

How Do Visual Design Elements in Multimedia Learning Material Induce Positive Emotions in Learners?

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Abstract—Previous research into multimedia learning has mainly focused on cognitive factors to investigate different instructional conditions and design principles. Emotional aspects have so far been widely neglected. This study investigates how the cheerful emotional interface design influenced learners' cognitive processes, emotional valences, learning outcomes, and subjective experience. This study used the PRISMA statement to identify the major themes from the literature. Following the strict inclusion and exclusion criteria for selecting records, we identified 47 articles for the analysis. This study used the VOS viewer for the themes using the content analysis and key term occurrences. The result shows two significant pieces, cognitive outcomes and affective outcomes, further divided into cognitive processes, emotional valences, learning outcomes, and subjective experience. In addition, the findings showed that learners using the cheerful emotional design had more positive emotions and higher comprehension and transfer test scores. Furthermore, learners who received the cheerful emotional design saw the materials as less challenging and expended more mental effort digesting them than learners who received the neutral design. They reported better motivation, contentment, and perception of the learning materials.

Keywords—cognitive outcomes, affective outcomes, positive emotions, learning outcomes, PRISMA, VOS viewer

1 Introduction

Instructional circumstances to improve computer-based multimedia learning have been examined mainly regarding cognitive variables (Park et al., 2014a). Despite various unsolved concerns, emotional elements have been extensively ignored in multimedia learning research (M. M. Khan et al., 2022). According to (Tuch et al., 2010) as with improvements in multimedia learning, the primary focus in human-computer communication, specifically web design, has been on cognitive and pragmatic challenges, including system usability. Given that the design of multimedia learning environments should be optimised to improve learning processes, the issue arises as to whether specific design components in such an environment elicit emotions and stimulate learning (Chiu et al., 2020). According to (Chiu & Churchill, 2015), the impact of positive emo-

tions created before learning and using an inspirational design with design features creates positive emotions during learning. In addition, positive emotions should be optimised when building multimedia learning environments to increase learning processes, according to research (TKF Chiu, 2015). The following inquiry is if specific design aspects elicit favourable feelings and promote learning. Instead of introducing an extra element, an emotive design should alter core design aspects such as forms and colours (Heidig et al., 2015a).

Emotional design has a long history in human engineering regarding how to design everyday objects, but it has not been rigorously researched in education until lately (Russell, 2003). Most evidence for the emotive design of visuals in multimedia classes comes from Plass and colleagues' studies (Plass et al., 2014a). In addition, the ability to harness affective processes that stimulate cognitive processes leading to advances in learning without distracting the learner from the actual content of the lesson is a critical problem in using emotional design principles to redesign visuals in multimedia classes (Akhtar et al., 2022). Also, a past study has found a link between learners' emotions and their learning (Goetz et al., 2012). Although emotional design in multimedia learning can influence learning performance, it is uncertain if it might assist learning processes by eliciting good feelings during learning (X. Wang et al., 2022a). As a result, the current study sought to determine if the emotional design might elicit good feelings in learners and aid their learning (Li et al., 2020). According to (Dong, 1 C.E.a) the aesthetically appealing design of learning materials (e.g., visual elements, design layout, colour, and music incorporated in multimedia environments) has been shown to elicit positive perception and intrinsically motivate multimedia learning.

Most research on multimedia learning advises that images and pictures should be explicitly connected to the learning material to aid learning; hence, just ornamental photos are not suggested (Mayer & Estrella, 2014). According to (Carney & Levin, 2002), pictures serve five distinct purposes. Four tasks directly aid learning: representation, organisation, interpretation, and transformation. A fifth role, ornamentation, has nothing to do with the learning text's substance. Although ornamental images lack knowledge about learning activities, they have been shown to have relatively few negative impacts on learning.

The current study aims to identify the impact of design elements (visual design elements) in multimedia learning material to induce positive emotions in learners. Additionally, this study analyses the emotional elements in the multimedia learning context.

