

# A Grounded Theory Exploration of the Cognitive Effects of Multimedia-Based Instruction on EFL Learners' Listening Skills

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**Abstract**—A deeper understanding of how multimedia-based instruction interacts with the cognitive processes of EFL learners during listening tasks is needed to maximize its effectiveness. By employing a grounded theory approach, this study aimed to develop a theoretical framework that explains how multimedia-based instruction influences EFL learners' cognitive processes during listening tasks. Two higher education institutions were chosen based on the consideration that they have experienced the use of multimedia in teaching and learning EFL listening skills. Twenty-four students were selected for a theoretical sampling with an open sampling pattern to help researchers form the best theory. To enhance the understanding of the phenomenon, participant observation and semi-structured interviews served as the primary data collection techniques in this study. The researchers directly observed the process of teaching listening and then proceeded with a semi-structured interview. This study had three stages of the data analysis process: open coding, axial coding, and selective coding. The results indicated the cognitive effects of multimedia-based instruction on students' listening skills include improved comprehension and enhanced knowledge retention. It also developed a theory that links educational technology, cognitive psychology, and language acquisition through data analysis using the grounded theory method. This hypothesis implies that multimedia facilitates complex mental processes and enables students to process information effectively, understand it better, and retain it in their long-term memory.

**Index Terms**—cognitive impact, multimedia learning, teaching listening, grounded theory

## I. INTRODUCTION

Multimedia-based instruction has gained significant attention in teaching and learning EFL listening skills, as it facilitates a comprehensive understanding of the cognitive processes involved in understanding spoken language. In Indonesia, universities increasingly use multimedia-based instruction methods to improve students' listening comprehension skills. Moreover, most lecturers combine audio sound system mixers, laptops, LCDs, and online materials to promote listening skill development.

Previous studies have emphasized the advantages of multimedia in language learning. Multimedia is an instructional tool for teaching and learning both productive and receptive skills of English at various educational levels in non-native-speaking countries (Bobrova et al., 2021; Chhattani, 2023; Pun, 2014). Furthermore, learning that uses multimedia gets students ready for real-world listening (Goh & Vandergrift, 2021). Using multimedia also provides cognitive input for EFL learners in learning listening.

Nadri et al. (2019) mention that listening is a mental activity that involves cognitive abilities, and indeed, there is a significant correlation between cognitive skills and listening comprehension (Kim & Phillips, 2014). Beginning with sound discrimination, the teaching of listening progresses to the cognitive stage, which entails literal comprehension, interpretation, and assessment (Wong, 1986).

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Thus, multimedia learning facilitates students in processing information through sensory memory and saves it in working memory temporarily and permanently in their long-term memory for later retrieval.

Numerous scholars have reviewed the use of multimedia in teaching listening skills. Adanech (2021) states that teaching listening through multimedia is the best option, and it can be applied easily in EFL classrooms, so teachers and learners do not have to rely on rigid strategies and materials like the conventional listening class. Sejdiu (2017) mentions that multimedia facilitates EFL learners in improving their listening skills. Multimedia improves the efficiency of teaching EFL listening (Brett, 1997; Meskill, 1996). Furthermore, the results of a review of articles published in 2020 and 2021 in Indonesia and Turkey found that multimedia-based listening materials increase interaction, involvement, and students' creativity, allowing them to understand the lessons given (Gökçe, 2022). Library research found that multimedia technology provides input and increases interest, motivation, and interaction in listening classes (Umar et al., 2023). Therefore, using multimedia in teaching listening skills offers many benefits that can enrich students' learning experiences and improve their listening skills.

Multimedia platform-based teaching provides a new experience for students in listening classes (Zhao et al., 2019), and many quantitative studies have investigated the efficacy of multimedia in teaching EFL listening with findings that support this. For instance, the use of interactive multimedia had a significant impact on listening skills in the studies of Alghamdy (2019), Arono (2014), and Asilestari (2016). Moreover, Setyawan et al. (2022) found that multimedia materials presented in listening classes attract interest and increase student motivation in listening classes. According to Aldera (2015), this is because multimedia provides audio-visual stimulus to students in learning listening. Multimedia instruction in teaching listening skills needs to be incorporated for improved learning results (Soleimani & Mirsayafi, 2019). Moreover, the use of multimedia applications has been proven to improve students' listening comprehension skills at the university level (Pangaribuan et al., 2017). The multimedia helps improve EFL learners' listening skills (Gjinali & Piri, 2023). Hence, multimedia learning is an authentic, flexible, and enjoyable language input that effectively improves understanding and encourages student engagement in the learning process.

