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e-ISSN: 3030-6086
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Hypertext Video for Visual Studies in Developing Contexts

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Received: November 10th, 2025
Accepted: December 19th, 2025
Published: December 22nd, 2025

ABSTRACT

In an era where digital aesthetics and pedagogy increasingly intersect, this research examines hypertext interactive video as a tool and artistic medium to enhance visual studies in developing countries. using Vygotsky's sociocultural theory, this study combines interviews, case studies, and literature review, supported by fieldwork in Yemen. Hypertext video, with layered visuals, non-linear navigation, and embedded assessments, turns passive learning into active artistic inquiry and encourages critical engagement. Beyond its pedagogical promise, the medium confronts structural realities: low bandwidth, limited digital literacy, and institutional resistance. The study proposes a hybrid design framework for low-resource contexts, making hypertext video both an instructional tool and a way to broaden access to arts education. By bridging artistic cognition and digital innovation, this work contributes to contemporary discourse on interactive media, inclusive pedagogy, and the future of creative education.

Keywords: Hypertext Interactive Video; Visual Studies Education; Digital Aesthetics; Creative Learning; Developing Contexts

1. INTRODUCTION

Interactive video redefines creative education, turning passive spectators into active participants. Within the field of visual studies, it offers immersive, participatory experiences where learners navigate non-linear pathways, engage with dynamic overlays, and interact with layered multimedia content. Hypertext features like clickable annotations, branching narratives, and embedded assessments transform this medium into HyperLearnX, merging digital art with interactive learning. HyperLearnX combines linear video, nonlinear navigation, clickable annotations, branching storylines, and embedded assessments, allowing self-directed, multimodal learning in, multimodal manner. Figure 7 shows the HyperLearnX interface, including video presentation, timeline toolbar, navigation, embedded questions, and interactive elements.
Table 1 presents HyperLearnX's core features, highlighting engagement, personalized learning, and interactivity. Additionally, it provides an overview of how

hypertext elements, adaptive content, and multimedia integration contribute to creating a more dynamic and effective digital learning experience. (Mack, 2024; Rouet, 2006; Zhang et al., 2022)

Table 1
Some Key Features of Hypertext Interactive Video Learning

Feature	Functionality	Impact on Learning
Overlays	Interactive elements appearing over videos	Enhances engagement and retention
Video Chapters	Divides content into sections	Allows easy navigation
Hotspots	Clickable areas providing additional information	Improves comprehension
Quizzes	Embedded assessment tools	Reinforces knowledge acquisition

2. A LITERATURE REVIEW

2.1 Hypertext Video in Educational Contexts

In the evolving dialogue between art and technology, interactive video emerges not merely as an instructional device but as a canvas of learning, transforming students from passive observers into co-creators of meaning (Zhang et al., 2022). Within this landscape, hypertext video represents a more fluid medium, an interwoven fabric of moving image, hyperlink, and learner choice. It transcends linearity, enabling students to wander, pause, and return, much like an artist navigating a studio filled with unfinished sketches and hidden inspirations (Mack, 2024).

HyperLearnX offers multiple learning paths, letting students revisit knowledge from different angles (Rouet, 2006). In this sense, hypertext video becomes an aesthetic experience of knowledge, where exploration itself is pedagogy. Table 2 contrasts linear and hypertext video, showing not only functional differences in interactivity and accessibility but also the deeper pedagogical resonance of hypertext video in low-resource contexts (Alshabi et al., 2025). Here, the comparison is more than technical; it reflects a philosophical shift from transmission to participation, from instruction to dialogue.

Table 2
Comparative features of linear video and hypertext video in educational contexts

Feature / Aspect	Hypertext Video	AR / VR-Based Learning	Flipped Classroom
Interactivity	Highly non-linear, with clickable overlays and branching paths	Very high immersive 3D environments	Depends on pre-class preparation

Navigation Style	User-controlled, hyperlinked sections	System/environment-driven	Teacher-planned
Bandwidth Requirement	Low to moderate	High	Low to moderate
Device Compatibility	Standard devices (PC, mobile)	Requires headsets/sensors	Standard devices
Pedagogical Flexibility	High customizable to user level and pace	High, but less accessible	Depends on in-class engagement
Content Depth & Layering	Multi-level with optional paths and resources	Context-rich but predefined scenarios	Based on pre-class video quality
Accessibility in Low-Resource Areas	High	Low	Moderate

Source: Developed by the author, based on the copyright concept of HyperLearnX (Alshabi et al., 2025)

As Table 2 illustrates, hypertext video grants learners greater agency, interactivity, and multimodal integration. Yet its value lies not only in function but also in form the way Overlays and quizzes guide learners toward comprehension and engagement (Cattaneo et al., 2019; Lee et al., 2025; Sauli et al., 2018). In these layered encounters, design becomes pedagogy, and aesthetics become method. Aesthetic presence is vital here. As Lee et al.(2025) observe, “aesthetic interactive video elements…allow students to navigate and engage with digital content in a dynamic and interactive manner.” The aesthetic is not decoration; it is what sustains attention, motivates inquiry, and animates the otherwise silent architecture of learning. Hu et al.(2024) and Jie et al.(2024) likewise highlight how visual richness deepens immersion, enabling students to experience knowledge not only as information but as artistic encounter.

The philosophical grounding for this lies in Vygotsky’s socio-cultural theory, which views learning as a mediated, collaborative process shaped by cultural tools (Looker, 2021). Lourenço (2012) reminds us that “the development of higher cognitive functions is inherently linked to social interaction and the use of cultural tools.” In this sense, hypertext video is not just a medium of delivery; it is a cultural artifact, mirroring the dialogic, interpretive nature of art itself.

HyperLearnX connects cognitive, aesthetic, and social learning, fostering creativity and critical thinking through adaptive branching, feedback, and visual exploration (Bulle, 2021; Cattaneo et al., 2019). It becomes not only a pedagogical tool but also an artistic medium of education, one that redefines how learners imagine, interact, and create. In this convergence, the digital is not opposed to the artistic; rather, it becomes the very stage upon which education unfolds (Mack, 2024).

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2.2 Visual Pedagogy and Digital Aesthetics

The merging of art and technology supports art and design pedagogy, emphasizing creativity, interpretation, and learner agency. HyperLearnX lets students explore visual concepts at their own pace, revisit materials, follow themes, and conduct self-directed artistic inquiry.
In art and design education, visual literacy and aesthetic engagement are central to the learning process. Digital aesthetics theory emphasizes how interactive multimedia can stimulate artistic cognition through multimodal experiences that combine visual, auditory, and textual elements (Webb, 2018). Hypertext video aligns with this approach by merging narrative flexibility with visual interactivity, allowing learners to explore multiple interpretations of artistic concepts.
Studies in visual pedagogy have highlighted that interactivity fosters deeper cognitive engagement and creativity.
Its pedagogical use in art and design education remains underexplored..(Looker, 2021) For instance, early experiments in Yemeni higher education demonstrated that embedding interactive annotations within video lessons enabled learners to overcome infrastructural barriers, such as unstable connectivity and limited access to a physical classroom (Alshabi et al., 2025). Evidence shows that HyperLearnX enhances comprehension, retention, critical thinking, and artistic interpretation in creative disciplines.

This study proposes aesthetic and structural frameworks to integrate HyperLearnX into digital education.
Figure 1 shows how HyperLearnX features overlays, dynamic video chapters, and real-time assessments support scaffolded learning, reduce cognitive overload, and improve self-paced knowledge acquisition.
This is particularly relevant in disciplines such as graphic design, where visual cognition plays a central role in learning outcomes. The Figure with modifications to align with the context of hypertext interactive video in Yemeni higher education.

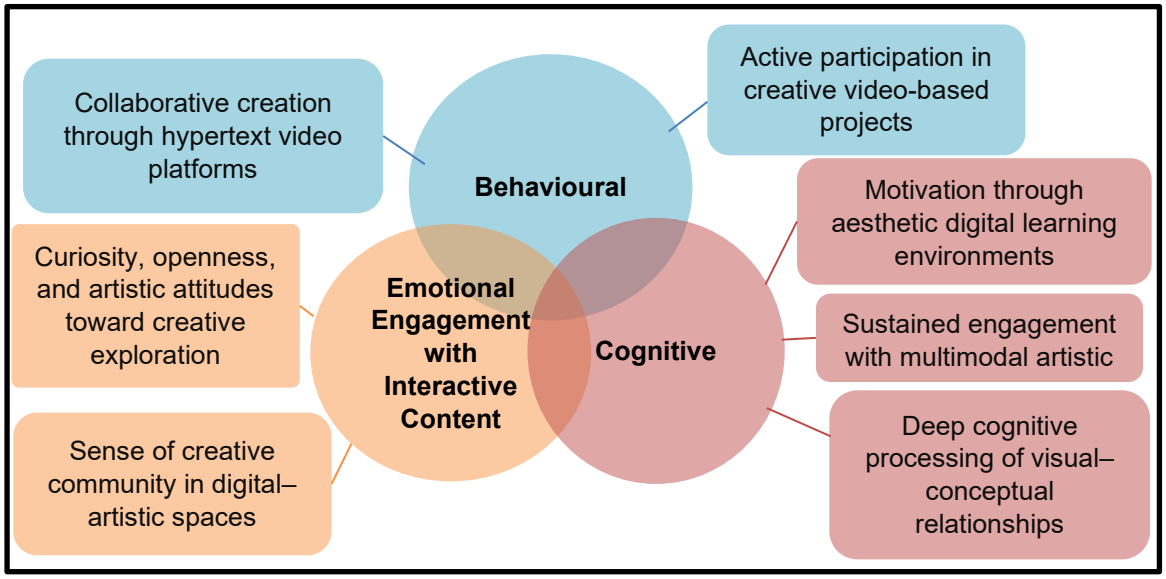

Figure 1. Framework for Aesthetic Interactive Video Learning ((Schindler et al., 2017,P 5)

