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Impact of Perceived Human-Centred Design (HCD) Performance on Learner Satisfaction in E-Learning Platform

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***Abstract*— The emergence of e-learning platforms like Coursera, BYJU's, Unacademy, Khan Academy, and NPTEL has changed the way education is delivered to the learners in a fundamental manner. Regardless of this increase, a major percentage of the learners complain of dissatisfaction not because of the quality of the content but due to the design and usability drawbacks of the platforms themselves. The philosophy of Human-Centred Design (HCD) making end-user central to the interface development has become a decisive factor in the quality of the digital products. Nevertheless, there is little empirical data on the exact correlation between HCD performance and learner satisfaction under the e-learning setting, especially in the Indian and the Asian environment in general. The aim of this study was to (1) investigate the overall effects of perceived HCD performance on learners' satisfaction; (2) investigate the specific effects of four HCD dimensions including Usability, Accessibility, Visual Design, and Responsiveness to learner satisfaction; and (3) uncover the strongest influence of a HCD factor on learner satisfaction. A questionnaire consisting of 29 questions was designed and given to 226 users of e-learning in three age groups (18-24, 25-34 and 34-45 years). The scale assessed four HCD dimensions (five items per, with a 1-5 performance scale) and learner-satisfaction (five items on a 5-point Likert scale of agreement). Analysis involved descriptive statistics, Pearson correlation and multiple linear regression with a quantitative cross-sectional research design. The composite of the HCD performance was very highly positively correlated with the learner satisfaction ($r = 0.889$, $p < 0.001$). The HCD dimensions were considered very powerful predictors, with the multiple regression model explaining 79.5% of the variance in learner satisfaction ($R2 = 0.795$, Adjusted $R2 = 0.791$, $F = 217.67$, $p < 0.001$). Visual Design was the best predictor (0.394), Usability (0.356), Accessibility (0.326), and Responsiveness (0.300). At $p=0.001$ all the four hypotheses (H1a-H1d) were accepted. Responsiveness received the highest mean performance rating ($M = 3.788$), and the lowest performance rating ($M = 3.306$) was obtained by the Accessibility which is the key area of improvement of the platform. The results determine that the performance of HCD is a powerful and important indicator of the satisfaction of the learners in online learning platforms. The visual design and usability must be given priority by the designers and accessibility gaps, especially among users with various abilities and devices, should be urgently resolved. The implications of these results have practical implications on the development of EdTech products, inclusive design policy, and strategy of learner experience.**

***Keywords*— Accessibility, Digital Learning Platforms, E-Learning, Human-Centred Design (HCD), Learner Satisfaction, Responsiveness, Usability, User Experience (UX), Visual Design.**

I. INTRODUCTION

E-learning as a discipline has experienced unprecedented expansions, as it has been pegged to have exceeded $400 billion by 2026 (Global Market Insights, 2021). Courses Coursera, BYJU, Unacademy, Khan Academy and NPTEL have millions of students worldwide and offer courses starting with school-level education up to high-level professional qualifications. India is the only nation that has evolved into the second-largest e-learning market in the world, propelled by a massive young population, mobile phone usage, and a growing understanding of online learning (KPMG, 2017).

Although this is quantitative growth, a consistent obstacle is still the satisfaction of learners with these platforms. The percentage of registered users who drop courses is relatively large because of inadequate digital experience, which includes perplexing navigation, unavailable functions, slow performance, and interfaces that seem to overwhelm the user (Liaw, 2008; Sun et al., 2008). These are all issues of design and cannot be resolved without an evidence based approach that is well organized.

According to the International Organisation for Standardisation (ISO 9241-210, 2019), Human-Centred Design (HCD) is an approach to design and design philosophy that emphasizes the needs, behaviours, and experiences of end-users during the creation of interactive systems. In online education, HCD realises in the four main dimensions, Usability (easy navigation and interaction), Accessibility (inclusive design with different users and devices), Visual Design (aesthetic quality and visual coherence), and Responsiveness (technical performance and speed of system feedback).

