

UNIVERSITI TEKNOLOGI MARA

**ADVANCING HYPERTEXT
VIDEO-BASED LEARNING IN ART
AND DESIGN EDUCATION:
AN INTERPRETIVE CASE STUDY
OF COLOUR THEORY LEARNING
AMONG ART STUDENTS
IN YEMEN**

**ELHAM MOHAMMED KAID
ALSHABI**

MA

July 2026

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IN YEMEN**

ELHAM MOHAMMED KAID ALSHABI

Thesis submitted in fulfilment
of the requirements for the degree of
Master of Arts and Design

Faculty of Art and Design

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CONFIRMATION BY PANEL OF EXAMINERS

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ABSTRACT

This study investigated the integration of hypertext-based interactive video in undergraduate Art and Design education in Yemen, with particular emphasis on colour theory instruction within resource-constrained and low-bandwidth environments. It addresses a critical gap in empirical and context-specific research concerning the pedagogical use, learner perceptions, and conceptual development of hypertext interactive video in higher education within developing contexts. The study was guided by three research questions: (RQ1) What is the current state and pedagogical use of hypertext interactive video in undergraduate Art and Design education in Yemen? (RQ2) How do students and instructors perceive the pedagogical, aesthetic, and technological components of hypertext interactive video in teaching colour theory in Yemeni universities? (RQ3) How can a contextually relevant and pedagogically grounded framework for hypertext interactive video be developed for higher education in Yemen? An interpretive qualitative case study design was adopted, grounded in a constructivist epistemological perspective informed by Vygotsky's theory of social interaction and mediated learning. Data were collected from 35 stakeholders representing four groups: academic staff, students, technical specialists, and policymakers. The data collection process included two focus group discussions with Ministry of Education representatives and 15 students, alongside twenty-three in-depth semi-structured interviews with participants from the Ministry of Communication and Technology, industry practitioners, technical experts, and students. Data were analysed using thematic analysis following Braun and Clarke's framework, supported by NVivo software to ensure systematic coding, transparency, and analytical rigour. The analysis generated three interrelated themes: pedagogical adaptation supporting scaffolded learning processes, aesthetic mediation enhancing visual cognition, and technological resilience in response to infrastructural limitations in low-bandwidth environments. Based on these findings, the study proposed a contextually grounded framework for hypertext interactive video in Art and Design education, integrating pedagogical, aesthetic, and technological dimensions to support accessible and adaptive learning experiences. Overall, the study contributes to advancing digital pedagogy in resource-constrained contexts and provides implications for educators and policymakers in higher education.

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LIST OF ABBREVIATIONS

Abbreviations

3D	Three-Dimensional
2G/3G	Mobile Network Generations
EBSCO	EBSCOhost Research Databases
Emerald	Emerald Insight Database
ICT4D	Information and Communication Technologies for Development
LMS	Learning Management System
RO1	Research Objective 1
RO2	Research Objective 2
RO3	Research Objective 3
SEM	Structural Equation Modelling
SWOT	Strengths, Weaknesses, Opportunities, Threats
SZCM	SmartZone Compression for Mobile Networks
UI/UX	user interface / User experience
WPR	What's the Problem Represented to be
Yolov3	You only look once version 3
ZOIs	for Zones of Interest
ZPD	Zone of Proximal Development

CHAPTER 1

INTRODUCTION

1.1 Introduction

As digital innovation continues to reshape the landscape of creative education, a critical question arises: Can hypertext video revolutionise the teaching of visual studies, particularly in developing regions where access to advanced educational technologies remains limited and uneven? This study explores the untapped potential of hypertext video as a dynamic bridge between artistic cognition and digital advancement, grounded in the principles of Vygotsky's socio-cultural theory. By promoting a non-linear, interactive learning environment, hypertext video fosters deeper, more participatory engagement with artistic materials. Adopting a qualitative methodology that combines structured case studies with a systematic literature review, this study examines the transformative possibilities of hypertext video within visual education.

Hypertext video is a form of digital art that combines linear video with hypertextual links to transcend passive viewing and foster deeper learning engagement. Unlike traditional educational videos or basic quiz-based interactive formats, hypertext video enables users to interact dynamically with layered content, making decisions, branching into related concepts, and navigating knowledge in non-linear pathways. This medium aligns closely with contemporary practices in digital art, where interactivity, immersion, and narrative flexibility are central. In the context of art and design education, hypertext video functions not only as an instructional tool but also as a creative medium that promotes exploration, critical reflection, and self-directed learning.

The findings highlight those features, such as interactive overlays, adaptive learning pathways, and embedded assessments not only captivate students but also catalyse a shift from passive observation to active artistic exploration, unlocking new realms of creative expression. However, alongside its promise lies a profound challenge: How can hypertext video flourish in educational contexts marked by fragile infrastructure, limited internet connectivity, and pervasive digital literacy gaps? This study addresses these pressing concerns directly, positioning hypertext video not merely

as an innovative instructional medium but as a critical catalyst for expanding access to arts education in under-resourced environments.