2 Materials and methods

The present study includes material from the well-known database used by scholars worldwide, Scopus. For our literature survey, we used the search terms "visual design elements", AND "positive emotions" AND "multi-media learning." In the beginning, 101 records were retrieved. The PRISMA framework filters the documents, as defined by (M. M. Khan et al., 2022; N. A. Qureshi et al., n.d.) and illustrated in Figure 1. Some of the primary specific criteria for this study were published English studies related to

the spectrum of multimedia learning and happy emotions. The evaluation includes review articles, book chapters, and articles. Stage 1 includes 83 conclusive studies for keyword cloud and keyword occurrence. After that, for each detected classification, a careful selection was made to examine associated articles, and only 42 publications were chosen to be included in the evaluation to synthesise it. Figure 1 details the current study's exclusive PRISMA 2020 statement selection and rejection method.

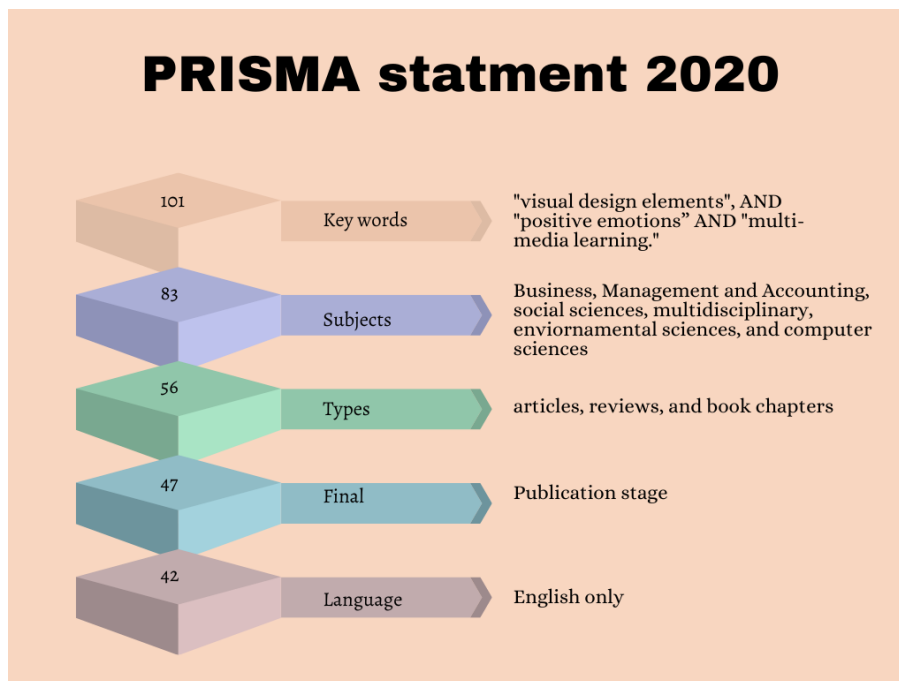


Fig. 1. PRISMA statement 2020 research methodology

3 Results

3.1 Descriptive analysis

This section may be divided into subheadings. This should include a concise and precise description of the empirical facts, their interpretation, and any empirical conclusions that can be drawn.

Following a thorough screening procedure, several publications were used for examination in this study. The articles account for 87% of the total records, while book chapters account for 10%. In this study, just 3% of the review papers passed the final analytic phase. Figure 2 illustrates the detailed view of the records included in the current study.

