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Unfolding Graphic Representation in Science Textbooks at Intermediate Level: A Narratological Appraisal

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ABSTRACT

This study aims to critically analyze science textbooks to refine and improve the content and images of science textbooks. The goal of this research is to use document analysis to assess the reliability produced approximately in textbooks. Selected science textbooks are major instructional resources from which students receive information. The study follows a mixed method approach with a more qualitative part. The systematic comprehension and categorizations of images, illustrations, drawings, pictures and texts are required for a comprehensive study of graphic interpretations. In contemporary science textbooks, graphic illustrations play a significant role in grasping key concepts. This research finds that these resources and strategies of visual image text interpretation of these perspectives, photographs, fine-art drawings, illustrations, and posters have become fundamental teaching tools in science books. Further studies should be conducted on different books and different narratological aspects.

Introduction

As the system of teaching and instruction has progressed, the employment of visual components is now a more prevalent reason. Various visual components may be extracted by one of the graphics. Numerical data graphs are used to help comprehend the connection between the visual components (Yalin, 2006). Prefer to utilize images because spoken data is much clearer and more succinct, and tables are also more impressive (Yigit, 2007). In this method, the reader's attention is drawn to key points in mind, and the significance of the topic is reflected, resulting in a more lasting impression (Ceyhan, & Yiit, 2005). In addition to assisting students in their learning, employing graphics helps students' problem-solving abilities by performing operations on geographic characteristics and comparing them to one another via classifications (Swartz, & Parks, 1994). Because visuals are by far the most effective ways to help kids improve their problem-solving abilities.

Textbooks are essential in the teaching and learning of science. All scientific disciplines attempt to give explanations and explanations for natural events in order to explain the complexity and connection of the natural universe (Gilbert, 2007). As a consequence, science teachers see textbooks as curriculum tools that assist instructors in planning and delivering scientific teaching that is aligned with applicable state-wide curricular requirements. As a result, textbook authors had complete freedom to express nationwide curricula and assessment requirements (Martinez-Gracia, Gil-Quilez, & Osada, 2006).

This research reveals one difficulty in the curriculum that possibly develops alternative ideas about scientific knowledge as the empirical domains is depicted as gathering (assembling or body of people, creatures, or objects) of data rather than evolutionary processes. The second method examines teaching materials as art objects that could impact the representation of curriculum and instruction. Because textbooks represent regional curriculum and cultural identity, they are important. According to this viewpoint, publications are written to communicate societal viewpoints.

Literature Review

Different aspects of quantitative techniques are available: quizzes, criteria, layouts, requirements, score mechanism, procedures, and computer programming of the indicators. When youngsters study scientific knowledge issues, science professors point out that deep comprehension of the concepts is more important than factual memory. As a result, skill and improvement of content-specific educational reinforcement that encourage comprehension among students of various backgrounds, interests, and skills are required. (Caldwell, Koppal, 2004; Koppal, Caldwell, 2004).

The role of visualizations in constructivist learning is recognized in the literature, which not only transmits information but also allows learners to complete their own investigations. The importance of interactive visualizations in learning has been demonstrated in studies, and thus useful graphical design principles should be synthesized. After evaluating two theoretical viewpoints on visual learning, Vekiri (2002) concluded hence the dual coding theory, as well as the pictorial explanations, are acceptable, despite the fact that every concept has its own presupposition.

Images present in School science books and articles manifest pedagogical functions. To conduct an analysis, a grid has been devised for the purpose of analysis. The study selected 2819 images from Science textbooks and 1630. Science textbooks utilised ten times more images as compared to press material. More images exhibit more power and visual learning facility (Dimopoulos, Koulaidis, & Sklaveniti, 2003).

Diagrammatic typology has been exploited to study the narratology of science books taught at middle-level schools in Turkey over the span of fifteen years. In this study, 36 textbooks were selected from 6th to 8th grade. The images were studied by categorizing them into captions, gender representation, icons, augmented reality, charts, tables and graphs (Akcay, & Akacy, 2018).

Textbooks are used to teach language skills as well as for conveying ideas and concepts for learning. In this study, four language and four science books had been

selected and they were taught at Austrian schools. They were divided into five categories: general structural setup, text types, learning goals, activities and text structures. Analysis reveals that reading comprehension ranges from 13.64 to 69.70% (Seifert, 2021).