By centring learners within an immersive, self-guided educational experience, hypertext video disrupts traditional models of design education and proposes a transformative new paradigm for teaching the visual arts in developing contexts. In doing so, this study contributes meaningfully to the broader discourse on digital aesthetics, multimodal pedagogy, and the evolution of arts education, championing hypertext video as a vital instrument for bridging global disparities in visual studies education.

1.2 Background of Study

Digital education has profoundly transformed the landscape of learning, offering flexible, interactive experiences that extend far beyond the confines of traditional classrooms (Bellal, 2021). As technological innovations continue to evolve, sophisticated digital tools are further reshaping how knowledge is constructed and delivered. Within this dynamic environment, hypertext video-based learning emerges as a pivotal development, enhancing interactivity through non-linear navigation and scaffolded instructional pathways addressing the inherent limitations of conventional video lectures. However, significant challenges related to accessibility persist, particularly within developing regions where socio-economic disparities and technological constraints hinder educational advancement (Webb, 2018).

As digital models increasingly supplant traditional teaching practices, weak infrastructure and unstable internet services in these areas remain critical obstacles (Kelly, Tim and Rossotto, 2012). In the Yemeni context specifically, limited connectivity and a lack of supportive digital policy further restrict the potential of interactive media, making alternative solutions such as hypertext video more practical and sustainable (Ahmed & Md Zaini, 2022).

Even cutting-edge solutions, such as virtual reality and AI-driven videos, often falter where connectivity is unreliable. Against this backdrop, Hypertext video presents a pragmatic and sustainable alternative, combining meaningful interactivity with relatively modest bandwidth demands.

While the term interactive video is broadly used in digital education, it encompasses a wide spectrum of technologies. Hypertext video, as applied in this study,

refers to a specialised form of interactive media that integrates clickable textual and visual elements layered within the video timeline. Unlike conventional interactive videos that may include simple branching logic or embedded quizzes, hypertext video promotes nonlinear navigation, multi-level content access, and active exploration, closely resembling hypermedia systems used in web design. In this context, hypertext video can also be viewed as a contemporary form of digital art, combining linear video with hypertextual overlays to move beyond passive viewing and enhance learner engagement.

This study is based on Vygotsky's socio-cultural theory, which asserts that learning transpires via social contact and directed assistance, particularly within a student's Zone of Proximal Development. Within this theoretical lens, hypertext video functions as both a digital tool and a scaffolding mechanism. In parallel, the concept of digital education in this study refers to creative, flexible learning environments enhanced by technology and no longer confined to traditional classroom structures, making it especially relevant in under-resourced contexts like Yemen.

To further clarify the conceptual distinction between hypertext video and other educational media, this study presents a hierarchical classification of video within digital art. Figure 1.1, illustrates the distinction between interactive and linear video formats and was developed by the researcher (2025). It further highlights subcategories such as hyperlink videos, animation, and AI-based videos under the umbrella of interactive media. The schematic also clarifies that interactive videos function through input and feedback mechanisms, while linear videos are restricted to one-directional output.

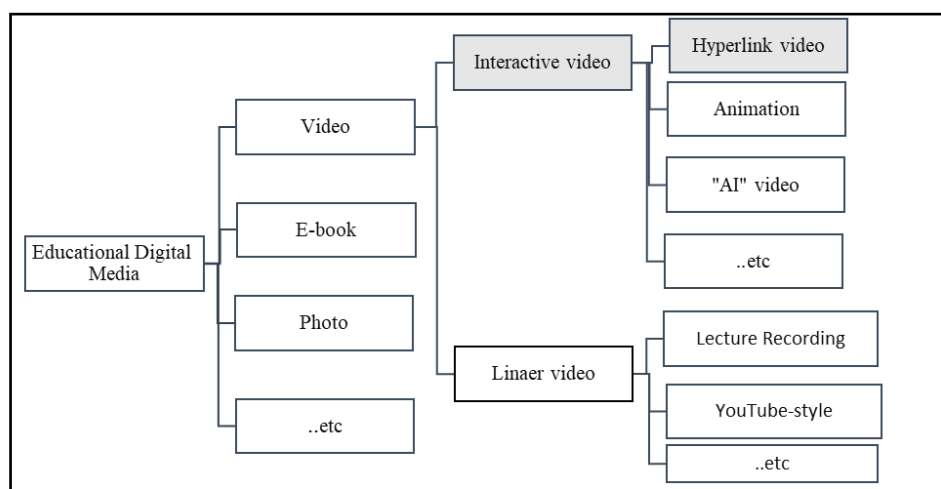


Figure 1.1 Classification of Digital Art Media: Linear and Interactive Video Types

In the realm of Yemeni higher education, particularly within state institutions, the use of organised digital technologies in art and design curricula is still constrained. Teaching methods are still predominantly traditional, and access to interactive resources is scarce. According to Tuparov et al (2015) The preparedness of students for online education in Yemen is deficient due to insufficient infrastructure, restricted internet access, and a lack of institutional support. Given these constraints, hypertext video emerges as a viable alternative. Its layered, low-bandwidth design supports visual learning and enables flexible navigation, making it especially suitable for resource-limited settings and creative disciplines such as colour theory.

