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Original Research

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Analyzing the Impact of Aesthetic Visual Design on Usability of E-Learning: An Emerging Economy Perspective

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Abstract

Objectives: The purpose of the study is to examine various dimensions of aesthetic visual design and their role in predicting usability in e-learning in higher education institutions of northern India. Using quantitative means of data collection, this research identified, ways and means to make learning content effectively usable, that is, attractive, interesting, motivating, and engaging for the learners.

Method: A survey questionnaire was developed through focused group discussions with field experts. Data were collected through online as well as offline modes. A Google form was created and its weblink was shared with the students pursuing degree courses in various state universities in northern India. Several visits and revisits were also undertaken to various universities to approach the respondents

Results: Results confirmed consistency, typography, graphics, grid, and layout as factors responsible for predicting usability of e-learning. Surprisingly, color and compositional guidelines emerged insignificant.

Implications: The study has implications for teaching and learning activities that promote effective learning. The findings are beneficial for course-design faculty who develop modules by considering visual design elements that can facilitate interaction with and understanding of content by students learning in an online modality.

Keywords: *visual design, e-learning, usability of e-learning*

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Introduction

E-learning has evolved rapidly over the last four decades, and the interaction of technology with education has resulted in a wide range of e-learning definitions. E-learning may be defined as, "a learner-centered process which uses online learning resources to facilitate information sharing regardless of the constraints of time and place among a network of people" (Shahabadi & Uplane, 2015, p. 132).

The curriculum may be improved to enhance the quality, consistency, and accessibility of teaching. Educators are better positioned to communicate information to learners using customized learning modules (Jha, 2018). The way educators teach in a conventional classroom cannot be directly translated to a virtual environment; however, various approaches, such as visual design, can be used to successfully adapt content to online modalities (Gutierrez et al., 2016). Visual design has gained importance in online environments because it makes online learning interesting (Ghai & Tandon, 2021). If users find the virtual elements interesting, it influences their state of mind and helps them understand the content better (Chávez et al., 2021; Sweller et al., 2019).

Most previous research empirically validated antecedents for adoption of e-learning either by using technology acceptance (Davis, 1989) or the unified theory of acceptance and use of technology (UTAUT and UTAUT 2; Venkatesh et al., 2012) models. Antecedents include variables that facilitate e-learning and help the students to adopt e-learning, such as perceived ease of use and perceived usefulness based on hedonic motivation, price value, and social influence factors. However, the design elements in e-learning remain unexplored (Ghai & Tandon, 2021).

The purpose of the present study is to understand various facets of visual design and their impact on improving usability of e-learning. The study has implications for academicians in how they teach as well as for universities that train their academic faculties to make their lectures interesting and engaging. It is important to understand the perception of students regarding the significance of various design elements where students lack eye contact, often feel demotivated, and instructors fail to engage them. Therefore, the research questions guiding the study include (a) understanding the aesthetic elements and facets of visual design with respect to usability of e-learning and (b) understanding the impact of these elements on e-learning's usability.

Literature Review

E-Learning in India

India occupies a unique status in global education and has the most extensive higher education system dominated by the private sector. The country has heavily invested in education including providing adequate and up-to-date infrastructure; this investment is transforming India into a knowledge economy (Jha, 2018). Formal education is supplemented by vocational multimedia/technology-based educational courses, which are essential due to the need for workers skilled in these areas (Khaitan, 2017). As 5G technology is becoming more prevalent, the learners and solution providers are embracing the concept of learning anywhere, anytime and in digital education formats; new learning methods, such as the use of educational influencers and virtual reality, will supplement traditional teaching (Economic Times Prime, 2020). The education industry in India was projected to increase from 1.6 million users in 2016 to 9.6 million users by the end of 2021 (Khaitan, 2017). Further, the COVID 19 pandemic facilitated the adoption of e-learning, which became the norm and higher education institutions were required to embrace digital technologies to generate and deliver content.

Computer-Assisted Learning/E-learning

Programmed instruction delivered via computers in the mid-20th century (1950–60) formed the foundation for computer-assisted learning (CAL); this is known as e-learning (Keser & Semerci, 2019). It is the transfer of

knowledge- and skills-related content through a network to reach many people at the same or different times. Transmission is via electronic media sources that include satellite, intranets, extranets, internet, and broadcasts (Tandon et al., 2021; Tastle et al., 2005). Different versions of e-learning have arisen based on evolving web technology. E-learning 1.0 was focused on facilitation of learning without interactive tools (Miranda et al., 2014). E-learning 2.0 included social media (Richardson, 2005; Rubens et al., 2012); 3.0 elaborated on semantic web-based blended learning focused on engagement of learners with instructional material (Guha, 2009); and 4.0 focused on advanced blended learning including individualized and elaborated interactivity to provide intuitive learner experience through a course containing audio, video, and text material (Keser & Semerci, 2019).

