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Intersemiotic Relations between Verbal and Visual Elements in Engineering Students' Final Project Reports: A Lesson of Academic Writing Courses

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Abstract

The integration of verbal and visual resources is critical for explaining technical information in engineering academic writing. While earlier research has looked extensively into intersemiotic relationships in textbooks, classroom materials, and scientific texts, limited attention has been paid on engineering students' final project reports. This study investigates the intersemiotic relationships between verbal and visual elements in final project reports written by engineering students. The study used a qualitative content analysis design and examined 20 final project reports from four engineering programs: Road and Bridge Design Engineering, Mechanical Design and Construction Engineering, Refrigeration and Air Conditioning Engineering, and Power Plant Engineering. Halliday's logico-semantic linkages and Martinec and Salway's intersemiotic framework served as foundations for the investigation. The results revealed two intersemiotic categories: elaboration (90.08%) and enhancement (9.92%), with no instances of extension observed. Clarification was the most frequent subtype of elaboration (74.09%), followed by exposition (9.18%) and exemplification (6.82%). Within enhancement, manner accounted for 81.25% of the occurrences, while spatial relations accounted for 18.75%. The high level of clarification suggests that engineering students rely largely on visual resources to clarify and reinforce technical concepts, procedures, and systems that are difficult to describe verbally. These findings indicate that engineering academic writing is essentially multimodal, with visual resources serving as primary meaning-making tools rather than supplemental illustrations. The study contributes to intersemiotic research by expanding its application to authentic engineering academic writing.

Keywords: Intersemiotic; Multimodality; Engineering academic writing; Verbal-visual relations; Multimodal literacy

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INTRODUCTION

Engineering professionals communicate disciplinary through a combination of written language, diagrams, technical drawings, pictures, charts, and other visual representations to express their knowledge. As engineering information gets more complicated, the ability to successfully integrate verbal and visual resources has become an important aspect of academic and professional communication. Contemporary research has shown that multimodal texts help in knowledge construction by allowing information to be distributed across multiple semiotic modes, reducing cognitive load and improving comprehension of complex concepts (Jewitt et al., 2025; Kress & van Leeuwen, 2020; Unsworth et al., 2022).

Intersemiosis in multimodal communication refers to the semantic relation between various semiotic modalities that work together to create meaning. Rather than acting independently, verbal and visual resources work together to develop integrated meanings that neither mode could achieve alone (Martinec & Salway, 2005; Royce, 2013). Lim (2004) further argues that meaning in multimodal texts emerges through the integration of multiple semiotic resources rather than through individual modes operating independently. This perspective reinforces the importance of examining how verbal and visual elements interact to construct disciplinary knowledge because scientific concepts are not single entities (Bezemer & Kress, 2020) but scientific concepts are semiotic hybrids (Carrió-pastor, 2021). Intersemiosis, from a Systemic Functional perspective, refers to the process by which meanings are distributed, reinforced, enlarged, or complimented across semiotic resources. Such interactions are especially crucial in academic discourse, where complicated knowledge frequently requires both linguistic and visual representation to be properly communicated.

The significance of intersemiosis is particularly obvious in engineering education. Engineering students commonly create academic writings that include schematics, pictures, process graphics, maps, technical drawings, tables, and graphs. These visual resources not only enhance the text, but also serve as important meaning-making tools, explaining processes, demonstrating systems, illustrating structures, and communicating technical discoveries. In addition, Aridasarie & Rohmah (2024) argue that students need explicit guidance in integrating multiple semiotic resources for effective communication. Previous research has shown that efficient visual-verbal integration increases understanding, promotes disciplinary literacy, and facilitates the sharing of scientific and technical knowledge (Bateman et al., 2018; Danielsson & Selander, 2021; Airey & Linder, 2017).