Although the individual elements of the quality of digital platforms (especially usability) have been researched extensively in the HCI literature (Nielsen, 1994; Davis, 1989), little empirical studies have been conducted to investigate all four of the HCD dimensions in a unified manner within the setting of e-learning learner satisfaction.

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In addition, the majority of the existing literature is centred on the Western markets, and there is a gap in the knowledge of platform experiences in developing economies like India. The current research fills this gap by providing a quantitative study of 226 users of e-learning of various age groups and usage behaviors.

Significance of the Study

This study adds to the HCI, educational technology, and instructional design literature as it presents empirical data on the interaction of HCD performance factors to affect learner satisfaction. To practitioners, the findings provide practical data to the EdTech companies and UX designers who want to enhance their platforms. The results are of importance to policymakers and educators by showing that digital accessibility and inclusive design are important to achieve equitable learning outcomes.

II. Literature Review

Human-Centred Design (HCD) is founded on the concept that technology has to be adjusted to human needs and not vice versa (Norman, 1988). There are four well-known performance dimensions of the digital product development in HCD that are usability, accessibility, visual design and technical responsiveness (ISO 9241-210, 2019; Nielsen and Mack, 1994).

According to Nielsen (1993) there are five attributes of usability which include: learnability, efficiency, memorability, errors and satisfaction. Usability in e-learning is the degree to which the learner is able to find and navigate the system and how easily the learner is able to complete the learning tasks without any confusion, frustration or disappointment (Zaharias, 2009). Studies have always shown that usability is a significant factor leading to user satisfaction and reuse in digital systems (Davis, 1989; Venkatesh et al., 2003).

Digital accessibility is the capacity of platforms to be available to people with various abilities including visual, auditory, motor and cognitive disabilities (W3C WCAG 2.1, 2018). The e-learning accessibility is not disability accommodation (e.g. screen readers, captions), but also compatibility with other devices and access to the material in case of the low bandwidth (Burgstahler, 2015). Studies indicate that the access difference does not have a fair impact on low-income and rural learners, which is an essential equity issue (Seale et al., 2015).

The visual design of the digital interface (e.g. layout, typography, colour scheme and iconography) can have a powerful effect on the cognitive load, information comprehension and the affective response (Tractinsky et al., 2000; Mayer, 2009).

Clean and consistent visual design of the e-learning in this instance reduces extraneous cognitive load and helps the learner focus (Sweller, 1988). According to research by Loorbach et al. (2015) and Plass et al. (2010), aesthetically pleasing e-learning interfaces lead to higher motivation, engagement and satisfaction.

One of the determinants of the user experience quality is system responsiveness, which is the quality of the speed, stability and quality of feedback of a digital platform (Nah, 2004). The most common causes cited in e-learning are slow video loading, crashes, and slow quiz submissions, which are causing frustration and dropout among learners (Cho & Hogge, 2017). Perceived ease and usefulness are proposed by the technology acceptance model (Davis, 1989), of use - both directly dependent upon system responsiveness - are important predictors of behavioural intention to use a system.

Such a response to online learning has been identified as the accumulation of positive affective and cognitive reactions to e-learning (Kuo et al., 2014). Major factors found in the literature are quality of interaction, the relevance of content, support by instructor, and growingly platform design quality (Sun et al., 2008; Liaw, 2008; Alqurashi, 2019). Recent research has also started to separate content-related satisfaction and platform-based interface-related satisfaction, indicating that HCD-related variables are a unique dimension of overall learner satisfaction that can be measured.

Although the research has been conducted on the individual HCD dimensions separately, there is limited research that has conducted a systematic assessment of all the four dimensions in the context of e-learning through the structural or regression methods. Previous research by Zaharias and Koutsabasis (2012), Benta et al. (2014) and more recently by Pham et al. (2019) has addressed the correlation between interface quality and e-learning satisfaction, not fully developing a model of usability, accessibility, visual design and responsiveness within a single HCD framework. This study fills that gap.