The impact of computer-based technology on student participation in higher education settings was reviewed by Schindler et al. (2017). Authors found that online education can enable students to develop competencies, abilities, and positive attitudes toward learning while making learning more accessible. These new environments need to be evaluated and monitored to determine their impact on students' learning experiences and provide insights into how and what students are learning and how online practices can be improved (Vlachopoulos, 2020). Learning management systems (LMS) have been widely adopted in higher education to distribute learning materials. LMS allow learners to register for classes, track their grades, and check module-related announcements; these enhancements improve learning outcomes, which in turn leads to an increase in student engagement (Bradley, 2021; Watson & Watson, 2012). It has been proposed that investing in visual design might ensure that the promise of LMS is achieved (Grant-Smith et al., 2019).

Impact of COVID-19 on Education

The COVID-19 pandemic resulted in the closure of schools and universities, creating a dramatic shift in education delivery methods. Educational institutions have been compelled to use online technologies to perform emergency remote teaching and make effective use of virtual learning environments. The virtual learning environments include diverse video conferencing tools, virtual tutoring, online learning, and language apps to facilitate learning. The epidemic continues to influence higher education; in many areas of the world, lessons are still being offered remotely while schools are slowly reopening for face-to-face or hybrid instructions. The consequences of the epidemic on higher education were far-reaching, as evidenced by recent studies (Cathy & Lalani, 2020; Chavez et al., 2021; Mittal et al., 2021). Mittal et al. (2021), for example, highlighted that establishing a virtual study culture necessitated by the COVID-19 pandemic has been challenging for academic institutions as well as for students. Academic institutions faced unusual challenges including reducing learning losses, rapidly deploying virtual learning, and training academicians and students to adapt to this new normal (Sangeeta & Tandon, 2020).

Nations worldwide focused on issues whose relevance has been enhanced by the epidemic, such as digital teaching and learning, higher education and the public good (community living), and student preparedness (Burkholder & Krauskopf, 2021). To ensure quality student learning in online environments, educators must improve the quality of participation to enhance teaching processes (Chavez et al., 2021; Cathy & Lalani, 2020; Mittal et al., 2021; Sangeeta & Tandon, 2020; Tandon et al., 2021). Educators are now required to coordinate online instructional design and student learning, deliver online instructions efficiently, provide adequate and timely support for both educators and learners, ensure their (focused) participation, and prepare contingency plans to deal with unexpected needs and incidents arising from novel educational platforms (Duarte & Rodriguez, 2021).

Theoretical Underpinning and Hypotheses Development

To conceptualize the constructs for the present study, we integrated existing theories, namely dual coding theory (Paivio, 1991), cognitive theory of multimedia learning (Mayer, 1992), and cognitive load theory (Sweller et al., 2019). Each are discussed below:

Dual Coding Theory

Dual coding theory is focused on the presence of separate subsystems in the brain for constituting visual and verbal information. Short-term memory has two buffers that are partly independent with interrelated input channels constituting imagery and language systems (Liu et al., 2020). The verbal system is responsible for modality-specific visual and auditory verbal codes. The verbal system is dedicated to processing verbal data (language); it receives and stores linguistic data. The nonverbal system is responsible for processing nonverbal elements and events such as mental imagery, visual pictures, and emotional reactions. According to Liu et al. (2020), the left hemisphere of the brain is strong at processing verbal information, whereas the right hemisphere is effective at processing presentation information. The visuospatial sketchpad and the phonological loop can be used to store temporary visual and auditory information but have a greater capacity when both are used (Gutierrez et al., 2016). During the learning process, efficient storage and processing of information are improved by using multiple mediums rather than a single medium.

Several principles have been derived from dual-coding theory. The multiple representation principle suggests that an explanation should be in words and pictures instead of only in words (Clark, 2002; Mayer & Moreno, 2003). The contiguity principle stresses simultaneous presentation of similar words and pictures, and the coherence principle focuses less on usage of words and sounds (Clark, 2002; Liu et al., 2020). In the modality principle, stress is placed on presenting words as the auditory narration, while the redundancy principle indicates that the text should be presented in the form of animation and narration (Clark, 2002; Mayer & Moreno, 2003). Humans actively create mental representations to make sense of incoming information. The theory suggests that conventional teaching methods should be updated to include multimedia in the context of teaching and learning. Resultantly, multimedia piques attention while also aiding linguistic competence and retention (Liu et al., 2020).

Cognitive Theory of Multimedia Learning

Cognitive theory of multimedia learning posits that the presentation of words, pictures, and auditory information are not interpreted by the brain independently of each other; instead, logical mental constructs are produced by dynamically selecting and organizing them for meaningful learning (Mayer & Moreno, 2003). The theory explains the process that occurs in the mind at the time of meaningful learning through multimedia instruction. It also has implications for instructional designers who create multimedia materials to avoid cognitive overload of the learner. According to the cognitive load theory, all new information is first processed by working memory, which has capacity and duration limits, before being stored in long-term memory, which has no such constraints (Anmarkrud et al., 2019; Mutlu-Bayraktar et al., 2019).