Theoretical Foundation

Since the late 1970s, conceptual shift approaches to instructional strategies in science have provided a solid basis for research on teaching and learning as well as instructional methodologies (Treagust & Duit, 2008). Over the last thirty years, the focus of brain growth outlooks on constructivist theory has shifted away from Piagetian psychological science, which emphasises process and site capacity is estimated, and toward other paradigms such as Ausubel's integration (Assubel, 1968), Vygotskian viewpoints, and others and others (Vygotsky, 1978). According to Ausubel (1968), the most essential aspect that determines knowledge is what the student has learned, thus teaching should be based on that. In categorizing students' perceptions on explications of their ideas and scientific concepts, Piaget's (1972) thesis emphasizes the interaction of assimilation and accommodation.

Material and Methods

Data for this study were gathered from secondary level science textbooks (Class 10th) in the subjects of chemistry and biology in Sindh Province, Pakistan. Predefined codes and categories are used to gather data. As a result, the diagrams in these textbooks are divided into three categories: iconic, schematic, charts, and graphs. The following is the research procedure: initially, all the visuals in the two scientific textbooks were coded. After that, The total percentage of graphics per unit in books was calculated. The preceding information is useful in comprehending the numerous diagrams included in each book. A "research approach for establishing reproducible and accurate inferences from texts to the settings of their usage" is defined as a comprehensive analysis. This sort of in-depth study is usually done using a mixed method approach or research.

Mixed Method Research

It is a method of inquiry that incorporates both qualitative and quantitative research. It is predicated on philosophical assumptions.

Qualitative Research

Qualitative research is a method of examining and comprehending the significance of a social or human issue to people or groups. Questions and methods are used in the research process, as well as data collection in the participants' environment.

Quantitative Research

The quantitative research approach is used to examine the connection between variables in order to evaluate objective hypotheses. These variables may be quantified, allowing statistical processes to be used to examine large amounts of data.

Research Design

Population of the Study

The area in which the researchers have undertaken the project is the Secondary Science Textbooks.

Sample

The sample of this study is 10th-grade Chemistry and Biology. The images in tenth-grade science textbooks are the subject of this research. The textbooks were chosen by the researchers because they are being utilized for the very first occasion in the province. Furthermore, although researchers have looked at the graphics in textbooks, there are still doubts about whether such textbooks are available in classroom libraries. Secondary grades were chosen as the focus of the study since this is when many pupils confront their first standardized content tests. This focus on testing shows that understanding the cognitive demands of graphics for secondary students is crucial since they are expected to not only absorb but also draw subject knowledge from their textbooks

Research Tool

The study's tool was an analysis sheet (appendix-B) based on Chiappetta et al (1991) .'s framework for determining the character of science based on four topics. The Graphical Analysis grid created by the researchers was used to code and evaluate all graphics in the chosen scientific textbooks. The graphs' shape, function, subject area, quality, representation of graphs, kind, and connection to the text were all examined by the researchers.

Table 1
lists the textbooks that were used in the research.

Books	Type	Pages
Biology	Textbook	184
Chemistry	Textbook	183
Total		367

Data Collection

Data was gathered by filling out the form and analyzing the content of secondary school science textbooks. The visual types and functions were calculated using SPSS Statistics software.

Data Analysis

A coding key was employed to achieve a firm understanding among the investigators for this investigation. For each section in each textbook, the statistics for each subcategory were collated. After that, the data was loaded into an excel spreadsheet, and qualitative data for each parameter were generated. Two experts in scientific education evaluated the grid. Three well-experienced scientific curriculum professionals assisted in the first categorization of the visualizations to improve the confirmability of the analytical technique. The data was then reviewed and re-entered into the spreadsheet's grid for descriptive frequency tables by the main author. On a

computer, the data was analyzed. Following that, data was entered on a sheet using a coding scheme. The results were then analyzed in the table by applying percentages to the data.

Table 2
Graphics included in the study

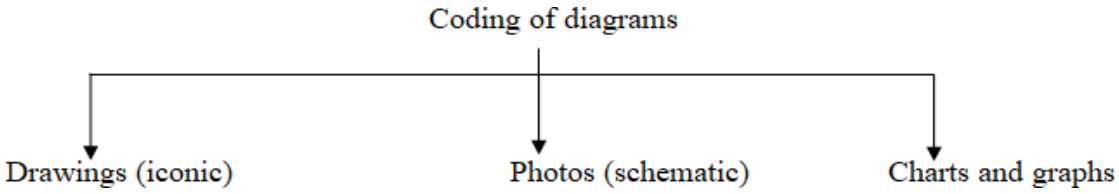
Books	Type	Graphs
Biology	Textbook	205
Chemistry	Textbook	173
Total		342

Table 3
Chapters are included in the textbooks.