Recent studies on intersemiosis and multimodal communication can be grouped into three major themes. The first theme is about how multimodal resources may help people make meaning of things and understand concepts. According to Ayik & Costu (2021), the density and layout of multimodal materials have a substantial impact on students' understanding of scientific concepts. Similarly, Wanselin et al., (2022) showed that multimodal representations help students understand by allowing information to be shared across many semiotic resources. More recently, Rahmanu & Molnár (2024) found that multimodal learning environments improve student engagement and comprehension in higher education settings. Collectively, these findings indicate that verbal and visual resources collaborate to help knowledge construction. Futhermore, using the SF-MDA method, Fernández-Fontecha et al., (2019) examined scientific sketchnotes and discovered that visual thinking facilitates the resemiotization of abstract scientific notions. In order to make complex ideas easier for readers who are not experts to understand, they are converted into simpler visual representations.

The second theme examines the use of visual resources in describing and clarifying discipline knowledge. Nur'graha et al., (2020) discovered that graphics in science textbooks typically serve analytical purposes by categorizing and explaining scientific occurrences. According to Alyousef (2021) diagrams, labels, and other graphical tools help to maintain textual continuity by supplementing verbal explanations in biology literature. Similarly, Sugianto (2021) demonstrated that visual and linguistic elements work together to realize conceptual concepts in science textbooks. These findings suggest that visual representations are vital for explaining difficult material and facilitating disciplinary communication. Moreover, By showing that the usage of multimodal representations in science learning is always connected to certain scientific genres, Tang & Park (2022) extend the idea of multimodal meaning-making in science education. They discovered that when writing information reports, experimental narratives, and scientific explanations, students employ varied combinations of text, symbols, and visuals.

The third theme looks at multimodal communication in scientific and technological situations. Florek & Hendges (2023) discovered that scientific discourse primarily depends on visual resources, especially in the methods and results sections, where graphs, diagrams, and pictures explain empirical findings. Danielsson & Selander (2021) also suggested that disciplinary learning in science and technology is dependent on students' abilities to comprehend and produce multimodal texts. These studies emphasize the significance of multimodal communication in technical and scientific knowledge creation.

Recent developments in intersemiotic theory have emphasized the need for empirical investigations across diverse disciplinary contexts, particularly in academic and professional communication settings (Nguyen, 2024). Despite this growing interest, engineering students' final project reports remain underexplored. This constraint is significant because engineering reports constitute true disciplinary communication in which students must utilize both verbal and visual resources to convey specialized technical knowledge.

To fill this gap, the current study explores the intersemiotic relationships between verbal and visual features in engineering students' final project presentations. Using the intersemiotic paradigm developed by Martinec & Salway (2005), this study investigates the types and frequencies of intersemiotic interactions used by students when delivering technical information. The study seeks to answer the following research questions: What types of intersemiotic relations occur between verbal and visual elements in engineering students' final project reports? How are elaboration, extension, and enhancement realized in the intersemiotic relations found in the reports? And what do the identified intersemiotic patterns reveal about multimodal meaning-making in engineering academic writing?

METHOD

Research Design

This study employed a qualitative content analyis to investigate relation between verbal and visual elements in engineering students' final project reports. Qualitiative content analysis was selected because it enables to examine how meaing is constructed therought the interaction of different semiotic resources within naturallly occuring text (Creswell & Creswell, 2017).

Data Sources and Collection

The data consisted 20 final project reports produced by applied undergraduate vocational students from engineering programs at public polytechnic in Bandung, Indonesia. The engineering programs were carefully chosen to ensure diversity in discipline content and visual communication approaches. Although all programs belong to the engineering area, each discipline uses various forms of visual representation to communicate technical information. The selected programs included Road and Bridge Design Engineering, which emphasizes spatial and geographical; Mechanical Design and Construction Engineering, which focuses on machine structures and technical designs; Refrigeration and Air Conditioning Engineering, which utilizes system and component diagrams; and Power Plant Engineering, which requently employs process-flow and operational schematics. All reports were completed in 2021 and selected through purposive sampling (Fraenkel et al., 2012). The selection criteria included: (1) the report contained both verbal and visual elements; (2) the report represent engineering disciplinaty writing; (3) the report was accessible in completed digital format of analysis.