Multimedia innovation in listening is also continuously carried out by researchers through research and design. The *Let's Listen* multimedia CD has a positive impact in the form of student-centered learning and increasing their motivation in listening classes (Wulanjani, 2017). Furthermore, educators can create their own interactive multimedia with Thinglink and Moodle to improve students' listening comprehension (Putri et al., 2024). Researchers such as Irawan (2021) and Karim and Ciptaningrum (2019) claim that a macro-media flash file attached to CDs was fun and exciting and motivated students to learn listening. Also, an interactive CD-ROM package is facilitating learners' needs in learning listening (Perdani, 2023). Additionally, Bozorgian and Fakhri Alamdari (2018) state that metacognitive learning through dialogic interaction improves listening comprehension through multimedia. Thus, research and development of multimedia learning in teaching listening involves various aspects ranging from effective research, technology development, implementation and evaluation, collaboration, and professional training.

In recent years, multimedia-based instruction has emerged as a promising approach to enhance language learning. Integrating visual, auditory, and interactive elements, multimedia tools can improve listening skills by providing contextualized, authentic, and engaging input. Despite the growing use of multimedia in EFL education, there is limited research on its cognitive impact, particularly in listening skill development. Existing studies often focus on quantitative outcomes, such as test scores, rather than exploring the underlying cognitive processes that influence learners' comprehension. A deeper understanding of how multimedia-based instruction interacts with the cognitive processes of EFL learners during listening tasks is needed to maximize its effectiveness.

This study seeks to address this gap by employing a grounded theory approach to explore the cognitive impact of multimedia-based instruction on EFL learner's listening skills. By doing so, the research question of this study is "How do EFL learners perceive the cognitive impact of multimedia-based instruction on their listening skills?" The purpose of the study is to investigate how multimedia-based instruction influences the cognitive processes of EFL learners in developing their listening skills. By employing a grounded theory approach, the study aims to develop a theoretical framework that explains how multimedia-based instruction influences EFL learners' cognitive processes during listening tasks. Theoretically, the findings may propose a new theoretical framework that explains the relationship between multimedia-based instruction and cognitive processes in EFL learners listening skills in Indonesian higher education settings. This theory could address how multimedia impacts comprehension, memory, and language processing during listening tasks.

## II. LITERATURE REVIEW

### A. Cognitive Theory of Multimedia Learning

Learning with audio and visuals is better than learning with just audio or images. According to Mayer (2003), the Cognitive Theory of Multimedia Learning is founded on three key principles. The first principle is the dual-channel assumption that suggests that humans process information through both auditory and visual channels. The second principle is the limited capacity assumption, indicating that humans have a finite capacity for processing the information they receive. The third principle is active processing, where individuals combine the information they perceive visually and audibly into a unified understanding, integrating it with their existing knowledge. Consequently, the cognitive

theory of multimedia learning serves as a foundational framework for enhancing the effectiveness and efficiency of learning, ultimately improving student outcomes.

In multimedia presentations, words and pictures are the essential components of the cognitive theory of multimedia learning (Mayer, 2007). The selection of words and images must be relevant to the learning material because this theory is directly related to the three structures of human memory storage. This theory also explains that humans have three memory storage structures. Those are the ears and eyes, located in sensory memory; sound and image, situated in working memory; and finally, long-term memory (Mayer, 2010). The components of the ears and eyes located in sensory memory capture multimedia presentations during the learning process. The sensory memory consists of the ears and eyes as a cognitive structure that allows the entry of new information visually and auditorily (Sweller, 2016). Consequently, sensory memory is the main gateway of knowledge.

Working memory is a cognitive structure that consciously processes information (sounds and images) obtained through the eyes and ears. In this process, sounds represent audio, which can be in the text, and words (Paivio, 1991), and pictures represent images, which can be graphics, videos, and animations, and are processed to produce verbal and pictorial models (Baddeley, 2010; Baddeley, 2008). Long-term memory is a component of the human memory system that stores information obtained through previously integrated processes for a long time (Antonis & George, 2023). Consequently, by understanding how these three types of memory work, educators can design more effective learning strategies to improve comprehension and retention of information.