Books	Type	Chapters
Biology	Textbook	09
Chemistry	Textbook	08
Total		17

Coding Scheme

The diagram coding technique was developed using Hegarty, Carpenter, and Just's (1991) typology, which categorized diagrams used in scientific instruction Iconic, schematic, charts and graphs are the three categories. In this study, content analysis refers to the systematic categorization and classifying of diagrams, drawings, pictures, charts, and graphs found in Secondary School Science textbooks



Iconic diagrams - These diagrams are useful for assisting pupils in recognizing the physical appearances that are visible to the naked eye.

Schematic drawings - These would be extremely idealized representations of actual life. elements and merely maintain the target information's physical connections.

Graphs and charts - A graph or chart is a graphical representation of data.

Coding Procedure

Different visuals utilized in the textbook were explained by the researchers. Then, for each visual kind and subtype, he produced or suggested instances and definitions. Because he is interested in graphics that were used to convey data. Only pictures in content textbooks may be coded by researchers. Researchers have long regarded captions to be a part of visualizations, and they are frequently employed to codify visual functions. The image was classified as representative with such a connection if the visual and written text both communicated a very similar amount of information however the description provided additional data.

Theoretical Foundations for Using Graphics in Curriculum Guide

The researchers' categorization method is based on two interconnected different theories: the duality programming concept (Sadoski, & Paivio, 2013) as well as the pictorial reasoning assumption (Sadoski, & Paivio, 2013; Larkin, & Simon, 1987). Inside a comprehensive review, Vekiri (2002) used these concepts to discuss the merits of using visuals in education. These ideas are cognitivist in nature, and they are founded on the data processing approach to teaching and learning, which posits that learning is limited by working memory. Thus, according to these theories, contributing visual effects provide memory skills by supplying two alternatives (verbally and non-verbally) for people who read by regionally splitting isolated data onto groupings, hence boosting brain power (Kulhavy et al., 1985; Sadoski, & Paivio, 2013) or by interpreting and retrieving data (Kulhavy et al., 1985; Sadoski & Paivio, 2013). (Larkin, & Simon, 1987). As a result, incorporating visuals into writing might aid with learning outcomes (Hannus, & Hyönä, 1999; Norman, 2010)

Visuals' Main Classes and Functional areas

A successful system for classifying visual kinds should be detailed to gather a wide range of data offered while staying wide enough to be used in a variety of contexts. Researchers have attempted to find a happy medium. Patterns, infographics, mappings, and (system) statistics are all examples of visual representations are four typical sorts of graphics, each with its own set of communication rules, according to Vekiri (2002). Fingeret (2012), on the other hand, presented eight categories of images, there are 58 subcategories in total. Even though Fingeret's categorization seems incorrect, extensive, the absence of specific distinction across subtypes makes replication difficult. Eight kinds were identified by Roberts and colleagues (2013). in relation to Fingeret's work: captioned graphics, diagrams, flowcharts, graphs, panes, maps, tables, and timelines. By offering construct definitions and instances for each type, this effort improved the field.

The researchers have focused on visual function. The five purposes identified by Levin and colleagues (1987) are the most common: a) ornamental, b) representational, c) organizational, d) interpretational, and e) transformative. A decorative visual act as a decorative element but does not contribute to the meaning of the text (e.g., a picture of such a leopard upon that opening of something like a science book). Representational graphics offer concreteness to abstract notions by showing one element of the literal meaning (e.g., a picture of Ellis Island with text discussing European immigration) (Sadoski, & Paivio, 2013). Because students remember structured material better than isolated facts, this organizing function is essential in informative textbooks. Interpretational graphs include two very different representative, as well as operational positions, including elements, however, go above and beyond by displaying data in a way that aids understanding (e.g., an 1860 U.S. map with arrows detailing the troop movement). Mnemonics are used to create transformational pictures, which aim to recode information in a more remembered manner (e.g., an atom depicted in a shape of a pen to provide a mnemonic device for proton, electron, and neutron). Researchers have lately incorporated extensional graphics, which convey relevant information not expressly contained in the text.

How Do Graphics Affect Learning?

Despite overlapping theoretical grounds, previous research on the efficacy of graphics in textbooks has produced conflicting results. Many of the aforementioned research is mostly quantitative and concentrate on students' reading results after examining a graphic, such as how a graph aided understanding. The latest conceptual studies have found the average impact fact on research (Guo, Zhang, McTigue, & Wright, 2017) found that using pictures had a medium beneficial influence on students' reading comprehension.