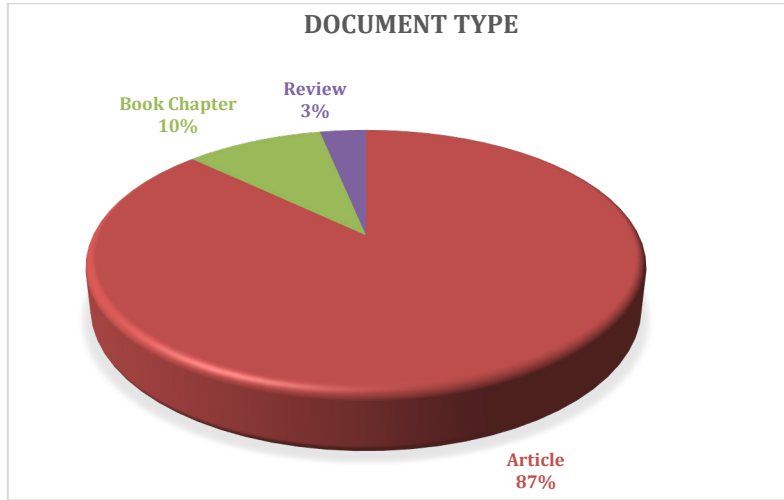


Fig. 2. The details of articles, book chapters and review papers

Figure 3 depicts the retrieved records from 2008-2023 and the Year-based publishing. This is necessary for evaluating the impact of multimedia learning and positive emotions. Figure 3 depicts an increasing number of articles published yearly, with 2020 holding the most significant publishing count frequency at seven articles. In the additional year 2022, it is on the second of the article list with the five articles, contribution.

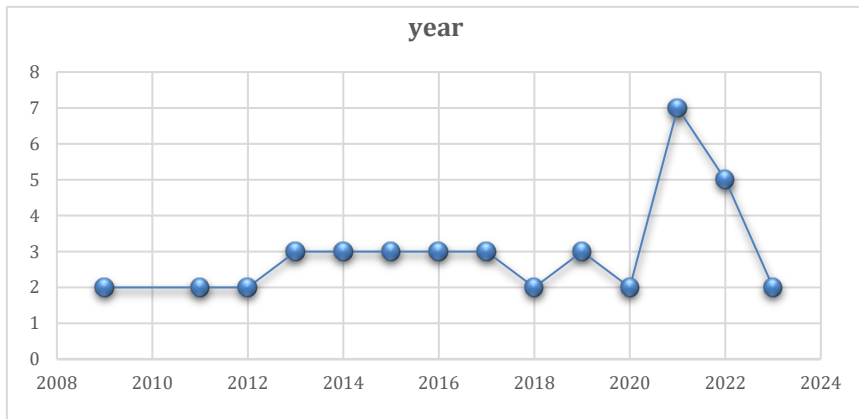


Fig. 3. Documents selected from each year

The country-based distribution is a significant indication for demonstrating the role of visual elements in multimedia learning. Figure 4 depicts a map of the nations that have contributed most to multimedia learning. The current analysis included ten publications provided by scholars from China. The United States researchers contributed

substantially, with four documents linked to the present review. United Kingdom, Germany, Italy, and Malaysian are the other nations that participated in the current study. Figure 4 depicts the geographical location that was provided for the current study.

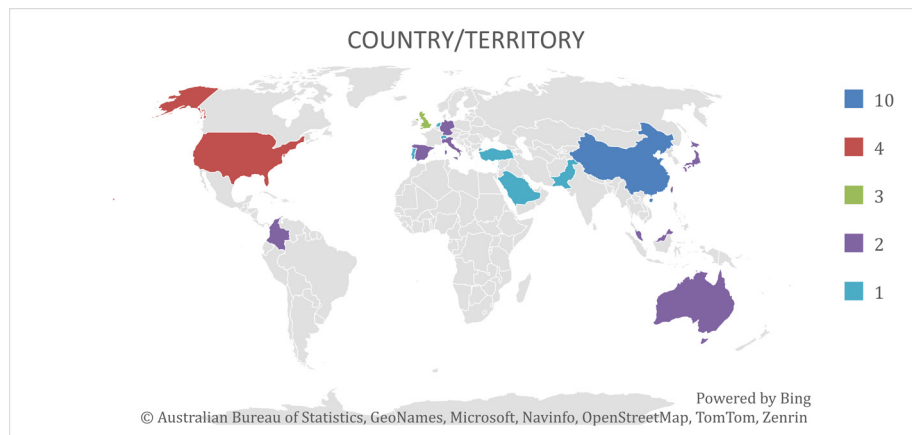


Fig. 4. Map of the countries that contributed to the current study

The citation report of the studies is shown in Table 1. The most-cited journal was Learning and Instruction, with 515 citations. Another journal with more citations is the Journal of Educational Psychology, with 311 citations. The third in the list of most-cited journals included in the current review is Computers and Education, with 233 citations total two years after the publication. The other journals with more citations are illustrated in the Table1.

