Pattern Analysis Of Genetics Animations Using Mayer's Principles And Its Implications For MBBS Students

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Abstract: Background: MBBS students access online animation videos to understand complex concepts. However, multiple studies have raised concerns regarding quality of online educational videos. Animations designed using Mayer's principles have been shown to improve learning outcomes. In this study, we analysed pattern and design quality of online genetics animations using Mayer's principles. Material And Methods: In this cross-sectional study, we analysed 59 online genetics animations chosen from MBBS 1st year Biochemistry syllabus. These animations were shortlisted through systematic search on www.google.com and www.youtube.com. These were analysed using Mayer's multimedia learning principles that manage extraneous processing. Result: 54% (33) of the animations complied with all the multimedia learning principles that manage extraneous processing. However, 44% (26) animations violated multimedia learning principles in various combinations. Amongst the animations that violated multiple principles, combination pattern of Signalling +Spatial Contiguity +Temporal Contiguity was most common (7 out of 26 animations). Conclusion: Majority of the animations follow all the Mayer's multimedia principles that manage extraneous processing. However, significant portion of animations violated multimedia leaning principles in various combinations and their use may result in poor learning outcomes. By adopting a few easy to implement measures, teachers can increase their effectiveness as visual learning aids for MBBS students. [Ravi Kishore Polepalli Natl J Integr Res Med, 2022; 13(1): 75-80, Published on 26/01/2022]

Key Words: Genetics Animations, Mayer's Principles, Medical Students, Online Animations

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Introduction: MBBS students access online access educational videos (ex. animations, lecture videos)[1]. However, previous studies have raised concerns regarding the quality of online educational videos[2-7]. Presence of irrelevant pictures, sounds (extraneous material) in the animations diverts cognitive capacity towards extraneous material in a phenomenon called as extraneous processing.

As a consequence, very little cognitive capacity may be available to understand the intended content[8]. Animations designed based on Mayer's multimedia learning principles have been shown to improve learning outcomes[9].

It is important for MBBS students to understand complex concepts in genetics to understand pathophysiology and management of many diseases. However, there is lack of evidence concerning design quality of online animations in genetics, based on multimedia learning principles to reduce extraneous processing. In this study, we analyse the design quality and patterns of online genetics animations based on Mayer's multimedia learning principles that reduce extraneous processing.

Material & Methods: This is a cross-sectional study for analysing online genetics animations. Ethical approval was not necessary for this study for as human subjects were not involved in this study and all the data (animations) used in the study is accessible online for public. Our study sample consisted of 59 online animations in genetics.

MBBS 1st year Biochemistry syllabus was reviewed and 17 genetics topics were chosen[10].

Using relevant key words, animations related to these topics were searched on search engines www.google.com and www.youtube.com.

Date of access of these platforms was July 24th and 25th, 2021.

We defined animation as follows- "Animation refers to a simulated motion picture depicting movement of drawn or simulated objects" [11].

Inclusion Criteria For The Animation To Be Shortlisted Were: 1. Animation should comply with the above definition. 2. Animation should be relevant to the topic.

Exclusion Criteria: 1.Animations that require user credentials or payment for access.

A total of 59 animations were shortlisted based on the above criteria.

Analysis Of Online Animations: We analysed the design quality and pattern of online animations using multimedia learning principles that reduce extraneous processing.

Multimedia Learning Principles: Multimedia Learning Principles, based on cognitive theory of multimedia learning, are evidence based guidelines that could be incorporated in the design of multimedia like animations to improve learning outcomes.

Richard E Mayer, a pioneer in the field of multimedia learning research proposed five principles to manage extraneous processing.

1. Coherence Principle: It states learning is better when extraneous words, pictures and sounds are excluded in the multimedia presentation rather than included.

2. Signalling Principle: It states that learning is better when essential words/graphics are highlighted in the multimedia presentation.

3. Redundancy Principle: It states that learning is better when graphics and narration are used in Multimedia presentation rather than graphics and on-screen text.

4. Spatial Contiguity Principle: It states that learning is better when corresponding words and pictures are presented in proximity rather than far from each other on the screen in a multimedia presentation.

5. Temporal Contiguity Principle: It states that learning is better when corresponding words and graphics are presented simultaneously rather than successively. Incorporating these principles in the design of multimedia presentation like animations has been shown to reduce extraneous processing and contribute to improved learning outcomes[8,12].