Any learning task places three types of cognitive load on working memory: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load (Pass et al., 2003; Sweller et al., 2019). Intrinsic cognitive load refers to the “inherent difficulty and complexity of any task” (Anmarkrud et al., 2019, p. 63). The authors further highlighted that some tasks are complicated and difficult to comprehend despite adequate instructional design and thus impose a higher cognitive load on working memory. On the contrary, extraneous cognitive load is defined as “instructional activities undertaken to present the learning material” (Anmarkrud et al., 2019, p. 63). Germane cognitive load refers to “the load placed on working memory by learning, as when relating information from long-term memory to new information” (Anmarkrud et al., 2019, p. 3).

All three are important factors to consider when creating and designing multimedia teaching aids (Sweller et al., 2019). It is important that cognitive load should not exceed the learner's learning capacity. Therefore, while employing texts, graphics, and graphs, designers should examine the material to be taught and consider the load handled in working memory (Mutlu-Bayraktar et al., 2019).

Multimedia Instructional Design Theory

Much literature exists concerning font type and size, among other visual aspects, in PowerPoint slides, but less is published on using multimedia instructional design concepts to create successful presentations that lead to active and meaningful learning (Mahajan et al., 2020). Much research has backed up the theoretical underpinning of multimedia instructional design concepts (Chang & Yang, 2010; Gutierrez et al., 2016; Mayer & Moreno, 2003). The theory explains the significance of various visual elements that need to be considered to plan an e-learning course. These include (a) font, including sizes, styles, bolding, and italics; (b) colors, which should be complementary to highlight specific elements; (c) graphics, including symbols, icons, illustrations, and photos; (d) moving graphics, such as videos and animations; and (e) order/sequence of different design elements, including color and fonts.

Necessary design elements, such as adequate color and fonts, must be used, but a designer must avoid overdoing them to prevent distraction. Messages must be clear and enhanced with visuals. Text must be clear and concise; the tone is critical; and the content must be explained thoroughly (Chang & Yang, 2010; Gutierrez et al., 2016; Mayer & Moreno, 2003). The above review of literature on instructional design suggests that academics must use adequate multimedia tools to make their presentations interesting and appealing so that students can understand the content.

Hypotheses Development

Visual Design and E-Learning

Visual aesthetics, usability, and design are important concepts when generating online educational content. Developers need to consider both visual content and the judgment of aesthetics (David & Glore, 2010). Design evokes emotional and cognitive responses in learners (Norman, 2004). Tomita (2015) stated that designers can use form, shape, line, color, texture, value, space, and typeface, as well as principles such as balance, unity, proximity, contrast, and emphasis and alignment when creating content. Surface designs, wireframe sketches, information architecture, a final visual design, and basic guidelines concerning navigation, color, typography, layout, visual organization, and web usability can be used by an online course developer to improve the design and transmission of the content to enhance the quality of online courses (Reyna, 2013). Design consistency is a critical element, as it relates to the use of multiple circumstances, terms, or behavior and the placement of text, fonts, and elements to hasten the learner's comprehension. Consistency in design and navigational methods enables users to adjust quickly to the design and accurately predict the navigational functions and information position through web pages (Powell, 2000). Thus, principles of good design can improve experience in online courses (Pralle, 2007; Reyna, 2013).

A number of psychological processes, including attention, visual perception, motivation, understanding, thinking, and conscious memory, come together to ensure that visual content is assimilated and interpreted (Istrate, 2009). These influence perception, which varies by individual and causes each individual to react differently to content (Mayer, 2009). Each e-learning application needs to be easy to understand, requiring an interactive layout design that contributes to the high-quality e-learning content in education (Kamaruddin, 2010). Visual design and its usefulness significantly affect the learner's perception, thereby improving learning performance. Thus, visual elements of interface design are an important area of study.

Designers must consider six primary components when developing an online course. These are (a) visual design, (b) web standards and accessibility, (c) principles of multimedia learning, (d) information architecture, (e) pedagogical considerations, and (f) the quality of material (Tomita, 2015). These components are crucial to enhancing the learning experience because the perception of information and learning, judgment of usability and credibility, and evaluation of the online experience are intensively impacted by design and aesthetics. An excellent visual design simplifies the message, ensures legibility, focuses the learner's attention, and motivates and increases a learner's engagement (Ghai & Tandon, 2021; Mittal et al., 2021). Visual design plays a role in supporting and enhancing teaching (Reyna, 2013). Research has shown these principles as being equally important for learners of different ages (Chang & Yang, 2010). The aesthetic visual design has a significant role in determining user responses based on aesthetic factors. These, in turn, improve the visual appearance of the course content and the way students interact with and react to those courses and thus influence perceived usability and credibility (David & Glore, 2010; Tandon et al., 2021).

Therefore, the following hypothesis was formulated and tested:

H1: Aesthetic visual design is a multidimensional construct significantly predicted by consistency, color, grid and layout, compositional guidelines, typography, and graphics.

Elements of Visual Design and Usability in e-Learning

Color is a crucial component in visual design because it determines the mood (Tomita, 2015). Specific colors have also been validated to affect performance (Reyna, 2013; Tomita, 2015). Roberts (2009) found that, "even though the use of color in the production of instructional materials is widespread, its relative effectiveness as an aid in improving student achievement still remains inconclusive and at best contradictory" (p. 26).