Table 1. Details of the source’s articles included

Source Title	Cited by	Number of Articles
Journal of Computer-Assisted Learning	28	5
Learning and Instruction	515	4
Library and Information Science Research	66	4
Biochemistry and Molecular Biology Education	19	3
Computers in Human Behavior	112	3
Frontiers in Psychology	15	3
Instructional Science	26	3
International Journal of Advertising	14	3
Journal of Educational Psychology	311	3
Computers and Education	233	2
Enterprise Information Systems	31	2
Human-centric Computing and Information Sciences	51	2
Educational Psychology	15	1

The studies were further examined through content analysis to discover the research classifications. VOS Viewer software was used to analyse the content of the published articles—data networks based on the text formed to cluster the linked ideas. Current research established that author keywords and keywords further in the journals' indexation procedure in the databases is like bibliometric analysis intended to discover the constructions of investigating field. Therefore, we hired both keywords for the co-occurrence analysis within the research field connected to digital disruption. In total, 42 records were included in the research, and the data provided 55 keywords. We carefully refined and selected only the most frequent 49 keywords repetitive in a minimum of 10 documents. Table 2 indicates the results of the content analysis.

Table 2. Key terms, label, classification

Number of times	Label	Classification	x	y
29	Participant	Multimedia Learning	0.3844	-0.1103
24	Learner		0.6034	-0.5761
45	Use		-0.7619	-0.0717
48	Way		-0.6636	0.1948
40	Test		0.5139	0.1309
18	Field		-0.7783	-0.2608
26	Multimediu		0.8471	-0.467
4	Basis		-1.1737	-0.153
15	Enjoyment		-0.6402	0.0328
42	Training		0.688	0.4309
21	Increase		-0.3951	0.4617
34	Product		-0.8585	0.2402
38	Teacher		-0.7911	0.2198
9	Contrast		1.0765	-0.2874
11	Effect		positive emotions	0.5142
36	Student	0.1598		-0.4722
7	Condition	0.9812		-0.1457
28	Outcome	0.8064		-0.6151
1	Age	0.0686		0.4292
14	Engagement	0.6505		0.2791
31	Person	-0.3588		0.2518
13	emotional design	-0.0836		-0.7115
6	Child	-0.1694		0.6079
25	Memory	0.5395		0.7703
16	Evaluation	0.1809		0.5514
22	Insight	0.51		-0.2818
33	present study	0.9872		0.0994
32	positive effect	0.7297		-0.7752
3	Anxiety	0.7055	0.6435	
27	negative emotion	-0.2312	0.1195	

Number of times	Label	Classification	x	y
5	Behaviour		0.2841	-0.401
30	Performance	visual design elements	0.565	-0.1539
8	Context		-0.5968	-0.3048
10	Development		-0.6457	-0.0593
23	Interaction		-0.6854	0.3211
17	Experiment		0.7418	-0.1205
37	System		-0.6311	0.4764
20	Game		-0.641	-0.3652
12	Effectiveness		-0.4756	-0.6857
2	Animation		-1.0988	-0.2253
39	Technique		-0.3487	0.3421
41	Time		-0.4244	0.6155
44	Understanding		-0.0758	-0.0523
35	Question		-0.9081	-0.4269
47	visual element		-0.8113	-0.6923
46	Valence		0.9588	-0.0062
43	Treatment		0.5264	0.8512
19	Function		0.2254	0.3428

The network showed four significant clusters in different colours in Figure 5. The cluster represented in green shows the research on condition, experiment, product, and learner. The cluster in blue is mainly attributed to the training, memory, affect, and field. The yellow cluster indicates learning emotional design, visual elements, and positive effect. Finally, the brown cluster indicates the practices and services. Each cluster is further analysed in the following subsections to discuss the previous literature.

