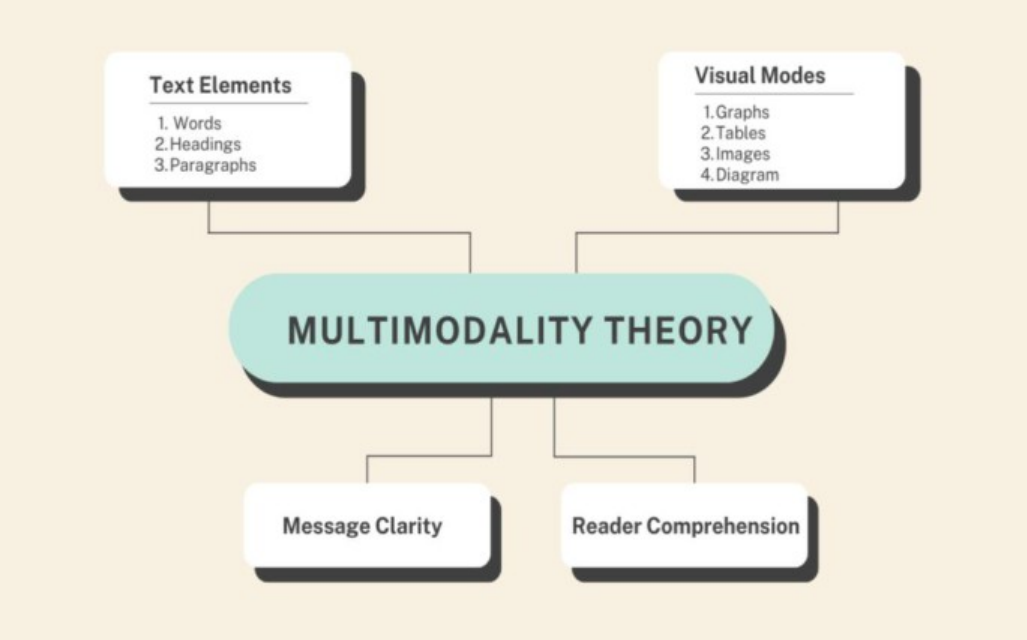

Figure 1. Conceptual Framework

This conceptual framework explained how textual and visual elements work together in scientific articles to improve clarity and reader prehension. The input include textual elements (words, headings,

paragraphs) and visual elements (graphs, tables, images, Diagram). These components provided information in different ways to enhance understanding.

The process guided by multimodality theory, which explain how text and visuals interact to create meaning. Proper integration of these elements made complex information easier to understand. The output improved the message clarity and better reader comprehension. When text and visuals are effectively combined, scientific articles became more engaging, structured, and accessible.