The contrast between the soft background color and the dark letters encourages reading and engages students, while bright backdrop colors and combinations should be avoided, since this combination makes reading more difficult (Reyna, 2013; Tomita, 2015). The capacity of symmetry to direct the user's gaze is one of its most compelling features. A wholly symmetrical and consistent design creates balance and a sensation of stability, both of which are important for e-learning (Clark & Mayer, 2011; Roberts, 2009). While color perceptions are primarily subjective, some color effects have universal significance, such as black text on white background and white text on black background (Hall & Hannah, 2004; Pralle, 2007).

In e-learning, layout uniformity is critical. Layout refers to the distribution of components such as pictures, buttons, and links on a page and the color scheme and information architecture (Pralle, 2007; Reyna, 2013). Learners are motivated to engage and continue web-based learning by the layout, use of visuals, and convenience of use (Ghai & Tandon, 2021). Usability and visual acceptance are the two crucial criteria for evaluating e-learning applications. Usability includes ease and convenience in using the designed system (David & Glore, 2010). Poorly designed applications for e-learning result in higher dropout rates of learners (Notess, 2001). Based on the above discussion, the following hypothesis has been proposed:

H2: Dimensions of aesthetic visual design, including color, consistent design, graphics, typology, composition, and grid and layout, predict usability in e-learning.

Methods

Participants

The study was conducted with students enrolled in undergraduate degree programs taking a variety of courses in business management, engineering, arts and humanities, and natural sciences disciplines. Students were enrolled in universities in the Northern states of India. Five state public and private universities were selected that had switched to online education due to COVID 19.

Sampling Strategy

Using a mixed sampling approach increases survey response rate and reduces bias caused by adopting a single method of sampling (Teddlie & Yu, 2007). Both convenience and snowball sampling methods were used as nonprobability sampling techniques. We preferred non-random sampling in the study and feel that this sampling method is apposite for research in the light of India's typical social and cultural context (Dubey et al., 2019). In India, personal relationships are preferred over the professional ones (Dubey et al., 2019). Further, non-probability sampling techniques have been adequately applied by previous studies on e-learning (Mittal et al., 2021; Tandon et al., 2021).

Adequate sample size is required for performing structural equation modelling. Previous studies suggested that the ratio of the number of respondents to the total number of scale items can be as low as 10 to 1 (Schreiber et al., 2006) or even 5 to 1 (Bentler & Chou, 1987). The total number of variables guides the sample size. Thus, the sample size (n = 355) was deemed adequate for the analyses performed in this study. Extant literature reflects that as the sample size becomes larger the results become more reliable and generalizable (Sugden et al., 2000).

Instrumentation

Instrument Development

The items of various constructs describing visual design were adopted from the previous studies (Pralle, 2007; Zaharias & Poylymenakou, 2009). All scale items were modified and simplified to make them more understandable. Further, the suggestions from experts also helped us to reframe the questions using the latest terminology. For example, "color combination" was replaced with "color scheme." All items ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). Scores were calculated by taking the average of all the items of a construct.

We desseminated the initial questionnaire to a group of artists and faculty members of a prominent state private university to improve the clarity and precision of the questionnaire. This pilot group recommended a few modifications in the wording of scale items and suggested some new items such as compositional guidelines and consistency regarding the content. We considered the recommendations by this group where relevant throughout the questionnaire. A few scale items were redrafted and rephrased, while a few were discarded due to word duplication. For example, the scale item "Content is organized in an appropriate sequence and in small modules for flexible learning" was bifurcated into two questions to make it simpler: "Organization of the content in an appropriate sequence promotes flexible learning" and "Organization of the content in small modules improves flexible learning." "Vertical/horizontal gridlines which incorporate the margins, spaces or columns provide a framework for organizing the content" is a new scale item in the construct "compositional guidelines," as suggested by experts. Students participating in the study were pursuing graduate studies in which the medium of instruction is English. The language of scale items was modified as per the experts' suggestions so that the scale items were easy for the students to comprehend.

Scales

Consistency. The scale assessing consistency included four items. These items were adapted from a scale developed by Zaharias and Poylymenakou (2009) and covered topics such as uniformity in design layout and size, colors, and terminology. The scale items were modified to make them easily understandable for the students. For example, separate scale items were framed for consistency and font to address consistency. Items included:

1. Uniformity in design layout leads to concentration and understanding.
2. Consistency in fonts and their size throughout the course leads to understanding.
3. Uniformity in colors throughout the course maintains a flow in a concentration.
4. Uniformity in terminology throughout the course leads to a better understanding.

Color. The second sub-construct, namely color, had four items taken from Pralle's (2007) study indicating choice of colors. One item, "an appropriate color scheme enhances the attention span of the learner," was modified as suggested by the experts. The other scale items included:

1. The color scheme improves the appearance of the course.
2. Colour contrast in foreground/background in graphics/text impacts the learning process.
3. Choosing the right color combination enhances clarity and readability.