In the same way, Figure 2 presents a Framework for Enhancing Creative Arts Education through Hypertext Video Elements. It illustrates a three-tiered framework for strengthening art and design pedagogy through hypertext video. At the top, the focus is on equitable access to creative and cultural expression, ensuring inclusivity in digital arts education. The middle tier emphasizes three pillars: technological infrastructure & digital artistry, pedagogical adaptation & aesthetic inclusion, and student-centered artistic engagement. The base tier addresses collaborative networks, cross-cultural accessibility, flexible creative opportunities, cultural influences, and implementation of digital arts strategies. This framework highlights how hypertext video can serve as both an educational medium and an artistic platform, fostering creativity, cultural participation, and inclusive innovation.

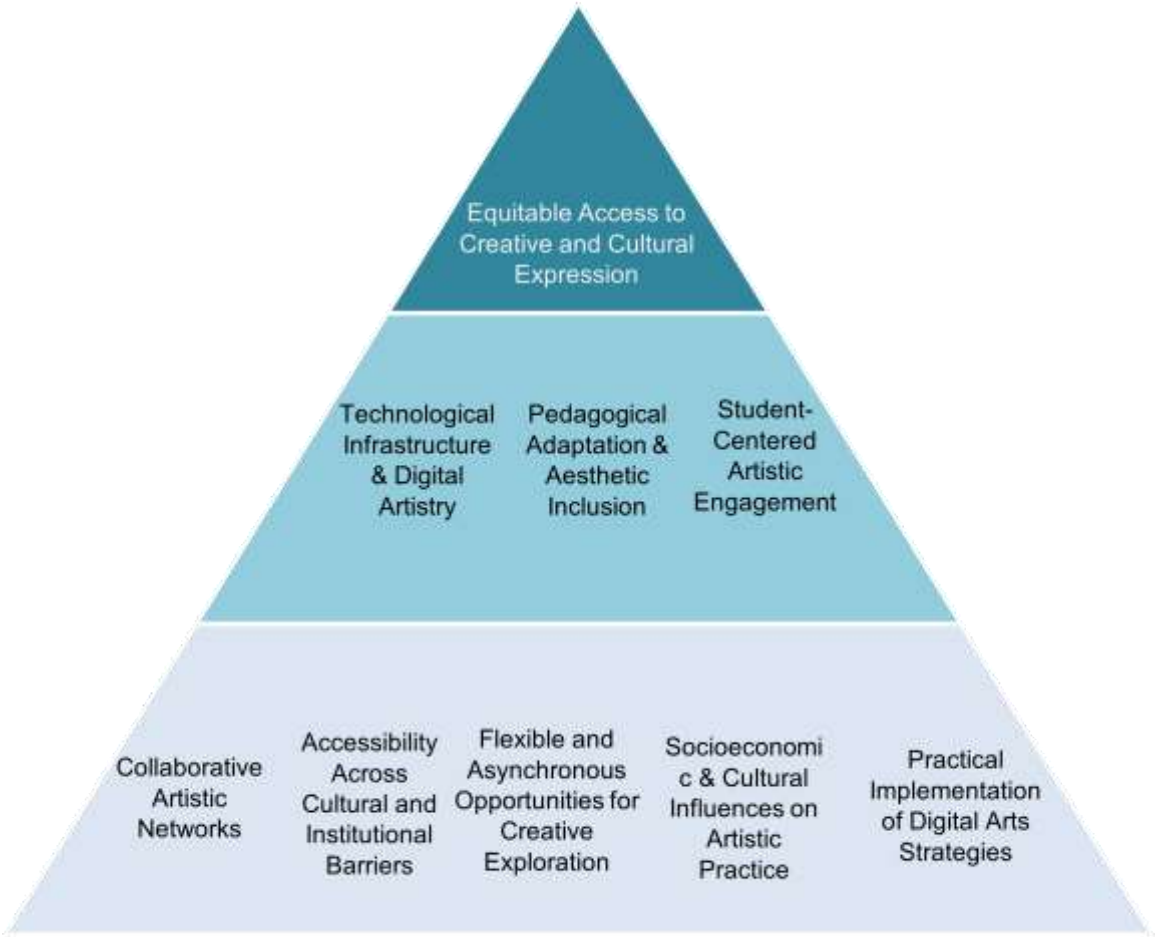

Figure 2 Framework for Enhancing Digital Learning through Interactive Video Elements (Mathrani et al., 2022, p.629)

2.3 Theoretical Foundation: Vygotsky's Sociocultural Theory

Vygotsky's theory helps explain how HyperLearnX functions as both a technological tool and a cultural artifact in art and design education. Vygotsky frames learning as a socially mediated process shaped by cultural tools, collaboration, and shared meaning-making(Amirul Fahmi Razali et al., 2024; Vygotsky, 1978). Within this framework, HyperLearnX serves as a mediating

artifact, helping learners build artistic knowledge through interaction, guided exploration, and peer collaboration.

In the context of visual arts, this mediation is especially powerful. HyperLearnX embeds prompts and quizzes to create a zone of proximal development, letting students explore artistic concepts while receiving structured guidance. Such design resonates with Vygotsky's view of cultural tools as bridges between individual creativity and collective cultural practice.

Figure 3 and Figure 4 illustrate these theoretical foundations. Figure 3 adapts Vygotsky's Social Development Theory (Pulido et al., 2021), emphasizing the centrality of social and communicative processes in learning. Figure 4 presents the triangular model of mediation (Daniels, 2008; Le Blanc & Singer, 1976), showing how cultural tools, here exemplified by hypertext video, mediate between teacher, learner, and artistic content. Together, these models highlight the role of interactive video as both an educational tool and a cultural artifact in shaping artistic cognition.

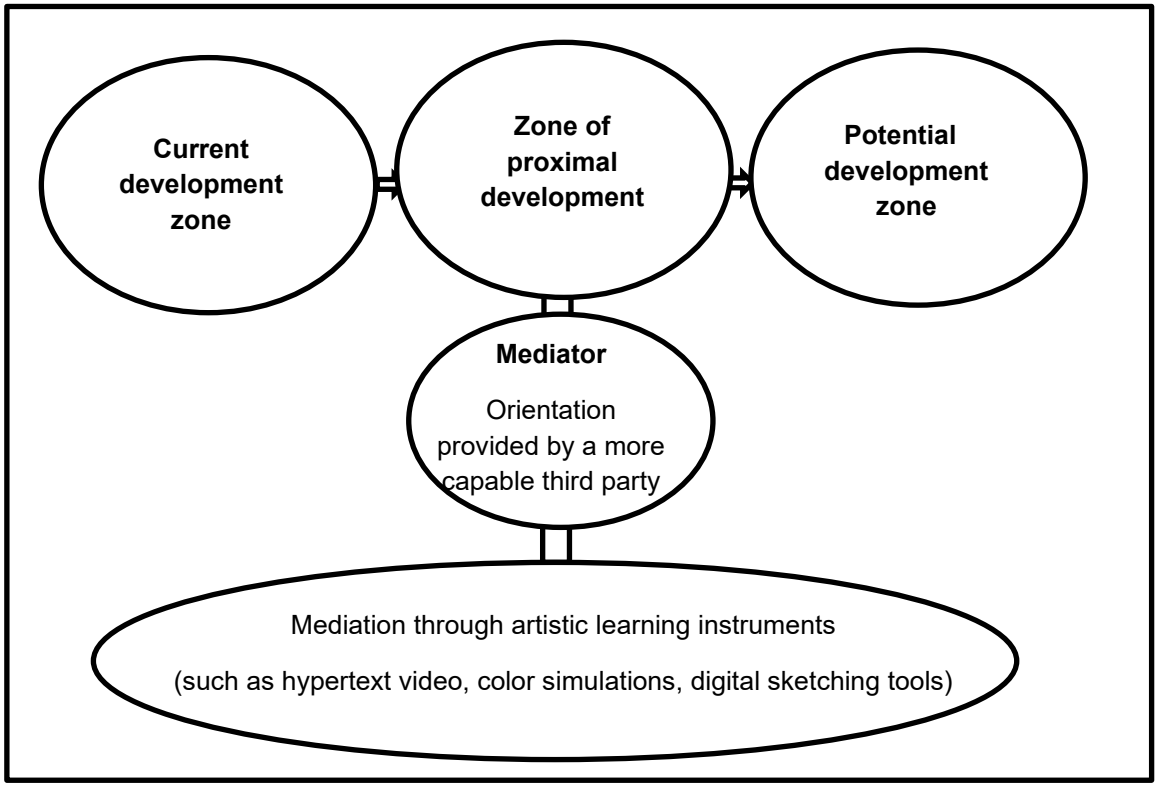

Figure 3. Vygotsky's social development theory. Adapted from (Pulido et al., 2021,p.27)