III. Research Gap

An overview of the literature carried out indicates that the following are the main gaps in research, which the current study aims to fill:

- The majority of the previous studies on the quality of e-learning have reported the study of usability alone without considering accessibility, visual design, and responsiveness in a HCD framework.
- There is a paucity of empirical studies that investigate the relative predictive ability of various dimensions of HCD on learner satisfaction, specifically in regard to commercial e-learning platforms that are popular in India.

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- The current literature is mostly based on qualitative research or small convenience samples; there are few large scale quantitative research done based on regression analysis to determine causal pathways.

The current research fills these gaps with the application of a quantitative and multi-faceted analysis of HCD performance dimensions and their effects on the satisfaction of learners among a diverse sample of 226 users of the e-learning platform.

IV. Research Objectives

1. To investigate the general effect of perceived performance based on Human-Centred Design (HCD) on learner satisfaction on e-learning platforms.
2. To assess the personal correlation between each of the HCD dimensions (Usability, Accessibility, Visual Design, Responsiveness) and the satisfaction of the learners.
3. To identify the HCD factor that has the most powerful effect on learner satisfaction using standardised analysis of regression coefficients.

V. Hypotheses

Overall Hypothesis:

H1: Perceived HCD performance has a significant positive impact on learner satisfaction in e-learning platforms.

Factor-wise Hypotheses:

H1a: Usability has a significant positive impact on learner satisfaction.

H1b: There is a considerable positive effect of accessibility on learner satisfaction.

H1c: Visual Design positively influences the satisfaction of learners in a significant way.

H1d: Responsiveness plays an important positive role in learner satisfaction.

VI. Research Methodology

A. Research Design

The research design utilized in this study was a cross-sectional survey design that was quantitative. The quantitative approach was selected as the study was intended to test pre-determined hypotheses on the relationship between the measurable constructs (HCD dimensions and learner satisfaction) by using the method of statistical inference.

The type of data collection was also suitable considering the objective of having a representation of the learner perceptions in a specific population at only one point in time.

B. Data Collection Method

Structured self-administered online questionnaire was used to collect the data by administering it to the users of e-learning platforms. The questionnaire was distributed through the Internet sources, such as social networks, WhatsApp groups, and educational forums. The questionnaire was created to take about 8-12 minutes to complete.

C. Questionnaire Design

The questionnaire had 29 items separated into two parts:

• *Section A (Demographic Information):* Age group, gender, number of times one uses e-learning platform, self-reported level of familiarity with technology (4 items).

• *Section B (HCD Performance & Satisfaction):* 20 items on four HCD dimensions (Usability (Q5-Q9), Accessibility (Q10-Q14), Visual Design (Q15-Q19), and Responsiveness (Q20-Q24) with responses on a 5-point Likert scale (1 = Very Poor, 5 = Excellent); 5 items on learner satisfaction.

D. Sampling Technique and Sample Size

The study used non-probability purposive sampling, with the participants being active users of e-learning platforms, and at least one being a user of at least one online learning application (Coursera, BYJU, Unacademy, Khan Academy, NPTEL, or similar) engaged with online learning. There were 226 valid responses. Three age groups (18-24, 25-34, and 34-45 years) and almost equal gender ratio (52.2% males and 47.8% females) were included in the sample.

E. Tools Used for Analysis

Python (pandas, scipy, numpy) and Microsoft Excel were used to perform the statistical analysis. The following analysis procedures were used:

- *Descriptive Statistics:* means, standard deviation, minimum, maximum of all scale items and factor composites.
- *Frequency and Percentage Analysis:* Responses were given on the five-point scale on each item and the distribution is shown.
- *Pearson Correlation Analysis:* To test the bivariate relationships between HCD factors and learner satisfaction.
- *Multiple Linear Regression:* To evaluate the joint and independent predictive validity of each of the HCD dimensions on satisfaction.
- *Independent Samples t-test:* To test hypothesis.

