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Typology and Cognitive Function of Visual Representations in Android-Based Digital Physics Modules: A Content Analysis Study

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Abstract

This study aims to identify the typology, functions, and cognitive appropriateness of visual representations in two Android-based digital physics modules — "Fisika 11 Merdeka" (Linear Studio Apps) and "Fisika Gelombang" (Qreatif) — using Levin's visual function taxonomy and Mayer's Cognitive Theory of Multimedia Learning (CTML) as analytical frameworks. Through a descriptive qualitative approach with systematic content analysis, data were collected via high-resolution screenshot documentation and structured coding sheets validated by two expert judges. Results reveal that "Fisika 11 Merdeka" is dominated by static visuals serving decorative (±35%), organizational (±25%), and representational (±30%) functions, with no dynamic or interactive representations found. In contrast, "Fisika Gelombang" optimizes Android's technological affordances through dynamic simulations, interactive features, and application of the signaling principle, with the majority of visuals serving interpretational and transformational functions (±60%). Evaluation of CTML principles shows that both applications effectively apply spatial contiguity; however, both critically violate the coherence principle due to commercial advertisements that generate extraneous cognitive load. This study concludes that digital modules do not automatically guarantee learning quality; developers should shift from mere text digitization toward the optimal use of interactive visual representations free from distracting elements.

INTRODUCTION

The rapid development of digital technology in the 21st century has brought about paradigmatic changes in the world of education, particularly in the science learning process. The COVID-19 pandemic accelerated the digital transformation of physics learning through the use of interactive multimedia, online platforms, and various educational technologies that enabled the learning process to continue effectively even when conducted remotely. The use of such digital technologies assists students in understanding abstract physics concepts and enhances their engagement in learning [1]. In the context of physics education, this shift presents its own set of challenges. Physics is a science that studies natural phenomena, which are often abstract, microscopic, and require a high level of imaginative reasoning, such as concepts relating to electric fields, electromagnetic waves, and quantum mechanics. Consequently, the presentation of physics material cannot rely solely on text; rather, it requires visual representations that are capable of bridging students' conceptual understanding [2].

Visual representation refers to the use of images, diagrams, graphs, tables, simulations, and animations to present information or scientific concepts. Within the cognitive theory of multimedia learning, Mayer [3] affirms that humans learn more effectively from words and pictures than from words alone (the multimedia principle). Appropriately designed visual representations serve to reduce the cognitive load on students' working memory, thereby enabling the processes of assimilation and accommodation of new information into their cognitive schemas to proceed efficiently [4]. Furthermore, visual representation plays a crucial role in physics learning, as it assists students in connecting abstract concepts with more concrete forms through diagrams, images, graphs, and mathematical representations. The use of various forms of representation enables students to construct deeper conceptual understanding and to reduce misconceptions in studying physical phenomena [5].

As smartphone penetration among students has increased dramatically, Android-based digital learning modules have emerged as a flexible and accessible alternative solution. Android-based digital modules offer advantages over conventional printed textbooks in that they are capable of integrating dynamic visual representations such as videos, 2D/3D animations, and interactive simulations [6]. The Android platform allows students to access learning materials flexibly at any time and in any location, and supports the presentation of content in the form of videos, animations, and simulations that render physics learning more interactive and contextual [7]. Nevertheless, the existence of digital media does not automatically guarantee improvements in learning quality if the design and visual representations are not developed based on pedagogical and cognitive principles [8].

A considerable body of prior research has examined the development of Android-based digital physics modules. Most of these studies have focused on product feasibility assessment and their effectiveness in improving students' cognitive learning outcomes. For instance, research by Silaban et al. [9] demonstrated that the use of Android-based learning media on thermochemistry material was effective in improving student learning outcomes and received positive responses from students. A similar study was conducted by Kurniawan [10], who developed an Android-based physics e-module grounded in problem-based learning, yielding excellent validity and practicality assessments. On the other hand, studies examining visual representation have been conducted predominantly on printed physics textbooks. Nurhayati [11] investigated visual representations in Senior High School physics textbooks under the 2013 Curriculum and found that static images still dominate the representation, while graphical representations and vector diagrams that are essential for conceptual understanding remain limited.