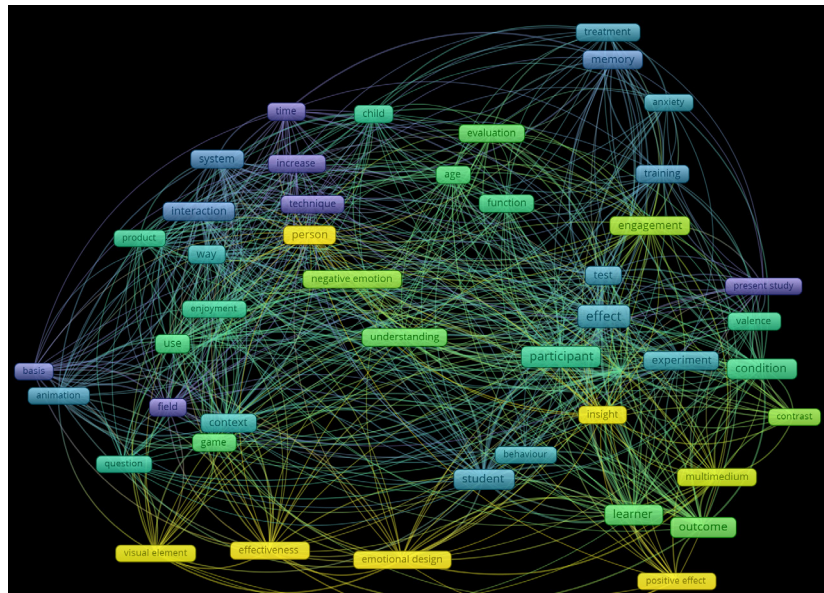


Fig. 5. Research classifications using the text network technique

3.2 Classification

After the VOS viewer content analysis and key term occurrences, the data were separated into three groups. The essential past study explores multimedia learning in most of the studies, the pleasant emotions and visual design were the other key research topics uncovered. This section discusses the categories in detail below.

3.3 Multimedia learning

Positive emotions have been shown in both theoretical and practical studies to aid learning in two ways successfully. To begin, the motivating effects of emotions may increase learning (Shangguan, Wang, et al., 2020a). Positive emotions can boost learners' motivation, increase their involvement in learning activities, and enhance learning outcomes (Chai et al., 2021). Second, happy emotions may improve the allocation of brain resources during learning. In addition, multimedia learning and graphic design are used holistically in scientific textbook design (Saha & Halder, 2016). Applying design principles holistically in the revised cell biology chapter resulted in significantly less time spent on relevant texts, significantly more successful integration of relevant texts and relevant images, and significantly higher achievement scores in the revised chapter group than the unrevised old chapter group (Altan & Cagiltay, n.d.). According to (Park et al., 2014b), several research on the expertise reversal effect has underlined the necessity of learners' existing knowledge for multimedia learning. More recently, studies have included learners' emotional state before learning as an essential predictor of learning performance (Knörzer et al., 2016b). Yet, these topics have only recently

been studied in a multidisciplinary way in multimedia studies. Instead of considering each assumption independently, such an integrating technique incorporates both parts, such as state and trait traits, using an interaction model (Sudario et al., 2022). Table 3 below illustrates the details of the authors of studies, citations, segments, and settings.

Table 3. Authors, citations, segments, and settings

Authors	Cited by	Segment	Settings
N. Khan et al., 2020	0	visual designs	navigation experience
Shangguan, Wang, et al., 2020	15	visually attractive emotional design	cognitive outcomes
Park et al., 2014	84	cognitive and affective processes	visual design
Altan & Cagiltay, 2022	0	visual design	design process
Chai et al., 2021	0	optimal learning and memory	multimedia learning materials
Saha & Halder, 2016	0	visual animation	instructional module
Sudario et al., 2022	0	presentation design	education quality
Knörzer et al., 2016b	28	the Cognitive-Affective Theory of Learning	emotional impact
Um et al., 2012	311	positive vs neutral emotions	positive emotional design
Liew, Tan, Gan, et al., 2022	0	emotional design principle	multimedia learning lessons
Dong C. 2009	3	broaden cognitively	The Model of Emotional Design
Muniady & Mohamad Ali, 2020	4	Quiz-based Multimedia Learning Environment	positive emotions
Dong, 1 C.E.b, 2008	0	cognitive resources	multimedia learning
L. Chen et al., 2021	2	multimedia learners	cognitive load,
Heidig et al., 2015b	112	cognitive factors	emotional design
Leutner, 2014	78	cognitive-affective theory of learning with media"	"Situational interest"