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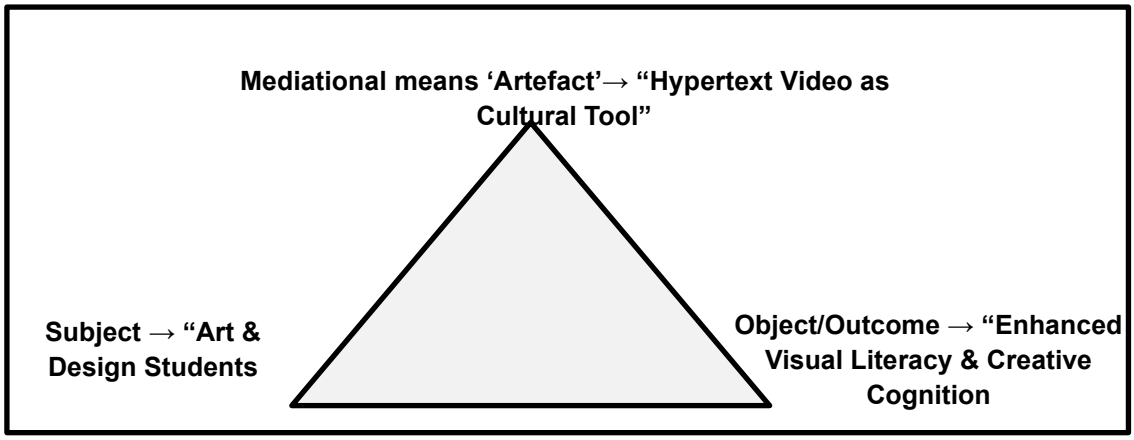

Figure 4. The basic triangular representation of mediation (Daniels, 2008, p.5). Vygotsky's notion of mediation is represented graphically (Le Blanc & Singer, 1976)

Building on this perspective, Table 3 categorizes the functions of interactive video artifacts in digital education, offering a typology that connects hypertext video with Vygotskian mediation and tool-use (Daniels, 2008).

Table 3
Functions Typology of Interactive Video Artifacts in Digital Education (Daniels, 2008,p.11)

Question	Artifacts	Function
What	interactive (hypertext) video	Object identification and description
How		Used to steer and guide activities and operations that occur on, inside, or between objects.
Why		Used to diagnose and explain object properties, evolution, and behaviors.
Where		Used to forecast future conditions or the potential evolution of objects such as social systems and institutions.

Furthermore, Table 4 aligns the research questions of this research with Vygotsky's functions of artifacts in learning, reinforcing how hypertext video serves as a mediational tool in art and design contexts. Beyond individual learning, the theory also supports collaborative modes such as peer annotation, shared commentary, or discussion forums linked to hypertext video modules. These practices reflect contemporary digital pedagogy, where autonomy and community-driven knowledge creation are combined to foster creativity, interpretation, and critical engagement (Yadav & Williamson, 2024).

Table 4
Research Questions Aligned with Vygotsky's Functions of Artifacts in Learning

Problem Statements	Objectives	Research Questions	Alignment with Vygotsky's Table 3
1. Unclear Digital Education Situation in Hypertext Interactive Videos for Learning.	To define the current situation of digital education using hypertext video as an interactive learning tool, specifically at the undergraduate level in Art and Design education in Yemen.	What are the defining characteristics, limitations, and usage practices of hypertext video in undergraduate art and design education in Yemen?	(What?) Object identification and description of hypertext interactive videos in digital education.
2. Challenges in Implementing Hypertext Interactive Videos in Yemeni Universities: A Case Study in a Developing Country.	To analyze the role and design components of hypertext interactive videos in teaching Color Theory, focusing on the needs and experiences of students and instructors in Yemeni universities.	How do interactive hypertext video design components facilitate learning, and what challenges affect their implementation in Yemeni universities?	(How?) Used to steer and guide activities and operations in learning through interactive video.
3. The Absence of a Guiding Framework for Developing and Applying Hypertext Interactive Videos in Education.	To propose a practical framework for developing and applying hypertext interactive videos in higher education institutions in Yemen, based on the pedagogical requirements of design-based subjects.	Why is a structured framework essential for the effective development and application of hypertext interactive videos, and how can it be tailored to Yemen's educational context?	(Why?) Used to diagnose and explain the role of interactive videos in education and forecast their future impact

2.4 Infrastructure Challenges in Developing Countries

Integrating HyperLearnX into art and design education depends on both pedagogical potential and infrastructural realities in developing contexts. Limited connectivity, fragile digital infrastructure, and uneven technological literacy continue to restrict the creative use of interactive video in higher education (Bellal, 2021; Sauli et al., 2018). As Sauli et al.(2018) observe, disparities in digital access remain a defining challenge, preventing learners from fully engaging with visually intensive and interactive materials. Economic constraints limit access to digital tools for institutions and students (Al-Hattami, 2025; Kelly, Tim and Rossotto, 2012). Such inequities risk limiting artistic exploration in precisely the disciplines of graphic design, visual studies, and color theory, where digital interactivity has the greatest potential. Nonetheless, mobile-responsive and low-bandwidth solutions offer a pathway forward. Scholars note that mobile and offline-ready HyperLearnX content can extend creative opportunities, allowing students to engage in multimodal learning (Chen et al., 2024; Sam, 2017; Yadav & Williamson, 2024)

Table 5 summarizes the key infrastructural, pedagogical, and user-experience barriers that hinder the adoption of hypertext video in developing countries, while also pointing toward strategies for equitable integration.

Table 5
Challenges in Hypertext Interactive Video Learning Adoption

Challenge	Description	Proposed Solutions
Limited Internet Access	Inconsistent or weak connectivity hinders digital learning.	Develop offline learning options and low-bandwidth content solutions (Ruiz & Gallagher, 2025)
Lack of Infrastructure	Limited access to digital tools and technologies.	Invest in cost-effective mobile-based solutions to expand accessibility (AlMunifi & Aleryani, 2021).
Digital Literacy Gap	Students and educators lack sufficient technical skills.	Implement targeted training programs and digital competency workshops (Al-Hattami, 2025)

2.5 Comparative Insights on Digital Learning Challenges in Developing Countries

Comparative evidence shows that digital learning in developing countries, including Yemen, faces structural and infrastructural challenges that affect educational equity. In Bangladesh, limited access to devices, unreliable internet connectivity, and socio-economic disparities hindered e-learning participation during the COVID-19 pandemic (Badiuzzaman, Rafiquzzaman, Rabby, & Rahman, 2021). In Sub-Saharan Africa, many students faced barriers due to high data costs, inadequate devices, and weak internet infrastructure (Olugbenga & Rufus, 2025; Adarkwah, 2021). In Zimbabwe, digital-learning initiatives reported scarce device availability, low digital literacy, and insufficient technical support as major obstacles (Kelly & Rutazihana, 2024). These examples show the need for low-bandwidth, resource-aware HyperLearnX designs to reduce digital inequities.

3. METHODOLOGY

This study uses a qualitative design with thematic analysis and a practical methodological model. The approach goes beyond data collection to develop a pedagogical framework for HyperLearnX in art and design education. Figure 5 shows the methodological framework combining technological, pedagogical, and socio-cultural dimensions as a guide for research design and analysis.

