Transforming multimedia presentation design practices in a health sciences first-year module: A reflective case study.

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Declaration

I, **Ntagi Gerald Mariri** declare that the treatise entitled **Transforming multimedia presentation design practices in a health sciences first-year module: A reflective case study**, submitted for the qualification of PGdip in Higher Education at the University of the Free State is my independent work.

All the references that I have used have been indicated and acknowledged by means of complete references.

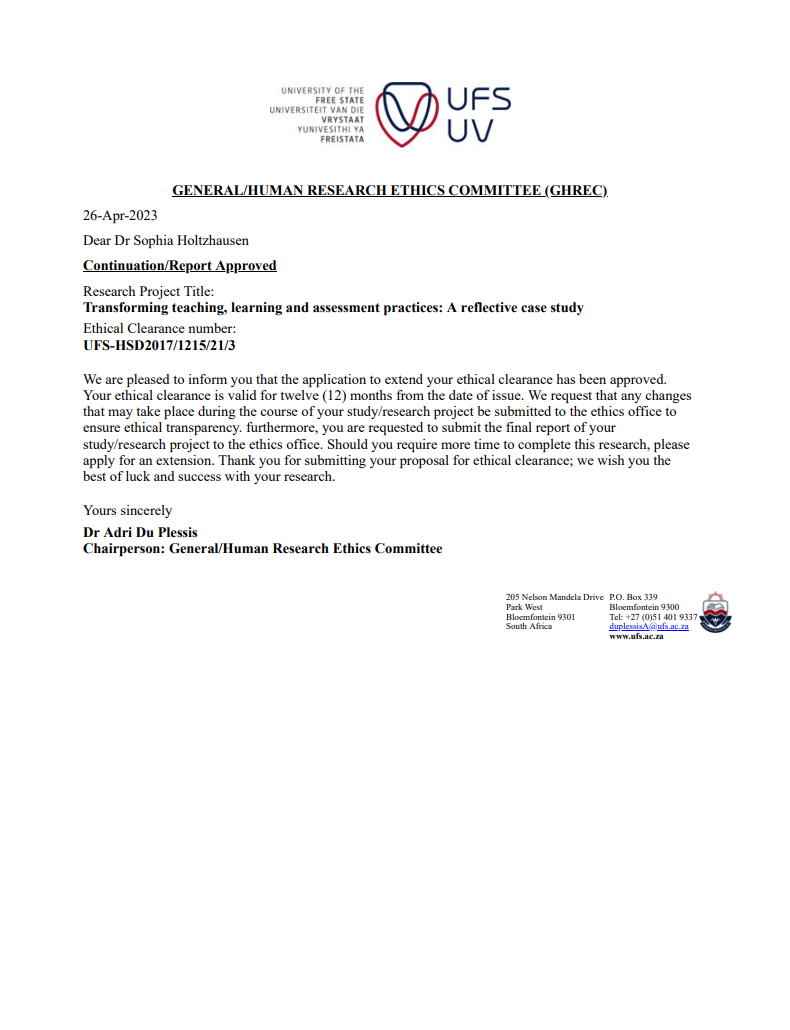
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Ethics Statement



Abstract

Many higher education institutions continue to rely on outdated curricula and teaching practices that are not aligned with the rapid technological advancements reshaping human life, work, learning, and interactions. While using multimedia in teaching has shown potential to improve cognition and comprehension, transitioning from traditional methods to multimedia presentations like Microsoft PowerPoint can sometimes hinder student engagement and performance. This study seeks to determine how to transform the teaching pedagogy adopted in a first-year health sciences module and identify the strengths, weaknesses, opportunities, and threats associated with current multimedia practices in the module. The transformation is guided by Richard Mayer's cognitive theory of multimedia learning. The research employs a pragmatic paradigm, an instrumental case study design and a mixed-method approach to analyze sets of 35-45 Microsoft PowerPoint slides across all 12 learning units. The approach combines quantitative and qualitative data collection methods, including Likert scales and SWOT analysis. Data analysis involves descriptive statistics for quantitative data and content analysis for qualitative data, with triangulation and a higher inter-rater reliability enhancing the study's rigor and consistency in data interpretation. Quantitative findings revealed a high degree of implementation of multimedia learning design principles in the teaching slides, focusing on principles like segmenting, pre-training, modality, coherence, signaling, spatial contiguity, and multimedia. Qualitative findings identified strengths, such as reducing extraneous cognitive load through principles like segmenting and signalling. Weaknesses were seen from underutilizing images, limiting the potential for improving cognitive processing. Opportunities included incorporating more images and enhancing signalling principles, while threats result from an overreliance on text, which can overload working memory's visual channel, particularly in technical subjects.

**Keywords**

**Transformation** refers to the practices that facilitate and guide the processes by which the composition, expression, or purpose of an entity is improved (Makgoba, 1997).

**Higher education** is a formal system that focuses on imparting knowledge and skills to students at post-secondary institutions (Bitzer, 2009).

**High-quality learning** involves acquiring and mastering new knowledge through scholarly engagements (Bandele and Oluwatayo, 2014).

**Multimedia learning** involves constructing a mental model from instructional material that includes both verbal and visual elements (Coskun and Cagiltay, 2021).

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Dedication

* This work and my life are dedicated to the cherished memory of my beloved late parents Tsheko and Mmantsulwana Mariri.

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List of Acronyms

|  |  |
| --- | --- |
| **Acronym** | **Word in full** |
| HE | Higher education |
| SAQA | South African qualifications authority |
| DHET | Department of higher education and training |
| NQF | National qualifications framework |
| IPM | Information processing model |
| CTML | Cognitive theory of multimedia learning |
| CLT | Cognitive load theory |

## Introduction

The concept of education is broad and lacks a universally accepted perception and definition in literature. However, it is generally viewed as the discipline that transfers and enhances knowledge, skills, societal values, and cultural heritage through various formal teaching and learning practices (Alemu, 2018; Petrus, 2019; van Wyk, 2008). Effective teaching requires the integration of cognitive, emotional, and environmental influences and experiences (Poulou and Norwich, 2002) to create productive and beneficial learning experiences for students (Bandele and Oluwatayo, 2014).

Higher education (HE) refers to the formal and organized systems and practices of educating and training at post-secondary or tertiary institutions, with the aim of producing qualified human resources that meet both the social and economic demands of societies (Alemu, 2018; Bitzer, 2009). Effective teaching and assessment are essential requirements for high-quality learning in HE, as they create the most productive and beneficial learning experiences for students (Bandele and Oluwatayo, 2014).

The South African Qualifications Authority (SAQA) Act of 1995 recognizes the need for a paradigm shift from a once-off, formal education system to an outcomes-based education system, where students and citizens must continuously re-orientate and educate themselves. In this context, student learning is crucial for achieving high-quality learning. According to earlier literature reports, students adopt either a surface or deep approach to learning (Tight, 2012). A strategic approach to learning, which combines aspects of both the deep and surface approaches, has also been identified (Troskie-de Bruin and Otto, 2004). Adopting a deep-level approach to learning is crucial to achieving the aims of the outcomes-based education system.

Effective teaching, learning, and assessment practices are interdependent and must be constantly transformed for HE to accomplish its diverse purposes. Updating the content delivered in HE is essential to achieving global acceptability and quality relevance. This reflective case study critically reflects upon the strengths, weaknesses, opportunities, and threats of multimedia presentation practices in transforming a health sciences first-year subject.

## Problem statement

The world is witnessing a rapid pace of technological advancement, leading to fundamental changes in how human beings live, work, learn, and relate to each other. These changes integrate the physical, digital, and biological realms, impacting how humans develop and learn. However, many higher education institutions continue to rely on outdated curricula and teaching practices that are not aligned with these technological advancements. The use of multimedia in teaching has been associated with improved cognitive abilities and faster memorization and learning processes among students, ultimately facilitating the comprehension of abstract concepts (Kotevski and Taveska, 2017).

Nevertheless, the transformation of teaching practices from traditional chalkboard writing to the use of multimedia presentations, such as Microsoft PowerPoint, can potentially decrease student participation and performance during lectures (Kibirige and Odora, 2021). This is a critical issue, as active student participation is essential for achieving outcomes-based learning, which is a key objective of higher education institutions.

Against this backdrop, this study seeks to transform the teaching pedagogy adopted in a first-year health sciences module. This transformation is guided by the multimedia presentation principles of Richard Mayer's cognitive theory of multimedia learning, which emphasizes the importance of effective communication, coordination, and integration of different sensory modalities during learning (Mayer, 2009).

## Research questions

This research study seeks to answer the following main research question: How can the multimedia presentation design practices in a health sciences first-year module be transformed?

The study also seeks to answer the following sub-question:

1. What are the strengths, weaknesses, opportunities, and threats associated with the current multimedia presentation practices in the health sciences first-year module?
2. How can the current multimedia presentation practices used in this module be improved?

## Aim and objectives of the study

The aim of this study is to determine how to transform multimedia presentation design practices in a health sciences first-year module.

The study has the following objectives:

1. To explore the strengths, weaknesses, opportunities, and threats associated with the current multimedia presentation practices in a health sciences first-year module.
2. To determine how to improve the current multimedia presentation practices used in a health sciences first-year module.