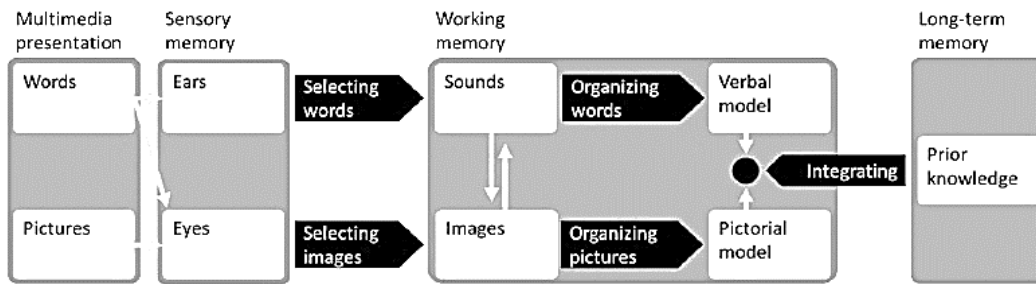


Figure 1. Cognitive Theory of Multimedia Learning Based on Mayer (2019) as Cited by Cavanagh and Kiersch (2023)

*B. The Basic Assumption of the Cognitive Approach of Multimedia-Based Instruction in Listening*

The cognitive approach to multimedia learning in listening emphasizes understanding how humans process information. It involves more than one of the learner's senses and is called the multi-sensory process. Combining interactive video, audio, text, graphics, pictures, and animation constitutes meaningful language input for the learners. In this approach, the audiovisual is used to improve understanding and retention of information. Videos and audio files can be used as instructional resources to teach listening skills (Pemberton, 2004). They can also offer opportunities for spoken communication as well as planned exercises and assignments that improve understanding and learning techniques. Listening in the multimedia environment provides a rich context that can improve listening skills because it involves interacting with various media types, such as audio, video, and animation, to understand and remember information (Goh & Vandergrift, 2021). When students listen and simultaneously see the content of listening materials, they can associate audio information with visuals in the learning process. Thus, the cognitive approach of multimedia in teaching listening aims to create a more dynamic, interactive, and effective learning environment to help students develop their listening skills.

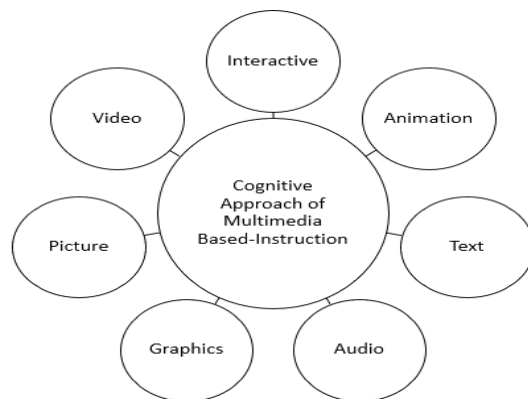


Figure 2. Cognitive Approach of Multimedia-Based Instruction in Listening

*C. Listening in Indonesian Higher Education*

Learning listening skills at a higher education level is more complex and specific. The fact that Indonesians are not native English speakers causes learning listening skills to be quite complicated for them. According to Cahyono and Widiati (2015), learning listening at higher education equips students with listening competencies to differentiate English sounds and identify general and detailed information. Moreover, students at the university level face several problems with listening skills (Lengkoan et al., 2022). The text's intricacy, phonological awareness, distortions, lexis recognition, speech tempo, and complexity all demonstrated high sensitivity that contributed to typical listening difficulties (Izzah & Keeya, 2019).

In the last decade, scholars have studied problems, strategies, the use of media materials, and the relationship between technology and listening, especially in the context of higher education settings. Pre-listening, while-listening, and post-listening were the three steps in which the lecturer organized different exercises to teach basic listening skills to EFL students (Saehu, 2016). Furthermore, qualitative studies have been conducted in Indonesian Islamic higher education assessing listening comprehension skills (Nur et al., 2023). Through listening resources, students in the English as a Foreign Language (EFL) classroom in these schools could interpret the speaker's arguments, recognize subjectivity in the message, and understand and evaluate the speaker's goal (Gunawan et al., 2023). The quality of listening material is a determinant of learning success (Episiasi et al., 2021).