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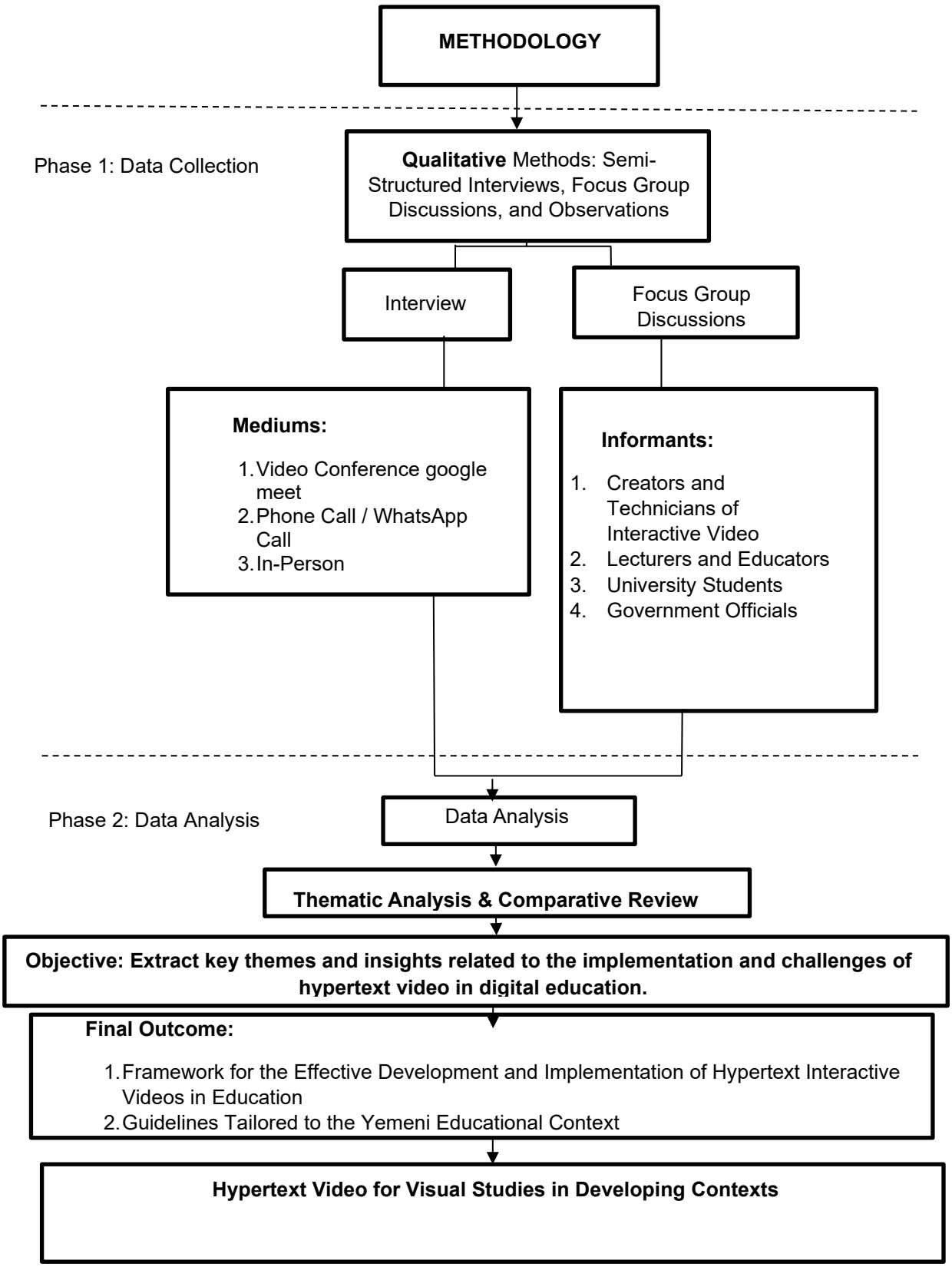

Figure 5 Methodology Framework for Research on Hypertext Video-Based Learning

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3.1 Research Design

This research employs a qualitative, multiple-case design focused on visual studies classrooms in Yemen and comparable developing-country contexts. Researchers purposively selected cases to match the study's artistic and design focus. Selection criteria included: Curricular relevance to visual studies (such as graphic design, drawing, visual culture, computer arts). Constrained infrastructure (like 3G or intermittent broadband). Willingness to pilot or reflect on hypertext video use. The research design is guided by the ADDIE instructional model (Analysis, Design, Development, Implementation, Evaluation) (Kamil et al., 2020, p.892) and grounded in Vygotsky's sociocultural theory, emphasizing how interactive artefacts mediate collaborative and creative learning in the arts.
Figure 6 illustrates the ADDIE model framework applied in this research. This framework not only synthesizes empirical findings but also provides a replicable model for applying hypertext video in low-bandwidth art and design contexts.

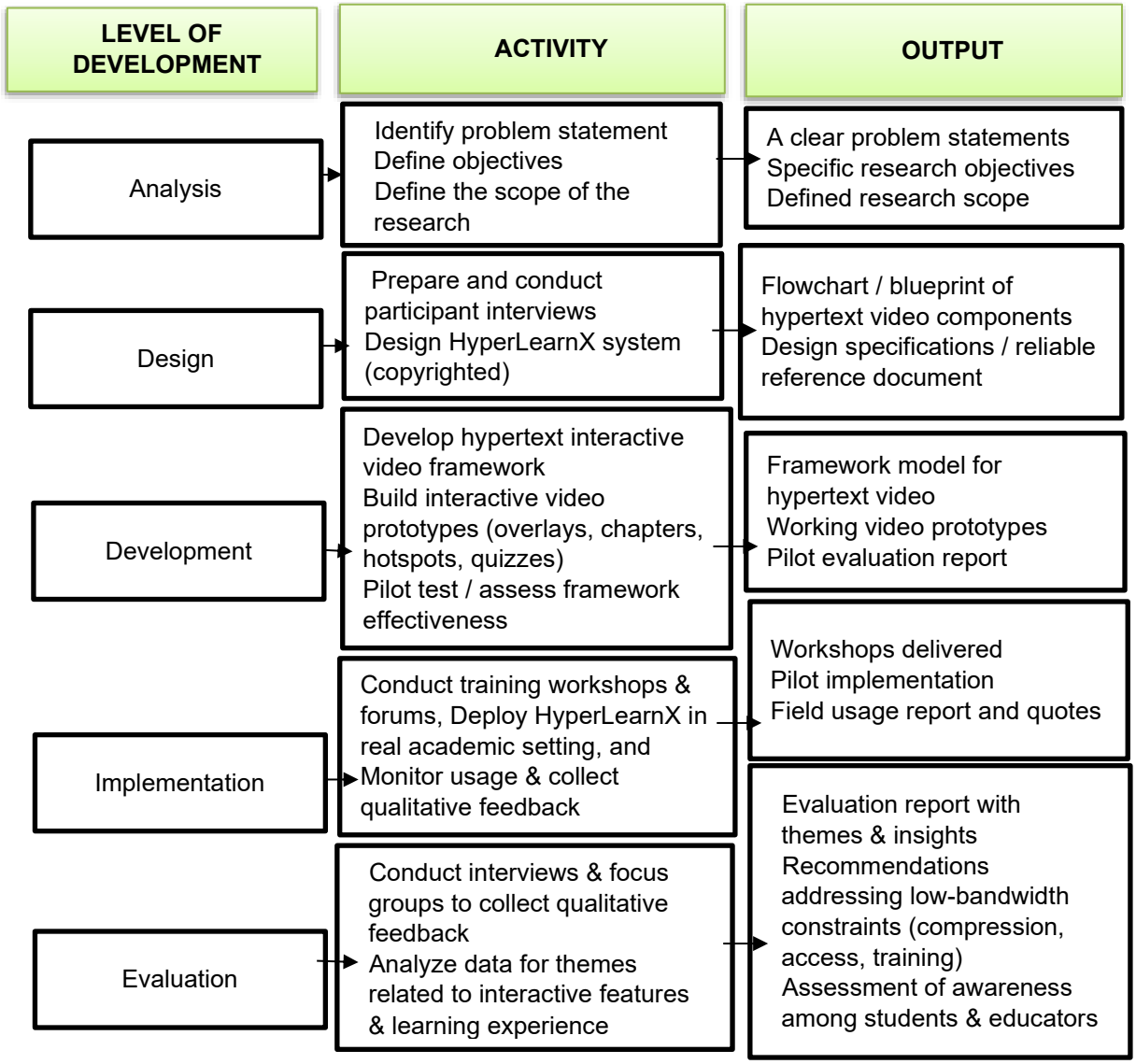

Figure 6 framework of ADDIE model (Kamil et al., 2020,p.892)

3.1.1 Participants and Sampling

Participants were recruited to represent Yemen's higher education ecosystem, from policymakers to students who directly experience digital learning in the classroom. At the highest level, seven government officials participated, including representatives from the Ministry of Higher Education, the Ministry of Telecommunications, and related agencies, as well as university leaders and senior decision-makers. Their strategic outlook was complemented by the voices of five university lecturers, who are directly engaged in shaping pedagogy and creative curricula, and eleven technical experts specializing in video development, software engineering, and digital infrastructure. To capture the learner's perspective, 19 undergraduate students from eight Yemeni universities, Sana'a, Saba, Aden, Taiz, Hodeidah, Ibb, Al-Razi, and the Lebanese International University, Yemen, were also included. Several participants embodied overlapping roles; for example, Dr. Abdulrahman Alsabri, Dean of the Computer College at Sana'a University, contributed simultaneously as a lecturer and technical advisor, while Prof. Ibrahim Sharaf, Deputy Minister of Education, engaged in both academic and policy-making capacities. To accommodate these layered identities, data collection combined focus groups (15 students and 3 government officials) with single interviews. This mosaic of voices, policy, pedagogy, technology, and artistry ensured a holistic understanding of how hypertext video may be integrated into creative and higher education, particularly in contexts challenged by low bandwidth

3.1.2 Instruments (Interview Protocol & Artefacts)

Figure 7 presents the structural components essential for developing an interactive video using Quizizz. The design framework includes the following elements: (1) a linear video serving as the primary content, (2) a timeline for sequencing interactive elements, (3) embedded questions to assess learner comprehension, (4) an option to incorporate comments or inquiries, (5) a preview of comment integration within the video, and (6) a preview illustrating the display of embedded questions. This screenshot is sourced from Quizizz (2025).