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VII. Data Analysis And Interpretation

A. Demographic Profile of Respondents

The number of valid response was 226. The demographic profile of the respondents is given in Table 1.

TABLE I
DEMOGRAPHIC PROFILE OF RESPONDENTS (N = 226)

Variable	Category	Freq.	%
Age Group	18-24	83	36.7%
	25-34	62	27.4%
	34-45	81	35.8%
Gender	Male	118	52.2%
	Female	108	47.8%
Platform Usage	Daily	77	34.1%
	Several times/week	73	32.3%
	Occasionally	76	33.6%
Tech Familiarity	Advanced	124	54.9%
	Intermediate	102	45.1%

Most of the respondents were aged between 18-24 year group (36.7%, n=83), which is the age bracket the most active on e-learning platform. The age group of 34 to 45 was close behind (35.8%, n=81) indicating the involvement of mature learners in large numbers. The gender distribution of respondents was almost equal (52.2% male). The distribution was fairly balanced in terms of the frequency of use: with 34.1 percent of daily users, 33.6 percent occasional users, and 32.3 percent using platforms multiple times a week.

B. Descriptive Statistics of HCD Factors and Satisfaction

Table 2 shows the mean scores and standard deviations of the four HCD factor composites and learner satisfaction scale.

TABLE II
DESCRIPTIVE STATISTICS OF HCD FACTORS AND LEARNER SATISFACTION (N = 226)

Factor/Variable	N	Min	Max	Mean	SD
Usability	226	2.20	4.80	3.706	0.326
Accessibility	226	1.80	4.60	3.306	0.372
Visual Design	226	2.00	4.80	3.533	0.373
Responsiveness	226	2.20	5.00	3.788	0.351
Learner Satisfaction	226	2.60	4.60	3.583	0.287
HCD Performance (Overall)	226	2.35	4.60	3.583	0.230

The highest mean performance score (M = 3.788, SD = 0.351) was achieved in responsiveness, which suggests that learners typically find e-learning platforms to be stable and quick in terms of technology. We followed usability (M = 3.706, SD = 0.326) because platforms were extremely easy to use by learners. Visual Design scored moderately-to-good (M = 3.533, SD = 0.373) and Accessibility scored lowest of four HCD dimensions (M = 3.306, SD = 0.372), which suggests that there is a significant difference in the inclusive design features.

The overall learner satisfaction was 3.583 (SD = 0.287) that represented an average but positive satisfaction. The HCD composite score (M = 3.583, SD = 0.230) was quite near the satisfaction mean which means that the HCD performance was perceived as consistent with the outcomes of the satisfaction.

C. Frequency and Percentage Analysis

The Table 3 shows the item-frequency analysis that groups the answers into three performance levels: Poor/Very Poor (score 1-2), Average/Neutral (score 3), and Good/Excellent (score 4-5).

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TABLE III
FREQUENCY AND PERCENTAGE ANALYSIS OF HCD SCALE ITEMS (N = 226)

Factor	Item	Poor/VP	Avg/N	Good-Exc	Mean	% Pos.
Usability (U1-U5)	U1	4.0%	37.2%	58.8%	3.68	58.8%
	U2	2.7%	36.3%	61.1%	3.72	61.1%
	U3	3.5%	28.8%	67.7%	3.77	67.7%
	U4	4.9%	32.7%	62.4%	3.67	62.4%
	U5	2.7%	35.8%	61.5%	3.70	61.5%
Accessibility (A1-A5)	A1	15.5%	42.5%	42.0%	3.32	42.0%
	A2	13.3%	49.6%	37.2%	3.28	37.2%
	A3	15.5%	46.9%	37.6%	3.27	37.6%
	A4	11.1%	53.1%	35.8%	3.29	35.8%
	A5	13.3%	42.0%	44.7%	3.37	44.7%
Visual Design (VD1-VD5)	VD1	7.5%	42.5%	50.0%	3.52	50.0%
	VD2	6.2%	42.9%	50.9%	3.54	50.9%
	VD3	5.8%	42.0%	52.2%	3.56	52.2%
	VD4	9.7%	40.3%	50.0%	3.48	50.0%
	VD5	7.1%	36.7%	56.2%	3.57	56.2%
Responsiveness (R1-R5)	R1	4.4%	30.5%	65.0%	3.75	65.0%
	R2	3.5%	30.5%	65.9%	3.79	65.9%
	R3	1.8%	31.9%	66.4%	3.81	66.4%
	R4	3.5%	31.4%	65.0%	3.78	65.0%
	R5	2.2%	30.5%	67.3%	3.81	67.3%