According to Down et al. (2021), the correct approach is required to help students overcome the challenges they encounter when learning listening. Direct and indirect strategies can be used to improve listening comprehension skills in an Islamic higher education context (Fetriani et al., 2020). Moreover, students' responses to instructional strategies may help them learn more and make engaging in listening activities easier once they have acquired the required skills (Nur & Alimuddin, 2022). The use of media sharpens students' sense of learning in listening classes (Loren, 2017). Lecturers no longer have difficulty teaching listening for general purposes, with listening textbooks combined with exciting videos that have been developed (Hustarna, 2023). Additionally, using authentic materials in the form of YouTube videos improves listening skills and forms a positive attitude among EFL learners in listening classes (Nurkholida, 2016). Hence, improving listening skills in Indonesian higher education involves a combination of instructional strategies, technology integration, and fostering a supportive learning environment.

### III. METHODOLOGY

#### *A. Research Design*

The researchers chose the grounded theory technique as the best methodological option in order to develop a new theoretical framework regarding the cognitive effects of multimedia-based instruction. The goal of the grounded theory is to create hypotheses based on information gathered methodically from the field (Charmaz & Thornberg, 2021; Stough & Lee, 2021).

#### *B. Setting of the Research*

The State Islamic Institute of Palopo and the University of Cokroaminoto Palopo served as the sites for this grounded study. These two colleges were selected because they employ computers, LCDs, audio mixer sound systems, and online resources for listening instruction as part of their multimedia-based learning approach.

#### *C. Participants*

Participants were ideally selected in a theoretical sampling with an open sampling pattern to help researchers form the best theory. The open sampling pattern aims to find as much data as possible regarding the formulation of the problem at the study's beginning (Charmaz, 2001). The reason is that in the early stages, the researcher was unsure which concepts were theoretically relevant, and the objects of observation and the people interviewed were also not limited. The data collected from this initial data collection activity were then analyzed using open coding. Therefore, the participants of this study consisted of 24 students in the second and fourth semesters at the State Islamic Institute of Palopo and the University of Cokroaminoto Palopo who have experienced multimedia in teaching and learning listening.

#### *D. Research Instrument*

The participants' observation and semi-structured interviews served as the primary data collection technique in this study, with the fundamental premise that it would enhance the researcher's understanding of the phenomenon. Participant observation aims to gain an in-depth understanding of a social, cultural, or behavioral phenomenon through direct involvement with the observed individuals or groups (Kimber & Maertens, 2023). Additionally, before the semi-structured interview was conducted, the researcher first provided interview guidelines to the participants. The outcomes of interviews or recordings of conversations and events were then either clearly identified as sub-elements or were rewritten or explained in text format. Furthermore, data elements of participant observation were then coded into the category of what was being observed. Additionally, the researcher informed all participants that they would disseminate all collected data anonymously.

#### *E. Data Collection*

The researcher directly observed multimedia-based instruction in the teaching of listening skills in the English Language Education Department, Faculty of Teacher Training and Education of the State Islamic Institute of Palopo and the University of Cokroaminoto Palopo, then continued with semi-structured interviews. This activity took place in stages over around a six-month period.

#### F. Data Analysis

This study had three stages of the data analysis process: open coding, axial coding, and selective coding. A grounded theory approach was used to examine the collected textual data (Corbin & Strauss, 2015). By breaking up information into segments, researchers could create preliminary categories of data regarding the topic under study using open coding. While researchers read and reread the material to better understand its meaning, a coding system was created based on the notes taken throughout the interview process after the transcription. Moreover, when axial coding, researchers assembled data in a new way after open coding. This data assembly was presented using a coding paradigm or logic diagram, where researchers identified central phenomena, specific strategies, and contexts and conditions that mediate them, and described the consequences of these phenomena. Meanwhile, in selective coding, researchers identified storylines and wrote stories that integrated categories in the axial coding model by presenting propositions.