# Review of the literature

## Transforming teaching practices in higher education

In South Africa, the period after 27 April 1994 is widely regarded as an ongoing period of transformation. Makgoba (1997:181) defines transformation as "an act or process whereby the form, shape or nature of something is completely changed or altered, a blueprint change". In higher education, transformation involves addressing historical inequalities, serving a new social order, meeting urgent national needs, and responding to new realities and opportunities (DHET, 1997). Achieving transformation in HE requires changes in educational budget allocations, educational bureaucracies, student and staff composition, the prescribed curriculum, and the prevailing ethos (Waghid, 2001). The necessary changes should be focused on how knowledge is acquired, produced, and implemented. A transformed HE system should produce individuals who can acquire and apply new knowledge to address past and present problems (Badat, 2010). This means that transforming HE should involve consistent changes in teaching and learning processes to empower educators and students to develop the critical ability to address the developmental needs of society (Waghid, 2001). Consequently, the design of instructions required for transformative learning must cater to the requirements of human cognitive architecture processes, thereby making active learning possible (Prempeh and Appiah, 2017).

Various factors, including higher education policy frameworks from external stakeholders such as the National Qualifications Framework (NQF), the Ministry of Education, and the South African Qualifications Authority (SAQA), influence transformation in HE (Waghid, 2001). The NQF is a formal system with a set of principles and guidelines that assigns credits to each level of learning achievement to ensure that skills and knowledge learned are recognized throughout the country. This is intended to accelerate the repair of the historical unfair discrimination in education, training, and employment opportunities (SAQA, 2020). Similarly, the Higher Education Act No. 101 of 1997 has been adopted to "restructure and transform programs and institutions to respond better to the human resource, economic, and development needs of the Republic" (Higher Education Act, No. 101, 1997:2).

## Teaching, learning and assessment in higher education

Effective teaching and learning at the classroom level require a multidimensional system that considers the teacher, students, teaching context, learning activities, and lesson outcomes. Koseoglu and Efendioglu (2015) found that incorporating visual aids can help students develop concrete mental models, understand theoretical concepts, and use higher order thinking skills, ultimately leading to a more effective learning environment. Utilizing visual materials during instruction is particularly important in science-related subjects, where abstract concepts can be difficult for students to grasp. Multimedia learning involves the construction of a mental model from instructional materials that include both verbal and visual elements (Campbell, 2013; Coskun and Cagiltay, 2021). Microsoft PowerPoint presentation slides can be used to deliver content in an understandable and appealing format to students, using a mixture of words, images, flow charts, diagrams, sound, and video clips (Kibirige and Odora, 2021).

High-quality teaching and learning require the integration of teaching and assessment methods that align with the subject outcomes (Brits *et al*., 2020; Papageorgiou, 2021). If assessments only test lower cognitive-level abilities rather than the curriculum objectives, the teaching and learning system will be guided by assessments rather than the curriculum objectives (Biggs, 1996). In higher education, assessment practices should serve crucial purposes beyond certification, such as facilitating current learning and lifelong learning (Colson *et al*., 2021).

## Theoretical framework

The current study is underpinned by the theoretical principles of the information processing model (IPM) and cognitive theory of multimedia learning (CTML) as originally developed by Richard Mayer in 1997 (Mayer, 2020) which draws from the grand theory of cognitivism. Cognitivism, popularized by Jean Piaget, holds that learning requires a mental process in which existing sets of information in the mind are perceived alongside new sets of information acquired through the senses (Oommen, 2020). Cognitivism involves studying mental activities such as sensation, perception, attention, encoding, and memory (Jordan *et al*., 2008).

The information processing model of learning is a theoretical framework that describes how individuals learn and focuses on the conditions required for students to develop knowledge by effectively managing the limited space of working memory (Stott, 2018). This entails minimizing extraneous cognitive load and prioritizing the clear presentation of information, to facilitate learners' utilization of essential and generative cognitive processes. This enables learners to effectively select and integrate knowledge elements (Stott, 2018), leading to the achievement of the two primary goals of learning: remembering and understanding (Stott, 2017). According to Mayer (2020:19), remembering is “the ability to reproduce or recognize the presented material, and is assessed by retention tests”. Understanding is “the ability to construct a coherent mental representation from the presented material, it is reflected in the ability to use the presented material in novel situations and is assessed by transfer tests”.

The information processing model of learning suggests that information is processed through a series of stages (Figure 1). Sensory input is the first stage, where information is received through any of the five senses, such as sight or hearing and perceived with the sensory memory. Attention is the second stage, where attention is focused on the sensory input and irrelevant information is filtered out and only selected information is passed along into the working memory. The working memory is a region in the human brain where information is contained and processed prior to the possibility of it being stored in the long-term memory. Therefore, learning occurs in the working memory. Encoding is the third stage, where we transform the sensory input into a format that can be stored in the working memory. Due to the limited capacity of the working memory, it is necessary to rehearse information to retain it in working memory, according to cognitive load theory. Storage is the fourth stage, where information is stored in the long-term memory. Retrieval is the final stage, where we recall information from the long-term memory into the working memory. Information can also be retained in the long-term memory by encoding information from the working model (Mundy and Potgieter, 2019).



**Figure 1:** The relationship between the IPM and CLT

Cognitive load theory (CLT) is a theoretical framework that describes how the human brain processes information and the factors that influence the availability and limits of working memory. CLT maintains that each processing channel of the working memory has a limited capacity at a given time (Asma and Dalle, 2020).

The CTML comprises three aspects that describe the working memory (Figure 1), in which learning occurs: the two channels (audio and visual) of information processing, the limited capacity of each channel, and the active processes of filtering, selecting, organizing, and integrating information based on prior knowledge (Kaheru and Kriek, 2016; Mayer, 2020). Therefore, CTML is founded on other well-established theories such as Pavio's theory of dual coding (Paivio, 2006) and the cognitive load theory (Asma and Dalle, 2020). According to Pavio's theory, working memory has two separate channels, one for processing images and another for processing words (Reju and Jita, 2017; Kibirige and Odora, 2021). However, CLT maintains that each of these channels of working memory have a limited capacity of processing information at a given time (Asma and Dalle, 2020). Therefore, if the available space in one channel (e.g., text) is unused, it cannot be reassigned to an overload in the other channel (images). Additionally, information from the two channels can be successfully transmitted when integrated with existing knowledge (Prempeh and Appiah, 2017; Mayer, 2020). Active processing within working memory is related to the intrinsic cognitive load imposed by the ability of the student to understand new information given their previous knowledge and the complexity of the material, the extraneous cognitive load resulting from poor instructional design, and the germane cognitive load reflecting the effort required to construct schemas when relating new information to long-term memory (Dirkx *et al*., 2021).

A large amount of research has been done to design the Principles of Multimedia learning (Table 1). Each of these principles is embedded in large scale empirical studies’ findings. Each of them has been interpreted in terms of cognitive load theory.

**Table 1**: The design principles of multimedia learning (Mayer, 2020; Mayer, 2021; Ceken and Taskin, 2022)

|  |  |  |  |
| --- | --- | --- | --- |
| **Cognitive load effect load** | **Principle** | **Description** | **How to implement** |
| Minimizes extraneous cognitive load effect | Coherence | Students learn better when extraneous material is not included and working memory is freed up | * Only Include text, graphics, and narration that support learning objectives (e.g., avoid decorative images or supplemental materials), * Avoid having background music during the lectures, * Use simple visuals (instead of realistic or detailed visuals) |
| Signalling | Learning can be enhanced when teachers use on-screen cues to direct the attention of the students towards the most important information and how it is organised | * Use signals like arrows, and highlighting, to attract student’s attention to the most important information on the screen * Include a slide that indicates how the multimedia presentation is organized and refer to it when you advance to a new section |
| Redundancy | Students do not learn better when printed text is added to graphics and narration, instead, they learn better from graphics and narration | * Use either graphics or text, but not both when delivering a narrated presentation, * Minimize the use of text during a narrated presentation |
| Spatial | Teachers must keep written words (like labels or captions) closer to the images and graphics that they describe | * Place words closer to the corresponding images, * Provide feedback shortly after asking the questions, * Present instructions on the same screen as the activity, * Have students read words before starting an animated graphic |
| Temporal contiguity | Students can learn better if visual and verbal material is presented simultaneously instead of successively | * Synchronize narration and material on the slide |
| Manages intrinsic cognitive load | Segmenting | Students learn effectively when multimedia lessons are split into shorter segments and presented sequentially with the students controlling the pace of the lesson | * Permit students to control the pace of the lecture, * Break down long and complex segments of information into smaller pieces |
|  | Pre-training | Students learn effectively if they know the names and characteristics of the main concepts of multimedia lessons. | * Define key terms (names, definitions, locations, and characteristics of components to be presented) at the onset of a process-based presentation, either in a separate presentation, handout, or similar material, * Ensure students are familiar with and can use tool (such as Excel) through which the learning activities will be performed |
|  | Modality | Students learn best when information is presented by combining spoken words with images or video with audio, in comparison to combining images and printed words. | * Avoid using on-screen text, except where it:   + Lists key steps,   + Provides directions,   + Provides references,   + Presents important information to non-native English speakers. |
| Reduces germane cognitive load | Multimedia | Students learn more effectively from multimedia presentations than from traditional, single-channel verbal or visual presentations. | * Include images to demonstrate key points, * Ensure that all images enhance or clarify meaning (instead of being purely decorative), * Preferably use static images over animations |
|  | Personalization | Students learn better from multimedia presentations when words are in conversational style rather than formal style | * Use contractions, * Use first and second person (“I,” “you,” “we,” “our,”), * Try to sound extemporaneous when using a script, * Use polite speech (“please,” “you might like to,”). |
|  | Voice | Students are more likely to learn and understand when content is delivered through words spoken in an appealing and friendly human voice instead of in a machine voice | * Use human-made narrations instead of those generated by a computer |
|  | Images | Students may not learn more effectively when the speaker’s image is on the screen. | * Avoid embedding a video of themselves during asynchronous multimedia presentations containing images and words * Consider embedding their faces within multimedia presentations when:   + There are no words or images,   + They intend to establish a teacher or social presence |

