

Analysing Explainer Videos for Geological Formations Based on Ge Song Principle Framework to Improve Visitor Learning Experience at Gua Tempurung

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ABSTRACT

Gua Tempurung, one of the largest limestone caves in Peninsular Malaysia, possesses significant geotourism value but continues to rely primarily on traditional interpretation methods such as guided tours and signboards. These approaches may be insufficient for explaining complex geological processes to younger visitors who increasingly prefer digital media. This study aims to identify key design elements of digital explainer videos that can enhance visitor learning experiences related to geological formations. A qualitative content analysis was conducted on nine publicly available YouTube videos explaining limestone cave formation. The videos were evaluated using Ge Song's (2021) Four Motion Graphic Principles Framework, comprising Logic, Transformation, Transition, and Music. Eight sub-criteria were assessed using a five-point Likert scale. The findings indicate that high-scoring videos consistently demonstrated clear information structure, dynamic visual transformation, smooth transitions, and effective audio design. In contrast, videos relying heavily on static visuals and limited audio engagement received lower scores. The results suggest that applying the Four Motion Graphic Principles can support the development of more effective educational explainer videos for geotourism contexts. These findings provide practical guidance for designing digital interpretation materials that may enhance visitor understanding and engagement at Gua Tempurung and similar geological heritage sites.

Keywords: *explainer videos, motion graphics, geotourism, visitor learning experience, geological formations*



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1 INTRODUCTION

Gua Tempurung in Gopeng, Perak is one of the largest limestone caves in Peninsular Malaysia, famous for its impressive geological features like stalactites, stalagmites and flowstones, which are about 400 million years old (Muhammad, 2010). The site is rich in natural resources but still needs to rely on traditional approaches to educate visitors, including tour guides and printed signboards. Digital media is increasing and there is a need to find alternative methods of communicating geological information to visitors, particularly via video. The combination of visuals, animation, and narration has been shown to be effective in making complex information easy to understand and engaging (Mayer, 2024). These videos are particularly useful for illustrating geology, such as the formation of caves, that is not visible to the unaided eye and occurs over a very long period of time. However, not every explainer video is well-designed, and if it is not, it can create the "illusion of understanding," which means that the viewer feels they have learned something but have not actually internalized it (Adler et al., 2025).

This study adopts the Four Motion Graphic Principles Framework from Ge Song (2021) to structure the assessment of the quality of these videos. The four principles of this framework are: Logic (how information is presented clearly and orderly in the video); Transformation (how the image changes in the video to convey a process over time); Transition (how the video moves from one idea to the next); and Music (how music, narration and background audio are used to support the message). These four principles offer a clear and practical framework to assess the educational suitability of a video. This study applies content analysis to analyse the existing YouTube limestone cave formation explainer videos, and to identify the key design elements that can be applied to enhance the learning experience of the visitors in Gua Tempurung.

1.1 Research Objective

The objectives are:

1. To identify the key design and content elements used in digital explainer videos for explaining cave formation.
2. To analyse how Ge Song's (2021) Four Motion Graphic Principles are applied in existing cave formation explainer videos.

1.2 Problem Statement

Cave tourism sites like Gua Tempurung still rely on traditional methods such as guided tours and printed signboards, are inadequate for communicating geological science to the general public (Davidson & Black, 2007), they are still used at cave tourism sites. The lack of digital interpretation tools is a disadvantage for limestone cave sites compared to other heritage sites that have introduced interactive digital content (IDC) (Dinis et al., 2024), and weakens Malaysia's geotourism competitiveness within the ASEAN geotourism compared to other countries (Sulaiman et al., 2016).

This is particularly a problem for visitors aged 15 to 24 who are much more into dynamic and visual digital content than traditional methods (Chardonnens, 2025). The invisible nature of the process of limestone cave formation, coupled with the fact that it takes thousands of years to form, necessitates effective visual communication to help the process be understood, if it is to be communicated at all (Brame, 2016). There are several cave formation explainer videos on YouTube, but this study aims to address that they have not been studied to determine if their design and elements are effective in this type of education, and tourism sites are lacking in evidence-based guidance on the type of digital content to use.