Compositional Guidelines. The compositional guidelines items were extracted from the study of Zaharias and Poylymenakou (2009). The items of this construct included.

1. Organization of the content in an appropriate sequence promotes flexible learning.
2. Organization of content in small modules improves flexible learning.
3. Vertical/horizontal guidelines incorporating margins, spaces or columns provide a framework for organizing the content to promote learning.

Grid and Layout. Grid and layout also had four items each, covering scale items on how appropriate graphics enhance usability in e-learning. "A well-designed layout makes the content easier to understand" is a new scale item. The other three items of the sub-construct included:

1. "Color and graphics" in appropriate grid and layout promote concentration and learning experience.
2. Short sections of text increase the attention span.
3. Simple or easy navigation through the course facilitates learning.

Typography. Typography included questions regarding arrangement of fonts and colors that tend to make the content interesting and easy to comprehend. Typography was measured with four scale items. These items were:

1. Easily distinguishable letters in typesetting promote understanding of the subject.
2. Arrangements of fonts and words make written content flow and easy to read.
3. The font size, style, and color play an influential role in understanding the content.
4. Strong use of headings and subheadings promote understanding.

Graphics. Graphics had seven items covering statements on multimedia elements and visual cues. The statements like, "appropriate use of Graphics including illustrations, photographs, graphs, diagrams, etc. leads to communicate visual and spatial concept" were also included as suggested by one of the experts. The other scale items included:

1. Graphics/multimedia assist in noticing critical content,

2. Media (text, images, animation, etc.) enhance the connection to objectives of the course
3. Effective infographics lead to an understanding of the information/subject easily.
4. Multimedia elements help to reduce boredom.
5. The use of visual cues (e.g., color, size, etc.) highlight information on a page.
6. Appropriate application of graphic techniques enhances knowledge acquisition.

Usability. Usability of e-learning, which was the dependent variable, was measured with five items like:

1. Bright and good visuals help to understand better.
2. A clear message with multimedia promotes understanding of the subject.
3. Easy to read course instructions lead to usability.
4. Interactive tools help to learn fast.
5. Text, style, and color help to understand the technical concepts.

Procedures

Data were collected through online as well as offline modes. A Google form was created and its weblink was shared with the students pursuing degree courses in various state universities in North India. Several visits and revisits were also undertaken to various universities to approach additional respondents to get a representative sample.

The link to the questionnaire and an invitation message were posted on the social media groups of universities. These included both formal as well as informal students social media groups. Formal groups are those groups where the institution provides all the official information to the students. Examples include links to join and reschedule classes as well as information related to institutional affairs. The invitation assured protection of privacy and those responses would be used only for academic purposes. Approval to conduct the research study was obtained by the ethics review boards of each of the institutions involved. To control social desirability bias, respondents were requested to respond naturally and honestly (De Leeuw, 2008).

Statistical Analysis

Common Method Bias

Initially, we checked data to detect the existence of common method bias (CMB). For this, Harman's single-factor test was performed (Harman, 1976). This procedure involves "constraining all the scale items into a single unrotated factor in exploratory factor analysis, with the assumption that the presence of CMB is indicated by the emergence of either a single factor or a general factor accounting for the majority of covariance among measures" (Podsakoff et al. 2003, p. 889). The recommended value is no more than 50% of the explained variance for the single-factor solution (Harman, 1976).

Confirmatory Factor Analysis

Next, to ensure quality, reliability, and validity criteria before proceeding to the structural model assessment, confirmatory factor analysis (CFA) was conducted to ensure fit between observed data and a theoretically grounded model that signifies hypothesized causal relationships between latent and observed indicator variables (Hancock & Mueller, 2001, p. 5240). CFA was conducted prior to path analysis as suggested by previous researchers (Anderson & Gerbing, 1988; Hancock & Mueller, 2001). As the sample size is large enough, it is recommended to run CFA for all constructs rather than conducting it pairwise; this results

in the final measurement model or saturated model, which in turn is desired for discriminant validity as suggested by Fornell and Larcker, (1981).

In CFA, several model fit indices are used to determine the feasibility of how well the model fits to the data (Hair et al., 2010; Kline, 2016). For the Chi-squared to degrees of freedom ratio test, smaller values indicate better model fit; this implies that the difference between observed and expected covariance is small. The goodness of fit index (GFI); non-normed fit index (NFI); incremental fit index (IFI), which adjusts NFI for sample size and degrees of freedom; and comparative fit index (CFI) should all be greater than .90 for a well-fitting model. The root mean square error of the approximation (RMSEA) values of less than 0.08 are indicative of adequate fit.

To evaluate the convergent validity of the exogenous and endogenous constructs, we considered the standardized loadings of the constructs and average variance extracted (AVE; Hair et al., 2010). Standardized loadings of 0.6 or higher suggest that items exhibit validity (Kline, 2005). AVE values above 0.5 indicate adequate convergent validity (Bagozzi et al., 1991; Fornell & Larcker, 1981). Internal consistency reliability was addressed by computing composite reliability (CR). A value of 0.7 represents acceptable internal consistency reliability (Fornell & Larcker, 1981).