Primary data were subsequently collected through semi-structured interviews (30–60 minutes with university students; 45–60 minutes with lecturers, creators, and technicians of interactive video; and 45–120 minutes with government officials) and focus groups to foster dialogic exchange. Interview protocols explored prior experiences with traditional or video-based learning; perceptions of hypertext video in visual learning and design contexts; requirements for aesthetic clarity (like faces, gestures, diagrams, on-screen text); infrastructural constraints; and low-tech adaptations.

In addition, teaching artefacts such as lesson plans, annotated clips, and prototypes were collected to triangulate interview data with actual pedagogical materials.

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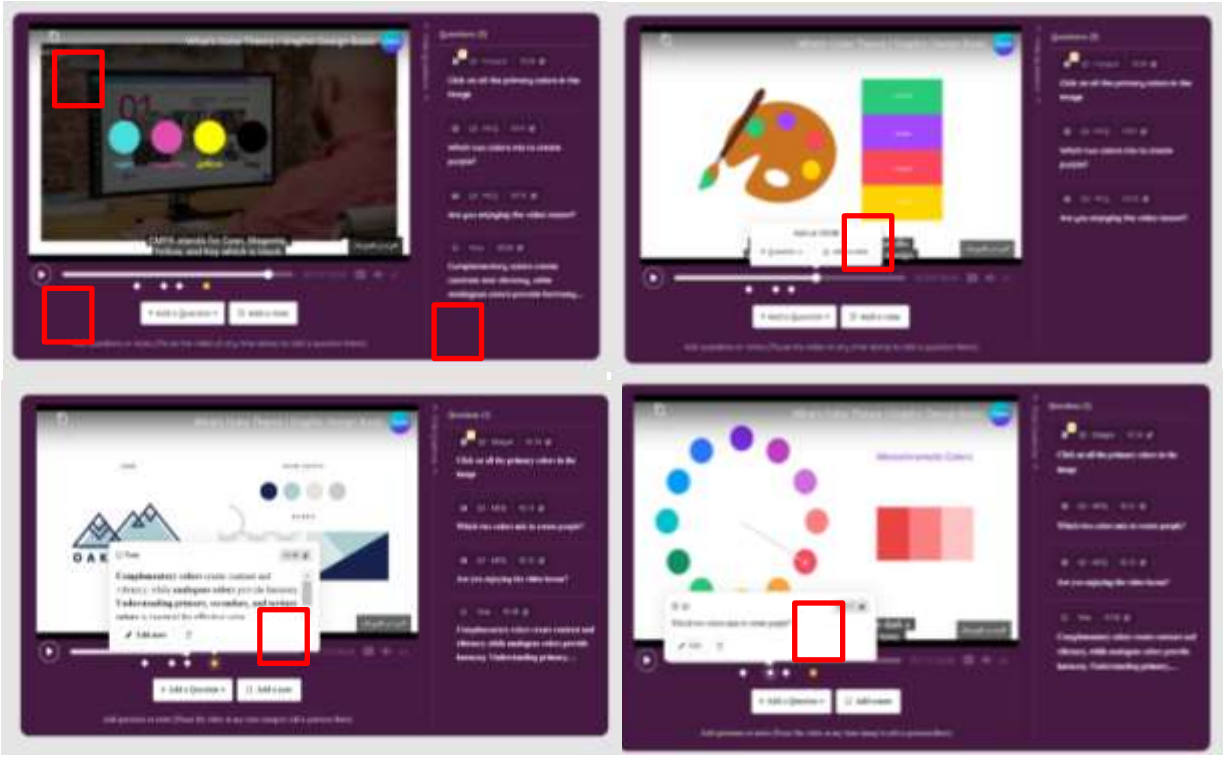

Figure 7 Structural Components of Hypertext Interactive Video. This screenshot was taken from the Quizizz platform (2025)

3.1.3 Procedure (Data Collection)

Data were collected in August, September 2025 using a combination of Zoom and Google Meet, depending on connectivity. Researchers audio-recorded, transcribed, and member-checked interviews and focus groups. Where bandwidth was unreliable, asynchronous voice notes and offline recordings were employed as alternative methods.

3.2 Data Analysis

The study used reflexive thematic analysis with NVivo for coding and data organization.(Braun & Clarke, 2006). The six iterative phases comprised familiarization, coding, theme generation, review, definition, and reporting. Coding was structured across multiple analytic layers, with themes and sub-themes systematically derived from the dataset. A consolidated thematic map was constructed (see Figure 8), illustrating the relationships between themes.
The final coding framework generated the following key themes and sub-themes:
Education_Value: Engagement, Learning Outcomes, Motivation, Content Quality, Interactivity.
Scaffolding_Vygotsky: Zone of Proximal Development (links, hints, interactive questions), Peer Collaboration, Teacher Guidance.
Technical_Dimensions: Bandwidth, Device Compatibility, Localization_Arabic, Compression, User Interface Simplicity, Server Hosting, Human Resources Skills, Caching. HyperLearnX_Features: Adaptive Streaming, Interactive Questions as Links, Open-Source Potential, Relevance to Context. Accessibility: Rural Access,

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Cost_Affordability, Infrastructure. Policy_Regulation: Government Support (positive and negative aspects, including political constraints), Organization Role, University Policy. Recommendations: Technical Partnerships, Training, Commercialization, Future Development. Quotes: Students, Technicians, Lecturers, Government Officials. To ensure trustworthiness, multiple quality-assurance strategies were employed. Credibility was enhanced through member checking and triangulation across interviews, artefacts, and prototype feedback. Dependability and confirmability were maintained via an audit trail of research decisions, coding revisions, and analytical memos. Transferability was strengthened by providing rich contextual descriptions. Intercoder agreement was assessed for 25% of transcripts to ensure consistency. Reflexivity was also practiced, with the researcher maintaining memos reflecting on positionality and assumptions throughout data collection and analysis.

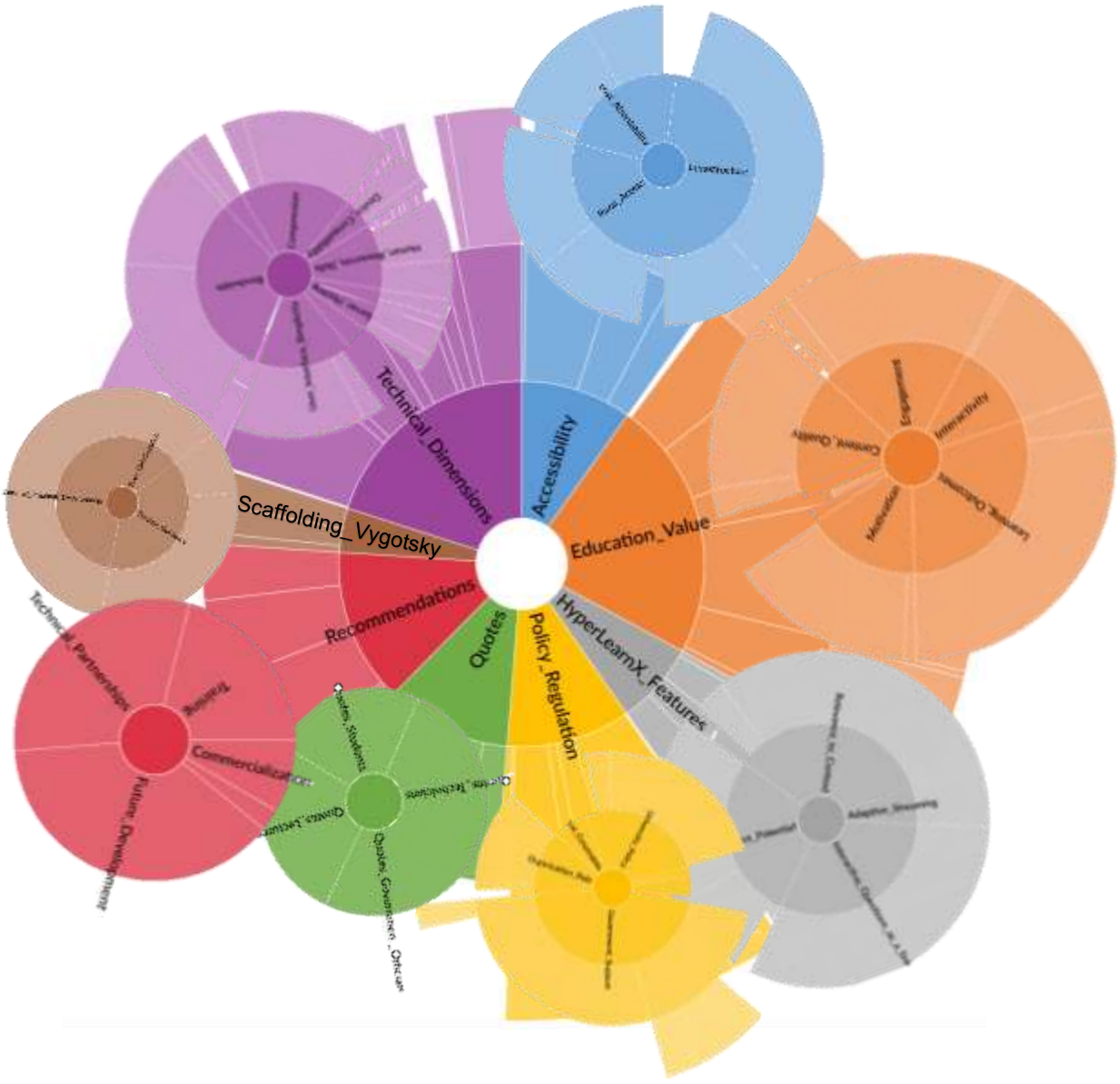

Figure 8 Consolidated Thematic Map of Coded Data (manually constructed from NVivo analysis)