2 LITERATURE REVIEW

A systematic search was conducted using Google Scholar. Keywords used in the search included “digital explainer videos education”, “motion graphics visual communication”, “visitor learning heritage interpretation” and “cave tourism geotourism Malaysia”. Articles and journals from the years 2007 to 2025 were selected to provide relevance and currency of the sources. Sources were chosen according to their relevance to the field of digital video design, multimedia learning, visual communication and geotourism education. This literature review is to point out the growing significance of digital explainer videos in education and tourism communication, especially in the context of making complex scientific information accessible and appealing using visual storytelling. Digital explainer videos have been used in the field of science education, heritage interpretation and in informal learning contexts, such as YouTube. The application of their use in cave tourism education, however, is not yet fully explored, particularly in explaining the geological formation in Gua Tempurung, and most of the existing cave-related content is still in the form of written text or verbal which is not cognitively and emotionally attractive to the younger generation. In order to fill this missing link, this study uses the four motion graphic principles developed by Ge Song (2021) as a guideline for analysing the existing YouTube explainer videos on the formation of caves.

2.1 Digital Explainer Videos Through Social Media

Digital explainer videos are particularly suitable for informal learning settings like YouTube as they combine visuals, animation and narration to present complex information in a simple and engaging way (Schorn, 2022). This is in line with Mayer's Cognitive Theory of Multimedia Learning, which holds that learning is more effective when the visual and auditory stimuli are presented simultaneously (Mayer, 2024). However, the quality of design is crucial to the success of the video in communicating the message effectively poor design can lead to what researchers call the "illusion of understanding," in which the viewer thinks he or she has learned something but actually has not absorbed it deeply (Adler et al., 2025). Abdul Wahid et al., (2025) also found that Motion graphics are also effective in promoting tourism destinations, where sound, colour and visual elements are important in engaging the viewers.

2.2 Visual Communication and Visitor Engagement in Tourism

Visual communication is also a crucial element of visitors' experience and interaction with a tourism site, guiding their attention and fostering emotional involvement through the use of colour, symbols and organised visual presentations (Liu, 2020). Digital visual content is particularly significant for cave tourism sites where geological processes cannot be seen with the naked eye such as Gua Tempurung, where the most practical method to make the visitors understand the process of limestone formation is through digital visual content. Well-designed digital interpretation tools are proven to be much more effective in enhancing visitor understanding and engagement than traditional text-based or verbal interpretation tools (Liu, 2020).

2.3 Ge Song's Four Motion Graphic Principles as Framework

This study takes the Four Motion Graphic Principles by Ge Song (2021) as the key framework to analyse the existing YouTube explainer videos about the formation of caves. Ge Song (2021) suggested that the evaluation of effective motion graphic works can be done using four principles: Logic, Transformation, Transition and Music. The principles can be used to evaluate whether a video is well designed for educational purposes and can be used in this study to identify the best design elements that can improve the learning of visitors at Gua Tempurung. According to previous studies, motion graphic techniques including timing, spacing, and rhythm are successful in communicating brand messages in promotional videos (Shahrulnizam et al., 2023).

2.3.1 Logic

This study takes the Four Motion Graphic Principles by Ge Song (2021) as the key framework to analyse the existing YouTube explainer videos about the formation of caves. Ge Song (2021) suggested that the evaluation of effective motion graphic works can be done using four principles: Logic, Transformation, Transition and Music. The principles can be used to evaluate whether a video is well designed for educational purposes and can be used in this study to identify the best design elements that can improve the learning of visitors at Gua Tempurung.

2.3.2 Transformation

Transformation is the process of altering the shape, form or appearance of visual elements in a motion graphic to convey a concept, process or change over the course of time. Ge Song (2021) said that transformation is one of the most powerful motion design tools because it is a way to depict complex or invisible processes in a way that the audience can easily understand. The importance of transformation is especially evident in the case of cave formation videos since the processes that create these caves, including the slow growth of stalactites from the dripping of calcium carbonate-rich water, are invisible to the naked eye and can best be communicated through animated visual transformation.

2.3.3 Transition

Transition is the way a motion graphic flows from one scene, idea, or visual element to the next, keeping the viewer's attention and understanding throughout the video. According to Ge Song (2021), poor transitions can break the flow of a video and confuse viewers, while good transitions help to link ideas and add continuity in the video, keeping viewers interested in the content. In the videos explaining the formation of caves, smooth transitions from one stage in the geology to another allow the viewer to follow the story without losing his/her place in the explanation.