## The design principles of multimedia in higher education

The theory of multimedia learning provides a framework for designing effective multimedia materials for learning, and its twelve principles have been proved through empirical research to be effective in maximizing learning outcomes (Mayer, 2020; Ceken and Taskin, 2022). These principles are grouped into three categories based on the type of cognitive load they address intrinsic, extraneous, and germane cognitive load (Table 1) (Mayer, 2020; Doherty, 2022). Intrinsic cognitive load can be managed through three principles: segmenting, pre-training, and modality (Ceken and Taskin, 2022). Poor instructional design can result in mental processing that does not contribute to schema acquisition or automation, resulting in extraneous cognitive load (Davids and Chikte, 2015). To reduce extraneous cognitive load, the five principles of coherence, signalling, redundancy, and spatial and temporal contiguity should be applied (Mayer, 2020; Ceken and Taskin, 2022). Finally, the four remaining principles of multimedia, personalization, voice, and images can be applied to minimize germane cognitive load (Ceken and Taskin, 2022).

## Principles for managing essential processing in multimedia learning

### The segmenting principle

The segmenting principle suggests that the multimedia lesson should be split into shorter segments to allow students to adequately process the information on each slide, and the lesson should be presented sequentially with students controlling the pace of delivery (Doherty, 2022; Mayer, 2020).

To adhere to this principle, teachers should:

* Allow students to control the pace of the lecture,
* Break down long and complex segments of information into smaller pieces.

### The pre-training principle

Presenting complex content using multimedia at a fast pace to students who do not have prior knowledge of it, can overload the student's cognitive capacity, as it requires them to process large amounts of new and intricate information. This phenomenon is known as intrinsic load and can be managed by providing the students with prior knowledge that will enable them to process the information they are receiving. Teachers can achieve this by:

* Defining key terms, such as names, definitions, locations, and characteristics of components, at the beginning of a process-based presentation, either in a separate presentation, handout, or similar material,
* Ensuring that students are familiar with and can use the tool, such as Excel, through which the learning activities will be performed (Jung *et al*., 2021).

### The modality principle

According to Mayer (2020), the modality principle is based on the concept that different cognitive systems are used for processing verbal and visual information (Paivio's theory of dual coding) and that combining both can lead to deeper understanding and better retention of the material being learned. The modality principle suggests that people learn best when information is presented using both visual and auditory modes. For instance, combining spoken words with images or video with audio can help learners process and retain information more effectively as compared to combining images and printed words. To adhere to this principle, the teacher when narrating presentations with graphics, must:

* Avoid using on-screen text except where it lists key steps, provides directions, presents important information to non-native English speakers, or provides references (Mayer, 2020).

## Principles for reducing extraneous cognitive in multimedia learning.

### The coherence principle

The coherence principle is focused on reducing extraneous cognitive load, thereby freeing up working memory to facilitate learning (Mayer, 2020). To achieve this, teachers must not include information in their multimedia presentations that is not relevant to the targeted learning outcomes, as this will distract them from achieving the learning outcomes (Davids and Chikte, 2015). To avoid interference with the student’s construction of mental models, the teacher’s methods of content presentation must:

* Only include text, graphics, and narration that support learning objectives (e.g., do not use decorative images or supplemental materials),
* Avoid having background music during the lectures,
* Use simplified visuals instead of realistic or detailed visuals (Mayer, 2020).

These practices help to ensure that the student’s attention is focused on the most relevant information and that they are not overwhelmed with unnecessary information or stimuli.

### The signalling principle

The signalling principle suggests that teachers must use on-screen cues to direct students' attention towards the most important information and how it is organized, reducing extraneous processing, particularly when multiple pieces of information are presented on-screen.

To adhere to the signalling principle, teachers can:

* Use signals such as arrows and highlighting to attract students' attention to the most important information on the screen,
* Include a slide that indicates how the multimedia presentation is organized and refer to it when advancing to a new section (Doherty, 2022).

### The redundancy principle

This multimedia principle suggests that people learn better from graphics and narration than from graphics, narration, and printed text, especially when the lesson is fast-paced (Mayer, 2020). Adding text to graphics and narration can overload students' visual channels and direct their cognitive processes towards resolving differences between spoken words and written text, rather than constructing new mental models. Therefore, the instructional design must minimize unnecessary working memory load when presenting new information. To adhere to this principle, teachers can:

* Use graphics or text, but not both, when delivering a narrated presentation,
* Minimize the use of text during a narrated presentation (Baceviciute *et al*., 2021).

### The spatial contiguity principle

The spatial contiguity principle suggests that teachers should keep written words such as labels or captions close to the images and graphics they describe, thus reducing the cognitive effort required to align the meaning of words and images. This avoids extensive scanning of the screen and reduces cognitive load.

To adhere to this principle, teachers should:

* Place words close to corresponding images,
* Provide feedback shortly after asking questions,
* Present instructions on the same screen as the activity,
* Have students read words before starting an animated graphic (Chen, 2020).

### The temporal contiguity principle

The teacher’s narration must be synchronized with the video or animation used in the multimedia presentation. This ensures that what the teacher says is synchronized with the material displayed on the screen. To implement this principle, the teacher must:

* Ensure that their narration of the content of the lesson is synchronized with the animations used (Mayer, 2021).

## Principles for optimizing germane load in multimedia learning

### The multimedia principle

The multimedia principle proposes that people learn better from multimedia presentations than from traditional, single-channel verbal or visual presentations by engaging different regions of the brain with different modes of information such as text, images, video, and audio. This principle is based on the understanding that providing information in multiple modalities can facilitate learning. To adhere to this principle, teachers should:

* Include images to demonstrate key points,
* Ensure that all images enhance or clarify meaning, and
* Preferably use static images over animations to avoid cognitive overload (Mutlu-Bayraktar *et al*., 2019).

### The personalization principle

According to Mayer (2020), multimedia presentations are more effective for learning when the language used is conversational in style rather than formal. As such, instructional materials should be designed and delivered through a more approachable colloquial language that is pitched using a relaxed tone instead of stiff, academic language. Therefore, the teacher must:

* Use contractions,
* Use first and second person (“I,” “you,” “we,” “our,”),
* Try to sound extemporaneous when using a script,
* Use polite speech (“please,” “you might like to,”).

### The voice principle

The voice principle suggests that students learn and understand better when content is delivered through words spoken in a friendly human voice rather than in a machine-generated voice (Mayer, 2020). As a result, the teacher should:

* Ensure that the multimedia content is narrated by a human rather than by a computer.

### The image principle

Students may feel disconnected when engaging with a multimedia lecture, especially when delivered online. To enhance students' sense of social presence, teachers may add an onscreen character that presents each aspect of the content of the slides, either as an animated pedagogical agent or an actual human teacher. This principle suggests that teachers should:

* Avoid embedding a video of themselves during asynchronous multimedia presentations containing images and words, and
* Consider embedding their faces within multimedia presentations when there are no words or images, or when they intend to establish a teacher or social presence (Mayer, 2020).

### 2.5. Conclusion

In order to facilitate effective teaching and learning in higher education, it is imperative to adopt a comprehensive approach that considers various factors, including the teacher, students, teaching context, learning activities, and desired lesson outcomes. By incorporating visual aids and multimedia materials, educational outcomes can be enhanced as they aid students in constructing concrete mental representations, comprehending abstract concepts, and applying advanced cognitive abilities. The theoretical framework of the present study draws upon the information processing model and the cognitive theory of multimedia learning. The IPM elucidates how individuals acquire knowledge and focuses on the prerequisites for effective knowledge development by managing working memory. The CTML highlights the significance of the two information processing channels (audio and visual) in working memory and the active processes of filtering, selecting, organizing, and integrating information based on prior knowledge. Design principles for multimedia in higher education, rooted in the theory of multimedia learning, provide a framework for creating impactful multimedia materials. These principles encompass intrinsic, extraneous, and germane cognitive load. The segmenting principle proposes breaking down information into shorter segments, the pre-training principle underscores the provision of prior knowledge, and the modality principle accentuates the combination of verbal and visual information. Principles for minimizing extraneous cognitive load comprise coherence, signalling, redundancy, spatial contiguity, and temporal congruity. The multimedia principle, along with the principles of personalization, voice, and images, optimize germane cognitive load.

In summary, this chapter provides a comprehensive literature review and establishes the conceptual and theoretical frameworks employed in the study. The subsequent chapter will delve into the research methodology, encompassing the paradigm, approach, design, sampling procedure, data collection, data analysis, validity, and reliability measures, as well as ethical considerations.

# Methods

## Research paradigm

The current study adopted a pragmatic research paradigm, which is a philosophical and methodological perspective that does not adhere to any specific system of philosophy or reality (Creswell and Creswell, 2018). According to this approach, reality is considered a dynamic concept that is constantly renegotiated, debated, and interpreted. Pragmatism suggests that researchers should select the philosophical and methodological approaches that are most suitable for investigating the research problem at hand (Kaushik and Walsh, 2019).