Multimodal learning is acquiring knowledge from an educational message containing verbal and nonverbal information (Um et al., 2012). The CATLM considers both cognitive and emotive components of multimedia learning (Moreno, 2006). According to the CATLM's assumptions, cognitive processes during multimedia learning occur within two separate information processing channels in working memory, where verbal and nonverbal information can be processed and coded concurrently (M. I. Qureshi & Khan, 2022). However, the Cognitive-Affective Theory of Learning with Media, a subset of the Cognitive Theory of Multimedia Learning, contends that motivational and metacognitive variables influence learning by supplementing or undermining learners' cognitive resources committed to the S-O-I process (Liew, Tan, Gan, et al., 2022). The Integrated Cognitive Affective Model Learning with Multimedia framework expands the theories mentioned above by stating that assimilating multimedia learning material into a mental model requires two unique channels of processing: (1) emotional schemas; (2) visual and verbal data (Dong, 1 C.E.b) According to (Leutner, 2014), yet, it

was demonstrated in both experiments that emotional design characteristics of the content might alter students' emotions, providing a good starting point for future study in this topic.

According to (Heidig et al., 2015b), instructional circumstances to improve computer-based multimedia learning generally focus on cognitive elements. Despite various unsolved concerns, emotional elements have been mainly ignored in multimedia learning research thus far. External emotional activation before learning and the emotional design of learning materials affect learners' emotions (L. Chen et al., 2021). Emotion activation techniques aim to differentiate between distinct emotional states generated in the emotional model. According to research, pleasant emotional design can boost learners' internal motivation and facilitate learning (N. Khan et al., 2020). (Muniady & Mohamad Ali, 2020) experimentally stimulated the emotions of the research participants, and the results revealed that pleasant emotions did increase cognition and motivation in the multimedia learning system.

3.4 Positive emotions

In recent years, research on multimedia learning has begun to consider the impact of emotional processes such as emotions (Park et al., 2015). Because emotions influence cognitive processes and understanding, the topic of how emotions affect multimedia learning emerges. Given that the design of multimedia learning environments should be optimised to improve learning processes, the issue arises as to whether specific design components in such an environment elicit emotions and stimulate learning (Sikandar et al., 2022). According to (Chung et al., 2015), for learning, positive emotions (such as delight) outperform negative emotions (such as fear). They proposed that a pleasant mood boosts learners' intrinsic motivation by encouraging their interest in learning new things, resulting in improved learning performance. They have, however, neglected the beneficial function of negative emotion or the differential consequences of emotional arousal (calm versus arousing). Negative emotions, such as tension or anxiety, may, for example, drive students to achieve better (Y. Wang et al., 2023). The effect of positive emotions created before learning and using an inspirational design with design elements creating positive emotions during learning was explored (San & Taş Alicenap, n.d.). Their findings demonstrated that a cheerful emotional design with circular forms, warm colours, and anthropomorphisms in multimedia education, as well as a happy attitude before learning, might create positive feelings and enhance learning (Liew, Tan, Pang, et al., 2022). Table 4 depicts the author's details, citations, segments and settings in which the research was conducted.

Several education specialists say emotions are intimately tied to and impact learning performance. Emotions can influence attention, meaning production, and memory channel construction (C. M. Chen & Wang, 2011). As a result, emotional status and learning are strongly correlated with identified emotional pairs consisting of positive and corresponding negative emotions, such as anxiety-confidence, boredom-fascination, frustration-euphoria, discouraged-encouraged, and terror-enchancement, all of which are likely relevant to learning (Y. Wang et al., 2021). According to (Plass et al.,

2014b), in the context of learning, have been interested in negative and positive emotions directly connected to instruction, learning, and accomplishment. According to (Ashraf et al., 2019), emotions in educational settings are generally associated with the substance of learning and teaching. From a pedagogical standpoint, it becomes a fundamental aim for learners to perceive and use their emotional experience on the learning content and the learning conditions (Knörzer et al., 2016a).