In addition to these structural limitations, recent empirical studies confirm the severity of digital access challenges in Yemen. Despite growing interest in e-learning globally, Yemeni universities continue to struggle with basic digital education infrastructure. Ahmed & Zaini (2022) state that “E-learning depends on a strong and fast internet, but Yemen suffers from few and slow internet lines” and that “it is facing many problems and obstacles”. Furthermore, recent reports highlight that families often spend over 30 % of their income on internet costs, severely limiting access to digital learning (Azcoiti, 2024). These findings emphasise the urgent need for low-bandwidth, affordable, and scalable educational interventions like hypertext video-based learning.

The study focuses on applying Hypertext video in the instruction of colour theory within graphic design education. Colour theory, a cornerstone of visual communication, requires both conceptual understanding and practical application. This makes it ideal for exploring the pedagogical value of hypertext video-based learning. Furthermore, the outcomes of this study may extend to related disciplines that also rely heavily on visual literacy, such as typography and composition.

Given its inherently visual nature, colour theory benefits from interactive engagement that promotes active learning; Hypertext video structures allow learners to investigate complex colour interactions dynamically, while simultaneously offering solutions to the digital divide faced by underserved regions. Grounded in Vygotsky’s Zone of Proximal Development, this study examines the ways in which interactivity and visual aesthetics influence student engagement, understanding, and educational accessibility. Notably, the design specifications for educational interactive video components are insufficiently articulated in the current literature (Zhang et al., 2022).

Through the integration of key theoretical and practical domains, including Interactive Video (Hypertext), Digital Aesthetics, Visual Cognition, Arts Pedagogy,

and the challenges faced by Developing Countries, this study proposes a holistic framework that connects academic theory with real-world educational needs.

To address these pressing gaps, this study examines the advancement of digital education through hypertext video-based interactive learning methodologies. Despite the continued expansion of online education, the aesthetic dimensions of interactive video remain understudied (Lee et al., 2025). By focusing on optimising the design elements of interactive videos, particularly in relation to teaching colour theory, this study seeks to enhance both the educational experience and accessibility for marginalised learners.

Employing a qualitative study approach that includes interviews and thematic analysis, the study aims to evaluate the aesthetic benefits of e-learning and offer targeted improvements to interactive video design. Ultimately, this work aspires to empower learners in underserved communities by providing them with access to high-quality Hypertext video interactive educational resources. In doing so, the findings aid in the development of inclusive, engaging, and context-sensitive digital education strategies for students operating within resource-constrained environments.

The interactive video model referenced in this study, as shown in Figure 1.2, which is a screenshot captured by the researcher, showcases three principal elements: (1) a linear video presentation, (2) a visual timeline toolbar displaying frames over the course of the video, and (3) a navigation system utilising multiple-choice questions paired with instructional guidance. These integrated features promote dynamic student interaction with the content, encouraging active engagement rather than passive consumption.