Pragmatism is often associated with mixed methods research, wherein researchers prioritize the research problem and question over specific methods and employ a combination of approaches to gain a comprehensive understanding of the problem (Creswell and Creswell, 2018). Pragmatism was best suited in this study because it encouraged the integration of diverse methods and perspectives to find ‘what works’ best to answer the research questions. It recognizes that different research approaches and methodologies can provide valuable insights and may be combined to achieve a comprehensive understanding of complex phenomena. Pragmatism emphasizes the importance of acting and implementing findings which can inform practical interventions and bring about positive change (Cohen *et al.,* 2018).

## Research design

An instrumental case study research design was selected to collect empirical data in order to empirically address the research question (Smit, 2018). A case study is a “study of a single case and is associated with one or very few participants” (Plowright, 2011:24). A case study research design was deemed most appropriate as it allowed the researcher to focus on answering the main research question, “how can the multimedia presentation design practices in a health sciences first-year module be transformed?”. A case study design is particularly suitable for this purpose as it is explanatory and focused on seeking to find answers to questions around causal links within real-life phenomena. Furthermore, the case study design employed in this research was exploratory, enabling the investigation of situations where the outcomes for the phenomenon were unclear (Ramchander, 2018). Specifically, the instrumental case study approach enabled the researchers to use a specific case, namely the different sets of Microsoft PowerPoint presentation slides used for lecturing in the module under investigation, as a means to gain insights into a broader issue or phenomenon—the transformation of multimedia presentation design practices in higher education—and draw generalizations. The primary objective of an instrumental case study is not to comprehensively understand the case itself, but rather to utilize it as an instrument to provide unique or critical information related to a larger research question (Mills et al., 2010). The purpose of using case studies is to demonstrate the process of critical reflection, which should be applied to all instructional materials to enhance the quality of instruction and learning. Both the information processing model and cognitive theory of multimedia learning have established a strong relationship between multimedia design and its impact on memory retention and comprehension. This study, in turn, utilizes this relationship to evaluate the effectiveness of multimedia presentations within the specific module being evaluated. When a case study presents evidence of a relationship between variables in a specific or multiple cases, a fuzzy generalization can be tentatively proposed, suggesting that the same relationship might exist in other cases. Fuzzy generalizations acknowledge the inherent uncertainty and imprecision associated with causality, allowing for the representation of varying degrees of truth and membership when applying causal relationships to similar cases with nuanced differences. Fuzzy generalizations do not undermine the fundamental nature of causal attribution. Instead, they offer a framework for reasoning with imprecise data, conveying that causal relationships are not absolute (Horng et al., 2003). In the case of this study, fuzzy generalizations suggest that the effective design of multimedia presentations in teaching in higher education holds the potential to facilitate the achievement of the primary learning goals, namely, remembering and understanding. Apart from the significance of this research in transforming the teaching practises in this specific module, it is anticipated that readers can extract overarching principles that they can employ to enhance their own modules as well. Nonetheless, fuzzy generalizations do not make categorical assertions that the effective design of multimedia presentations in teaching invariably guarantees the attainment of the primary learning goals (scientific generalization). Moreover, they do not assert that the effective design of multimedia presentations in teaching will yield a specific percentage of students achieving the primary learning goals (statistical generalization) (Hammersley, 2001).

## Research approach

The present study aimed to analyze the strengths, weaknesses, opportunities, and threats associated with the use of multimedia presentation practices in a health sciences first-year module and determine how to improve the multimedia presentation practices used in the module. To accomplish this, the researcher relied on a mixed-method approach, in which the 12 different sets of Microsoft PowerPoint presentation slides used for lecturing in the module were subjected to a SWOT analysis against the design principles of multimedia learning derived from literature, particularly Mayer (2020) and Mayer (2021). For the purpose of this study, a teaching slide refers to a single Microsoft PowerPoint presentation slide (Figure 3), whereas a set of teaching slides is a series of Microsoft PowerPoint presentation slides (35-45 slides) used to teach a single learning unit (lesson) in the investigated module.

A mixed-method approach combines the characteristics of both quantitative and qualitative research methods. The fundamental assumption of this form of inquiry is that the integration of quantitative and qualitative data produces a deeper understanding that surpasses the insights offered by either quantitative or qualitative data alone (Creswell and Creswell, 2018). Quantitative research aims to explain phenomena by collecting detailed, numerical data, which is then analyzed using mathematically based methods such as statistics (Mohajan, 2020). Quantitative data typically includes closed-ended responses (Creswell and Creswell, 2018). As a result, quantitative research may provide limited insights into the underlying reasons, motivations, or subjective experiences of participants. It may not capture the richness and complexity of human behavior and emotions. Therefore, in this case, the quantitative research approach would have not provided insight to the strengths, weaknesses, opportunities, and threats of using multimedia to transform teaching practices in the module. This limitation was addressed by integrating the use of qualitative research along with quantitative research. Qualitative research investigates humans or systems through interaction or observation of the participants in their natural environment. It is systematic, logical, empirical, reductive, and transmittable (Ngidi *et al*., 2022). Qualitative data tends to be open-ended without predetermined responses (Creswell and Creswell, 2018). Qualitative research methods are particularly valuable in examining intangible concepts, opinions, or experiences in greater depth. They aim to uncover and interpret the meaning behind research findings by collecting in-depth and contextually relevant answers pertaining to the concepts under investigation (Kawaguchi-Suzuki et al., 2023).

## Sampling procedure

Sampling involves selecting cases with ample information for an in-depth analysis by experts on the investigated phenomenon (Ngidi *et al*., 2022). The term sampling usually refers to selection of human participants, however, in the case of artefacts analysis, it can refer to sampling of artefacts (Plowright, 2011). In the present study, a total population sampling procedure was employed as the target population comprised of all the different sets of the Microsoft PowerPoint presentation slides covering the 12 learning units of the syllabus of the investigated module. A total population sampling technique is more appropriate for studies that explore a relatively small number of cases (Botha and Coetzee, 2022).

## Data collection and instrumentation

This research study occurred from June to August 2023. Data was collected through the quantitative evaluations of the 12 different sets of the Microsoft PowerPoint presentation slides used to teach a first-year health science module, based on criteria (Annexure A) developed from Richard Mayer's cognitive theory of multimedia learning and the design principles of multimedia learning (Mayer, 2020; Mayer, 2021).

The same criteria were used to collect data qualitatively by analyzing the strengths, weaknesses, opportunities, and threats of using multimedia to transform teaching practices in the module. Data was collected using tabulated criteria that include a series of five-point Likert scales, ranging from "never" to "always". The Likert scale was chosen as a measurement tool because it provides a structured approach to quantifying qualitative responses in an objective manner (Das, 2021). The first column of the used criteria (Annexure A) indicates which presentation slides were evaluated. The second column specifies the principle being evaluated. Column three describes the concept involved in implementing the specific principle of multimedia learning. The fourth column was used to indicate the frequency with which the concepts involved in applying each of the twelve design principles of multimedia learning were implemented in the lecturing presentation slides. The last column was reserved for making the corresponding choices. An additional row was added to the tabulated criteria for the qualitative description of the strengths, weaknesses, opportunities, and threats associated with the use of multimedia in transforming teaching practices used in the module.

## Data analysis

The quantitative data collected through the artefact analysis of all different sets of the Microsoft PowerPoint presentation slides used for teaching was analyzed using descriptive statistics, including the frequency of concept implementation (Khalo and Bayaga, 2015). These statistics provided a summary of the quantitative data obtained by evaluating the different sets of the Microsoft PowerPoint presentation slides against criteria for the design principles of multimedia learning derived from Mayer's cognitive theory of multimedia learning (Mayer, 2020; Mayer, 2021).

Meanwhile, the qualitative data collected from performing a SWOT analysis of the use of multimedia in transforming teaching practices in the module was analyzed using the content analysis approach (Lindgren *et al*., 2020). This method enabled the researchers to analyze descriptive content and categorize results into themes. In this study, the data was coded into four categories: strengths, weaknesses, opportunities, and threats, providing a comprehensive analysis of the use of multimedia in the module.

## Validity, reliability, credibility, and trustworthiness

In general, a mixed-method research approach should include a description of how researchers establish validity and reliability for the quantitative aspects, credibility, or trustworthiness for the qualitative aspects, and how the qualitative and quantitative results for the overall project are integrated (Meyer and Schutz, 2020).

Validity refers to the concept of how believable the outcomes of a particular study are, or the degree to which the findings are consistent with reality. Reliability refers to the extent to which the study rationale and methodological approaches are reported and offers an audit trail to make it possible to replicate a study (Ramchander, 2018). In this study, the researcher reports transparently and incorporates descriptions, examples (screenshots), and explanations of their evaluations to enable readers to illustrate general trends and assess their validity.

The credibility of a study is judged by the sampling procedures and whether there was persistent engagement allowing for a deep description to convince the readers of the meticulous analysis. The trustworthiness of a research study is established by scrutinizing the chosen methods and data collection techniques and analyzing how results are reported (Meyer and Schutz, 2020). To establish validity, reliability, credibility, and trustworthiness, this study was guided by the theoretical principles of the cognitive theory of multimedia learning.