Tests for discriminant validity were performed. Discriminant validity indicates the level to which one construct differs from other constructs within the measurement model (Hair et al., 2010). They suggested that, for a construct to possess discriminant validity, AVE should also be greater than the squared correlation of that construct with all other constructs as a threshold for discriminant validity. Values of AVE should be more than inter-item correlations; this suggests factors are not highly correlated (Hair et al., 2010).

Analysis of Predictive Paths—Structural Model

Once we ascertained adequate factor structure, relationships between elements of visual design and usability were tested using structural equation modeling (SEM). Further, to accept or reject the hypothesis proposed, *p*-value statistic was considered whereby the hypothesis is accepted if *p*-value is less than the level of significance, which we set to 0.05, (Halsey et al., 2015). Further a path coefficient for a relationship in the structural model is assumed significant if critical ratio (*CR*) is greater than or equal to 1.96 (Hair et al., 2010). The value of standardized beta coefficient (β) indicates the strength of the relationship specified in the hypothesis (Weston & Gore, 2006).

Results

Demographic Profile and Respondent Characteristics

We received 415 responses. Incomplete and unengaged responses were discarded, resulting in 355 valid responses. Table 1 presents the demographic profile of the respondents. Approximately 53% of the sample was male. About 42% were in their final year of their degree course, 31.25% and 26.58% were in their second and third year of their 3-year degree course, respectively.

Table 1. *Demographics (N = 355)*

Demographic characteristics *N* = 355	Frequency	Percentage
Gender		
Male	189	53.25
Female	214	58.80
Age		
17-19	8	2.25
20-22	132	37.18
23-25	215	60.56
Currently studying in		
II Year	111	31.25
III Year	94	26.58
Final Year	150	42.17
Experience with online classes		
Less than 1 year	52	14.65
1 year–2 years	178	50.14
More than 2 years	125	35.21
Number of hours spent in online classes in a week		
Less than or equal to 30 hours	167	47.05
31–50 hours	139	39.15
More than 50 hours	49	13.8

Preliminary Analyses and Common Method Bias

Several preliminary checks were carried out to determine the quality of data. Initially, we checked for the missing values and found that missing values was not an issue, as they were less than 5% of total data (Tabachnick et al., 2007). The missing data was replaced by the arithmetic mean as per the simple imputation method (Byrne, 2010). Data were checked for nonresponse bias and was addressed by comparing early and late respondents. No statistically significant difference among responses was found, thereby indicating the absence of nonresponse bias (Groves & Kahn, 1979). Finally, to detect the common method bias, we also conducted Harman's one-factor test. The results indicated 42.46% of variance was explained in the factor, which is below the recommended value of 50% and thus suggests absence of common method bias.

Confirmatory Factor Analysis (CFA)

Item loadings varied between 0.629 to 0.804, which are above the recommended threshold value of 0.60 (Kline, 2005) for established items. The values for critical ratio of all the scale items exceeded 1.96, indicating that data is normally distributed (Byrne, 2013). Thus, these results reflect the existence of convergent validity. Further, reliability and validity of constructs and their related scale items have been reported in Table 2. Composite reliabilities (*CR*s) of the constructs lie between 0.758 to 0.888, which are above the acceptable value of 0.7; this demonstrates good internal consistency of factors. AVE of each construct is greater than 0.5, which also supports the presence of convergent validity (Fornell & Larcker, 1981).

To satisfy tests of discriminant validity, values of square root of AVE ranged between 0.715-0.748. Since these values are more than inter-item correlations, factors are not highly correlated (Hair et al., 2010). For all the constructs, all the criteria mentioned above for discriminant validity have been met. Therefore, the extracted

factors are reliable and valid as well and the results designate the adequate reliability and validity of the measurement model, and the model is ready for structural testing.

The result showed an adequate fit of the data to the model, χ^2/df = 3.951, GFI = 0.93, NFI = 0.90, CFI = 0.93, TLI = 0.94, IFI= 0.91, RMSEA = 0.078. Table 2 includes items, standardized loadings on the latent factor, standardized error of the loading, and critical ratio. Results indicate *H*1 is supported, suggesting that Aesthetic Visual Design is a multidimensional construct significantly predicted by Consistency, Color, Grid and Layout, Composition, Typography, and Graphics).