Based on this literature review, a significant research gap has been identified. First, the majority of existing research has focused on the development and effectiveness of digital modules, yet relatively few studies have analytically examined in depth the quality and characteristics of the visual representations they contain. Second, research on visual representation remains confined to printed textbooks, whereas Android-based digital modules possess the affordance to present far more complex visual representations. To substantiate this claim, a systematic search of the Scopus and Web of Science databases using the keywords "visual representation AND Android module AND physics" yielded no more than 12 articles published between 2018 and 2024, none of which specifically analyzed the pedagogical functions of visual representations in Android physics applications using both Levin's and Mayer's frameworks simultaneously. This confirms that the study of visual representations in the context of Android modules remains an area that has not been systematically explored. Firmansyah [12] lamented that many digital module developers merely perform digitization — transferring printed text and images to a screen — without harnessing the potential of dynamic visual representations offered by the Android operating system. The use of digital technology in physics e-modules provides pedagogical affordances in the form of the integration of multiple representations (verbal, visual, graphical, and audiovisual) that support the formation of students' conceptual understanding [13]. In addition, the examination of the functions of visual representations — whether decorative, informative, or operational — in the context of Android modules has rarely been explored [14].

In view of the critical role of visual representation in constructing students' conceptual understanding of physics and the considerable research gap that remains, this study focuses on the investigation of visual representations in Android-based digital physics modules. Rather than developing a product, this study aims to identify, categorize, and evaluate the pedagogical quality of visual representations currently available and in use by teachers and students.

Grounded in the foregoing background, this study is framed through three research questions (RQs): (RQ1) What is the dominant typology of visual representations employed in the Android-based digital physics modules "Fisika 11 Merdeka" and "Fisika Gelombang"? (RQ2) How do the visual representation's function based on Levin's taxonomy (decorative, representational, organizational, and interpretational) in supporting students' conceptual understanding of physics in both modules? (RQ3) How appropriate are the visual representations in both modules with respect to Mayer's cognitive multimedia design principles?

The objectives of this study are: (1) to identify the dominant typology of visual representations in both modules; (2) to examine the functions of visual representations based on Levin's taxonomy; and (3) to evaluate the conformity of visual representations with Mayer's cognitive multimedia principles. The findings of this study are expected to make an empirical contribution to the theory of physics learning, particularly with regard to visual instructional design in the digital era, as well as to serve as an evaluative reference for module developers and teachers in designing high-quality and pedagogically sound digital teaching materials.

METHOD

This study employs a descriptive qualitative approach using the content analysis method. This approach was selected to enable an in-depth understanding and description of the phenomenon of visual representation in digital physics modules without numerical manipulation [15]. Content analysis is used to draw valid inferences from visual media to the context of their use, with emphasis on the meaning and pedagogical function of visuals rather than merely the frequency of their occurrence [16].

1. Data Sources and Sampling Technique

The primary data sources consist of two Android-based digital physics modules: the application "Fisika 11 Merdeka" (developer: Linear Studio Apps) and the application "Fisika Gelombang" (developer: Qreatif), both downloaded from the Google Play Store in January 2025. Sample selection employed purposive sampling with the following explicitly defined criteria: (1) the module must be an Android-based application downloadable from the Google Play Store; (2) it must contain Senior High School/Madrasah Aliyah physics material relevant to the national curriculum; and (3) it must have a rating of at least ≥4.0/5.0 and a minimum of 1,000 downloads, as measurable indicators that the module has been used and deemed beneficial by active users. The application "Fisika 11 Merdeka" has a rating of 4.2/5.0 with more than 10,000 downloads, while "Fisika Gelombang" has a rating of 4.5/5.0 with more than 5,000 downloads at the time of data collection.

2. Data Collection

Data collection was carried out through systematic documentation and structured observation. The researcher thoroughly downloaded and navigated every feature of both modules. The unit of analysis was defined at the level of individual visual elements, namely each visual object that could be independently identified on a single screen (images/photographs, diagrams, graphs, animations, simulations, or interactive elements). Each visual representation element was captured via high-resolution screenshots. Field notes were used to document the contextual occurrence of visuals, supporting textual explanations, and user interaction mechanisms [17]. The total number of visual elements identified and coded was 47 elements in "Fisika 11 Merdeka" and 31 elements in "Fisika Gelombang".