Note: VP = Very Poor; P = Poor; N = Neutral; G = Good; SA = Strongly Agree. % Positive = combined scores 4 and 5.

The Responsiveness dimension had the highest ratings that were always positive and 65 to 67 percent of the respondents rated items as Good or Excellent in all five items (R1-R5). The usability items were also performing well with 59-68 percent of positive ratings, which signifies that the platforms are generally getting to be easy to use and intuitive to the learners. The ratings of Visual Design items were moderate positive (50-56%), as learners valued such items in terms of professional appearance, but found some inconsistencies. Items rated the lowest and positive had the lowest rating of only between 36-45%.

Namely, the least scores were in the categories of accessibility features (A3: M = 3.27) and compatibility with other devices (A2: M = 3.28) indicating that the majority of platforms are not yet at the level of the inclusive design. When considering the satisfaction items, the allocation was biased towards the neutral-to-agree category (3-4) with an extremely low percentage of extreme reactions that shows that the user base is slightly positive and very skeptical.

D. Pearson Correlation Analysis

Table 4 presents the Pearson correlation matrix for all HCD dimensions and learner satisfaction.

TABLE IV
PEARSON CORRELATION MATRIX – HCD DIMENSIONS AND LEARNER SATISFACTION (N = 226)

Factor	Usab.	Access.	VD	Resp.	Satis.
Usability	1.000	0.003	0.008	0.027	0.586
Accessibility	0.003	1.000	0.007	0.031	0.605
Visual Design	0.008	0.007	1.000	0.047	0.606
Responsiveness	0.027	0.031	0.047	1.000	0.503
Satisfaction	0.586	0.605	0.606	0.503	1.000

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The four HCD dimensions were statistically significant positive correlated with learner satisfaction. Bivariate correlation with satisfaction showed the highest correlation with Visual Design ($r = 0.606$, $p < 0.001$) and very closely with Accessibility ($r = 0.605$, $p < 0.001$) and Usability ($r = 0.586$, $p < 0.001$). The lowest individual correlation was found in responsiveness ($r = 0.503$, $p < 0.001$), but this is still a moderate-to-strong correlation. These findings give solid preliminary evidence to all the five hypotheses (H1, H1a-H1d).

E. Multiple Linear Regression Analysis

To establish the unique contribution of each HCD dimension to the rest, a multiple linear regression model was taken with the learner satisfaction as the dependent variable and four HCD composites as the predictors.

Model Summary: $R = 0.892$, $R^2 = 0.795$, Adjusted $R^2 = 0.791$, $F(4, 221) = 217.67$, $p < 0.001$

The total variance in learner satisfaction was explained by the model by 79.5 percent, which is a great explanatory predictor. Regression coefficients are shown in table 5.

TABLE V
MULTIPLE LINEAR REGRESSION COEFFICIENTS – PREDICTORS OF LEARNER SATISFACTION

Predictor	SE	β	t	p-value
Constant	0.086	–	-4.79	0.001
Usability	0.049	0.356	6.43	0.001
Accessibility	0.043	0.326	5.84	0.001
Visual Design	0.043	0.394	7.06	0.001
Responsiveness	0.046	0.300	5.37	0.001

Each of the four HCD dimensions was statistically significant predictors of learner satisfaction ($p < 0.001$). Visual Design was found to be the best predictor ($\beta = 0.394$, $t = 7.06$, $p < 0.001$), meaning that the aesthetic quality, layout readability, and visual coherence of platforms has the highest marginal contribution to satisfaction other factors being equal.