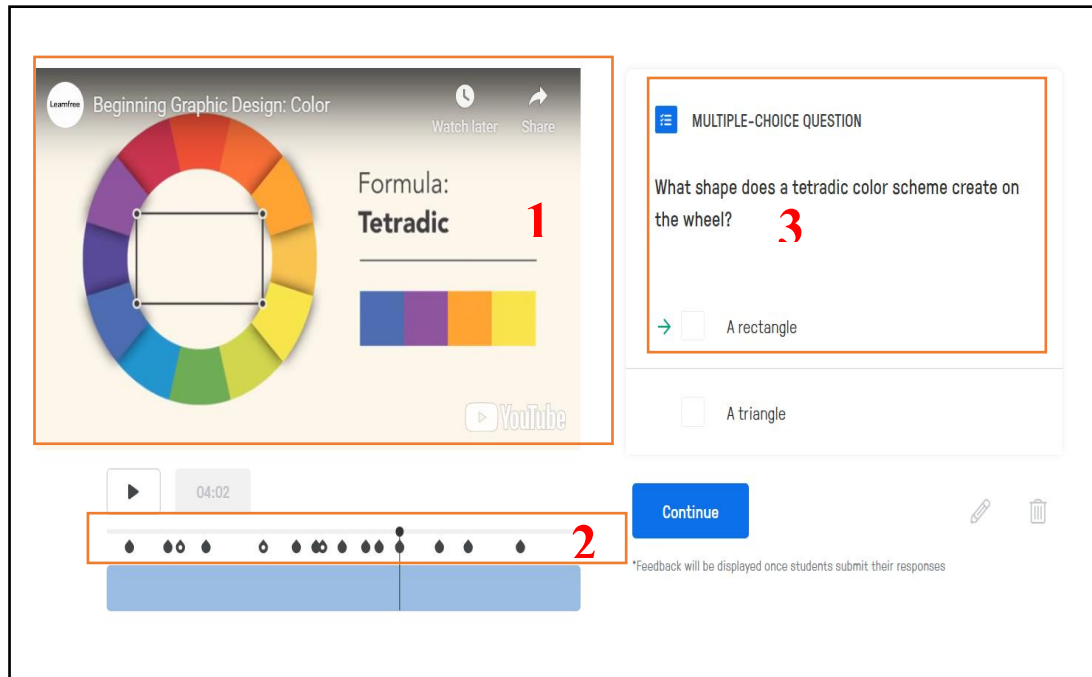


Figure 1.2 Example of an Interactive Hypertext Video Interface with a Toolbar and Multiple-Choice Question

Platforms for interactive video learning, such as the example presented in Figure 1.2, create structured opportunities for learner engagement. The illustrated interface example was documented by the researcher (2025) to demonstrate the integration of interactive toolbars and embedded assessment mechanisms within hypertext video environments. By embedding assessment activities within the video content itself, these systems promote active learning and guide students along personalised, adaptive learning pathways. This instructional strategy is consistent with Hypertext video educational models, fostering deeper cognitive engagement and active participation within digital learning environments.

1.3 Research Problems

The research problem was identified through a critical synthesis of the literature presented in Chapter Two, which revealed interconnected conceptual, contextual, and pedagogical gaps in the field of digital learning and hypertext interactive video in higher education:

1.3.1 Unclear Digital Education Situation in Hypertext Interactive Videos for Learning.

Although Interactive video has increasingly been incorporated into digital education, its pedagogical structure, learning design, and instructional role remain insufficiently defined. Existing studies indicate a lack of consensus on how hypertext structures function within learning environments. Magsalin (2022) and Mukherjee (2018) note that while interactivity is widely emphasised in multimedia learning, its pedagogical interpretation remains fragmented. Similarly, Zhang et al.(2022) observe that current implementations are largely limited to linear, quiz-based video formats, which do not fully support adaptive, exploratory, or scaffolded learning experiences. Recent studies continue to report that many interactive educational video systems remain interaction-light and pedagogically linear, limiting learner autonomy, cognitive engagement, and exploratory learning experiences (Beege & Ploetzner, 2025; Deng et al., 2025).

From a theoretical perspective, scholars such as Adolph (2016) and Bulle (2021) relate educational video to Vygotsky's sociocultural theory, particularly its potential to support learning within the Zone of Proximal Development (ZPD). However, these contributions remain largely conceptual, with limited empirical validation in discipline-specific contexts such as Art and Design education. Moreover, Webb (2018) and Kamil et al. (2020) Highlight that this limitation becomes more critical in resource-constrained environments such as Yemen, where access to structured digital learning tools is still developing. Despite growing interest, there remains a lack of empirically grounded understanding of how hypertext interactive video operates as a pedagogical tool in such contexts.

1.3.2 Challenges of Accessing Digital Education in Yemeni Universities: a case study in a developing country.

Internet penetration in Yemen is estimated at approximately 24%, according to the International Telecommunication Union (ITU, 2023), internet penetration in Yemen is approximately 24%, substantially below the global average.

This limited connectivity, combined with electricity instability and insufficient institutional infrastructure, has hindered the effective adoption of e-learning systems in higher education institutions (Muthanna & Karaman, 2011; AlMunifi & Aleryani, 2021). Furthermore, many universities remain in the early stages of digital transformation, with limited or underdeveloped Learning Management Systems (LMS) (Al-Hattami, 2025). Many universities remain in the early stages of digital transformation, particularly in developing countries where institutional, technological, and financial barriers continue to constrain the effective integration of digital learning systems (Omar & Abdullahi, 2024).

Additional studies highlight broader structural challenges, including chronic underinvestment in educational technology, gender-based access restrictions in certain regions, and low levels of digital literacy among both educators and students, Alshoibi (2019) Although mobile-based and low-bandwidth solutions have been recommended as viable alternatives (Ruiz & Gallagher, 2025; Sam, 2017). There is still a lack of empirically tested, context-specific educational models that address these constraints effectively.