3. Research Instruments

The primary instrument in this study is the researcher themselves [18]. To ensure objectivity and replicability, an auxiliary instrument in the form of a coding sheet was developed based on two principal theoretical frameworks: Levin's visual function taxonomy and Mayer's cognitive multimedia principles. The coding indicators encompass: (1) visual typology (static: photographs/images, static diagrams, graphs; dynamic: animations, simulations; interactive: elements with user response); (2) Levin's visual functions (decorative, representational, organizational, interpretational/transformational); and (3) cognitive appropriateness based on Mayer's principles (spatial contiguity, coherence, signaling, segmenting). The coding sheet was validated through expert judgment involving two lecturers specializing in physics learning technology [19].

4. Coding Procedure and Reliability

The coding procedure was carried out in two stages. In the first stage, two researchers — the primary researcher and an independent coder with a background in physics education — coded all 78 documented visual elements separately and independently. In the second stage, the coding results of both researchers were compared, and the inter-rater agreement was calculated using Cohen's Kappa ($\varkappa$). The results yielded $\varkappa = 0.81$ for the visual typology dimension and $\varkappa = 0.76$ for the visual function dimension, both of which fall within the categories of substantial agreement to almost perfect agreement [16]. Any remaining disagreements were resolved through consensus discussion with reference to the operational definitions set out in the coding sheet.

5. Data Analysis

Data analysis followed Miles and Huberman's interactive model [20]. The data reduction stage involved classifying visual elements into typology categories. Data display was presented in a descriptive matrix mapping visuals according to their function codes and cognitive appropriateness, supplemented by frequency distribution tables per application. Conclusion drawing and verification were conducted by interpreting the patterns that emerged and verifying them against the original data sources.

6. Data Trustworthiness

The trustworthiness of the data was ensured through: (1) source triangulation by comparing visual representations across both applications; (2) theoretical triangulation using perspectives from visual semiotics and the cognitive theory of multimedia learning; (3) intercoder reliability ($\varkappa \geq 0.76$) as a measure of coding objectivity; and (4) peer debriefing through discussions with colleagues who have a background in physics education to test the consistency of interpretations [21].

RESULTS AND DISCUSSION

1. Research Findings

Based on the content analysis of 78 visual elements documented from both applications (47 elements from "Fisika 11 Merdeka" and 31 elements from "Fisika Gelombang"), the research findings are presented in accordance with the three research questions (RQ1–RQ3) as follows.

a. Typology of Visual Representations (RQ1)

The analysis results reveal a significant contrast in the typology of visual representations between the two applications. The distribution of visual typologies in each application is presented in Table 1.

Table 1. Frequency Distribution of Visual Representation Typologies

Visual Typology	Fisika 11 Merdeka (n=47)	%	Fisika Gelombang (n=31)	%
Static Images/Photography	17	36.2%	3	9.7%
Static Diagrams	12	25.5%	4	12.9%
Static Graphs	9	19.1%	2	6.5%
Concept Maps	3	6.4%	0	0.0%
Dynamic Animations/Simulations	0	0.0%	11	35.5%
Structured Verbal Representations	6	12.8%	5	16.1%
Interactive Elements	0	0.0%	6	19.4%
Total	47	100%	31	100%

The data in Table 1 confirm that "Fisika 11 Merdeka" is dominated by static visual typologies (81.7% of total elements), while "Fisika Gelombang" contains a significant proportion of dynamic and interactive visuals (54.9% of total elements). In "Fisika 11 Merdeka", the visual typology is predominantly static in nature, with the application essentially adopting a conventional e-book format. The representations identified include illustrative images/photographs (36.2%), static diagrams

(25.5%), graphs such as sinusoidal wave graphs (19.1%), and concept maps (6.4%). No dynamic visual representations or interactive simulations were found in this application.

In contrast, "Fisika Gelombang" has optimized the affordances of Android technology by presenting a more diverse and dynamic typology. This application features dynamic simulations/animations at 35.5% and interactive elements at 19.4% of total visual elements, which represent the fundamental distinguishing factor from print-based modules. The following provides a detailed description of each typology found in "Fisika Gelombang":

1) Structured Verbal (Text) Representation Verbal representations in this application are ergonomically designed with consideration for the visual limitations of smartphone screens. The use of high-contrast text — white and yellow on a dark blue background — is not merely an aesthetic choice, but is grounded in the principles of visual psychology. On mobile devices that are frequently used under varying lighting conditions, high contrast ensures that text legibility is maintained. Furthermore, the use of yellow for key terms constitutes an implementation of the signaling principle within cognitive multimedia theory, which helps direct students' attention to essential information. This approach effectively reduces extraneous cognitive load, as students are not required to expend additional cognitive effort to distinguish text from its background.