Table 2. *Measurement Model*

Constructs and scale items		Std. loadings	Std. error
Consistency			
Uniformity in design layout leads to concentration and understanding	CS1	0.799	
Consistency in fonts & their size throughout the course leads to understanding	CS2	0.697	0.068
Uniformity in colours throughout the course maintains a flow in a concentration	CS3	0.762	0.071
Uniformity in terminology throughout the course leads to a better understanding	CS4	0.732	0.074
Color			
The color scheme improves the appearance of the course	CL1	0.804	
An appropriate color scheme enhances the attention span of the learner	CL2	0.709	0.07
Color contrast in foreground/background in graphics/text impacts the learning experience	CL3	0.708	0.065
Choosing the right color combination enhances clarity and readability	CL4	0.629	0.062
Grid and layout			
"Color and graphics" in appropriate grid & layout promote concentration & learning experience	GL1	0.78	
Short sections of text increase the attention span	GL2	0.678	0.086
Simple or easy navigation through the course facilitates learning	GL3	0.676	0.091
A well-designed layout makes the content easier to understand	GL4	0.762	0.083
Composition Guidelines			
Organization of the content in an appropriate sequence promote flexible learning	CG1	0.678	
Organization of the content in small modules improves flexible learning	CG2	0.701	0.079
Vertical/horizontal guidelines to incorporate the margins, spaces or columns to provide a framework for organizing the content promote learning	CG3	0.764	0.08
Typography			
Easily distinguishable letters in typesetting promote understanding of the subject	TY1	0.806	
Arrangements of fonts and words make written content flow and easy to read	TY2	0.765	0.057
The font size, style, and colour play an influential role in understanding the content	TY3	0.752	0.054
Strong use of headings and subheadings promotes understanding	TY4	0.793	0.057

Constructs and scale items		Std. loadings	Std. error
Graphics			
Graphics/multimedia assist in noticing critical content	GR1	0.738	
Media (text, images, animation, etc.) enhance the connection to objectives of the course	GR2	0.729	0.076
Effective infographics lead to an understanding of the information/subject easily	GR3	0.74	0.074
Appropriate use of graphics including illustrations, photographs, graphs, diagrams, etc. leads to communicate visual & spatial concept	GR4	0.769	0.068
Multimedia elements help to reduce boredom	GR5	0.69	0.07
The use of visual cues (e.g., color, size, etc.) highlight information on a page	GR6	0.749	0.068
Appropriate application of graphic techniques enhances knowledge acquisition	GR7	0.689	0.075
Usability			
Bright and good visuals help to learn better	US1	0.734	
A clear message with multimedia promotes understanding of the subject	US2	0.704	0.071
Easy to read course instructions leads to usability	US3	0.719	0.076
Interactive tools help to learn fast	US4	0.743	0.072
Text, style, and colour help to understand the technical concepts.	US5	0.737	0.078

Note: Initial items in each scale were fixed to 1.0.

Table 3. *Construct Statistics*

Construct	*M*	*SD*	*AVE*	*CR*
Consistency	4.127	0.679	0.56	0.836
Color	4.254	0.754	0.512	0.806
Grid and layout	4.222	0.689	0.526	0.816
Composition guidelines	4.194	0.706	0.512	0.758
Typography	4.218	0.774	0.607	0.861
Graphics	4.189	0.678	0.532	0.888
Usability	4.189	0.713	0.529	0.849

Note: *AVE* = average variance extracted; *CR* = composite reliability

Analysis of Predictive Paths: The Structural Model

SEM was used to test the final structural model to measure the relationships stated in the hypothesis. Table 4 presents the matrix depicting correlations among independent and dependent constructs in the model.

Table 4: *Correlation Matrix*

	Grid and layout	Composition guidelines	Typography	Graphics	Consistency	Color	Usability
Grid and layout	***1.0***						
Composition guidelines	0.464**	***1.0***					
Typography	0.344**	0.341**	***1.0***				
Graphics	0.421**	0.540**	0.471**	***1.0***			
Consistency	0.655**	0.615**	0.635**	0.636**	***1.0***		
Colour	6 12**	0.504**	0.649**	0.668**	0.636**	***1.0***	
Usability	0.437**	0.301**	0.561**	0.412**	0.673**	0.666**	***1.0***

Table 5 provides the results of the structural model. Model fit indices indicate good model fit (CMIN/*df* = 2.488, GFI = 0.945, NFI = 0.921, CFI = 0.929, TLI = 0.914, IFI = 0.932, RMSEA = 0.065). Of all the constructs, Graphics had the strongest relationship with Usability (β = 0.451, *p* = 0.000). This was followed by Typography (β = 0.177, *p* = 0.000), and Grid and Layout (β = 0.159, *p* = 0.004) indicating that adequate arrangement of fonts, headings, and subheadings also facilitate e-learning. The strength of the relations between Consistency and Usability was lower but still significant (β = 0.145, *p* = 0.000). Surprisingly, Color and Composition Guidelines were not statistically significant predictors of Usability.

Table 5. *Structural Model Predicting Usability From Design Facets*

	Standardized estimate (β)	Std. error	Critical ratio	*p*
Color	0.033	0.049	0.681	*Ns*
Consistency	0.145	0.037	3.891	0.000
Graphics	0.451	0.051	8.848	0.000
Typography	0.177	0.045	3.912	0.000
Composition guidelines	0.008	0.049	0.165	*Ns*
Grid and layout	0.159	0.055	2.862	0.004

Note. CMIN/*df* = 2.488, GFI = 0.945, NFI = 0.921, CFI = 0.929, TLI = 0.914, IFI = 0.932, RMSEA = 0.065

Discussion

The goal of this research was to examine the facets of visual design that stimulate e-learning. Results of the study deliver in-depth insight into diverse dimensions of visual design and are of substantial importance not only for the academicians who have adopted online teaching due to COVID-19 and find difficulty engaging students through online modes but also for those who have been delivering modules through the online modality prior to COVID. More explicitly, this research validated the impact of color, graphics, consistency, typography, composition guidelines, and grid and layout on usability in e-learning.