1.3.3 The Absence of a Guiding Framework for Developing and Applying Hypertext Interactive Videos in Education.

Despite increasing interest in digital and interactive learning tools, there remains a lack of structured pedagogical frameworks guiding the design and implementation of hypertext interactive video in education. Existing literature tends to focus on basic interactive formats such as embedded quizzes or annotations, rather than nonlinear, layered hypertext systems that support deeper cognitive engagement (Palaigeorgiou et al., 2019; Wei et al., 2022). Ruiz & Gallagher (2025) argue that the absence of clear instructional design frameworks results in inconsistent application and limited pedagogical impact. This challenge is particularly evident in developing contexts such as Yemen, where instructional innovation must align with technological constraints and contextual realities. Sauli et al.(2018) further emphasise the need for standardised and theory-informed design models to ensure quality, inclusivity, and educational effectiveness in interactive video systems. However, current research lacks an integrated framework that combines pedagogical theory, user experience design, and contextual constraints into a unified model for hypertext-based learning.

Summary of Research Gap

Overall, the literature reveals three interconnected gaps: (1) conceptual ambiguity regarding the pedagogical function of hypertext interactive video, (2) significant structural and infrastructural barriers to digital education access in Yemen, and (3) the absence of a systematic framework for designing and implementing hypertext video-based learning in higher education. These gaps highlight the need for a contextually grounded and empirically informed approach to interactive video pedagogy in resource-constrained educational environments. Therefore, this study seeks to develop a pedagogically informed and locally adaptive framework for hypertext interactive video in Art and Design education in Yemen.

1.4 Objectives

This study aims to investigate the integration of Hypertext video within digital education in Art and Design, with a specific focus on colour theory instruction in Yemen. The following objectives are formulated to directly address the identified research problems and gaps in the literature.

- a) To examine the current state and pedagogical use of hypertext interactive video in digital education, particularly within undergraduate Art and Design programs in Yemen.
- b) To analyse the pedagogical, aesthetic, and technological components of hypertext interactive video in teaching colour theory, based on the experiences and perceptions of students and instructors in Yemeni universities.
- c) To develop and propose a contextually relevant and pedagogically grounded framework for the design and implementation of hypertext interactive video in higher education, addressing the constraints of resource-limited in the context of Yemen.

These objectives provide the foundation for the formulation of the research questions and guide the overall research design.

1.5 Research Questions

To ensure alignment with the research objectives, the research questions were formulated to reflect the conceptual, empirical, and framework-related dimensions of

the study. These questions directly correspond to Vygotsky's socio-cultural theory (1978), as interpreted by Daniels (2008), particularly in relation to the mediating role of cultural and technological tools in learning processes.

The formulation of the research questions was directly informed by the gaps identified in the literature review. Each question was designed to address a specific dimension of the problem: conceptual ambiguity, contextual challenges, and the absence of a guiding framework. The questions were aligned with the research objectives to ensure methodological consistency across all components of the study. Table 1.1 presents the research questions alongside their corresponding research objectives.

Table 1.1
Research Questions and Research Objectives

Problem Statements	Objectives	Research Questions
1. Conceptual ambiguity of hypertext interactive video in education	RO1: To examine the current state and pedagogical use of hypertext interactive video in Art and Design education in Yemen	RQ1: What is the current state and pedagogical use of hypertext interactive video in undergraduate Art and Design education in Yemen?
2. Implementation and experiential challenges in teaching colour theory	RO2: To analyse the pedagogical, aesthetic, and technological components of hypertext interactive video in teaching colour theory	RQ2: How do students and instructors perceive the pedagogical, aesthetic, and technological components of hypertext interactive video in teaching colour theory in Yemeni universities?
3. Lack of a guiding framework for hypertext video design	RO3: To develop and propose a contextually relevant and pedagogically grounded framework for the design and implementation of hypertext interactive video in higher education, addressing the constraints of resource-limited in the context of Yemen.	RQ3: How can a contextually relevant and pedagogically grounded framework for hypertext interactive video be developed and proposed for higher education in Yemen?

The research questions are conceptually aligned with Vygotsky's socio-cultural theory, particularly the mediating role of tools and artefacts in shaping learning processes and knowledge construction.

1.6 Scope of the Study

This study is specifically focused on the integration of hypertext interactive video in undergraduate Art and Design education in Yemen, with a particular emphasis on the teaching and learning of colour theory as a representative subject within design-based disciplines.

The scope of the study is conceptually bounded by three key dimensions: pedagogical processes, aesthetic representation, and technological implementation, which are examined strictly within the context of hypertext interactive video as a learning medium. These dimensions are not treated as separate independent variables but are analysed as interrelated components within the learning experience of colour theory education.

The study is limited to undergraduate students and instructors from selected public and private universities in Yemen. It excludes postgraduate education and all disciplines outside Art and Design. Furthermore, it does not evaluate or compare alternative digital learning technologies such as virtual reality, augmented reality, or gamified learning systems.