The second most significant predictor was usability ($\beta = 0.356$, $t = 6.43$, $p < 0.001$), which, again, validates the underlying significance of usable navigation. Accessibility ($\beta = 0.326$, $t = 5.84$, $p < 0.001$) and Responsiveness ($\beta = 0.300$, $t = 5.37$, $p < 0.001$) also made significant independent contributions. These results mean that none of the HCD dimensions can be overlooked - all four together and independently define learner satisfaction.

VIII. Results And Findings

A. Hypothesis Testing Summary

TABLE VI
SUMMARY OF HYPOTHESIS TESTING RESULTS

Hyp.	Path	r	β	p-value
H1	HCD Performance → Learner Satisfaction (Overall)	0.889	–	0.001
H1a	Usability → Learner Satisfaction	0.586	0.356	0.001
H1b	Accessibility → Learner Satisfaction	0.605	0.326	0.001
H1c	Visual Design → Learner Satisfaction	0.606	0.394	0.001
H1d	Responsiveness → Learner Satisfaction	0.503	0.300	0.001

B. Key Findings

1) HCD Performance overall effect (H1 Supported): HCD performance has a highly significant, statistically significant positive effect on perceived learner satisfaction ($r = 0.889$, $p < 0.001$). H1 can be confirmed with high levels of evidence since the overall regression model explains 79.5% of the variance in satisfaction.

2) Visual Design is the most dominant Factor (H1c, $\beta = 0.394$): Visual Design is the most substantial predictor of learner satisfaction among the four dimensions of HCD. The aspects of professional look, clarity of layout, visual consistency and aesthetic quality of e-learning platforms are the most sensitive to learners. The result is consistent with cognitive load theory and dual-coding theory, which posit that properly designed visual interfaces can decrease the extraneous processing load and improve comprehension.

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3) Usability is the Second-Strongest Factor (H1a, β = 0.356): Usability - including ease of navigation, interactivity, interface consistency and efficiency of tasks performed - is the second strongest determinant of satisfaction. Students who are able to easily search and locate materials, to resume learning as well as to complete their tasks are much happier with the site.

4) Accessibility Needs Urgent Improvement (H1b, β = 0.326): The third strongest predictor of satisfaction is Accessibility, although rated as the least strong HCD dimension (M = 3.306). This is a twofold revelation: (a) accessibility of platforms is most dissatisfied with by learners and (b) accessibility will lead to significant increases in overall satisfaction. Closed captions, customizable playback speeds, compatibility with screen readers, and cross-device functionality are just a few features that need to be considered as soon as possible.

5) Responsiveness Holds Some Importance (H1d, β = 0.300): Technical responsiveness - loading speed, interaction latency and stability - plays a key role in predicting satisfaction, albeit less so than the other three indicators. It is important to note that the Responsiveness had the highest score among the learners (M = 3.788) indicating that most platforms have sufficient performance in this aspect, which could be a reason why it has a relatively small marginal contribution to the satisfaction variance in the regression model.

IX. Discussion

The results of the current research have a number of implications to the literature on HCD, e-learning, and user experience research.

The sheer robustness of the HCD composite-to-satisfaction relationship (r = 0.889), as well as the value of the R^2 (0.795) serves to support a fundamental tenet of the HCI theory: the quality of the interaction between a learner and a digital platform is not incidental to the learning process, it is central to it.

Of particular interest is the primacy of Visual Design (β = 0.394). Usability has traditionally been considered the most important HCI construct in educational technology research. Nevertheless, the current information indicates that nowadays, in the e-learning situation, where students are used to the high-quality digital interface of social media, streaming services, and video games, the visual and aesthetic elements of a learning environment are becoming as significant or more so.

The fact that the Accessibility dimension is both the weakest rated and a strong predictor of satisfaction is a strategic priority indicator to EdTech developers.