### IV. RESULTS

Improved comprehension and enhanced knowledge retention are the cognitive effects of multimedia-based instruction on EFL learners' listening skills that emerged from participant observation and analysis of 24 semi-structured interviews that were systematically examined and assessed using a grounded theory approach.

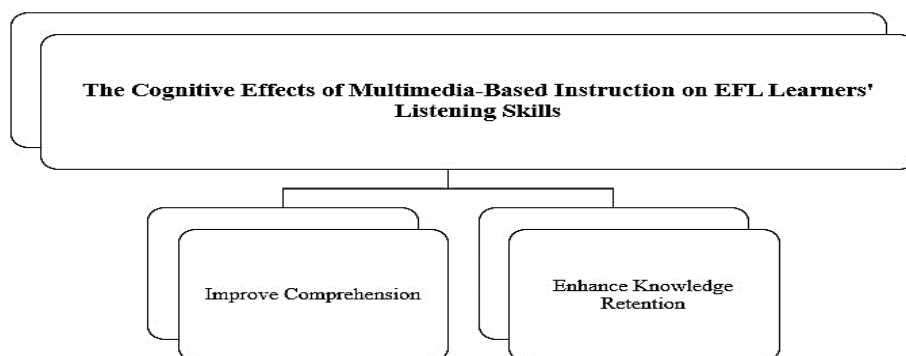


Figure 3. The Cognitive Effects of Multimedia-Based Instruction on EFL Learners' Listening Skills

#### A. Improve Comprehension

Students can understand the material better than using just one medium. Multimedia enhances understanding by combining text, audio, video, images, and animation to create a more dynamic and engaging learning experience.

"In each listening exercise, images are provided to clarify the audio, making it easier to understand, as the speaker's words correspond to the pictures" (Student 1, Interview May 2024).

"Teaching listening through multimedia that combines audio and images makes the material easier to learn and comprehend" (Student 3, Interview July 2024).

"Multimedia makes it easier to comprehend because, in each listening lesson, images and text are displayed in alignment with the speaker's voice" (Student 4, Interview June 2024).

"Multimedia enhances comprehension because the native speaker's voice matches the images on the screen" (Student 6, Interview July 2024).

"Multimedia helps us to understand the material because we can match audio and images simultaneously" (Student 7, Interview July 2024).

Five participants stated that multimedia combining audio and visuals improves understanding. With the addition of visual elements, such as images or videos, students can see situations or expressions relevant to the audio material. Visual elements clarify the context of the learning material, helping students understand the meaning of the conversation or narrative they are listening to.

"The audio and images in multimedia help us understand the material by allowing us to match the vocabulary heard in the audio with the corresponding pictures" (Student 8, Interview July 2024).

"Multimedia enhances understanding of listening material by aligning the sounds heard with corresponding images. Additionally, it helps us focus more on listening, thereby improving our listening skills over time" (Student 9, Interview July 2024).

"Multimedia in listening enables a detailed understanding of instructions and their content" (Student 10, Interview July 2024).

“The listening material is easy to understand through the videos and animations shown in the listening class” (Student 12, Interview August 2024).

“Multimedia tools, such as images, videos, and text, enhance understanding and listening skills, making it easier to comprehend the speaker's intentions in listening classes” (Student 13, Interview August 2024).

“Multimedia combines audio and images to improve comprehension, allowing us to see what the speaker is saying” (Student 14, Interview August 2024).

“Visualization and audio in multimedia enhance the understanding of listening material” (Student 16, Interview August 2024).

In line with this, several students also emphasized that multimedia facilitates the understanding process by providing visual clues in the form of situations, facial expressions, or movements accompanied by audio, making it easier for students to understand the meaning of the words or phrases they hear.

“My listening ability is very different before and after the use of multimedia in listening class” (Student 18, Interview September 2024).

“This semester, my listening score is higher compared to last semester. Therefore, it can be said that multimedia improves listening skills” (Student 21, Interview August 2024).

“I actively answered questions in listening class this semester, so there will be a significant increase in listening skills through multimedia” (Student 24, Interview July 2024).

Meanwhile, some argued that using multimedia in teaching listening improved their listening skills significantly.

### *B. Enhance Knowledge Retention*

Multimedia effectively increases information retention in listening by activating various cognitive pathways, providing visual context, catering to different learning styles, and improving students' memory.

