The Use of Visual Representations for Light and Sound Topics in Science Textbooks: A Cross-Cultural Study

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Abstract. This study compared graphical representations in primary school science textbooks in Turkish and English contexts regarding the light and sound concepts in physics.186 visual representations were analyzed across four textbooks using document analysis methodology. The analysis encompassed graphical types (e.g., iconic, schematic), indexing and captioning of representations, quality (dynamic vs. static), and function of visuals. Results revealed differences between Turkish and English science textbooks, indicating variations in the representation of light and sound topics.

Introduction

Science textbooks use text and graphics to represent content knowledge [1]. While text can help clarify the meaning of knowledge, more is needed to convey complex concepts and abstract principles. Educators use textbooks to design lessons, represent sources of information, and assign problems and exercises related to the topics they teach [2]. Representations refer to the way of communicating ideas, which may be specific to a particular field or more broadly applicable and involve different modes of presentation to visualize concepts or thoughts [3]. Thus, students can actively participate in teaching materials through verbal and visual aids [4]. Research on multiple representations explores the simultaneous use of two or more forms of representation [5, 6]. These representations may be within a single sensory mode, such as visual representations like words, pictures, and symbols, or across multiple sensory modes involving combinations like spoken words and printed images. Specifically, we have analyzed the visual representations used for the physics topics of light and sound, which directly appeal to our senses of seeing and hearing, for comparison. This research aims to compare the utilization of graphic representations in the elementary and secondary science textbooks used in Turkey and England during the academic years 2022-2023. The advantages of studying in multiple countries generate greater variations in variables of interest than studying in only one country [7]. Accordingly, we compared the use of visual representations in Turkish and English textbooks and explored the following research question:

- Do visual representations of light and sound topics in Turkish and English science textbooks differ or resemble each other regarding the graphic type, representation, indexing, captioning, quality, and functionality?

Methods and Findings

This study examined four primary science textbooks that included light and sound topics. Document analysis was used to analyze visual representations in textbooks, primarily aiming to analyze printed materials containing information about the main phenomena or phenomena under investigation [8]. For the analysis, a coding sheet was formed by using the categories identified in previous research studies [9-10]. These are (a) graphic type, (b) indexing, (c) captioning, (d) quality, and (e) function of visuals.

The analysis revealed that iconic visual representations dominate science textbooks for light and sound topics. Turkish textbooks use fewer images for the light concept than sound, while

English textbooks show the opposite. In English textbooks, we observed increased schematic representations (39.5%) at grade level 8 for sound topics compared to light topics (14.3%). Using charts, graphs, and augmented reality was minimal besides iconic and schematic representations in Turkish and English contexts. The percentages referring to visual representations in the text were relatively higher in English textbooks (How we see things: 85.7%, Energy transfer and sound: 81.1%). In Turkish textbooks, we observed that the percentage of using captions for visual representations was quite low for both topics (Propagation of light: 6.6%, Sound and its properties: 9.3%). When the quality of representations is considered, static visual representations are mainly used compared to dynamic ones in all aspects. In other words, the progression of an idea or event was rarely presented in these grade levels independent of the light and sound topics. Moreover, the visual representations are used to decorate and relate them with text. For the light topics, the English textbook related more visuals with text (60.7%), while the Turkish textbook used them to both decorate (53.2%) and relate to text (46.8%). On the other hand, similar trends are observed in Turkish and English textbooks for sound topics.

Conclusion

After analyzing science textbooks on light and sound topics, it is evident that both Turkish and English textbooks use minimal charts, graphs, and augmented reality. English textbooks use more schematic representations, especially for sound topics, while Turkish textbooks rely more on iconic visual representations. Additionally, English textbooks generally show higher percentages of visual representations in text compared to Turkish textbooks. Both contexts favor static visual representations mainly for decorative purposes and text connections. English textbooks are more effective at integrating visuals with text, particularly for light topics. Examining how science textbooks use visual representations and comparing them cross-culturally can help improve student cognition and aid curriculum designers and teachers.

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