Extraneous Processing: Animations may include certain elements that do not serve the instructional objectives. These elements may include irrelevant verbal statements, sounds (ex music), onscreen texts or pictures.

These constitute extraneous material. Extraneous processing is a type of cognitive processing that does not serve the instructional objective, and it is caused by presence of extraneous material in the animation or due to confusing layout of the presentation. For instance, there is prominent background music in the animation.

It may have been added to make the animation "attractive" for the viewers.

However, such an irrelevant addition tends to divert cognitive capacity away from intended information as the attention of learner diverted towards distracting music rather than the intended lesson in the animation.

This problem can be avoided by having words and sounds only relevant to the instruction in the animation.

If extraneous processing takes up all or major portion of the learner's available cognitive capacity, then the learner is not left with enough cognitive capacity for selecting, organizing and integrating the presented material.

This leads to impaired understanding the concept at deeper level. The result is reduced learning outcomes[8,11,12].

The shortlisted animations (n=59) were evaluated using the multimedia learning principles mentioned above.

For the signalling principle, we considered only visual cues that highlight essential material. Verbal cues were not included[12].

Higher the number of violations of multimedia principle seen in a single animation, poorer the design and potentially higher the adverse impact on learning outcomes when such an animation is used.

Statistical Methods: Descriptive statistics was used in the form of proportion was used.

Results: Results are as follows.

Table 1: Distribution Of Animations Based On Compliance/Violation Of Individual Multimedia Learning Principles

Principles	Number Of Animations Complying With The Principle (%)	Number Of Animations Violating The Principle (%)
Coherence	55(93)	4(07)
Signalling	46(78)	13(22)
Redundancy	48(81)	11(19)
Spatial Contiguity	50(85)	9(15)
Temporal Contiguity	50(85)	9(15)

Table 2: Pattern Of Violation Of Multimedia Learning Principles

Number Of Principles Violated By An Animation	Number Of Animations (Total=26)	Pattern Details –Principles Violated (Number Of Animations)
1	14	Coherence (3) Signalling (3) Redundancy (8)
2	4	Temporal + Spatial Contiguity (1) Signalling + Redundancy (2) Coherence + Redundancy (1)
3	7	Signalling +Spatial Contiguity + Temporal Contiguity (7)
4	1	Signalling + Redundancy+ Spatial Contiguity + Temporal Contiguity (1)

59% (33 out of 59 animations) complied with all the multimedia learning principles for reducing extraneous processing. The number of animations violating multimedia learning principles was 44% (26 out of 59 animations).

Highest proportion (22%) of violations was seen with respect to Signaling principle. In contrast, least violations (7%) were seen with respect to Coherence principle (Table1). Distribution of animations by violations and pattern of violations is shown in Table 2.

Most common group was animations that violated single principle. This was followed by animations that violated three principles, two principles and one principle.

Violation of redundancy principle was the most common (8 out of 26 animations) followed by a combination of Signalling +Spatial Contiguity+ Temporal Contiguity (7 out of 26 animations).

Discussion: In this study, we analysed the design quality of online genetics animations. We used multimedia learning principles to analyse potential of genetics animations to induce extraneous processing overload. In other words, does the design of animations encourage the learners to focus on essential content or does it distract the learners owing to presence of distracting elements or confusing layout?

Violation Of Individual Principles: Though 56% of the animations complied with all the multimedia learning principles that reduce extraneous processing, significant portion of them (22%) violated signalling principle. Users of such animations may not be able to focus on essential content as the important content may not be prominently highlighted.

As a result, cognitive capacity of learner may be spent in visually scanning the screen for relevant content (extraneous processing) and learner may be left with little cognitive capacity to select, organise and integrate presented content (images and spoken words) that leads to deeper learning.

Minimising extraneous processing has an effect of making maximum cognitive capacity available for deeper learning. Redundancy principle was violated in 19% of the animations suggesting the learners may be distracted by redundant onscreen text that is same as the narration, leading to diversion of precious cognitive resources[8,11].

Spatial contiguity principle was violated in in 15% of the animations. Printed words in these animations were not placed closer to graphics leading to overwhelming of cognitive capacity as the learners tries hard to make sense of presented content. Temporal contiguity principle was violated in same proportion of animations.

Lack of precise labelling of essential component in such animations leads to learners not being able to connect the narration and graphics, thus creating an effect of asynchrony between presented graphics and narration. Minor proportion of animations violated Coherence principle suggesting that irrelevant sounds/ graphics contributed to the problem to the least extent[11].