“Animations, videos, and images in multimedia stimulate memory, making it easier for us to retain the material and recall the listening themes discussed in subsequent meetings” (Student 19, Interview June 2024).

“The combination of text, audio, video, and animation in multimedia is beneficial for remembering listening material because the sounds heard align with the images seen” (Student 20, Interview June 2024).

Two participants stated that the combination of animation, video, images, and interactivity helps them understand and remember learning materials better.

“Multimedia makes it easier to remember material because, without realizing it, we engage two types of senses—auditory and visual—in the learning process” (Student 22, Interview June 2024).

“Using multimedia tools such as LCDs and speakers makes it easier to remember the material because it maximizes both audio and visual senses” (Student 23, Interview August 2024).

“Audio and images in multimedia make it easier to remember listening material, and this method of learning differs from the way I have learned before” (Student 2, Interview June 2024).

“Multimedia is very helpful for remembering listening material because it combines images displayed on LCDs and sounds played through speakers” (Student 5, Interview June 2024).

“Multimedia makes it easier for me to remember listening materials because the learning content is presented as videos and images accompanied by audio through LCDs. This combination of visualization and audio from native speaker explanations allows the material to be remembered and understood comprehensively” (Student 11, Interview June 2024).

Furthermore, some participants assert that multimedia creates a richer and more immersive multi-sensory learning experience by integrating audio, visual, and interactive elements. This strategy helps students understand information better and ensures that they can remember and use it in the future.

“The combination of LCDs that display images and speakers that produce audio makes it easier to remember learning material” (Student 15, Interview August 2024).

“Listening material displayed on the screen, accompanied by audio played through speakers, stimulates memory. The combination of images and audio helps match vocabulary with sounds, making the learning process more varied and less monotonous” (Student 21, Interview August 2024).

“Listening materials delivered through multimedia, such as videos, photos, and audio, help improve understanding and long-term retention of learning materials because they provide a direct visual overview of the content” (Student 18, Interview September 2024).

“Simultaneously listening to and viewing images through videos makes it easier for me to remember the material” (Student 12, Interview August 2024).

“The combination of video, images, text, and audio stimulates our brains, making it easier to remember the material being discussed” (Student 13, Interview August 2024).

Accordingly, participants contend that visual elements like text, images, diagrams, videos, and animations aid students in understanding the context of listening materials and help them associate sounds with written words, thereby enhancing their memory.

“One of the advantages of multimedia in teaching listening is that it helps me remember the material, making me more active in participating and answering questions” (Student 14, Interview August 2024).

“I remember more and am able to answer the lecturer's questions about what was learned in the previous meeting because I learned listening using a combination of LCDs that display videos and images and speakers that play the speaker's voice audio” (Student 16, Interview August 2024).

Specifically, another participant stated that the combination of audio-visual presentation allows for the storage of learning materials in long-term memory and their recall during listening classes.

## V. DISCUSSIONS

The use of multimedia, which combines visual and audio elements, is an effective solution for improving students' comprehension skills. Audio-visual support makes it easier for students to capture information, understand intonation, capture implicit meaning, and relate to the context of the conversation. Multimedia activates various sensory pathways in listening so that students can identify the implied meaning in the context of the conversation through the conversation, facial expressions, body movements, and the background of the situation that they see visually. Specifically, students can receive information in various ways to understand the listening material more deeply. The impact on improving comprehension occurs in students' listening skills because multimedia combines various presentation elements that strengthen cognitive processes and help students capture and remember information more effectively. Additionally, the multimedia approach attracts students' attention and concentration compared to audio or text alone. In line with this, simultaneously presenting words and images promotes comprehension by enabling learners to establish links between verbal and visual representations (Mayer, 2024). In other words, multimedia enhances listening skills by utilizing audio, visual, textual, and video elements as tools to facilitate comprehension of spoken language. Research shows that students who learn listening through multimedia show significant improvements in comprehension and have positive attitudes toward learning listening (Thi, 2021). Multimedia is more effective than conventional teaching techniques, as students utilizing multimedia generally exhibit superior listening skills compared to those who do not utilize multimedia (Taghani & Ghafournia, 2014). Therefore, rich and contextual language input is obtained from the audio-visual combination contained in multimedia, thus helping students organize information from spoken texts by involving sensory imagery and verbal information to represent data.