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3.2.1 Design Framework Methodology

The design framework of this research is structured around Vygotsky's Sociocultural Theory, which emphasizes interaction, scaffolding, and the use of cultural tools in the learning process. The framework is tailored to address the challenges of delivering interactive video-based learning in low-bandwidth environments, particularly for teaching graphic design in art and design.

The conceptual framework, Figure 9, illustrates how sociocultural principles are integrated into the design of hypertext video for educational purposes. Building on this theoretical foundation, the conceptual model of HyperLearnX operationalizes these principles into a practical system. The model incorporates SmartZone Compression for mobile networks, adaptive scaffolding strategies, and low-bandwidth optimization techniques to ensure effective delivery of interactive learning content.

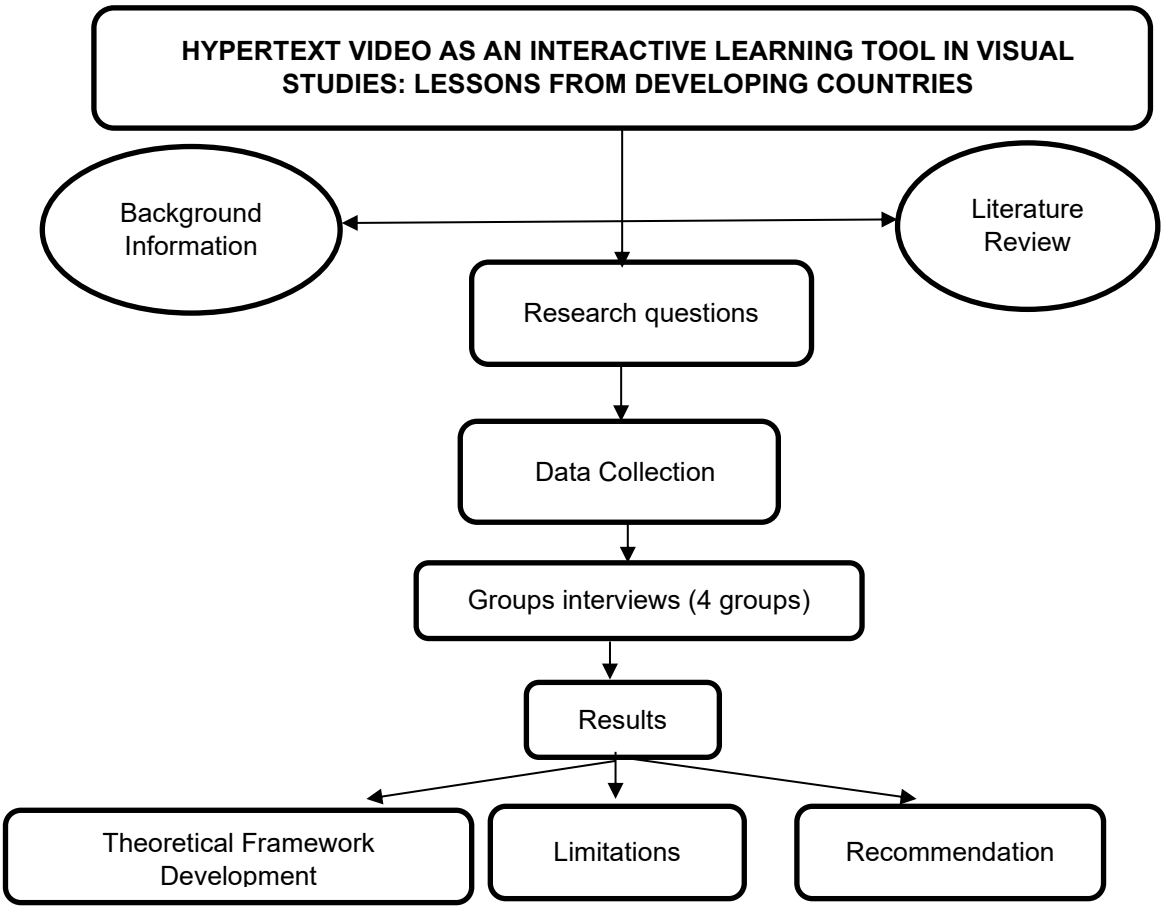

Figure 9: Conceptual Framework for Hypertext Video-Based Interactive Learning

The conceptual framework of HyperLearnX is situated at the intersection of digital media design and pedagogy. Rather than approaching the system purely as a technical solution, the model demonstrates how interactive video aesthetics can be reshaped to function effectively under low-bandwidth conditions.

As shown in Figure 10, the design unfolds in three stages:

Stage 1: Creative Content Ingestion – Video material is enhanced with hypertextual layers, such as interactive annotations, hotspots, and visual cues that guide learners through the narrative.

Stage 2: Adaptive Mediation – Visual compression and adaptive streaming are applied to maintain the artistic quality of the video while reducing bandwidth demands, ensuring accessibility without sacrificing aesthetics.

Stage 3: Interactive Delivery – Learners engage with the hypertext video through branching storylines, embedded quizzes, and clickable design elements, creating an experience that blends visual pedagogy with interactive digital art.

This approach positions HyperLearnX not merely as a technological tool but as a digital art-based learning environment, where interactivity and visual design converge to democratize access to creative education in developing contexts.

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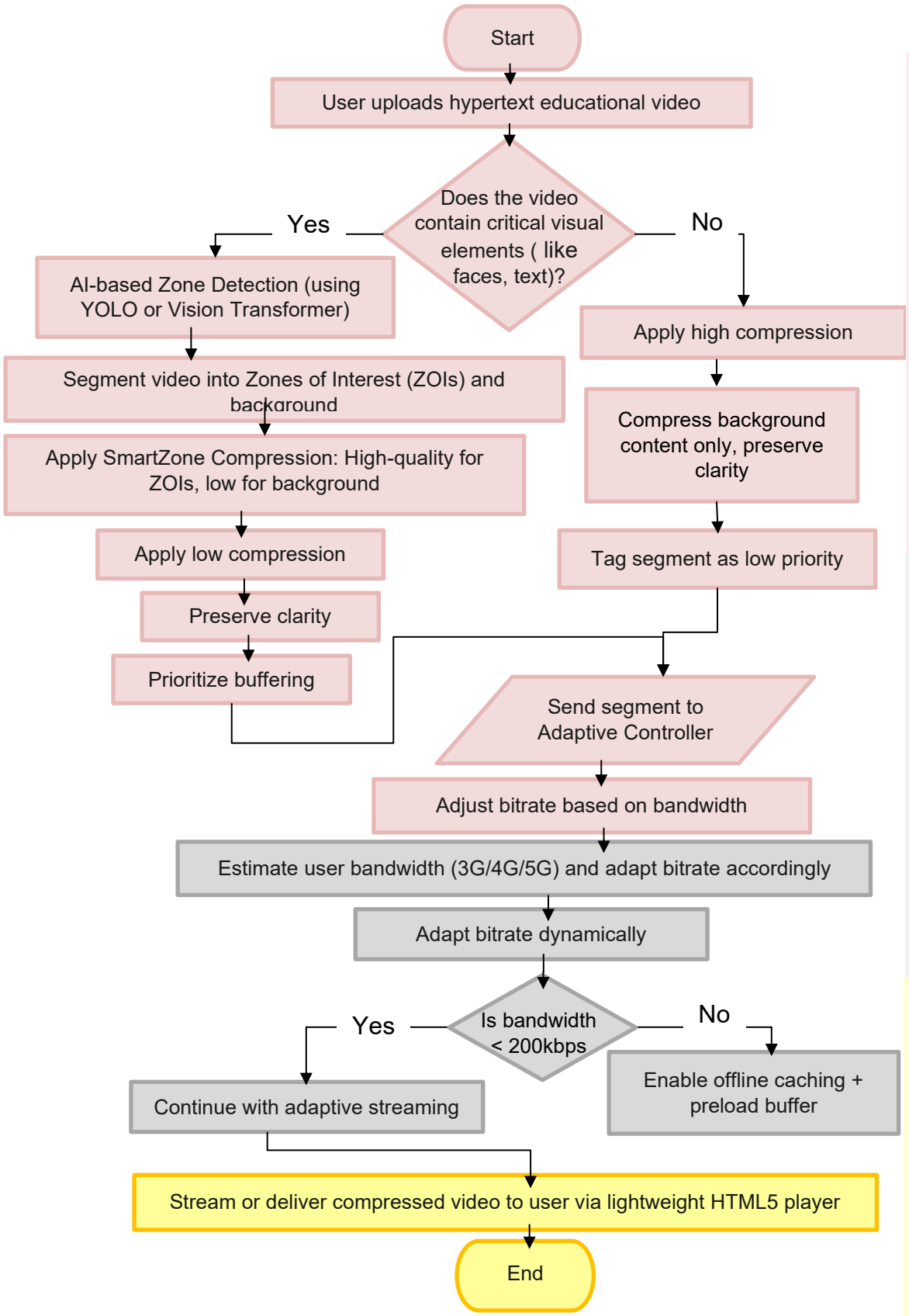

Figure 10. Conceptual framework of HyperLearnX showing the three design stages: (1) Creative Content Ingestion, (2) Adaptive Mediation, and (3) Interactive Delivery.