Each verbal-visual pair found in the reports served as the unit of analysis. A verbal-visual pair is a combination of language and a visual element, such as images, diagrams, technical drawings, charts, maps, or process illustrations. All identifiable verbal-visual pairs from the selected reports were evaluated. The analysis was based on Halliday et al., (2014) concept of logico-semantic relations and Martinec & Salway (2005) intersemiotic framework. Following Martinec and Salway, intersemiotic connections were divided into three major expansion categories: elaboration, extension, and enhancement. Elaboration happens when a visual restates, clarifies, or illustrates information offered in a spoken text. Extension happens when a graphic provides additional information that is linked but not identical to the verbal text. Enhancement happens when a sight conveys situational meanings such as method, time, cause, condition, or location.

Data Analysis

The analysis proceeded in four steps. First, all verbal and visual aspects from the reports were identified and retrieved. Second, each verbal-visual pair was analyzed to see if an intersemiotic relationship existed. Third, the identified relations were divided into three categories: elaboration, extension, and enhancement, and then coded into subcategories. Finally, the frequency and distribution of each category were calculated and evaluated to determine the prevalent intersemiotic patterns in the data set. Table 1 presents the operational definitions used in coding the expansion categories.

Table 1. Expansion Categories

No	Expansion categories	Indicators
1	Elaboration	The visual restates, exemplifies, classifies, or clarifies information presented in the verbal text.
2	Enhancement	The visual provides circumstantial meanings such as manner, location, time, cause, or condition.
3	Extension	The visual contributes additional information beyond what is explicitly expressed in the verbal text.

Table 2 presents the coding scheme for the expansion subcategories adapted from Martinec & Salway (2005).

Table 2. Subcategories of Expansion

Categories	Subcategories	Indicator
Elaboration	Exemplification	The image functions as an example of the verbal text.
	Exposition	The image restates information presented in the verbal text.
	Clarification	The image provides details necessary for understanding the verbal explanation.
Enhancement	Manner	The image illustrates how a process occurs.
	Temporal	The image indicates time sequence or duration.
	Spatial	The image indicates location or spatial arrangement.
	Causal	The image shows cause-effect relationships.
	Conditional	The image indicates conditions or possible outcomes.
Extension	Addition	The image contributes additional information.
	Variation	The image presents contrast or opposition.
	Alternation	The image presents alternative possibilities.

To improve analytical dependability, the coding method was iterative. The researchers checked the verbal-visual pairs and coding decisions several times to ensure that the theoretical framework and data interpretation were consistent. Disputes were settled by conversation until a consensus was established. Ethical considerations were taken into account during the investigation. The final project reports were obtained with permission from the head of the library since the researchers asked the data from that unit and used only for research purposes. In order to protect students' privacy, all personal information, including their names, identification numbers, supervisors' names, and other identifying information, was anonymized during data collection and analysis. The study focused solely on the linguistic and visual parts of the reports and did not assess individual student performance. All data were securely maintained and analyzed in compliance with institutional research ethical procedures.

RESULTS AND DISCUSSION

This study identified two major intersemiotic relations (see Figure 1) in engineering students’ final project reports, namely elaboration (90.08%) and enhancement (9.92%). No instances of extension were found in the analyzed reports. The redominance of elaboration indicates that visuals resources are primarily used to to expand upon, clarify, and restate technical information presented in verbal text. The finding reveals that engineering students construct disciplanaty knowledge through the integration between verbal and visual modes.

This research implies that engineering students use visual resources to clarify, reinforce, or enhance knowledge previously offered in verbal text, instead of trying to introduce independent complementary information. The lack of extension may reflect the technical and explanatory nature of engineering academic writing, in which visual and verbal parts must retain a high level of semantic coherence. This pattern suggests that students prefer to use pictures as intrinsic explanatory resources rather than as standalone sources of additional meaning.