Multimedia in learning listening significantly increases students' knowledge retention through the presentation of richer, more interactive material that involves multiple senses. With multimedia, knowledge retention can increase because students receive information through several sensory pathways (Mayer, 2017). Multimedia greatly influences the increase in knowledge retention during listening by fostering connections between new concepts and previously learned information. Multimedia provides visual and auditory context that not only helps students understand but also remember information better (Mayer, 2011). This integration reinforces the theory that visual images enhance the recall of verbal information. Humans assimilate information via two distinct modalities: auditory and visual, also known as dual-channel processing (Mayer, 2010). It allows learners to integrate verbal and visual information, enhancing retention by creating more robust mental representations in listening activities. The combination of images, sound, and text strengthens associations between new words, their definitions, pronunciations, and examples of their use. Information in audio-visual form helps learners retain information and build relationships between form and meaning (Teng, 2023). Multimedia-based instruction utilizes dual coding and provides information redundancy, which can increase the possibility of encoding vocabulary into long-term memory (Ramsin, 2022). Multimedia tools provide an engaging and effective way to enhance both comprehension and retention in listening exercises, making them valuable in teaching and learning EFL listening. Overall, the combination of audio-visuals increases memory activation and makes information easier to remember, meaning that when students learn through multimedia, they can better recognize and understand the material's content because the brain associates visualization with auditory content.

## VI. CONCLUSION

Data analysis using the Grounded Theory approach revealed that improved comprehension and enhanced knowledge retention are the cognitive effects of multimedia-based instruction on EFL learners' listening skills. Multimedia facilitates complex mental processes and enables students to process information effectively, understand the information better, and recall it more easily from the long-term memory. Furthermore, multimedia provides cognitive input for EFL learners, which allows them to integrate verbal and visual information, enhancing retention by creating more robust mental representations in listening activities. The combination of audio-visuals and animated videos improves learners' understanding of foreign language conversations through contextual and rich nuances. In other words, this approach enhances the mental processes involved in understanding spoken language. However, using multimedia in listening classes presents several challenges, such as disrupting the learning process when the device or platform malfunctions and making it difficult for some students to understand material with unfamiliar accents or intonations.

This study's findings may have significant implications for educational technology, cognitive psychology, language acquisition, EFL pedagogy, and the design of multimedia-based language learning tools. By identifying the cognitive effects of multimedia instruction on listening skills, the research could inform educators on how to more effectively integrate multimedia into language teaching strategies, fostering improved listening comprehension and retention

among learners. The study's insights could also lead to developing more targeted, cognitively engaging multimedia resources tailored to EFL learners' needs. The Grounded Theory approach contributes to a deeper understanding of the role of cognitive processes in language learning, encouraging further exploration of how different types of multimedia instruction influence various aspects of language learning.

This grounded study was conducted in a specific learning environment involving participants from different cultural and linguistic backgrounds, so the results of this study cannot be fully generalized to the context of English language learning in general. Moreover, the cognitive impact of multimedia-based instruction in this study is highly dependent on the availability of adequate technological infrastructure. Therefore, technological limitations in some learning environments may hinder the widespread application of the findings of this study. Future studies could explore how different types of multimedia (e.g., videos, podcasts, and interactive tools) impact specific cognitive processes involved in listening comprehension and retention across various proficiency levels. Additionally, longitudinal studies could assess the long-term effects of multimedia-based listening instruction on EFL learners' language acquisition. Further research could also investigate how factors such as learners' individual cognitive styles, cultural backgrounds, and prior language proficiency mediate the effectiveness of multimedia instruction. Comparative studies between multimedia-based instruction and traditional listening methods could provide valuable insights into their relative cognitive impacts. Finally, the development of a standardized framework for multimedia-based listening instruction could be a useful area for future research to enhance consistency and applicability in EFL classrooms globally.

#### ACKNOWLEDGEMENTS

Many thanks go to Beasiswa Pendidikan Indonesia (BPI), PPAPT Kemdiktisaintek and LPDP, Indonesian Education Scholarship, Center for Higher Education Funding and Assessment, and Indonesian Endowment Fund for Education for funding this research.

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