Technologically, the study is restricted to hypertext interactive video as the sole instructional medium under investigation, without assessing its comparative effectiveness against other platforms or tools.

Geographically, the research is confined to the Yemeni higher education context, particularly institutions operating within resource-constrained environments characterised by limited internet access and digital infrastructure.

1.7 Significance

This study aims to identify effective approaches for designing Hypertext video learning in undergraduate Art and Design education in Yemen, with a specific focus on colour theory instruction. It investigates how such an approach can enhance pedagogical effectiveness, visual engagement, and accessibility within resource-constrained higher education environments.

The significance of this study lies in its contribution to addressing both pedagogical and infrastructural challenges in Yemeni higher education. In particular, it responds to the limited access to digital learning resources caused by low internet penetration, inadequate institutional infrastructure, and restricted technological readiness in universities.

Furthermore, the study provides a context-sensitive solution for improving learning accessibility among undergraduate students in Art and Design disciplines. While its primary focus is Yemen, the findings may offer insights relevant to other developing contexts facing similar educational and technological constraints.

The study also contributes to bridging the gap between instructional design and visual pedagogy by proposing structured approaches for integrating hypertext interactive video into colour theory instruction. Ultimately, it aims to support the development of more inclusive, engaging, and adaptable digital learning environments in higher education.

1.8 Definition of Key Terms

1.8.1 Hypertext Interactive Video

A form of digital learning media that integrates non-linear navigation, allowing learners to interact with embedded links, layers, and pathways within video content to construct personalised learning experiences.

1.8.2 Digital Education

The use of digital technologies and platforms to facilitate teaching and learning processes, particularly through online or technology-mediated environments.

1.8.3 Colour Theory

A fundamental area in Art and Design education that explores the principles of colour relationships, harmony, contrast, and visual perception in creative practice.

1.8.4 HyperLearnX

A conceptual adaptive hypertext video system developed by the researcher, designed to optimise video-based learning for low-bandwidth environments through structured compression and interactive design principles.

1.8.5 Learning Management System (LMS)

A digital platform used by educational institutions to manage, deliver, and monitor learning content and student engagement.

1.9 Theoretical Framework

This study is grounded in Vygotsky's socio-cultural theory (1978), as interpreted by Daniels (2008), which emphasises the role of social interaction and cultural tools in cognitive development. Central to this theory is the concept of the Zone of Proximal Development (ZPD), which describes the gap between what learners can achieve independently and what they can achieve with guidance.

In this study, hypertext interactive video is conceptualised as a mediating learning artefact that supports learners within their ZPD by providing guided, non-linear, and interactive learning pathways. This allows learners to construct knowledge actively rather than passively receiving information.

The integration of hypertext video within Art and Design education aligns with Vygotsky's view that learning is socially and culturally situated. The interactive structure of hypertext video facilitates scaffolding, exploration, and cognitive engagement, particularly in visually oriented subjects such as colour theory.

Therefore, Vygotsky's framework provides the theoretical foundation for analysing how hypertext interactive video can function as an effective pedagogical tool in resource-constrained educational environments such as Yemen.

1.10 Research Limitations

This study acknowledges several limitations that define the scope of its findings.

1.10.1 Technological Limitations

The HyperLearnX model proposed in this study was not developed as a fully functional or finalised system. Instead, the research focused on conceptual design, including flowcharts, system architecture, and illustrative hypertext video examples presented during interviews to facilitate participants' understanding of the proposed approach. The demonstrative hypertext video used in this study was not optimised for low-bandwidth conditions and does not represent the intended technical performance of HyperLearnX. As a result, the study does not empirically evaluate system efficiency, bandwidth optimisation, or real-time technical performance in low-resource environments.

1.10.2 Subject-Related Limitations

The study was confined to the teaching of colour theory within Art and Design programmes. This deliberate narrowing of the subject scope enabled focused exploration of visual learning processes but limits the direct transferability of the findings to other subject areas or disciplines with different pedagogical and cognitive requirements.

1.10.3 Design and Scope Limitations

This research concentrated exclusively on hypertext video as the instructional medium used to communicate the HyperLearnX concept. Although other emerging educational technologies, such as augmented reality, virtual reality, and gamified learning platforms, were discussed at the conceptual and literature levels, they were not implemented or empirically tested. Furthermore, participant feedback was based on conceptual demonstrations rather than sustained interaction with a fully deployed system, which may influence perceptions of usability and effectiveness.

These limitations should be considered when interpreting the findings and underscore the need for future research to implement, test, and evaluate HyperLearnX as a complete system across diverse technological and educational contexts.

1.11 Conclusion

This chapter has established the foundation of the study by outlining the research problem, objectives, and questions, all of which are grounded in Vygotsky's socio-cultural theory. It has highlighted the key challenges in digital education within Yemen, particularly in relation to limited infrastructure, low internet accessibility, and the lack of structured digital learning frameworks in higher education.