2.3.4 Music

In Ge Song's (2021) definition, music is defined as including all elements of sound in a motion graphic such as background music, sound effects, and narration. These audio elements are essential in enhancing the emotional impact and delivery of the video; the appropriate music and narration can make the content more engaging, understandable, and memorable for the viewer. This is further supported by research on educational videos which shows that a balance of clear narration and suitable audio components can greatly enhance the engagement and understanding of learners when integrated with effective visuals (Song, 2021). For cave formation explainer videos, audio features like soothing background music and straightforward narration keep young viewers (15-24) engaged and help them grasp the geology being explained.

3 RESEARCH DESIGN

The study applies a qualitative content analysis method to analyze the digital explainer videos related to limestone cave formation. Content analysis is a systematic and objective analysis technique that is suitable for analyzing the characteristics of media content (Neuendorf, 2017). This was selected as it is a study of the design and content of the videos themselves, rather than measuring responses of the viewer. The four motion graphic principles (logical, transformation, transition and music) proposed by Ge Song (2021) are used for analysis. This approach is consistent with recent studies that have applied Ge Song's (2021) four motion graphic principles to analyse awareness videos in the Malaysian context (Azlani et al., 2026).

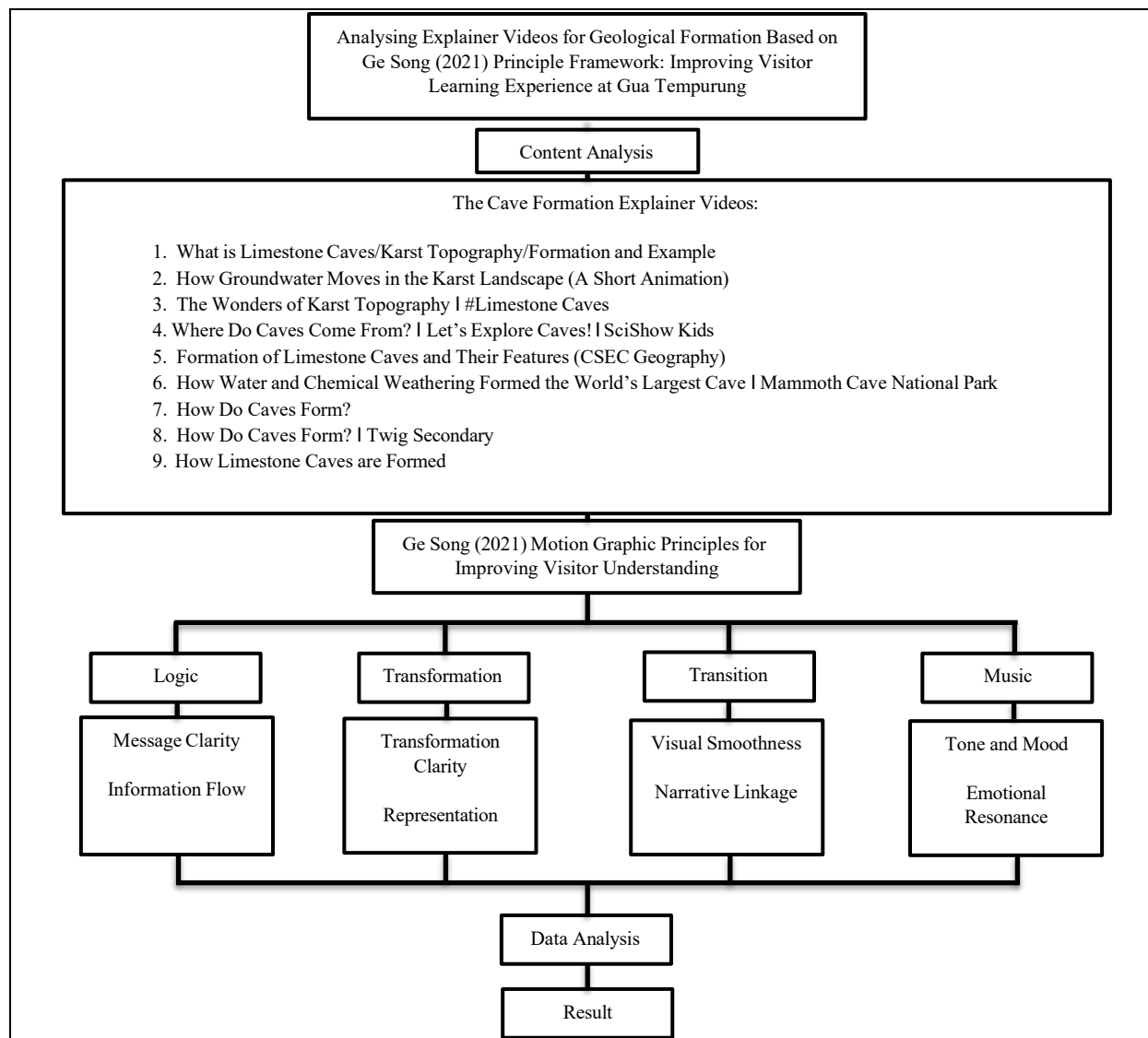
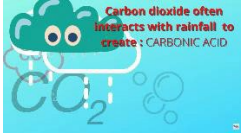