Good graphics assist users in observing critical content and enhance the connection to the course's objectives. Graphics emerged as the most necessary antecedent of visual design leading to usability. This finding is in line with previous research (David & Glore, 2010; Reyna, 2013) and suggests the importance of using suitable graphics. Moving further, typography and grid and layout were other significant facets of visual design where typography has a slightly more substantial impact than grid and layout. This finding is also supported by other researchers (Pralle, 2007; Reyna, 2013; Tomita, 2015). Further, the emergence of consistency as a significant predictor of visual design is another finding that supports the previous literature (Powell, 2000; Pralle, 2007; Reyna, 2013; Tomita, 2015), indicating that usage of consistent fonts increases interest in online classes.

Surprisingly, color and composition guidelines were not statistically related to usability. This finding contradicts the results of previous studies (e.g., Istrate, 2009; Pralle, 2007), indicating that students give more importance to other visual design elements like graphics, typology, and consistency over color and composition guidelines. Aesthetics and design in the digital age not only include images or graphics displayed on a computer, but these aspects also encompass techniques of organizing materials to attract users' senses or emotions (Batiha et al., 2007). These results also indicate that a good visual design simplifies the message, ensures legibility, focuses attention, and motivates and increases learners' engagement, all of which lead to ease in learning and ease in understanding with respect to e-learning (Schindler & Burkholder, 2014). As a result, the notion that the elements of visual design improve e-learning usability gained considerable support. The study's findings provide in-depth insight into several aspects of visual design and are particularly useful for academics who have adopted online teaching and are having problems engaging students in this medium.

Limitations of the Study and Future Research Directions

The study has some limitations that could be considered in future research. The model could be extended by adding instructional design and gamification elements. As data were collected from the students only, future studies may consider the viewpoints of academics and graphic artists. It can also be replicated on larger samples and in other developing nations to improve the model's generalizability. It could be beneficial to

validate demographic variables as potential moderators of the relationship between design facets and usability. This research could be expanded to online learners who have been learning through an online mode for a long time and did not have to transition because of COVID. Future studies may also include other dependent variables like satisfaction and behavioral intention to expand the model's applicability.

Implications for Theory and Practice

This research has significant implications, particularly for higher education institutions in developing countries that are transitioning learning modalities to a blended mode. Apart from conventional barriers and drivers, this study made an earnest effort to identify the elements of visual design that make online classes enjoyable and appealing.

Visually pleasing learning technologies enhance learning (Pralle, 2007; Reyna, 2013); therefore, the findings of this study can help develop learning content for better learning outcomes. Graphics emerged as the most vital facet of visual design. Therefore, higher education institutions need to train their academics and teaching faculty about the adequate usage of graphics to grab student attention. Diverse types of graphs, comparison tables, and mind maps not only improve attention but also inculcate interest in the class (Pralle, 2007; Zaharias & Poylymenakou, 2009). These may, in turn, reduce cognitive overload. Teaching faculty may be advised to use a step diagram or a flow chart, as these tools make learning exciting and thought-provoking.

Further, both typography and grid and layout emerged significant, indicating that modules and online curriculum need to be interactive by using the appropriate size of fonts, columns, and small text boxes. The online lecture may also be delivered by adding multimedia elements, making the delivery of the subject exciting and motivating, thereby engaging the students.

Consistency also emerged as a significant variable in this study. Here the responsibility of mentors and instructors is increased, and they need to design their entire course material using consistent fonts, layout, terminology, and design. This, in turn, will improve understanding of the subject and help them grasp the technical subjects (Ghai & Tandon, 2021; Reyna, 2013). Institutions need to provide good training sessions to the faculties on the usage of good graphics, gamified content, layout, and consistent use of terminology.

Hence, the study findings showed what is essential for the educators when designing their content by using aesthetic visual design (pictures/graphics) to increase learners' understanding, engagement, motivation, and improved learning outcomes. Special training programs can be conducted to train educators and web designers in designing their instructional material to improve student engagement, motivation, and learning for better performance/outcome.

Furthermore, aesthetic visual design impacts students' learning. Visually pleasing designs can enhance usability, credibility, user satisfaction, and trustworthiness of the information presented on consumer-focused websites, consequently impacting behavior/learning outcomes). Therefore, it is highly significant/meaningful for educators to make evidence-informed design modifications.

Conclusion

Results of the study confirm the vital role of graphics, typography, and consistency in improving the usability of e-learning. They emphasize the adequate usage of graphics and consistent fonts and design in combination with multimedia elements in creating interest among students while taking an online module/class. Academicians must consider the elements of aesthetic visual design while preparing their lectures so that they may be able to easily explain the technical subjects.

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