Table 4. Authors, citations, segments, and settings

Authors	Cited by	Segment	Settings
Liew, Tan, Pang, et al., 2022	1	multimedia learning environment	E-learning
Park et al., 2015	150	emotions on learning	design element
Chung et al., 2015	26	learning performance	emotional valence
Sikandar et al., 2022	1	in-depth learning	emotional designs
Y. Wang et al., 2021	0	multimedia lessons	learning materials
C. M. Chen & Wang, 2011	66	learning performance	video-based multimedia material
Heidig et al., 2015	0	emotions in learning	multimedia designers
Knörzer et al., 2016a	64	cognitive load	learning outcomes
X. Wang et al., 2022b	1	learning outcomes	emotional design group
Y. Wang et al., 2022	5	emotion regulation	pedagogical agent
Plass et al., 2014b	289	emotional design of multimedia learning material	comprehension
San & Taş Alicenap, 2020	0	emotional design	multimedia theory
Ashraf et al., 2019	3	visual design	positive and negative emotions
Tomita, 2018	3	learners' emotions	learning context

Emotion regulation refers to the collection of regulated and automated processes by which humans exert influence over how they feel or express their emotions to regulate or affect the trajectory, duration, and intensity of emotions (X. Wang et al., 2022b). Five emotion regulation techniques are identified under the process model of emotion regulation: context selection, situation alteration, attentional deployment, cognitive reappraisal, and expressive suppression (Y. Wang et al., 2022). In addition, the positive emotional design variation of the materials in the research featured rich, warm colours and round face-like forms to create happy feelings (Tomita, 2018). The neutral design used achromatic (greyscale) screens and square forms that did not resemble human faces as the control condition.

3.5 Visual design elements

In recent years, research on psychology, neurology, and decision-making has also demonstrated that people's emotional state influences their decision-making to a large extent since emotion alters how individuals perceive information (Q. Wang et al., 2014). Prior research on emotional design in multimedia learning has concentrated on

the visual level, with colour and anthropomorphism highlighted as essential visual design aspects that can successfully trigger pleasant feelings (Shangguan, Wang, et al., 2020b). Warm colours, in the example, were shown to evoke larger and more pleasant emotional arousal than cold colours, and baby-like anthropomorphism was found to be positively connected with good emotions (White et al., 2013). Nevertheless, new research on the emotional and cognitive consequences has produced conflicting results (Wright et al., 2013). According to specific research, cheerful emotional design on visual components can create happy feelings and improve cognitive outcomes such as cognitive load and learning performance (Arthur et al., 2018). In addition, cognitive psychology provides a foundation for studying user behaviour and habits for user design (Zhang & Hao, 2021). "By comparing the emotional performance and function of visual design and the analysis of the emotional mechanism in interface design, it is concluded that the emotional expression of the user interface has two functions: one is to shape and convey the emotional theme of the user interface, and the other is to satisfy the user's unique emotional appeal in different scenarios (Chang, 2015). Table 5 illustrates the details of authors, citations, segments, and settings.

Table 5. Authors, citations, segments, and settings

Authors	Cited by	Segment	Settings
Chang C.	14	cognitive responses	positive emotion and enjoyment.
Zhang & Hao, 2021	0	emotional theme	cognitive process
Q. Wang et al., 2014	31	positive emotions	image appeal
Shangguan, Wang, et al., 2020b	15	behavioural emotional design	learning materials
Kuba & Jeong, 2023	0	higher-quality infographics	visual design processes
Kühl et al., 2022	1	visual design variations	multimedia learning experiments
Wright et al., 2013	19	Experiments	communication theory
Liew et al., 2017	51	higher positive emotions	cognitive outcome
C. M. Chen & Sun, 2012	83	visual and verbal cognitive	Style of Processing

Prior knowledge of learners is conceptualised in terms of existing cognitive or knowledge structures related to the investigated area. It is recognised as one of the most critical aspects impacting the results of multimedia learning (Shangguan, Gong, et al., 2020). Prior research has shown that learners' past knowledge influences learning processes and results. According to (Nima et al., 2020), the human picture is one of the most frequent visual design components in website design. Yet, research on the influence of human photographs in the context of online buying is minimal. In addition, combining human photographs and appropriate language on a website can create a social presence in visitors, providing a sense of other people's presence (Golding et al., 2020). According to the findings, when a human image and socially rich words were utilised, the perceived social presence was much higher than when available text and a simple product photo were used (Xia et al., 2021). In addition, visual design elements such as colour and graphics, which may influence people's perceived beauty and emotion, are often employed in emotional design (Özdemir & Bengisoy, 2022). The second

stage is behavioural design, which is frequently related to usability. Whether or whether the product allows consumers to interact with the task is directly tied to behavioural design (Shangguan, Wang, et al., 2020c).