Figure 1 Four Key Motion Graphic Principles (Ge Song, 2021), adopted for this study

4 SELECTION OF CAVE FORMATION EXPLAINER VIDEO

The videos selected for this study were chosen based on several inclusion criteria. All videos must be publicly posted on YouTube and clearly describe the formation of limestone caves. As for design, the videos need to have animation or motion graphics in their visuals and should have narration or audio explanations to accompany the content. In addition, all videos selected should be in English, to allow for consistency in content analysis, and must have been published between 2020 and 2026, to ensure that the content reflects current digital media practices. Table 1 presents the full list of selected videos together with their publisher and a brief justification for selection.

Table 1 Selection Sample of Cave Formation Explainer Videos

Title	Publisher	Platform/Date Published	Label	Justification
1. What is Limestone Caves/Karst Topography/Formation and Example 	Geotourism and Modern Geotechniques	Posted on Youtube January 29 th 2026	EV1	Provides a general introduction using basic diagrams
2. How Groundwater Moves in the Karst Landscape (A Short Animation) 	Minnesota Department of Agriculture	Posted on Youtube September 15 th 2020	EV2	Focuses on groundwater movement using clear animation
3. The Wonders of Karst Topography I #Limestone Caves 	The Earth Explorer	Posted on Youtube September 1 st 2023	EV3	Presents in a visually engaging way suitable for general audiences
4. Where Do Caves Come From? I Let's Explore Caves! I SciShow Kids 	SciShow Kids	Posted on Youtube January 23 rd 2023	EV4	Explains in a simple and fun way for young audiences
5. Formation of Limestone Caves and Their Features (CSEC Geography) 	Geography Journey	Posted on Youtube Jun 2 nd 2021	EV5	Represents a formal academic approach to explain the formation
6. How Water and Chemical Weathering Formed the World's Largest Cave I Mammoth Cave National Park 	Outsider Classroom	Posted on Youtube November 5 th 2024	EV6	Produced in official cave tourism site, combining real footage with professional animation
7. How Do Caves Form? 	Earth Explained	Posted on Youtube April 9 th 2021	EV7	Provides a simple and clear explanation for a general audience

8.	How Do Caves Form? Twig Secondary 	Twig Science Reporter	Posted on Youtube September 15 th 2020	EV8	Produced by educational media platform for secondary school learners
9.	How Limestone Caves are Formed 	ExpertVillage Leaf Group	Posted on Youtube December 13 th 2020	EV9	Provides a concise and focused explanation using simple diagrams and narration

5 DATA ANALYSIS

The four principles of the Ge Song (2021) framework were used to analyse and rate each video with a five-point Likert scale (Likert, 1932). Likert Scale is a commonly used measurement instrument in qualitative research that enables researchers to rate the extent of a characteristic in a subject in a systematic manner (Joshi et al., 2015). Each sub-criteria are rated on a scale of 1 (Very Poor) to 5 (Excellent) and can be evaluated in a structured and comparable manner for the nine videos in this study. ScoreS in Table 3 are assigned using the five-point Likert Scale described in Table 2, following a systematic content analysis approach (Neuendorf, 2017).