Pattern Of Violations Of Multiple Principles: 26 animations violated multimedia principles to varied degrees. Animations with violation of single principle constituted majority of them (54%). The principles violated were Coherence (n=3), Signalling (n=3) and Redundancy (n=8).

Violation of Coherence and Redundancy principles induces extraneous processing which may be due to presence of extraneous graphics/words/ sounds in the animation[13]. On the other hand, extraneous processing overload induced by violation of signalling principle is due to confusing layout of presentation that does not highlight essential information.

15% of animations violated two principles each. In this subset, the pairs of principles violated were Temporal with Spatial contiguity (n=1), Signalling with Redundancy (n=2) and, Coherence with Redundancy (n=1).

31% of the animations violated 3-4 principles. In summary, violation of all these principles could be caused by irrelevant content and confusing layout of presentation resulting in extraneous processing overload and deficiency of cognitive capacity leading to poor learning[8, 13].

Violation of multiple multimedia principles in a single animation may have cumulative adverse effects on learning outcomes. These effects may depend upon the number of principles violated and type of principles violated.

It is possible that more the violations in an animation, more the extraneous processing overload and lesser than cognitive capacity to understand the intended content of animation. However, precise effects of such violations can be determined by rigorously designed experimental studies that test effects of violations of various combinations of multimedia learning principles.

Till such empirical data becomes available, we could choose animations based on compliance with maximum number of multimedia learning principles.

Proposed Solutions: Ideally, teachers could choose online genetics animations that comply with all the multimedia learning principles and recommend the same to MBBS students for learning. However, such animations may not available for all topics of interest in genetics. In such situations, we recommend teachers may analyse available animations and choose the ones with minimal violations.

Teachers could increase the effectiveness of such animations with a few easy to implement solutions:

1. Violation Of Coherence Principle: Any extraneous sounds (ex. background music) can be eliminated by muting the default audio and compensating it with supplementary narration.

2. Violation Of Signalling Principle: Pointer can used to highlight the essential components on screen.

3. Temporal And Spatial Contiguity Principles: Simultaneous presentation of narration with graphics and use of audio cues such as verbal highlighting of components using appropriate words. In addition, visual cues (ex. using a pointer) can be used to highlight important content.

It may not be feasible to compensate for violation of redundancy principle, due to lack of an option to turn off onscreen text that is redundant because of narration.

It can be partially compensated by instructing the students to focus on the graphics. This approach may not be feasible if the text is in the centre of the screen.

These solutions are best implemented by teachers in a classroom setting.

These suggestions are based on multimedia learning principles coupled with the author's substantial experience of using animations for teaching in a classroom setting[8,11].

Our study had several strengths. We analysed the quality of genetics animations using evidence based Mayer's multimedia learning principles that reduce extraneous processing.

The topics in genetics shortlisted were from 1st year MBBS Biochemistry syllabus and hence, the findings would be relevant to MBBS students and teachers. We used two of the most popular search engines and the same were popular amongst students too for online animation search as observed in an informal survey of students in our college[15].

Hence, our findings to some extent are applicable to kind of animations that they access. We present a simple yet evidence based approach that could be used by teachers to select best amongst available online animations.

There are a few limitations that need to be considered. These principles (findings) are more strongly applicable when the learners have low prior knowledge of the topic of animation, pace of animation is fast and topic is complex.

Given the potentially vast number of genetics animations on www.google.com and www.youtube.com, additional studies are necessary to confirm our findings. We analysed the animations based on their ability to reduce extraneous cognitive processing.

Animations may also be assessed based on the principles that manage essential and generative processing, that are important for subsequent phases of learning. We welcome complementary studies that analyse online animations based on these principles.

Conclusions: It is generally assumed that any concept that is animated holds attention of viewer and automatically leads to better learning outcomes. But that may not always be the case as we demonstrate in our study. In fact, extraneous content in the animation may do more harm than good.

Majority of the animations we analysed have been designed in a way consistent with all the Mayer's multimedia learning principles that manage extraneous processing.

Learners can benefit from improved learning by using such animations. However, significant portion of them violated principles to varying degrees and may lead to poorer learning when used. Teachers and students must be aware of limitations of such easily accessible online animations. Teachers could support student's visual learning by choosing the best available animations by using the simple and easy to follow approach that we present in this study.

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