The finding is consistent with prior research emphasizing the role of multimodal resources in knowledge creation. According to Ayik & Costu (2021), the density and layout of multimodal materials have a substantial impact on students' understanding of scientific concepts. Similarly, Wanselin et al., (2022) discovered that multimodal representations aid meaning-making by disseminating information across complementing semiotic resources. The current study builds on previous findings by establishing that elaboration is the dominating intersemiotic approach in engineering students' final project reports.

Elaboration

To provide a more detailed analysis, the study further examined the elaboration subcategories: exemplification, exposition, and clarification. These subcategories elucidate how visuals enhance the clarity of the accompanying text. Findings showed that clarification is the most prevalent subcategory, constituting 74.09% of the elaboration instances, followed by exposition at 9.18% and exemplification at 6.82%.

Elaboration-Clarification

Clarification involves using visuals to reinforce and expand on the textual content, often addressing areas where text alone may be insufficient. This indicates that students frequently rely on visuals to provide comprehensive explanations of complex information. This dominance indicates that engineering students construct technical knowledge primarily through explanatory visual-verbal integration. Roehrich (2016) supported this observation by highlighting that clarification through visuals reflects an author's recognition of the limitations of textual explanations and the need for alternative modes of communication—such as an image—to convey specific scientific concepts effectively. The dominance of clarification (74.09%) indicates that students usually believe verbal explanations are insufficient for expressing technical concepts. Engineering knowledge frequently includes structures, procedures, processes, and spatial linkages that are difficult to convey only through language. As a result, students rely on visual representations to connect the communication gap.

An illustrative example of the clarification subcategory was seen in a final project report from the Road and Bridge Design Engineering study program. In this report, the student aimed to describe plant heights, stating in the text, *Tinggi tanaman dibedakan menjadi tiga, yang dapat dilihat pada Gambar 6 di bawah ini*. (Plant height can be divided into three, as shown in Figure 6 below). However, the textual explanation lacked detailed information about the plant heights, relying instead on the visual to convey the necessary distinctions. This use of visual clarification underscores how students often utilize images to supplement and enhance the verbal description, providing a clearer understanding of complex concepts.

An additional example from a Mechanical Design and Construction Engineering student's final project report illustrates the use of visuals for clarification. In this report, the student provided a general description of a soft capsule encapsulation machine, outlining its basic functions without detailed elaboration. To supplement this explanation, the student included a visual representation of the machine. This visual aids in bridging the gap between the textual description and a more comprehensive understanding of the machine's components and operation. The visual effectively supports the verbal description by offering a clear depiction of the machine, thus enhancing the reader's grasp of the technical details. The extract from the data further underscores how visuals are utilized to clarify and complement written explanations.

The soft capsule encapsulation machine, or softgel machine, is an electromechanical device designed to fill tightly sealed soft shells (which are single-piece units) with semi-solid, liquid, or suspension materials. This machine is widely used in the pharmaceutical industry for producing softgel capsules containing medications, supplements, and multivitamins. Specifically, the process involves creating a gel sheet that is cooled by a cooled drum. This gel sheet is then molded using a roller die while liquid is injected through a wedge, with the liquid being pushed by a product pump. The soft capsule encapsulation machine operates through three main coordinated mechanisms: sheet formation, molding, and liquid injection.

This finding aligns with the findings of Nur'graha et al., (2020), who discovered that graphics in science textbooks typically serve analytical roles such as identifying and describing scientific phenomena. Similarly, Alyousef (2021) found that diagrams, labels, and graphical resources improve textual cohesiveness by enhancing the link between verbal and visual information. Sugianto (2021)also proved that visual and verbal modes work together to convey ideational meanings in science literature. The current study strengthens these findings by demonstrating that clarification is the major intersemiotic interaction in engineering students' academic writing. Additionally, This finding supports Danielsson & Selander (2021) argument that disciplinary learning in science and technology depends heavily on the ability to interpret and produce multimodal texts. Similar findings were reported by Wanselin et al., (2022), who found that visual representations play a crucial role in supporting learners' understanding of disciplinary concepts by clarifying and reinforcing verbal explanations.