In this study, the qualitative methodological approach employed for data collection had certain limitations that necessitated the use of the quantitative methodological approach to compensate for them. Qualitative researchers are often susceptible to personal biases and limitations that arise from relying solely on a single methodology. Moreover, qualitative researchers do not prioritize the generalization of research findings to a broader population. Therefore, the data collected, and the conclusions drawn from the qualitative approach are specifically relevant to the transformation of multimedia presentation design practices within the examined module. These findings cannot be extended to other modules in higher education (HE). However, the value of these findings is in allowing readers to form fuzzy generalizations, wherein they extract relevant information from this study and infer that to their own situations (Coliier-Reed et al., 2013).

To address the above-mentioned concerns, a parallel mixed method research approach was employed, wherein qualitative and quantitative data were collected and analyzed simultaneously. The integration of the resulting data took place during the interpretation phase, following the principles of triangulation (Shorten and Smith, 2017). Triangulation involves gathering information about different events and relationships from various perspectives. This entails posing different questions, seeking diverse sources, and utilizing different methods. By employing triangulation, validity and reliability in quantitative research can be greatly enhanced. It bolsters the credibility and trustworthiness of qualitative research by ensuring consistency between the constructed reality derived from the utilized criteria (see Annexure A) and the attributes ascribed to them by the researcher. Triangulation enabled the study's results to remain objective and facilitated the exploration of multiple and divergent perspectives on how the design practices of multimedia presentations, used for teaching in higher education, can be transformed (Webb, 2009). In the present study, the researcher's research results were cross-checked with the findings of an independent senior lecturer using the inter-rater reliability technique. Inter-rater reliability evaluates whether another observer, who shares the same theoretical framework and observes the same phenomena, would have arrived at the same interpretations (Cohen et al., 2018). This technique measured the consistency between the researcher and an independent senior lecturer in their assessment decisions (Belur *et al*., 2021). In order to establish consistent and accurate data entry into the relevant categories when evaluating the implementation of multimedia learning design principles (as outlined in Annexure A), measures were taken to ensure common understanding between the independent observer and myself. For example, during our briefing session, I provided instructions that a cross (X) indicates agreement while categories that are not applicable are left blank. Subsequently, the percentage of inter-rater agreement between us was calculated using the following method:

X 100

In cases where the percentage of agreement between raters exceeds 90%, it is considered to be a strong indication of inter-rater agreement (Cohen et al., 2018). The inter-rater reliability index (extent of agreement) for the current study was 100% for learning units 2 and 5, 90% for learning unit 6 and 95% for learning unit 11. The overall average inter-rater reliability index for the study is 96%.

In accordance with Cohen et al., (2018), when the percentage of agreement between raters surpasses 90%, it is considered a strong indication of inter-rater agreement. In the current study, the inter-rater reliability index, reflecting the extent of agreement between the researcher and the independent observer, achieved high scores of 100% for learning units 2 and 5, 90% for learning unit 6, and 95% for learning unit 11. This indicates strong agreement among the two raters in their assessments and evaluations of the data. Calculating the overall average inter-rater reliability index across all learning units, the study obtained an impressive score of 96%, further supporting the reliability and consistency of the data interpretations.

## Ethical considerations

In research, the concept of ethics refers to the principles of right and wrong as accepted by a particular group of people (Ntseane, 2007). This study was part of a larger collaborative project that received ethical clearance from the General/Human Research Ethics Committee (GHREC) with ethical clearance number: UFS-HSD2017/1215/21/3. The present study upheld ethical principles, particularly regarding data protection and storage, through the implementation of rigorous practices. To ensure the privacy and security of the research, the institution where the research was conducted and the name of the course in which the analyzed teaching slides were utilized were intentionally withheld. This precautionary step was taken to mitigate potential risks and adverse consequences resulting from the research. The researcher also implemented stringent security measures to prevent data breaches and unauthorized access by storing the data on a secure, password-protected computer, thereby preserving the integrity of both the research and the institution where the study was conducted. Moreover, ethical decision-making remained integral throughout the study, as the researcher consistently assessed moral values, principles, and potential outcomes to inform his actions and choices (HSREC preparation guide: Application for ethics clearance, 2022).

## Conclusion

The current study adopted a pragmatic research paradigm, providing flexibility in selecting philosophical and methodological approaches suitable for investigating the research problem. An instrumental case study research design was employed to address the main research question regarding the transformation of multimedia presentation design practices in a health sciences first-year module. The study utilized a mixed-method approach, combining quantitative and qualitative research methods. To ensure comprehensive analysis, a total population sampling procedure was employed, involving the analysis of all different sets of the Microsoft PowerPoint presentation slides covering the 12 learning units of the investigated module. Data collection included quantitative evaluations of the different sets of the presentation slides using established criteria derived from cognitive theory and design principles of multimedia learning. The same criteria were used for qualitative data collection, conducting a SWOT analysis to identify strengths, weaknesses, opportunities, and threats associated with the use of multimedia in transforming teaching practices. Data analysis encompassed descriptive statistics for quantitative data and content analysis for qualitative data. Validity, reliability, credibility, and trustworthiness were established through the application of theoretical principles, triangulation, inter-rater reliability to measure consistency, and careful reporting of methods and results to ensure replicability and convince readers of the study's meticulous analysis.

In conclusion, this chapter has provided a comprehensive explanation of the research methodology employed in the study. It covered various aspects, including the research paradigm, approach, design, sampling procedure, data collection, data analysis, as well as validity and reliability considerations. Ethical considerations were also taken into account throughout the study. By elucidating these methodological details, this chapter has laid the foundation for the subsequent analysis and findings presented in the study.

This study is anticipated to make a positive contribution to the generation and dissemination of knowledge. It possesses the potential to offer valuable insights not limited to the findings of this particular module, but also to enlighten teaching practices in higher education by showcasing the transformative potential of multimedia presentations.

# Data presentation and analysis

## Introduction

The aim of this study was to determine how to transform multimedia presentation design practices in a health sciences first-year module. This chapter firstly presents the quantitative findings of the current study in response to one of the objectives of the study. The objective was to determine how to improve the current multimedia presentation practices the researcher uses in a health sciences first-year module by using established criteria derived from cognitive theory and design principles of multimedia learning. The criteria instrument (annexure A) used five-point Likert scales of never, rarely, sometimes, often and always. The data was analysed using a trinomial test based on infrequent (I) (consisting of never and rarely), moderate frequency (MF) (consisting of sometimes and often) and high frequency (HF) (consisting of always). As a result, infrequent frequency meant that the principles associated with implementing the evaluated multimedia learning principle were either “never” or “rarely” applied when designing the teaching slides. A moderate frequency signifies cases in which the principles related to implementing the evaluated multimedia learning principle were either “sometimes” or “often” implemented during the design of the teaching slides. On the other hand, a high frequency indicates that the principles linked to implementing the evaluated multimedia learning principle were “always” integrated when creating the teaching slides. The purpose of using the trinomial test was to determine the frequency with which the concepts involved in implementing the design principles of multimedia learning, are implemented in the lecturing slides used in the investigated module. The frequency of concept implementation of the Likert scores were calculated for each item. The frequencies of concept implementation were specifically calculated within dimensions that are relevant for evaluating individual sets of teaching slides on their own, rather than the individual sets of teaching slides together with the lecturer's narration. Consequently, the frequencies of concept implementation were not calculated for the redundancy principle and temporal contiguity principle of multimedia learning. This decision was made due to the specific nature of the teaching slides, which primarily function as supplementary materials to support the teacher during lessons, rather than being self-explanatory resources for independent understanding when assessed alongside the teacher's narration. Furthermore, the frequencies of concept implementation were also not calculated for the personalization principle, voice principle, and images principles. These principles are primarily relevant to verbal narrations and are less applicable to the visual and supplementary materials, which are the focus of this evaluation.

The quantitative data analysis process in this study, incorporates the following stages: assessing raw data, identifying potential patterns within the data to form hypothetical links, inputting and transferring data, data processing, data interpretation, and presenting research findings.

In the current chapter, the findings of the qualitative method are also presented in response to the first objective of the study, which is to analyze the strengths, weaknesses, opportunities, and threats associated with the then-current multimedia presentation practices in the investigate module. The criteria instrument (annexure A) included additional rows for the qualitative description of the SWOT analysis of the use of multimedia in transforming teaching practices used in the module. The data was analyzed using the content analysis approach (Lindgren et al., 2020). Content analysis allowed the researchers to analyze descriptive content and categorize results into themes. In this study, the data was coded into four categories: strengths, weaknesses, opportunities, and threats, providing a comprehensive analysis of the use of multimedia in the module. This is followed by a concluding summary of the research findings which attempts to integrate the findings.

## Findings and discussions

### Quantitative findings and discussions

4.2.1.1. The segmenting principle of multimedia learning

The evaluation of the multimedia presentation practices used in the investigated module has shown that the current presentation practices adhered to Mayer's segmenting principle of multimedia learning. Table 2 below depicts this. The first concept involved in implementing the segmenting principle of multimedia learning was employed with a high frequency, while the other concept was equally incorporated with moderate and high frequencies in the different sets of the teaching slides used in the investigated module.

Table 2: Results of the evaluation against the segmenting principle (n=12)

|  |  |  |  |
| --- | --- | --- | --- |
| Concepts involved in implementing the principle | Number of sets of slides which displayed each frequency of concept implementation | | |
| I (%) | MF (%) | HF (%) |
| Permits students to control the pace of the lecture | 00 | 05  (41.67) | **07**  **(58.33)** |
| Breaks down long and complex segments of information into smaller pieces | 00 | **06**  **(50.00)** | **06**  **(50.00)** |

I: Infrequent; MF: Moderate frequency; HF: High frequency

Bold-faceted data show noteworthy results.