2) Symbolic (Mathematical) Representation Symbolic representations in the form of physics equations are rendered through the use of prominently colored orange accent boxes. In the context of physics learning, mathematical equations frequently become a cognitive bottleneck for students due to the density of abstract symbols. The presentation of formulas within visually contrasting colored boxes creates a visual hierarchy. Pedagogically, this functions to separate declarative information (narrative text) from procedural information (formulas), in alignment with the segmenting principle. This visual separation prevents the split-attention effect, whereby students become cognitively fatigued from parsing a combined mixture of text and symbols.

3) Visual/Pictorial Representation (Dynamic Simulation) The presence of dynamic simulations — particularly the stationary wave rope simulation — represents the most significant form of technological affordance utilization. The concept of stationary waves, particularly the phase difference between a fixed end and a free end, is exceptionally difficult to understand if one relies solely on static images. This moving visual simulation renders abstract phenomena into observable objects. In accordance with the multimedia principle, the combination of text and moving images yields deeper understanding. Cognitively, this simulation assists students in constructing a real-time mental model of wave dynamics, thereby reducing the imaginative burden that ordinarily places demands on working memory. Accordingly, the function of visuals here is no longer merely representational, but has evolved into interpretational and transformational functions.

4) Interactive Representation The interactive representation typology constitutes the most fundamental distinguishing feature between digital modules and printed textbooks. The presence of navigation buttons, play/pause buttons, and an interactive multiple-choice feature transforms students' role from passive information recipients to active participants. The play/pause button on the wave simulation grants students full control over the rate of information delivery in accordance with their working memory capacity (an implementation of the segmenting principle). The multiple-choice feature provides immediate feedback that promotes generative processing, whereby students mentally connect the visual information they observe with their existing knowledge.

b. Functions of Visual Representations Based on Levin's Framework (RQ2)

The distribution of visual functions in each application, analyzed based on Levin's visual function taxonomy, is presented in Table 2 below.

Table 2. Frequency Distribution of Visual Functions Based on Levin's Taxonomy

Visual Function (Levin)	Fisika 11 Merdeka (n=47)	%	Fisika Gelombang (n=31)	%
Decorative	16	34.0%	2	6.5%
Organizational	12	25.5%	5	16.1%
Representational	14	29.8%	5	16.1%
Interpretational	5	10.6%	10	32.3%
Transformational/Interactive	0	0.0%	9	29.0%
Total	47	100%	31	100%

The data in Table 2 indicate that "Fisika 11 Merdeka" is dominated by decorative (34.0%) and representational (29.8%) functions, while "Fisika Gelombang" is dominated by interpretational (32.3%) and transformational (29.0%) functions.

1) Organizational Function According to Levin's taxonomy, the organizational function refers to the capacity of visuals to arrange, categorize, and map the relationships among concepts in a structured manner. In "Fisika 11 Merdeka", this function is realized through the Kinematics concept map, which organizes the hierarchy of knowledge from general concepts to specific branches. Pedagogically, this concept map functions as an advance organizer that provides students with an overarching picture (big picture) before they delve into the details of the material, thereby minimizing cognitive load because the new information to be learned already has a well-defined cognitive schema.


Mengapa penerjun payung mendarat melenceng dari posisi sebenarnya? Lihat Gambar 1.2. Salah satu penyebabnya adalah tiupan angin yang mengubah arah gerak penerjun payung.

Gambar 1.2 Penerjun payung mendarat melenceng

Gambar 1.3 menunjukkan beberapa kabel menopang suatu jembatan. Setiap kabel memberikan gaya sehingga ada beberapa vektor gaya.

Gambar 1.3 Beberapa kabel menopang suatu jembatan

Ayo, Berpikir Kritis!

Bagaimana cara menggambar vektor, resultan vektor, komponen vektor serta menghitung besar dan arah resultan vektor dalam sebuah pengamatan?

A. Konsep Vektor

Konsep vektor dapat ditemukan dalam kehidupan sehari-hari, misalnya seorang pilot pesawat terbang menggunakan komputer navigasi yang dihubungkan dengan cara vektor sehingga pilot yang mengemudi tidak salah arah atau berpindah ke tempat yang tidak diinginkan. Agar kalian dapat memahami konsep vektor, ayo lakukan Aktivitas 1.1.