Unlike previous studies that focused primarily on science textbooks and instructional materials, the present study demonstrates that clarification also dominates authentic engineering students' academic writing. This finding suggests that explanatory visual-verbal integration remains a central feature across different disciplinary genres.

Elaboration-Exposition

The second subcategory of elaboration is exposition, which involves restating information or arguments through visual elements. In this case, the visuals reinforce the content presented in the verbal text by offering an alternative but equivalent representation. This dual-mode presentation provides readers with two complementary pathways to comprehend the same information—through both verbal description and visual depiction. Exposition allows writers to convey the same message in multiple formats, enhancing clarity and reinforcing key points. For instance, in Figure 5, the visual restates the information provided in the text, ensuring that readers can grasp the concept more fully by relying on either modality.

The excavation and demolition debris is transported to a dump truck, and subsequently disposed of in the designated disposal area. Following this, the excavation site is cleaned using a compressor and leveled for further work. Although exposition occurs only 9.18% of the elaboration category, its existence illustrates that students are aware of the importance of reinforcing key information using numerous semiotic modalities. In this interaction, visual and verbal aspects convey essentially the same idea through various representational forms.

The finding supports Kress & van Leeuwen (2020) observation that multimodal texts frequently use multiple semiotic resources to reinforce crucial points. Similarly, Bateman et al., (2018) claimed that the repetition of content across modes improves coherence and accessibility in multimodal publications. In the current study, students employed graphics to complement procedural and technical descriptions, ensuring that readers could comprehend the content even when one mode was less accessible. However, the low frequency of exposition indicates that engineering students prefer to employ visuals to enhance information rather than simply repeat it. This tendency reflects the functional characteristics of technical communication, in which visuals are anticipated to bring extra informational value.

Elaboration-Examplification

The final subcategory identified in this study is exemplification (6.82%). In exemplification, rather than providing an extensive verbal explanation, students present visuals that serve as concrete examples to support their text. This method allows the visual elements to play a central role in conveying information, with the images supplementing or illustrating concepts that are only briefly mentioned in the verbal content.

For instance, in a report from the Mechanical Design and Construction Engineering program, the student refrained from providing a detailed verbal explanation of different capsule types. Instead, the report included visual representations of various soft capsule shapes and sizes, as demonstrated by the excerpt: *Berikut beberapa bentuk dan ukuran kapsul lunak.* (Here are some shapes and sizes of soft capsules). In this case, the visual example effectively complements the text by providing specific, observable details that might be cumbersome to describe solely through written language.

This implies that students often avoid depending entirely on examples to explain technical information. They appreciate visuals that explicitly clarify or explain details. This finding is in line with Jewitt et al., (2025)argument that instances play an essential role in multimodal meaning-making by connecting abstract concepts to observable representations. Similarly, Unsworth et al., (2022) proposed that visual exemplification improves comprehension by making difficult knowledge easier to reach and concrete.

Enhancement

Although enhancement occurs in just 9.92% of total intersemiotic relations, it remains important in enabling the conveyance of procedural and contextual information. Unlike elaboration, enhancement adds meanings that go beyond the information clearly provided in the verbal language. This research implies that engineering students use visuals mostly to reinforce current explanations rather than to convey completely new knowledge. The distinction may reflect disciplinary traditions, as engineering communication often emphasizes precision and consistency across modalities. The findings showed that the category comprises two subcategories: manner (81.25%) and spatial (18.75%).