The implementation of the segmenting principle of multimedia learning in the design of the different sets of teaching slides is depicted in Figure 2 below. Figure 2 illustrates how the researcher breaks down instructional content into manageable and coherent segments or chunks. The researcher effectively organizes information into discrete and concise sections, each focusing on a specific concept or topic. This information is delivered in the following teaching slides through brief and uncomplicated sentences, reducing extraneous cognitive load and enabling students to process and understand each piece of information more effectively. This approach aligns with the limited capacity of working memory, presenting a strength in alignment with Mayer's multimedia principles concerning the type of cognitive load they address (Chen and Yen, 2021).

A person sitting at a desk with a computer

Description automatically generated

**Figure 2:** Learning unit 5 outcomes and presentation organization

4.2.1.2. The pre-training principle of multimedia learning.

In the different sets of the investigated module's teaching slides, an evaluation of their alignment with the pre-training principle of multimedia learning revealed a high frequency of implementation for both concepts, as indicated in Table 3. The evaluation of the second concept within this principle was exclusively conducted for learning unit eight, as it was only relevant to this particular lesson. This distinction arises from the fact that learning unit eight is the only unit where specialized equipment was employed.

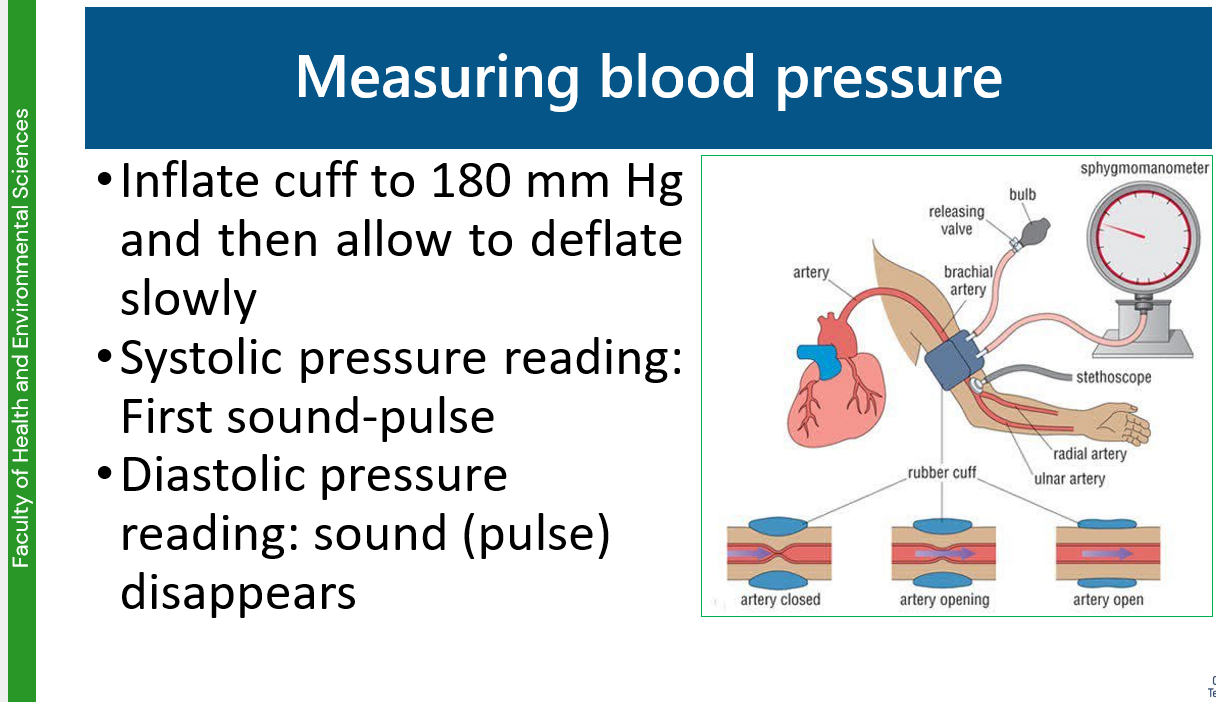
Table 3: Results of the evaluation against the pre-training principle (n=12/1)

|  |  |  |  |
| --- | --- | --- | --- |
| Concepts involved in implementing the principle | Number of sets of slides which displayed each frequency of concept implementation | | |
| I (%) | MF (%) | HF (%) |
| Defines key terms (like names, definitions, locations, and characteristics of components to be presented) at the onset of a process-based presentation, either in a separate presentation, handout, or similar material | 00 | 01  (8.33) | **11**  **(91.67)** |
| Ensures that the students are familiar with and can use the tool (such as stethoscopes and sphygmomanometers) through which the learning activities will be performed | 00 | 00 | **01**  **(100.00)** |

I: Infrequent; MF: Moderate frequency; HF: High frequency

Bold-faceted data show noteworthy results.

In learning unit eight, where students receive instruction on blood pressure measurement principles (Figure 3), the researcher ensures that students become proficient in utilizing specialized tools - stethoscopes and sphygmomanometers, before the lesson. These instruments are essential for performing the learning activities, specifically blood pressure measurements. This type of content delivery offers the design of these multimedia learning tools an opportunity to integrate both written text and images. This approach optimizes the use of working memory through utilizing both of its channels. It also manages germane cognitive load by supporting integration between images and text. Pre-training on fundamental concepts related to blood pressure measurements can simplify the learning process, reduce decrease intrinsic cognitive load and enhance the students' proficiency (Akcayir and Akcayir, 2018, Jung et al., 2021).



**Figure 3:** A slide from learning unit 8

4.2.1.3. The modality principle of multimedia learning

Approximately two thirds (66.67%) of the different sets of the teaching slides used in the module in question implemented the modality principle of multimedia learning at a moderate frequency, while the remaining 33.33% implemented the principle at a high frequency as demonstrated in Table 4.

Table 4: Results of the evaluation against the modality principle (n=12)

|  |  |  |  |
| --- | --- | --- | --- |
| Concepts involved in implementing the principle | Number of sets of slides which displayed each frequency of concept implementation | | |
| I (%) | MF (%) | HF (%) |
| Avoids using on-screen text, except where it:   * + Lists key steps,   + Provides directions,   + Provides references,   + Presents important information to non-native English speakers. | 00 | **08**  **(66.67)** | 04  (33.33) |

I: Infrequent; MF: Moderate frequency; HF: High frequency

Bold-faceted data show noteworthy results.

The implementation of the modality principle of multimedia learning in the design of the different sets of teaching slides is demonstrated in Figure 3 above. Figure 3 depicts how the researcher conveys information through multiple sensory modalities, including visual, auditory, and kinesthetic. This is achieved by the teacher's use of visual teaching slides, spoken explanations during the lesson, and hands-on kinesthetic learning, allowing students to physically handle and use stethoscopes and sphygmomanometers to measure their classmates' blood pressure readings. Presenting information in multiple formats enhances students' cognitive processing. Combining visual illustrations on teaching slides with spoken and written words can improve the learning of complex concepts (Antonietti et al., 2015). This approach offers an opportunity to transform teaching practices in line with Mayer's design principles of multimedia learning, particularly those aimed at managing intrinsic cognitive load (segmenting, pre-training, and modality principles).

4.2.1.4. The coherence principle of multimedia learning

The evaluation of the multimedia presentation practices used in the investigated module revealed that the current presentation practices adhered to Mayer’s coherence principle of multimedia learning. Table 5 below illustrates this. Two of the three concepts involved in implementing the coherence principle of multimedia learning are implemented with high frequency, while the other concept was implemented with moderate frequency in the lecturing slides used in the investigated module.

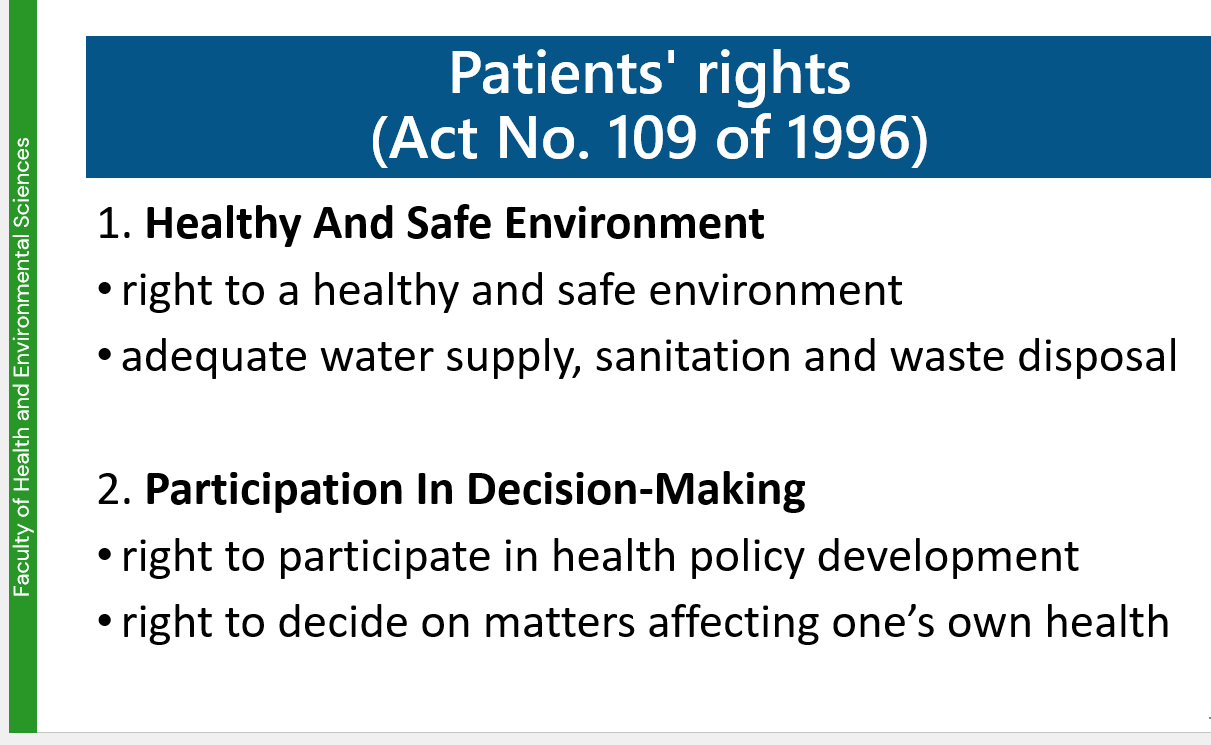
Table 5: Results of the evaluation against the coherence principle (n=12)