The sort of reader who benefits from images, on the other hand, is less obvious. An earlier study revealed that pictures enhance low-achieving readers' understanding in diverse ways (Hayes, & Reinking, 1991; Holmes, 1987), the advantage of graphics, according to experts, stems from getting data which wasn't deciphered. According to Holmes (1987), participants did better with a visual text, even though more proficient when analyzing material, users performed better. Other studies disputed those images helped individuals who were less proficient, suggesting that graphics might benefit expert readers differently. Studies of a plausible explanation for gaze have been revealed: The capacity of kids to absorb knowledge in images is restricted, according to Jian (2016), owing to such intellectual cost of dealing with multiple streams. Exceptional scholars, on the other hand, are strategic processors who concentrate on relevant visual portions (Hannus, & Hyönä, 1999; Jian & Ko, 2017). The data suggest whether experienced readers have more advanced techniques for juggling several sources.

Discussion and Directions for Study in the Future

Future research in the domains such as discipline or visual intelligence may benefit from the findings of this study. The findings may help secondary school teachers concentrate visual literacy education on the most prevalent visual forms. Learners are unlikely to increase their knowledge of multimodal material without formal teaching (Peeck, 1993). Furthermore, the rising usage of design with layers of pictures needs extra attention in order to assist pupils in navigating such complicated formats.

Even if most Secondary School instructors employ graphics in their regular education, they seldom teach how to evaluate or create visuals, as previously stated (Coleman et al., 2011). As a result, visual literacy teaching techniques should be incorporated into teacher career progression (Metros, 2008). Teachers may incorporate visual literacy into realistic learning experiences using recognized frameworks (Callow, 2008). Visuals should be taught to students since they frequently include information that isn't found in the text. Less proficient readers, who typically do not develop advanced methods on their own, would most likely benefit from modelling and coaching in these areas (Jian, & Ko, 2017).

Students also need discipline-specific teaching on how to interpret images in many genres in adding to these fundamental concepts. Students' knowledge of three kinds of visuals in Secondary Science textbooks was recently investigated by Roberts and Brugar (2017). Although there was a lot of difference across grades, none of the pupils comprehended all features of these graphical gadgets. Learners can "use this

knowledge as a gateway to understanding the more conceptual purpose of using graphics in courses" (Roberts, & Brugar, 2017, p. 762), but effective utilization requires explicit guidance and mentoring. Because their research is limited to three sorts of images, it would be beneficial to expand their work to include more popular visuals. This research identifies the sorts of graphics that Learners would notice most frequently in scientific and cultural subjects' texts, indicating the door to more investigation.

Since there is concurrent proof showing graphical understanding affects pupils' abilities as learners (Hannus, & Hyönä, 1999; Mayer, & Gallini, 1990; Roberts et al., 2015), few studies consider students' learning from actual texts. In most studies, a single visual is used to accompany a bit of text. This study demonstrates that visualization tools and layouts are becoming more complicated, and studies are needed on how learners deal with similar situations, according to the authors. Furthermore, research on how respect to factors rises through all the grades (including both textbooks of commerce publications) would be especially valuable in understanding the infrastructure that children require to absorb visuals as children progress through school. To fully comprehend the value of captions, further study is required. According to research by Roberts and Brugar (2017), just ten per cent of secondary pupils can properly identify captions.

Finally, research may be conducted using e-books or by examining electronic, especially interactive, images that students experience when reading online; the influence of this format should be examined in future studies. Students exhibited higher understanding following a period of extensive studying on articles instead of on laptop displays, according to Mangen, Walgermo, and Brnnick (2013). One of the reasons they gave is that "the fixity of text written on paper helps reader's building of the spatial context of the text by giving clear and fixed spatial signals for text retention and recall," which is directly linked to visuals (p. 66). This study should be expanded to include graphics in computer-based informative texts in the future.

Conclusion

In today's textbooks, graphic illustrations play an important role. The goal of this research is to use document analysis to assess the reliability produced approximately in textbooks. This research also describes these resources and strategies of visual image text interpretation of these perspectives, photographs, fine-art drawings, illustrations, and posters have become fundamental teaching tools in science books or data presentations. Textbooks are essential in the teaching and learning of science. All science disciplines strive can provide interpretations and interpretations for natural phenomena to describe correlation and the sophistication of the physical world (Gilbert, 2007). As a result, science educators view textbooks as curriculum resources that help teachers plan and deliver science instruction in accordance with relevant and statewide curricular standards. The role of visualizations in constructivist learning is recognized in the literature, which not only transmits information but also allows learners to complete their own investigations. The importance of interactive visualizations in learning has been demonstrated in studies, and thus useful graphical design principles should be synthesized.

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