The finding adds support for Martinec & Salway (2005) approach, which suggests that visuals can enlarge verbal meanings through enhancement relations. This finding is also consistent with Lim (2021), who argues that intersemiotic relations enable meaning to be distributed across different semiotic modes, allowing visual resources to contribute meanings that cannot always be fully expressed through verbal language. In the present study, enhancement relations demonstrate how images provide procedural and contextual information that complements verbal explanations in engineering reports.

Enhancement-Manner

The manner subcategory refers to the relationship where the visual component illustrates "how" the process described in the verbal text unfolds. In other words, the image provides a demonstration or clarification of the procedure mentioned verbally. This form of intersemiosis was identified across all the students' final project reports. For instance, in a Power Plant Engineering report, the student provided a general verbal explanation of the solar power plant's working principle. To enhance understanding, the student included a visual representation of the process, thereby clarifying the verbal description and allowing the reader to more effectively grasp the technical steps involved. This exemplifies the manner subcategory, where the visual element directly supports the procedural details provided in the text.

The Solar Power Plant (PLTS) operates on a relatively simple principle. The solar panel is the primary component in this system. The arrangement of photovoltaic cells within the solar panel plays a critical role as it serves as a collector of solar energy, converting sunlight into electrical energy). The high number of manner within enhancement (81.25%) indicates that engineering students frequently use visuals to illustrate how a process works. This finding is consistent with Florek & Hendges (2023) discovery that scientific language relies extensively on visual resources to communicate methods, procedures, and empirical processes. Similarly, Danielsson & Selander (2021) contended that disciplinary communication in science and technology relies on multimodal representations that make dynamic processes visible and accessible. The finding also resonates with Huang & Xia (2024) who reported that multimodal representations facilitate the communication of complex procedural knowledge by enabling learners and readers to visualize processes and relationships that are difficult to represent through text alone. The engineering reports analyzed in this study employed diagrams and process illustrations to communicate operational procedures and system mechanisms more effectively. Pedagogically, this result shows that engineering students require explicit instruction in creating successful process diagrams and integrating them effectively into written explanations.

Enhancement-Spatial

The second subcategory within the enhancement category is spatial, which refers to visuals or images that depict the physical location of elements mentioned in the verbal text. The spatial subcategory is about 18.75% of enhancement interactions. Although less common than manner, spatial enhancement is critical in transmitting locational and geographical information. Engineering projects frequently entail site-specific conditions, therefore visual representations are essential for effectively portraying spatial relationships. This subcategory was found in final project reports from Road and Bridge Design Engineering, Refrigeration and Air Conditioning Engineering, and Power Plant Engineering. In these reports, students included visuals such as maps or diagrams to clarify the geographic context of their projects. For example, in the Road and Bridge Design Engineering report, the student provided an image to pinpoint the exact locations of BH-1 and BH-2. By incorporating these visuals, the readers gain a clearer understanding of the project’s location, thus reinforcing the accompanying textual explanation.

The distance between points BH-1 and BH-2 is 29 meters. Based on soil testing results, the groundwater table was found at a depth of -6.90 meters at BH-1 and -5.00 meters at BH-2. In addition to the information on the groundwater table, a description of the soil layers at points BH-1 and BH-2 can be made.

This finding contributes to Danielsson & Selander (2021) claim that disciplinary meaning-making frequently relies on visual representations to convey spatial relationships and contextual information. Similarly, Airey & Linder (2017)observed that scientific and technical disciplines frequently use visual resources to communicate knowledge that is difficult to express linguistically. The current study demonstrates that engineering students use visual resources to describe the spatial and environmental features of their projects. Nevertheless, the presence of spatial relations demonstrates that visual resources play a significant role in communicating contextual information within engineering academic writing.

Intersemiotic Patterns and Engineering Academic Writing

The study shows that engineering students construct and communicate discipline knowledge through a systematic integration of verbal and visual forms. The prominence of elaboration, particulary clarification and manner relations emphasizes the importance of visuals in describing technical concepts, procedures, and systems. At the same time, enhancement relations provide procedural and contextual information that helps readers comprehend engineering processes and project contexts.