|  |  |  |  |
| --- | --- | --- | --- |
| Concepts involved in implementing the principle | Number of sets of slides which displayed each frequency of concept implementation | | |
| I (%) | MF (%) | HF (%) |
| Only includes text, graphics, and narration that support learning objectives (e.g., do not use decorative images or supplemental materials) | 00 | 03  (25.0) | **09**  **(75.0)** |
| Avoids having background music during the lectures | 00 | 00 | **12**  **(100.0)** |
| Uses simple visuals (instead of realistic or detailed visuals) | 04  (33.33) | **07**  **(58.33)** | 01  (8.33) |

I: Infrequent; MF: Moderate frequency; HF: High frequency

Bold-faceted data show noteworthy results.

Figure 2, located above, outlines the intended learning outcomes for the fifth learning unit in the module under investigation. Figure 4 serves as a practical example of a slide utilized during the lesson to explain "the concept of patient rights," a key learning outcome of the lesson. The slide in Figure 4 has been thoughtfully crafted to eliminate any unnecessary or irrelevant information, such as unnecessary details, decorations, or content that does not directly support learning objectives (De Back et al., 2021). This simplified approach ensures that students can concentrate on the core content, facilitating their cognitive processes and making it more manageable for them to learn and remember the information. The qualitative findings of this study have pinpointed a notable strength in the form of the effectiveness of the multimedia presentation design techniques utilized within the assessed module. This strength is particularly evident in their successful reduction of extraneous cognitive load. However, this approach does not optimize the use of working memory because only one of the two channels is utilized.



**Figure 4:** A slide from learning unit 5

4.2.1.5. The signaling principle of multimedia learning

In the different sets of the teaching slides of the investigated module, the designer employed both concepts required for implementing the signalling principle of multimedia learning with high frequency, as illustrated by Table 6 below. This indicates that the designer succeeded in applying the signalling principle to highlight key points, emphasize critical information, or direct the students' focus toward specific elements to enhance comprehension and retention.

Table 6: Results of the evaluation against the signaling principle (n=12)

|  |  |  |  |
| --- | --- | --- | --- |
| Concepts involved in implementing the principle | Number of sets of slides which displayed each frequency of concept implementation | | |
| I (%) | MF (%) | HF (%) |
| Uses signals such as arrows, and highlighting, to attract the student’s attention to the most important information on the screen | 03  (25.0) | 03  (25.0) | **06**  **(50.0)** |
| Includes a slide that indicates how the multimedia presentation is organized and refer to it when you advance to a new section | 00 | 00 | **12**  **(100.0)** |

I: Infrequent; MF: Moderate frequency; HF: High frequency

Bold-faceted data show noteworthy results.

Figure 5, displayed below, attests to the designer's effective application of the signaling principle in multimedia learning. For instance, in learning unit two, when explaining the definitions of "health" and "healthcare," the designer employs signals like the use of red highlighting to draw attention to critical terms. This strategic approach in the multimedia design aids students in focusing on and understanding essential information with minimal cognitive effort, ultimately improving germane cognitive load (Longo and Orru, 2022).

Furthermore, Figure 2, depicted above, offers a representative example of one of the teaching slides found throughout the different sets of the teaching slides. These slides serve to clarify how the multimedia presentation is structured. The inherent benefit of including such a slide is to ensure that the teacher successfully addresses all the designated learning objectives by the end of the lesson (Chen et al., 2017).



**Figure 5:** A slide from learning unit 2

4.2.1.6.The spatial contiguity principle of multimedia learning

The evaluation of the different sets of teaching slides in the investigated module revealed that both concepts involved in implementing the spatial contiguity principle were implemented with a high frequency of 75% and 100%, respectively.

Table 7: Results of the evaluation against the spatial contiguity principle (n=12)

|  |  |  |  |
| --- | --- | --- | --- |
| Concepts involved in implementing the principle | Number of sets of slides which displayed each frequency of concept implementation | | |
| I (%) | MF (%) | HF (%) |
| Places words closer to the corresponding images | 03  (25.00) | 00 | **09**  **(75.00)** |
| Provides feedback shortly after asking the questions | 00 | 00 | **12**  **(100.00)** |
| Presents instructions on the same screen as the activity. | - | - | - |
| Allows students to read the words before starting an animated graphic. | - | - | - |

I: Infrequent; MF: Moderate frequency; HF: High frequency

Bold-faceted data show noteworthy results.

Figure 6, displayed below, shows a transformed slide intended for future use in learning unit 7. In this slide, the designer has taken care to position words in close proximity to their corresponding images, effectively implementing the spatial contiguity principle. This deliberate arrangement ensures that learners can readily connect the textual and visual information. Additionally, cognitive load is known to be reduced when descriptors are incorporated within a figure or diagram since this eliminates the need for cognitive resources to be used in integrating the descriptors and the figure or diagram (Hillard and Sedaghat, 2021).

The qualitative findings of this study have highlighted weaknesses in the design strategies employed in the analyzed module. These weaknesses are primarily associated with the absence of relevant images in the teaching slides, resulting in the underutilization and inefficient use of the available space within the working memory's image-processing channel. It is evident that there is an opportunity to transform these design practices by aligning them with the principles that govern how information should be presented in educational materials, ultimately improving the enhancement of learning and comprehension.

A poster with different types of physical restraint

Description automatically generated with medium confidence

**Figure 6:** A transformed slide for future use with learning unit 7

4.2.1.7. The multimedia principle of multimedia learning

Two-quarters of the different sets of the presentation slides used for teaching in the investigated module included images to illustrate key points at a high frequency, while a quarter implemented this concept of the multimedia principle at a moderate frequency, and the remaining quarter implemented the concept infrequently. The remaining two concepts of the principle were applied at a higher frequency as seen in Table 8.

Table 8: Results of the evaluation against the multimedia principle (n=12)

|  |  |  |  |
| --- | --- | --- | --- |
| Concepts involved in implementing the principle | Number of sets of slides which displayed each frequency of concept implementation | | |
| I (%) | MF (%) | HF (%) |
| Includes images to demonstrate key points | 03  (25.00) | 03  (25.00) | **06**  **(50.00)** |
| Ensures that all images enhance or clarify meaning (instead of being purely decorative) | 03  (25.00) | 00 | **09**  **(75.00)** |
| Preferably uses static images over animations | 03  (25.00) | 00 | **09**  **(75.00)** |

I: Infrequent; MF: Moderate frequency; HF: High frequency

Bold-faceted data show noteworthy results.

The teaching slides, as exemplified by Figures 3 and 6, illustrate the designer's skill in incorporating images to illustrate key points. These slides ensure that all images serve to enhance or clarify meaning, avoiding mere decorative elements. In this way, most of these teaching slides effectively adhere to one of the fundamental principles in instructional design, known as the multimedia principle. In educational materials design, the integration of both text and related visuals enriches the learning experience (Rapchak, 2017). For instance, when presenting a concept, a combination of textual explanations alongside accompanying images or animations can significantly help students in understanding the content more readily (Zhang and Di Zou, 2022).

### Qualitative findings and discussions

The qualitative results of this study will be structured and presented in line with the theoretical framework underpinning the study and emerging themes from the analysis of the data. The following paragraphs present the results of the analysis of strengths, weaknesses, opportunities, and threats associated with the current multimedia presentation practices in the module under investigation.

**Strengths**

The theme “strengths” entails a description of the analysis of the strengths associated with the current multimedia presentation practices when evaluated against Mayer’s multimedia principles based on the type of cognitive load they address. The overall strength of the multimedia presentation design practices adopted in the investigated module is mostly the implementation of the principles that successfully reduce extraneous cognitive load.

Figure 7 below illustrates the findings extracted from an analysis of learning unit five, focused on identifying the strengths related to the utilization of multimedia presentation practices within a first-year health sciences module. The aim is to discover insights for enhancing these practices within the module.