The chapter has also justified the need for investigating hypertext interactive video as a pedagogical tool within Art and Design education, with a specific focus on colour theory instruction. In doing so, it has identified critical gaps in existing literature related to conceptual clarity, contextual challenges, and the absence of a structured implementation framework.

The following chapter will present a detailed review of the relevant literature on interactive video, hypertext learning systems, and their application in educational contexts, particularly within Art and Design education.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter offers a critical review of current research on the use of interactive video in digital art education, providing a thorough examination of its foundational theories, historical evolution, and prospective directions for advancement.

It critically examines the role of interactive video as an educational tool, which has been widely recognised for enhancing learning outcomes, particularly within Art and Design education in low-resource contexts such as Yemen, with particular attention to its application in economically disadvantaged regions. The review highlights essential interactive design elements such as overlays, segmented video chapters, clickable hotspots, and embedded quizzes as key features for enhancing digital learning experiences. Additionally, it underscores the significance of these strategies within the context of developing countries and highlights the methodological approaches employed in the existing literature for designing and implementing interactive video technologies.

To understand the pedagogical value of interactive video, it is essential to examine its conceptual evolution and technical foundations. This sets the foundation for understanding how interactive video, particularly in its hypertext form, can transform pedagogical practices in resource-constrained environments.

2.2 Definition and Evolution of Interactive Video

This section presents a comprehensive review of how interactive video has evolved within the context of digital education, highlighting key study trends, technological gaps, and the emergence of hypertext video as a potential solution.

Interactive video has evolved from a passive content delivery medium into an interactive learning environment that enables user control, feedback, and non-linear navigation. However, despite its recognised pedagogical potential, its structured application in educational contexts remains limited and insufficiently theorised. By enabling features such as clickable elements, branching pathways, and interactive feedback, it redefines traditional video into a personalized and immersive learning

experience (Bai et al., 2024) An advanced form of interactive video is hypervideo, which integrates hyperlinks within visual content to enable non-linear navigation, deliver contextually relevant insights, and connect viewers to external resources, thereby facilitating multi-layered interpretation and deeper knowledge construction (Sauli et al., 2018). To fully grasp how interactive video arrived at its current state, it is important to examine its historical development and scholarly progression.

2.2.1 Historical Evolution of Interactive Video

This section outlines the historical and scholarly development of interactive video in digital education, emphasising gaps in design knowledge and the emerging need for pedagogical frameworks.

Although Sauli et al. (2018) emphasised that numerous scholars have highlighted the urgent need for comprehensive reforms and enhancements in the field. They further observed that only a limited number of studies have addressed interactive video from a technical perspective. As a result, detailed knowledge regarding the design of interactive videos remains scarce, underscoring the necessity for further study to advance understanding in this area.

Interactive video has been widely acknowledged for its potential to enhance educational experiences; however, its application within teaching and study settings remains relatively limited (Poquet et al., 2018). This limited application reflects broader gaps in both theoretical and technical understanding, as highlighted by Poquet et al (2018).

The existing literature on interactive video design in education identifies several critical areas that warrant further research. Sauli et al. (2018) stressed the importance of focusing on key aspects such as selecting or producing effective videos, embedding interactivity, and integrating these materials into instructional frameworks. This prompts an important question regarding how hypertext structures within interactive videos can be optimised to enhance learning outcomes. A critical extension of this argument is that discussion, Palaigeorgiou et al. (2019) and Zhang et al. (2022) observed that limited research has explored the educational effectiveness of different interactive video designs. They emphasised the necessity for further research to uncover the multifaceted instructional potential of interactive video, noting that the limited number of studies in this field, particularly within digital art education, continues to fuel

uncertainty about the role and impact of hypertext interactive videos in advancing digital education.

This gap highlights the lack of clarity regarding how hypertext video is currently used pedagogically, which directly supports the need to investigate Research Question one. Building on this, other scholars have explored platform-related challenges in more depth. Wei et al (2022) contributed to this discourse by advocating for further research into both video content and platform design. They emphasised the critical need to understand how the quality of content and the structure of platforms influence the educational effectiveness of interactive videos. In light of the challenges faced by Yemeni universities in adopting hypertext interactive videos, gaining deeper insights into platform usability, content integration, and the interactive functionalities is crucial for effective implementation. While the preceding section examined the overall development of interactive video, the following explores its specific application within under-resourced educational settings. This contextual shift is particularly critical in understanding how educational innovation can be localised, as seen in the case of Yemen.

Despite the technological and conceptual advancements discussed above, the pedagogical application of hypertext video remains insufficiently defined, and the pedagogical role and structured application of hypertext interactive video remain unclear. This gap directly informs Research Question 1, which seeks to examine the current state and pedagogical use of hypertext video in Art and Design education.