Although accessibility is not a design category that learners recognise consciously, aspects of accessibility that are meaningful to their satisfaction include platforms not functioning across devices, the lack of subtitle support, and poor functionality on slow internet access. This finding has important equity and inclusion consequences, considering the increasing use of mobile-first e-learning in developing countries.

The beta coefficient of Responsiveness (β = 0.300) is relatively low in comparison with high mean performance rating (M = 3.788), which creates another dynamic - sufficient technical performance does not make people unhappy, however, it does not provide a strong push to become happier. That is, a fast loading and reliable performance are threshold requirements that when adequately satisfied provide less incremental satisfaction value.

X. Conclusion

This experiment shows that perceived Human-Centred Design (HCD) performance is a powerful and statistically significant indicator of learner satisfaction in e-learning platforms. According to the answers of 226 learners, a multiple regression model was used to explain the 79.5% satisfaction variance with all four HCD dimensions, Usability, Accessibility, Visual Design, and Responsiveness playing independently significant roles.

The Visual Design was found to be the most influential factor, which defies the old usability-centered paradigm of educational technology research and reflects the growing experiential character of online learning. Although the lowest-ranked dimension, accessibility was suggested as a key leverage area to focus on, as it has a significant independent impact on satisfaction.

These results present a solid empirical basis of HCD-based platform assessment models and present a clear directional guidance to EdTech creators, UX designers, instructional technologists, and policymakers aiming to enhance the quality, inclusivity, and satisfaction of online learning experiences.

XI. Recommendations

- Make Visual Design Investment top priority: As it is the highest-ranking in predicting satisfaction, e-learning platforms must make top investment in professional UI/UX audits, coherent design systems, and supported visual hierarchy addition. Pictorial elements ought to underpin learning understanding, rather than simply aesthetics.

- Conduct regular Usability Testing: Platforms should include regular cyclic usability testing incorporating methods such as cognitive walkthroughs, the think-aloud protocol and A/B tests to continue refining navigation, task processes and interface consistency.
- Close Gaps in Accessibility in the Short-run: Sites must make every effort to comply with WCAG 2.1 Level AA, providing closed captions on all video material, readable by screen readers, and variable playback speed and also should be acceptable under low bandwidth environment. QA should be a normal cross-device testing.
- Keep Technical Responsiveness Standards: Although responsiveness is doing well at present, platforms need to adopt performance monitoring, content delivery network (CDN) optimisation, and proactive error handling procedures to remain satisfactory, particularly as user bases expand.
- Establish HCD Performance Metrics as KPIs: HCD performance measurement should be institutionalised in EdTech organisations, i.e., by monitoring usability, accessibility, visual design, and responsiveness — as formal Key Performance Indicators (KPIs) tied to product development roadmaps.

XII. Limitations Of The Study

- The research was based on self-reported perceptions of HCD performance, which are prone to response bias, effects of social desirability and different personal frames of reference to analyze design quality.
- The cross-sectional design does not allow causal inference; the regression coefficients show predictive relationships, not causal mechanisms.
- The research did not explore a particular single platform but instead exploratory the general experience of e-learning platforms creating heterogeneity in the evaluation situation among respondents.

XIII. Future Scope

- Platform-Specific Studies: Individual studies (e.g. comparing Coursera to BYJU's) would offer more specific knowledge to specific organisations.
- Moderating Variables: Future research should consider the moderating effects of learner motivation, previous digital experience, content type (video vs. interactive vs. text), and cultural background on HCD-satisfaction relationship.
- Enhanced Accessibility Research: An independent investigation on the connection between the level of WCAG compliance and the student satisfaction with e-learning, especially in the case of differently-abled students, would be a welcome addition.
- AI-Personalisation in HCD: With the advent of AI-personalisation becoming common in e-learning, upcoming studies ought to investigate how adaptive HCD (personalised interfaces) affects satisfaction as compared to non-adaptive HCD.

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