A close-up of a white background

Description automatically generated

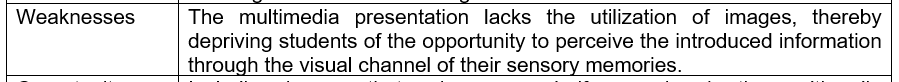
**Figure 7:** Strength analysis results: transforming multimedia design practices (learning unit 5 extract)

The figure presented as Figure 2 illustrates the intended learning outcomes for learning unit five of the investigated module, while Figure 4 provides an illustrative example of a slide used during the lesson to convey "the concept of patient rights". By including a slide that indicates how the multimedia presentation is organized (Figure 2), the designer effectively adheres to the signalling principle of multimedia learning (Chiu and Churchill, 2014).

Figure 4 is designed with the intention of reducing extraneous cognitive load by including only text that supports the intended learning outcomes on the slide and avoiding the use of full sentences within the slides (Young et al., 2016).

**Weaknesses**

The "weaknesses" theme involves a description of the shortcomings linked to the present multimedia presentation design methods when assessed in terms of how they align with Mayer's multimedia principles in addressing cognitive load types. The results (Figure 8) indicate that within the majority of the different sets of teaching slides, the instructional design had shortcomings in effectively enhancing germane cognitive load for the students by effectively managing intrinsic cognitive load. This is because the instructional material mainly presented information through written text (see, for example, Figure 5). Although, the written text does not use full sentences and supports the intended learning outcomes, the exclusion of appropriate images means that the available space in the image-processing channel of the working memory is not utilized and is therefore wasted.



**Figure 8:** Weaknesses analysis results: transforming multimedia design practices (learning unit 5 extract).

**Opportunities**

The theme "opportunities" focused on the analysis of the possibilities for transforming the current multimedia presentation techniques. These opportunities were evaluated in the context of how well they would adhere to Mayer's multimedia principles in addressing different types of cognitive load. The data emerging from the analysis of the opportunities to transform the multimedia presentation design practices in a health sciences first-year module lie with adopting instructional design techniques that implement Mayer’s multimedia presentation principles that reduces extraneous processing to enhance germane load (Lange, 2023). This is clearly illustrated in the image below, which displays the findings of the opportunity analysis regarding the utilization of multimedia to transform teaching practices within the module, with a specific focus on learning unit 2.

A close-up of a white paper

Description automatically generated

**Figure 9:** Opportunity analysis results: transforming multimedia design practices (learning unit 2 extract)

The instructional design techniques applied in learning unit 2 (Figure 10) have the potential to improve their effectiveness by reducing extraneous processing, thus promoting active processing within working memory to enhance germane cognitive load (Greenberg and Zheng, 2023). For example, in future iterations of teaching slides used in the instruction of the investigated module (Figure 5), the designer should use signals like highlighting to direct the students' attention to the most important information on the screen, as prescribed by the signaling principle of multimedia learning.

A close-up of a health and healthcare

Description automatically generated

**Figure 10:** A slide from learning unit 2

Furthermore, Figure 11 below illustrates a teaching slide from learning unit 7 within the module under investigation before transformation. This slide conveys information solely through text, engaging only one channel (text) of working memory. This text-centric approach could potentially overwhelm students' textual processing and redirect their cognitive efforts toward reconciling disparities between spoken words and written text (Jabbour, 2012).

On the contrary, a modified slide, presented as Figure 6 above, serves the same informational purpose. In this slide, the designer has strategically placed words near their corresponding images, effectively applying the spatial contiguity principle. This intentional arrangement ensures that learners can easily connect textual and visual information, allowing for the optimal utilization of both channels within working memory (Woollacott et al., 2022).

A white and blue sign with black text

Description automatically generated

**Figure 11:** A slide from learning unit 7 before the transformation

**Threats**

The theme of "threats" reports on the analysis of the threats to the potential transformation of the current multimedia presentation design practices, in light of their alignment with Mayer's multimedia principles for designing effective multimedia materials for learning (Grech, 2018). The data developed from the analysis shows that these threats result from the fact that in order to capitalize on the opportunity to better utilize both channels of working memory space, the designer would have to source relevant images, which will be time consuming and might incur some costs if there are no appropriate images available in the public domain, requiring hiring an artist or buying the right to use images. Also, since technical images may be required for technical subjects, it is less likely that appropriate free images may be obtainable.

Figure 11 provides an example of an untransformed teaching slide from learning unit 7 within the investigated module. The figure highlights the threats to the transformation of current multimedia presentation design practices resulting from excessive reliance on written text, prompting only the use of one channel (text) of the working memory. The delivery of information in this manner has the potential to overwhelm students' visual channels and divert their cognitive processes toward resolving disparities between spoken words and written text. This, in turn, hinders their ability to construct new mental models. To address this challenge, a more effective approach involves combining minimal written text and appropriate images in the slides (Figure 6) supplemented verbal explanations provided by the teacher. This modification would promote active processing within working memory, ultimately leading to an enhancement in germane cognitive load.

### Limitations of the study

There were certain limitations in this study that originated from the method of collecting qualitative data. Qualitative data was obtained through a SWOT analysis of the use of multimedia in transforming teaching practices within the module. The researcher's observations during this process are susceptible to bias and subjectivity, which may have implications for the findings' validity and reliability. Therefore, it is essential to exercise caution when attempting to generalize some of the specific qualitative findings of this study.

To address the aforementioned concerns, the researcher adopted a parallel mixed-method research approach. Within this approach, both qualitative and quantitative data were collected and analyzed concurrently. The integration of these resultant datasets occurred during the interpretation phase, following the principles of triangulation. The researcher also addressed this concern through using a second assessor to apply the rating system to a selection of the slides. A high inter-rater agreement was found, as has been discussed in the Methods section.

## Conclusion

In conclusion, this study aimed to transform multimedia presentation design practices in a health sciences first-year module by aligning them with established criteria derived from cognitive theory and design principles of multimedia learning. The quantitative findings highlighted the degree to which these principles were implemented in the teaching slides, with a focus on principles like segmenting, pre-training, modality, coherence, signaling, spatial contiguity, and multimedia. The results revealed a mix of strengths and weaknesses in the current practices.

The strengths of the current multimedia presentation practices include effective reduction of extraneous cognitive load, as demonstrated by the adherence to principles like segmenting and signaling. These practices allow students to better process and understand information, aligning with cognitive theory and design principles.

However, weaknesses were also identified, particularly in the underutilization of images, which could enhance the visual channel of working memory, ultimately improving germane cognitive load. These weaknesses hindered the efficient use of cognitive resources and the full potential of multimedia materials.

Opportunities for improvement were also identified, such as incorporating more images to enhance understanding and applying signaling principles to direct students' attention effectively. These opportunities have the potential to transform teaching practices and enhance the alignment with cognitive principles.

Threats were also recognized, mainly stemming from the overreliance on written text, which can overload the visual channel of working memory and hinder the construction of mental models. These challenges arise from the need to better use both memory channels and the cost and scarcity of relevant images, especially in technical subjects.

In summary, this study provides valuable insights into the strengths, weaknesses, opportunities, and threats associated with the current multimedia presentation practices in a health sciences first-year module. By addressing the identified weaknesses and capitalizing on the opportunities, these practices can be transformed to better align with cognitive theory and design principles, ultimately enhancing the learning experience for students in the module. Furthermore, beyond the value of this study in transforming this particular module, it is hoped that readers are able to abstract general principles that they can apply to their own modules to aid their transformation too.

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Annexure A.   
  
Table 2: The criteria for evaluating the implementation of the design principles of multimedia learning (Mayer, 2020; Mayer, 2021; Ceken and Taskin, 2022)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Microsoft PowerPoint presentation slide** | **Principle** **of multimedia learning** | **Concepts involved in implementing the principle** | | **Frequency of concept implementation** |  |
|  | 1. Coherence | Only includes text, graphics, and narration that support learning objectives (e.g., do not use decorative images or supplemental materials) | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Avoids having background music during the lectures | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Uses simple visuals (instead of realistic or detailed visuals) | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| 2. Signalling | Uses signals such as arrows, and highlighting, to attract the student’s attention to the most important information on the screen | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Includes a slide that indicates how the multimedia presentation is organized and refer to it when you advance to a new section | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| 3. Spatial contiguity | Places words closer to the corresponding images | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Provides feedback shortly after asking the questions | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Presents instructions on the same screen as the activity | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Allows students to read the words before starting an animated graphic | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| 4. Segmenting | Permits students to control the pace of the lecture | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Breaks down long and complex segments of information into smaller pieces | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| 5. Pre-training | Defines key terms (like names, definitions, locations, and characteristics of components to be presented) at the onset of a process-based presentation, either in a separate presentation, handout, or similar material | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Ensures that the students are familiar with and can use the tool (such as Excel) through which the learning activities will be performed | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| 6. Modality | Avoids using on-screen text, except where it:   * + Lists key steps,   + Provides directions,   + Provides references,   + Presents important information to non-native English speakers. | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| 7. Multimedia | Includes images to demonstrate key points | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Ensures that all images enhance or clarify meaning (instead of being purely decorative) | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| Preferably uses static images over animations | | Never | О |
| Rarely | О |
| Sometimes | О |
| Often | О |
| Always | О |
| **SWOT analysis** **of the use of multimedia in the lesson** | Strengths |  | | |
| Weaknesses |  | | |
| Opportunity |  | | |
| Threats |  | | |

Annexure B   
  
Turnitin Report Turnitin Report