3.2.2 Key Interactive Features of Hypertext Video-Based Learning

HyperLearnX includes interactive features for art and design, allowing critical and creative engagement. These features include:

Overlays: clickable annotations that provide links to related visuals or supplementary explanations.

Video chapters with hyperlinks: supporting non-linear navigation and allowing learners to revisit or skip to specific segments.

Hotspots: interactive points embedded within the video to enable deeper exploration of design elements.

Quizzes and branching pathways: integrating reflective tasks and inquiry-driven engagement through embedded assessments and alternative learning routes.

Together, these features transform hypertext video into a dynamic learning tool that combines aesthetic exploration with pedagogical scaffolding, thereby fostering active participation and creative inquiry in art and design education.

4. RESEARCH CONTEXT AND VALIDATION

4.1 Coding Framework

This research employed a reflexive thematic analysis situated within a practical methodological model that integrates technological, pedagogical, and socio-cultural dimensions. Coding is aligned with the theoretical foundation explained previously. Codes were informed by the theoretical lens discussed in Section 3.2.

The resulting codebook comprised three interrelated layers: (i) pedagogical and aesthetic values (Education_Value, Content_Quality, Engagement, Motivation), (ii) technological and infrastructural frictions (Bandwidth, Accessibility, Device_Compatibility, Localization_Arabic, Caching), and (iii) policy and institutional factors (University_Policy, Government_Support, Policy_Regulation). Reliability was supported by iterative coding, peer discussion, and the maintenance of an audit trail.

4.2 Identified Research Gap

The literature review has emphasized the pedagogical and aesthetic value of hypertext video in art and design education, particularly its capacity to enhance interactivity, creativity, and multimodal engagement (Cattaneo et al., 2019; Lee et al., 2025; Mack, 2024). However, most of these studies were conducted in technologically advanced and politically stable environments.
By contrast, the NVivo analysis of interviews with Yemeni policymakers, lecturers, and ICT experts revealed additional dimensions overlooked in the global literature. Dr. Mohammed Al-Riyashi, President of the Yemeni Union of Information and

Communication Technology, stressed the infrastructural constraints: “The main reason for slow Internet is the targeting of infrastructure due to the war. Human resources are available, but without resources and institutional support, sustainability cannot be ensured.” Similarly, Dr. Mohammed Alshargabi, International Specialist and accreditation board member, emphasized affordability and equity: “IT infrastructure is limited to certain areas such as Sana’a, and mainly for those who can afford it… If we consider the actual target population of your idea, they unfortunately lack the necessary IT or internet infrastructure. This is the biggest challenge.”

At the policy level, Tahani Lutf Alswari, senior official at the Ministry of Higher Education, highlighted systemic limitations: “The Ministry of Higher Education views digital transformation as an urgent priority, yet implementation remains constrained by financial limitations, infrastructural instability, and the absence of cohesive national strategies.”

From a governmental perspective, Mr. Ibrahim Sharaf, Deputy Minister of Education, observed: “Higher education in Yemen suffers from the absence of clear strategies. The war has halted many projects… If we want to implement interactive video at a national level, we need three steps: official recognition of digital education, coordination between the Ministry of Higher Education and the Ministry of Telecommunications, and financial and technical support from international partners.”

Institutional stakeholders also expressed cautious optimism. In focus group discussions, deputy ministers and university leaders noted: “If the technology proves effective, universities can be required to adopt it. But there must be a clear framework, staff training, infrastructure, and equipment.”

Academic experts reinforced the pedagogical gap. As Professor Fekri M. Abduljalil explained: “We lack clear models that integrate sociocultural learning theories with digital tools. Digital education will inevitably arrive, but without a structured framework, implementation will remain fragmented.”

Taken together, these insights underline a pressing research gap: while the literature theorizes the aesthetic and pedagogical potential of hypertext video, it neglects the institutional, infrastructural, and socio-political conditions that determine feasibility in fragile and resource-constrained contexts. This research addresses the gap by integrating Vygotskian socio-cultural theory with practical strategies for low-bandwidth optimization, institutional alignment, and policy sustainability in Yemeni higher education.

Table 6
Thematic coding framework with illustrative quotes

Theme	Code	Definition	Exemplar Quote	Role / Position
Technical Dimensions	Adaptive Media Compression	Methods to reduce video size while retaining interactivity.	"We need compression that works for mobile bandwidth; otherwise, students cannot even load the lecture."	Dr. Hesham – Head of CS Dept., Saba University
	Efficient Media Delivery	Pre-loading and offline access strategies.	"Without caching, students in rural areas cannot continue when the network drops."	Dr. Al-Riyashi – IT Director, University of Sana'a
Pedagogical Framework	Cultural Localization	Adapting content linguistically and culturally (Arabic context).	"Content must be localized in Arabic to be accepted by students and faculty."	Marwan Amin – Lecturer, Fine Arts College
	Creative Scaffolding	Application of Vygotskian principles to guide learning.	"If you design it with scaffolding, students will not get lost; they can follow step by step."	Dr. Samira – Professor of Education
	Artistic Engagement	Interactive features that motivate active participation.	"Hyperlinks and branching make students feel they are part of the learning, not just watching."	Ahmed Saleh – Graphic Design Lecturer
Accessibility & Equity	Affordability	Economic feasibility for students in fragile contexts.	"Many students cannot afford extra internet bundles; affordability is the first condition."	Student Interviewee – Sana'a University
	Rural Access	Bridging the digital divide for remote areas.	"In my village, the internet is available only at night; offline videos with hyperlinks are the only solution."	Student Interviewee – Rural Taiz

Policy & Institutional	Policy Alignment	Need for national policy recognition of digital education.	"Higher education in Yemen suffers from the absence of clear strategies. … We need official recognition, inter-ministerial coordination, and external support."	Mr. Ibrahim Sharaf – Deputy Minister of Education
	Institutional Support	Role of universities and decision-makers in implementation.	"If the technology proves effective, universities can be required to adopt it. But there must be a clear framework, staff training, infrastructure, and equipment."	Deputy Ministers & University Leaders (FGD)
Academic Perspectives	Pedagogical Gap	Lack of integrated models linking theory and technology.	"We lack clear models that integrate sociocultural learning theories with digital tools. Without a structured framework, implementation will remain fragmented."	Prof. Fekri M. Abduljalil – Senior Academic Expert

As shown in Table 6, the thematic coding framework demonstrates how participants' perspectives were categorized into key dimensions of accessibility, affordability, creative flexibility, infrastructural limitations, rural access, educational value, content quality, usability, and learner engagement. The exemplar quotes not only reflect challenges such as limited infrastructure, unstable connectivity, and economic constraints but also highlight opportunities, including enhanced creative flexibility, enriched educational value, and deeper artistic engagement through interactive hypertext video. These findings illuminate the contextual realities of digital learning in low-bandwidth environments while emphasizing its potential to transform art and design education. By anchoring the analysis in participants' lived experiences, the framework strengthens the validity of the identified research gaps and underscores the relevance of digital pedagogy in creative fields.

To ensure the credibility and integrity of these findings, it is crucial to discuss the measures taken to enhance the trustworthiness and ethical soundness of the research. The following section (4.2) outlines the strategies employed to establish rigor in qualitative analysis and to safeguard participants' rights and confidentiality.

4.3 Trustworthiness & Ethics.

To ensure the trustworthiness of this research, several measures were undertaken. Credibility was strengthened through triangulation of data sources, including interviews, focus groups, and document analysis, as well as peer debriefing with academic supervisors. Multiple stakeholders (students, lecturers, and policy officials) were engaged to provide diverse perspectives, which enhanced the depth and accuracy of the findings.

Dependability was established by systematically documenting the research process, including coding decisions, data management procedures, and analytical steps, so that the research could be replicated or traced by other researchers. NVivo software was used to maintain a transparent audit trail of coding and thematic analysis.