The result supports previous study that multimodal resources help with knowledge production by trasnfering meaning across different semiotic modes (Ayik & Costu, 2021; Wanselin et al., 2022). The findings are further supported by Rahmanu & Molnár (2024), who concluded that multimodal learning environments enhance comprehension and engagement by integrating multiple semiotic resources. The present study extends this perspective by demonstrating that multimodal integration is not only important for learning processes but also for the production of disciplinary knowledge in engineering academic writing.

Furthermore, this finding is consistent with Lubis & Surip (2024), who argue that intersemiotic complementarity enables visual and verbal resources to contribute distinct yet interconnected meanings within a multimodal text. Visual resources are more than just illustrative decorative elements; they are important meaning-making instruments that convey technical knowledge, procedural information, and discipline notions. Effective engineering communication thus requires not only linguistic proficiency, but also students' strategic integration of verbal and visual resources. The findings also support Zapletalová (2015) observation that effective visual-verbal integration contributes to clearer communication of scientific and technical information.

CONCLUSION

The study focuses on examining the intersemiotic relation between verbal and visual elements in engineering students' final projects. The results reveal that elaboration and enhancement are the two dominant intersemiotic categories employed by students to construct technical meaning. Elaboration appeared as the most common category, especially through clarification, demonstrating that students rely substantially on visual resources to explain, reinforce, and expand technical information delivered in verbal form. Enhancement, although less common, provides additional procedural and spatial information that helps readers grasp technical procedures and project environments.

The high frequency of clarification indicates that technical knowledge is mostly delivered through multimodal representations rather than language alone. Students regularly use diagrams, pictures, technical illustrations, and other visual resources to convey concepts, systems, and processes that would be difficult to express simply through verbal descriptions. More importantly, the identified intersemiotic patterns reveal that engineering academic writing is fundamentally a multimodal knowledge-construction practice. From a theoretical perspective, the study contributes to earlier research on intersemiosis by illustrating how elaboration and enhancement function in engineering students' academic writing. The findings present empirical evidence that the intersemiotic framework remains effective for understanding multimodal meaning-making in technical and vocational environments. The dominance of explanation emphasizes the importance of visuals in facilitating the communication of specialist engineering information.

The findings have substantial pedagogical implications. These findings suggest the importance of incorporating multimodal literacy instruction into engineering education where engineering students should be equipped not only with linguistic competence but also with the ability to design and integrate visual resources effectively in academic and professional communication. Developing multimodal literacy is becoming increasingly crucial in enabling students to communicate complicated technological information in academic and professional contexts. Overall, the findings demontrate that effective engineering academic writing is inherently multimodal. The effective integration of verbal and visual resources allows students to communicate technical information more clearly, accurately, and comprehensively. These findings highlight the significance of incorporating multimodal literacy into engineering education and contribute to a more comprehensive understanding of how disciplinary knowledge is created through intersemiotic connections.

RECOMMENDATION

Several limitations should be highlighted. First, the study focused only on final project reports created by engineering students in a specific educational setting. As a result, the findings may not accurately reflect multimodal practices in other disciplines or institutions. Second, the study concentrated solely on intersemiotic relationships between verbal and visual modes, ignoring other semiotic resources that may contribute to meaning-making in academic texts. Third, the study did not look into students' intents, design decisions, or levels of multimodal literacy, all of which could have an impact on the construction of intersemiotic interactions.

Future studies may extend the analysis to reports and academic texts from a wider range of disciplines, including science, social sciences, and the humanities. Comparative research may demonstrate whether disciplinary knowledge is generated using various multimodal processes. Further research may look into the relationship between students' multimodal literacy and the quality of their academic writing. Classroom-based intervention studies could also look into how explicit instruction in multimodal communication affects students' capacity to successfully combine verbal and visual resources. Such research would help to deepen an understanding of multimodal academic communication and provide useful insights for designing more effective educational methods to academic writing in higher education.

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