Table 2 Five-Point Likert Scale Rating

Score	Level	Description
5	Excellent	Outstanding use of the principle with no noticeable weaknesses.
4	Good	Strong use of the principle with only minor areas for improvement.
3	Adequate	Meets basic requirements but lacks depth or consistency.
2	Weak	Limited application with significant gaps in effectiveness.
1	Very Poor	The principle is largely absent or ineffective,

Table 3 Analysis of Motion Graphic Principles in Cave Formation Explainer Video

Cave Formation Explainer Videos (Label)	Logic		Transformation		Transition		Music	
	Message Clarity	Information Flow	Transformation Clarity	Representation	Visual Smoothness	Narrative Linkage	Tone and Mood	Emotional Resonance
1 EV1	3	3	3	3	3	3	3	3
2 EV2	5	5	5	5	4	5	4	4
3 EV3	4	4	4	4	4	4	4	4
4 EV4	5	4	4	5	5	4	5	5
5 EV5	4	4	3	3	3	4	3	3
6 EV6	5	5	5	5	5	5	5	5
7 EV7	4	4	4	4	4	4	3	3
8 EV8	5	4	4	4	4	4	4	4
9 EV9	4	4	4	4	4	4	4	4

6 RESULTS

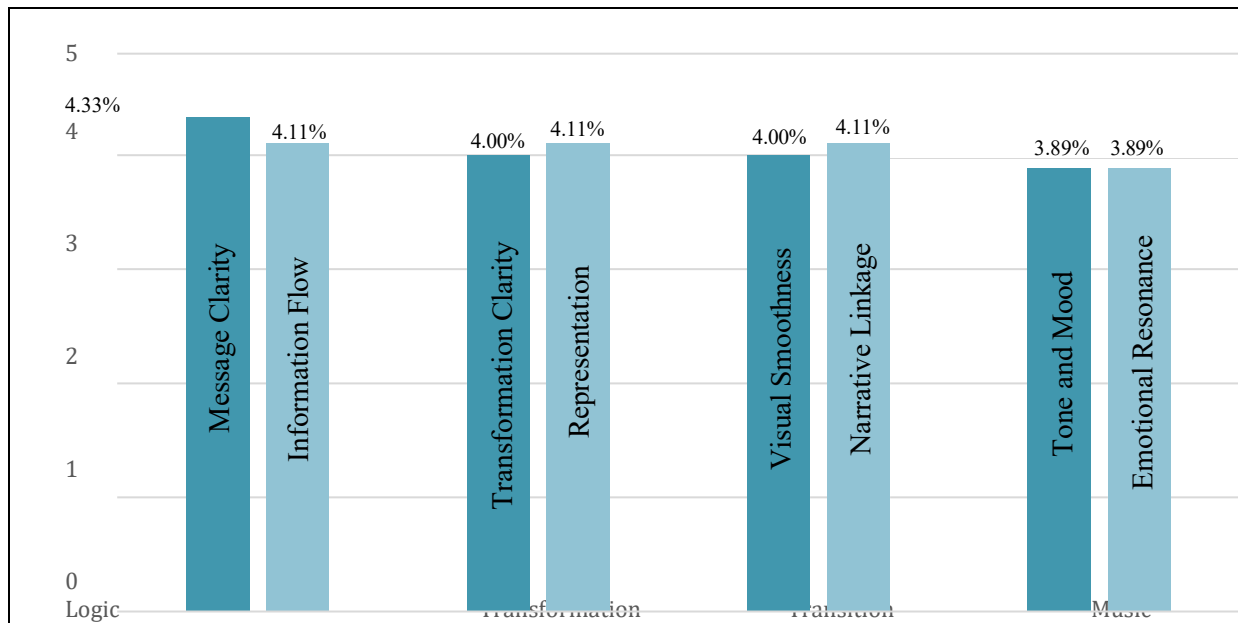


Figure 2 Result of analysis of motion graphic principles in cave formation explainer video

7 FINDINGS

In this study, nine YouTube explainer videos about limestone cave formation were analyzed based on the Four Motion Graphic Principles Framework developed by Ge Song (2021) and Likert scale of five-point. The videos were evaluated based on eight sub-criteria which fall into four principles: Logic, Transformation, Transition, and Music. The lowest score for any of the videos was 3 and the highest was 5. EV6 getting the highest scores on most of the principles because EV6 applied all four principles with great success, using dynamic transformation animations, smooth transitions in visuals, and meaningful music to provide educational experiences that were informative and emotional, besides that EV1 is the lowest score in the sample. The main reasons are its minimal animation, disconnected scene transitions and background music that did not add much to the viewing experience.