Ethical considerations were strictly observed in line with the approval obtained from the Universiti Teknologi MARA (UiTM) Research Ethics Committee (Ref. No: REC/08/2025 (PG/MR/474)). All participants were provided with an informed consent form prior to data collection, and their voluntary participation was emphasized. Privacy and confidentiality were ensured by storing data securely and restricting access to the research team only. While participants were given the option to remain anonymous, all of them explicitly consented to have their real names disclosed in this research. As such, their contributions are presented under their actual identities, respecting their wish for acknowledgment while maintaining compliance with ethical approval requirements.

5. FINDINGS AND DISCUSSION

5.1 Hypertext Video as a Pedagogical Tool in Visual Studies

The findings indicate that Hypertext Video, particularly in the form of the HyperLearnX prototype, can serve as a powerful pedagogical tool for teaching visual studies such as color theory. Participants highlighted its ability to summarize lengthy content into concise segments, thereby saving students' time and enhancing understanding. For example, Dr. Hesham noted that "a two-hour video can be reduced to just 15 minutes… this would be a radical change, a real revolution". Similarly, lecturer Marwa Alhadi emphasized that students prefer summarized content: "they watch less but gain more information".
Interactive features such as embedded questions and immediate feedback were perceived as highly beneficial for engagement. As student Elyas Almajedi noted, 'What impressed me most was the feature of answering a question and getting immediate feedback,' a design element that not only aligns with Vygotsky's ZPD but also fosters active sensory engagement, enhancing attention and retention.
Another advantage identified was the ability of HyperLearnX to support learners in low-bandwidth environments. As Dr. Abdulrahman Alsabri observed, "if designed to produce lightweight videos with minimal file size while preserving interactivity, students in low-bandwidth environments could benefit". This makes the tool

particularly suitable for the Yemeni context, where internet connectivity is unstable. This reflects Vygotsky's view of technology as a cultural tool mediating learning in specific ways.

Finally, several participants stressed the role of HyperLearnX in expanding access to visual studies. Dr. Fua'ad Hasan highlighted its potential societal value: "Having a technology like HyperLearnX would represent a major societal achievement". This echoes Vygotsky's emphasis on collective advancement through mediated tools, suggesting that interactive hypertext video can democratize art and design education in developing contexts.

5.2 Student Engagement and Aesthetic Experience

The research revealed that student engagement with Hypertext Video was not limited to cognitive understanding but extended to aesthetic and sensory dimensions of learning. Participants described their interaction with the videos as more immersive compared to traditional lectures or static digital content. Lecturers also highlighted the value of creative engagement, where interactivity allowed students to actively participate in constructing meaning rather than passively consuming information. As Marwa Alhadi explained: "Students want summarized content… they watch less but gain more information." This reflects a form of visual pedagogy, where learning occurs through the fusion of sensory experience and critical reflection.

The fusion of art and technology was further recognized as a strength of HyperLearnX. Dr. Fua'ad Hasan described the platform as "a major societal achievement" if successfully implemented, noting that its ability to combine artistic practice with digital interactivity makes it both educational and inspiring. This aligns with scholarship on digital aesthetics, which suggests that learning environments enriched with artistic and sensory elements foster deeper engagement and intrinsic motivation.

Overall, the findings indicate that Hypertext Video provides not only pedagogical efficiency but also an aesthetic learning experience that resonates with students in art and design disciplines. This underscores its potential to transform digital education into an aesthetic practice.

In summary, the findings of this study directly address the research objectives. The first objective, which aimed to examine students' experiences with hypertext interactive video, is demonstrated through the emergence of themes related to accessibility, engagement, and self-paced visual learning. The second objective, which focused on identifying pedagogical advantages in low-resource contexts, is reflected in the results showing reduced cognitive overload, improved visual reasoning, and greater flexibility in learner autonomy. The third objective, which examined how Vygotskian principles manifest in the learning process, is supported by the evidence of scaffolding, mediation, and meaningful learner–content interaction. Together, these findings show that hypertext interactive video effectively advances visual pedagogy in developing contexts such as Yemen.

5.3 Barriers in Resource-Constrained Contexts

Despite the promise of hypertext video in enriching art and design education, students highlighted several barriers that limited the depth of their aesthetic and creative engagement. Weak internet connectivity, for instance, did not merely restrict access to digital lessons but interrupted the continuity of artistic flow, breaking the immersive experience that the medium is designed to provide.

Another recurring challenge was the gap in digital literacy among both students and educators, which hindered their capacity to engage with hypertext video as a space for creative exploration. Instead of navigating the content as an interactive and aesthetic journey, many participants defaulted to passive consumption, reflecting a missed opportunity for artistic co-creation. These findings resonate with previous literature that underscores how contextual barriers, whether infrastructural or pedagogical, can dilute the transformative potential of digital learning (Ruiz & Gallagher, 2025; AlMunifi & Aleryani, 2021; Al-Hattami, 2025).

Ultimately, the barriers in resource-constrained contexts are not only about access but about the diminished possibility of experiencing digital education as an aesthetic practice. Without stable platforms, supportive infrastructure, and creative digital competencies, students risk losing the artistic value that hypertext video seeks to cultivate.

5.4 Implications for Art and Design Education

The findings suggest important directions for advancing art and design pedagogy in resource-constrained contexts. Hypertext video shifts learning from passive viewing toward inquiry-based exploration. Preserving visual salience, such as faces, gestures, and textual cues, is essential to sustaining aesthetic meaning and comprehension. Finally, low-bandwidth adaptations, including pre-caching critical segments and providing text-first fallbacks, proved effective in normalizing participation, ensuring that students remain engaged despite infrastructural limitations. Collectively, these insights highlight the need to integrate interactive technologies into art curricula, train educators in digital pedagogy, and develop content tailored to both creative practice and technical constraints.

6. DESIGN RECOMMENDATIONS FOR LOW-BANDWIDTH CONTEXTS

This research recommends embedding interactive video in art and design education through strategies that reconcile technical constraints with creative practice. Low-bandwidth optimization via compression, pre-caching, and offline modes should be prioritized to preserve essential visual cues such as color and gesture. HyperLearnX pedagogical design should include scaffolding, hyperlinks, annotations, and short clips to maintain artistic engagement. Equally important is equipping educators with digital literacy skills and involving students in co-design processes to ensure that interactive video functions not only as a technological tool but as an aesthetic medium aligned with studio-based learning.

7. LIMITATIONS

The study has several limitations. First, the purposive sample, while diverse across policymakers, lecturers, technical experts, and students, remains limited in size and confined to the Yemeni higher education context. Second, the reliance on interviews and focus groups conducted online meant that unstable connectivity occasionally disrupted the completeness of interaction. Third, the absence of a full-scale classroom trial restricts the ability to assess long-term pedagogical outcomes. These limitations do not invalidate the findings but indicate that results should be interpreted as context-specific rather than universally generalizable. Future research may address these constraints through multi-site comparative studies, larger cohorts, and system-level evaluations.

8. CONCLUSION AND IMPLICATIONS

This research contributes to the field of art and design education in two key ways. Theoretically, it extends Vygotsky's sociocultural theory to the digital domain by demonstrating how hypertext video functions as a mediating cultural tool that supports scaffolding, collaboration, and creative inquiry. Practically, it proposes a design framework for implementing interactive video in resource-constrained environments, addressing bandwidth limitations and infrastructural barriers while preserving aesthetic and pedagogical value.

Findings from Yemen show that HyperLearnX can democratize visual studies, but digital literacy, connectivity, and institutional support remain challenges.
These insights underscore the need for context-sensitive pedagogical strategies, educator training in digital-aesthetic integration, and institutional frameworks that embed interactive media into long-term educational planning. Looking forward, future research should include experimental classroom trials to evaluate the effectiveness of hypertext video on learning outcomes and aesthetic engagement, as well as comparative studies across multiple institutions to examine scalability. Further work could also explore how hypertext video fosters creative cognition and visual literacy in other art-related disciplines. In summary, hypertext video is not only a technological tool but also a cultural and aesthetic medium that bridges artistic cognition with digital innovation. Its careful adaptation offers a pathway toward equitable, creative, and sustainable education in developing contexts.
Overall, this study demonstrates that hypertext interactive video can significantly enhance visual learning in low-resource environments by improving accessibility, supporting learner autonomy, and enabling scaffolded visual reasoning. The findings highlight practical implications for art and design education, particularly the need for low-bandwidth, culturally adaptable, and mobile-friendly instructional tools. Based on these insights, the study recommends that educators integrate interactive video as a core component of visual studies curricula and that institutions invest in lightweight, offline-capable digital platforms to ensure equitable access for students in developing contexts. Future research may extend this work by testing hypertext video across additional disciplines and evaluating long-term learning outcomes.

ACKNOWLEDGMENT

The author would like to thank all participants for their valuable contributions to this study. The author also acknowledges the use of ChatGPT to assist with language refinement, organization, and clarity; all ideas, interpretations, and scholarly arguments presented in this manuscript are solely the author's own.

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