Instructional resources are no longer restricted to static text; presentation is shifting from text-based materials to multimedia elements to capture student attention and interest (Liew et al., 2017). Emphasis has been placed on developing interactive multimedia resources to increase learning motivation and performance (Kuba & Jeong, 2023). Therefore, it is necessary to determine if various multimedia products with the same learning content and objectives have the same effects on learners' emotions and performance for learners with different cognitive types (C. M. Chen & Sun, 2012). Because each learner has a unique cognitive learning style linked with multimedia material learning, offering improper multimedia learning materials to students may harm their learning (Kühl et al., 2022).

4 Conclusion

The current study's main objective was to identify the impact of design elements (visual design elements) in multimedia learning material to induce positive emotions in learners. Additionally, this study analyses the emotional elements in the multimedia learning context. The findings showed that learners using the positive emotional design had more positive emotions and higher comprehension and transfer test scores. In addition, results shown that emotions are intimately tied to and impact learning performance. Findings demonstrated that a cheerful emotional design with circular forms, warm colours, and anthropomorphisms in multimedia education, as well as a happy attitude before learning, might create positive feelings and enhance learning. Figure 6 depicts the study outcomes related to positive emotions, visual designs and multidisciplinary learning.

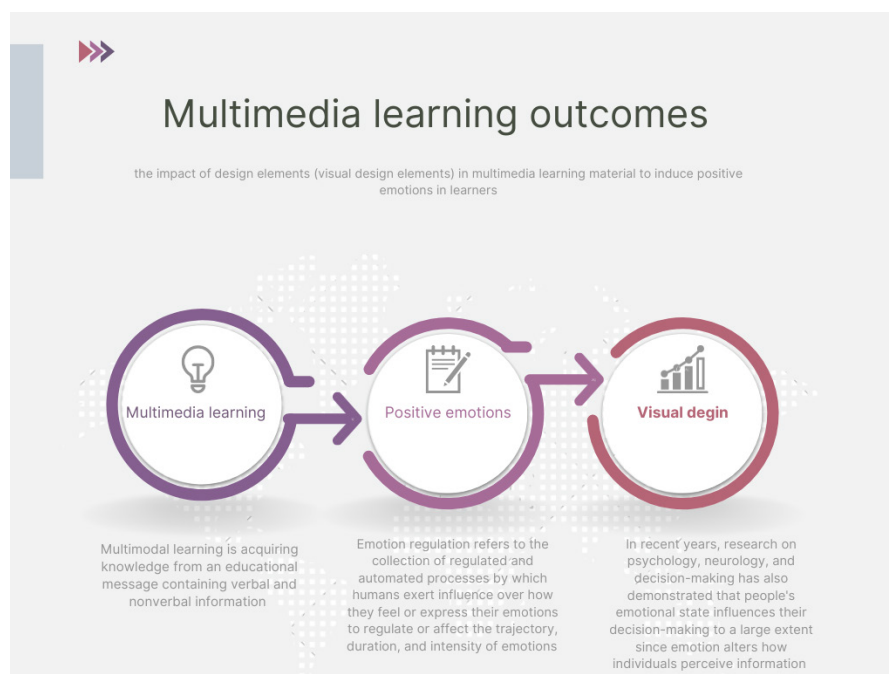


Fig. 6. The outcomes extracted from the documents

Furthermore, learners who received the cheerful emotional design saw the materials as less challenging and expended more mental effort digesting them than learners who received the neutral design. They reported better motivation, contentment, and perception of the learning materials. In addition, findings show that people's emotional state influences their decision-making to a large extent since emotion alters how individuals perceive information. Also, the results of this study indicate that visual design elements such as colour and graphics, which may influence people's perceived beauty and emotion, are often employed in emotional design.

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