The majority of videos had a score of 4 and 5 for Message Clarity and the average is 4.33, indicating that most videos conveyed the concept of the cave formation in a clear and understandable manner for the Logic principle. EV2, EV4, EV6 and EV8 were the top scorers as they all used a clear step-by-step structure with strong visuals and narration for their audience. EV1 scored 3, indicating that the message was more difficult to understand without prior knowledge. EV2 and EV6 both earned a score of 5 for Information Flow with average score of 4.11, since both videos led the viewer through a full and logically connected geological journey from start to finish. EV1 had the score of 3 because it jumped from idea to idea with no clear connecting thread, making it difficult for viewers to build understanding incrementally.

EV2 and EV6 were again the best videos for Transformation because they both scoring 5 for Transformation Clarity with average score of 4.00. It is clear that they both included dynamic animation which was clearly able to illustrate how geological processes change over time. EV1 and EV5 both had a score of 3, both were too reliant on static diagrams, which were not able to show how one geological stage leads to the next. For Representation with average score is 4.11, EV2, EV4, and EV6 received the highest score 5 as the animation was a visual representation of the complete geological change, which was accurate and easy to understand, whereas V1 and V5 received the lowest score 3 as the animation was not a visual representation of the full geological change and was not easy to understand. The other videos all received a score of 4, indicating that the visual design was good, but not outstanding.

For the Transition principle, EV4, and EV6 got the highest scores of 5 for Visual Smoothness with average score is 4.00 as they had intentional animated transitions and visual continuity between scenes. EV1 and EV5 had the scores at 3, as they used abrupt direct cuts between scenes with little visual continuity. EV2 and EV6 both scored 5 for Narrative Linkage with average score of 4.11, since they always ended one thought and started the next, and maintained the viewer's attention throughout the video. EV1 scored the least at 3 because the narration did not always tie one thought to the next, and there were some noticeable gaps between sections. The majority of the other videos received a score of 4, which means there was a good, but not outstanding connection between the scenes.

The principle that varied the most in the sample was Music. EV4 and EV6 both had perfect scores of 5 across Tone and Mood with average score of 3.89 because their music was intentionally selected to evoke the emotion of what they were showing, energetic and curious for V4 and cinematic and awe- inspiring for V6. EV1, EV5 and EV7 received the lowest score which is 3, as their background music was generic and neutral, and did not add any real atmosphere to the viewing experience. For Emotional Resonance with average score is 3.89, the highest score 5 was given to V4 and V6 as they used the music to create an exciting and memorable experience for the viewer, which also had a strong emotional impact, whereas V1, V5, and V7 scored the lowest 3 as they used the music as a background filler rather than to have an emotional impact on the viewer, or to create an exciting and memorable experience. The other videos all received a 4, reflecting the quality of the audio design which was good, but not particularly memorable or emotive, but supported the educational tone.

In summary, the findings highlight that videos that include dynamic animation, clear logical structure, smooth transitions, and intentional music create a higher level of engagement than those that are static with little attention to audio design and that these four elements should be emphasized in any digital video that is intended to increase the education of visitors to Gua Tempurung.

8 CONCLUSION

In conclusion, this study demonstrates that the use of a well-designed digital explainer video is a powerful tool to enhance the learning of geology formation at Gua Tempurung. From the analysis of nine YouTube videos based on the four motion graphic principles of logic, transformation, transition and music, it can be seen that videos in which the motion graphics are smooth, the logic is clear and logical, the scene transitions are well connected and the music is suitable, are more effective in explaining the complex process of cave formation, than videos that use a series of still images or poor audio design. The results offer insightful recommendations for creating educational and entertaining digital products, particularly for younger visitors, 15-24 years old. In the future, the use of these principles in the development of Gua Tempurung's explainer videos can significantly enhance the visitor experience and contribute to the competitiveness of Malaysia's geotourism in the region.

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AUTHOR CONTRIBUTIONS

All authors played equal contributions towards the production of this paper.

CONFLICT OF INTEREST

The author declares no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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