Figure 1. Visual Representation Serving an Organizational Function

2) Representational Function The representational function refers to the use of visuals to directly illustrate what is described in the narrative text. In "Fisika 11 Merdeka", this function is realized through photographic illustrations of a parachutist and a bridge. The abstract and mathematical nature of vector concepts is given concrete form through these images, demonstrating how vectors operate in real-world phenomena. Cognitively, this representation bridges the gap between physics symbols and real-world reality.

Figure 2. Visual Representation Serving a Representational Function

3) Interpretational Function The interpretational function refers to the capacity of visuals to clarify the meaning of abstract information, particularly quantitative or mathematical data. In "Fisika 11 Merdeka", this function is realized through wave graphs that interpret mathematical symbols such as lambda (wavelength) and T (period) into dimensioned geometric forms. Students are able to visually observe that lambda represents the physical distance between two wave crests, facilitating the cognitive process of translating from the language of mathematical symbols to visual-spatial representation.

Figure 3. Visual Representation Serving an Interpretational Function

4) Decorative and Transformational Functions In "Fisika 11 Merdeka", visual elements such as images of aircraft or student illustrations that bear no direct epistemological connection to the content are categorized as decorative (34.0%). In contrast, "Fisika Gelombang" highlights the transformational function through stationary wave simulations that allow students to directly and dynamically observe physical variables — a function entirely absent in "Fisika 11 Merdeka" (0.0%).

c. Conformity with Mayer's Cognitive Multimedia Principles (RQ3)

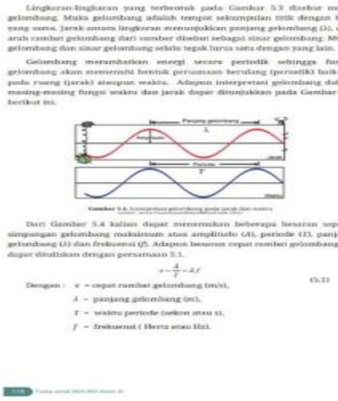
The evaluation of the conformity of visual representations in both applications with Mayer's Cognitive Multimedia Principles is presented in Table 3 below.

Table 3. Evaluation of Conformity with Mayer's Cognitive Multimedia Principles

Mayer's Principle	Fisika 11 Merdeka	Fisika Gelombang
Multimedia (words + images)	Met (all visuals accompanied by text)	Met (all visuals accompanied by text)
Spatial Contiguity	Met (labels on graphs are adjacent)	Met (play/pause button is adjacent to the simulation)

Signaling	Not optimal (no explicit visual cues)	Met (yellow color for key terms)
Segmenting	Not present (no user control)	Met (play/pause button)
Coherence	Violated (commercial advertisements on content pages)	Violated (commercial advertisements on content pages)
Redundancy	Partial violation (some narrative text duplicates graphs)	Minimal

Evaluation through Mayer's cognitive theory of multimedia learning yields three principal findings. First, the spatial contiguity principle has been effectively applied in both applications — labels on graphs and the play/pause button adjacent to the simulation minimize the split-attention effect. Second, the modality principle and interactivity are more advanced in "Fisika Gelombang", where interactive features facilitate the user's cognitive segmenting. Third, and most critically, both applications significantly violate the coherence principle due to the presence of commercial advertisements (banners and pop-ups) on learning content pages.


Lingkaran-lingkaran yang terbentuk pada Gambar 5.3 disebut muka gelombang. Muka gelombang adalah tempat sekumpulan titik dengan fase yang sama. Jarak antara lingkaran menunjukkan panjang gelombang (λ), dan arah rambat gelombang dari sumber disebut sebagai sinar gelombang. Muka gelombang dan sinar gelombang selalu tegak lurus satu dengan yang lain.

Gelombang merambatkan energi secara periodik sehingga fungsi gelombang akan memenuhi bentuk persamaan berulang (periodik) baik itu pada ruang (jarak) ataupun waktu. Adapun interpretasi gelombang dalam masing-masing fungsi waktu dan jarak dapat ditunjukkan pada Gambar 5.4 berikut ini.

Dari Gambar 5.4 kalian dapat menemukan beberapa besaran seperti simpangan gelombang maksimum atau amplitudo (A), periode (T), panjang gelombang (λ) dan frekuensi (f). Adapun besaran cepat rambat gelombang (v) dapat dituliskan dengan persamaan 5.1.

$$v = \frac{\lambda}{T} = \lambda f \quad (5.1)$$

Dengan : v = cepat rambat gelombang (m/s),
λ = panjang gelombang (m),
T = waktu periode (sekon atau s),
f = frekuensi (Hertz atau Hz).

Figure 4. Violation of the Coherence Principle Due to Commercial Advertisement Elements

The results of the analysis of the two digital physics modules confirm the existence of a duality in current Android-based instructional material development practices, which can be understood through the answers to the three research questions posed.

a. Addressing RQ1 (Typology) The findings indicate that "Fisika 11 Merdeka" represents a tendency among developers to merely transfer static text and images into a digital format, as cautioned by Firmansyah [12]. With 81.7% of visual elements being static and no interactive simulations present, students are still required to rely on high-level mental visualization to understand motion and waves from still images. In contrast, "Fisika Gelombang", with 54.9% dynamic and interactive visual elements, has demonstrated a more effective integration of visual representations in accordance with the characteristics of mobile learning. The use of interactive simulations, the visual demarcation of formulas through orange-colored blocks, and the ergonomic user interface (UI) layout indicate that the developers have taken into consideration the user experience (UX) and students' cognitive load.

b. Addressing RQ2 (Function) The distribution data of visual functions (Table 2) confirm that "Fisika 11 Merdeka" remains confined to the level of decorative (34.0%) and representational (29.8%) functions, in which visuals serve merely to adorn or illustrate the text. This indicates that the potential of higher-level functions — interpretational and transformational — has yet to be exploited. In contrast, "Fisika Gelombang", with its dominance of interpretational (32.3%) and transformational (29.0%) functions, fulfills a higher epistemological role: the simulations in this application are not merely viewed, but are operated to construct scientific reasoning [13].

c. Addressing RQ3 (Cognitive Appropriateness) The most critical finding of this study is the violation of the Coherence Principle in both applications due to the presence of commercial advertisements. In accordance with Mayer's cognitive theory of multimedia learning [3], irrelevant elements trigger extraneous cognitive load. Advertisements function as seductive details that compel students' working memory to process information outside the scope of learning objectives. The compromise between the monetization needs of free applications on the Play Store and instructional design principles ultimately diminishes the cognitive benefits that could otherwise be maximized from such digital media [8].

Overall, these findings affirm that the existence of Android-based digital media does not automatically guarantee improvements in learning quality. The integration of appropriate visual typologies (static, dynamic, interactive) must be accompanied by conformity with cognitive principles — particularly ensuring visual cleanliness from distracting elements — so that the processes of assimilation and accommodation of physics knowledge can proceed efficiently.

The evaluation of cognitive multimedia principles reveals that although both applications comply with the spatial contiguity principle, they both critically violate the coherence principle due to the presence of commercial advertisements that trigger extraneous cognitive load. Therefore, the existence of digital modules does not automatically guarantee improvements in learning quality. Future developers of physics modules must move beyond the mere transfer of printed text to a screen, toward the optimal utilization of interactive visuals while maintaining visual cleanliness from distracting elements, so that abstract physics knowledge can be efficiently assimilated by students.

CONCLUSION

This study successfully identified a significant contrast in the typology, function, and cognitive appropriateness of visual representations between the two Android-based digital physics modules examined. "Fisika 11 Merdeka" is dominated by static visual typologies (81.7%), serving predominantly decorative (34.0%) and representational (29.8%) functions, with no dynamic or interactive elements whatsoever, reflecting a conventional digitization model that has yet to harness the full pedagogical affordances of Android technology. In contrast, "Fisika Gelombang" demonstrates a more advanced integration of visual representations, with 54.9% dynamic and interactive elements dominated by interpretational (32.3%) and transformational (29.0%) functions, which are more consistent with the principles of mobile learning and the conceptual learning objectives of physics.

Despite the superiority of "Fisika Gelombang" in terms of visual typology and function, both applications critically violate Mayer's Coherence Principle due to the presence of commercial advertisements that generate extraneous cognitive load, thereby undermining the cognitive benefits that digital media could otherwise provide. These findings lead to the conclusion that digital modules do not automatically guarantee learning quality; the presence of technology alone is insufficient without sound pedagogical design. Future developers of Android-based physics modules are strongly encouraged to shift from mere text digitization toward the optimal utilization of interactive and dynamic visual representations, while simultaneously ensuring visual cleanliness from distracting elements, so that abstract physics knowledge can be efficiently and meaningfully assimilated by students.

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