2.2.2 Application in Developing Contexts

This section examines the challenges and contextual limitations facing the implementation of interactive video in developing countries, with a particular focus on Yemen.

Although Zakham et al (2020) stressed the importance of the global community collaborating to develop sustainable solutions for Yemen's ongoing educational challenges. In a related discussion, Nchofoung and Asongu (2022) examined how alternative learning methods, particularly through interactive video, can foster consistent productivity improvements across various income groups and regions. However, despite the growing global attention to digital education, the integration of hypertext interactive videos into learning environments remains limited and poorly

understood, especially within developing contexts such as Yemen. These broader developmental concerns are echoed in localised studies on Yemen's educational context.

In contrast to Mufhanna & Karaman (2011) argued that education policymakers in Yemen have largely neglected the improvement of educational software and the effective implementation of the instructional methods they have proposed. In a similar vein, Webb (2018), A scholar with a particular focus on education in Yemen contended that the development of the country's education system must be carried out in a manner that respects and aligns with local customs and traditions. Nevertheless, significant challenges remain in integrating hypertext interactive videos into Yemeni universities, largely due to the absence of structured digital learning policies and inadequate technological infrastructure. Addressing these challenges is critical for formulating strategies that facilitate the successful adoption of interactive video-based education.

Conversely Webb (2018) further noted that in Yemeni society, universities are often perceived as more essential for men than for women, leading to greater employment opportunities for men, particularly when resources are scarce. This situation underscores the urgent need for accessible, interactive, and adaptable educational strategies, such as hypertext interactive videos that can offer flexible, home-based learning opportunities and contribute to narrowing the gender gap in education. These cultural and institutional dynamics not only influence access but also shape the design considerations for deploying hypertext video tools effectively.

Such institutional and socio-cultural challenges call for innovative and inclusive learning models. Educational institutions, particularly universities in Yemen, urgently require alternative solutions to support home-based education, especially for female students. Saba and David (2020) emphasised that national development strategies should be tailored to the unique needs and contextual conditions of each country. In a related context, AlMunifi and Aleryani (2021) highlighted the importance of addressing educational challenges in Yemen, advocating for greater attention to technical factors that can enhance performance and encourage student engagement with online learning platforms. Nevertheless, despite these calls for customised digital education initiatives, the absence of a clear and systematic framework for designing and implementing hypertext interactive videos continues to hinder their effective integration into educational practices. Beyond technological infrastructure and implementation challenges, the role of hypertext video in creative education warrants special attention.

In order to overcome these challenges, it is crucial to investigate the technological dimensions of interactive video, which the next section explores in detail.

These contextual and infrastructural challenges highlight the need to understand how hypertext interactive video can function within constrained environments, which directly supports Research Question two.

2.2.3 Hypertext Video in Arts and Design

Building on the technological and contextual foundations discussed earlier, this section explores the unique intersection between hypertext video and art and design education, highlighting its pedagogical and aesthetic significance.

Yadav and Williamson (2024) emphasised the ongoing need for research into the role of arts activities in promoting well-being, particularly within conflict-affected areas and disadvantaged communities. They suggested that interactive video presents a valuable tool for advancing arts education by offering structured, engaging, and accessible learning experiences. In particular, Hypertext video formats enable learners to navigate and explore content in dynamic and meaningful ways.

Further, researchers have examined how interactive aesthetics influence deeper cognitive engagement in visual design education. Expanding on this perspective, Jie et al. (2024) Recommended that future studies explore how employing ethnographic approaches and interactive aesthetics can enhance artistic thinking in multimedia design, encompassing different types of interactive video. Likewise, Kolyvas et al. (2024) emphasised the importance of further examining the digital information needs of visual art educators, viewing this inquiry as a vital step toward the meaningful integration of technology into art education practices.

This is supported by other studies that have focused on how digital tools facilitate broader artistic participation and interpretation. In a related context, Rushton and Callow (2018). In their study on the intersection of arts and literacy through mobile learning, they identified various tools that promote reading and participation in the arts. However, Wu et al. (2025) highlighted a limitation in their study, which concentrated on the semantic relationship between text and imagery, overlooking factors such as shape and Colour. These elements, they suggested, may significantly influence the creative process and the visual outcome of artistic work, and should be addressed in future studies to better understand the complexity and diversity of artistic creation.

While several studies have made valuable contributions. Despite growing literature, several critical areas remain underexplored, particularly regarding the educational effectiveness of hypertext video in real-world contexts.

These technical limitations directly relate to Research Question Two, which explores how technological constraints influence the usability and perception of hypertext video in Yemeni universities.

2.2.4 Research Gaps and Future Needs

While several studies have explored interactive video in general, significant research gaps remain in the context of hypertext video design, implementation, and pedagogical effectiveness, especially in resource-constrained environments. This lack of targeted investigation is evident in both technological design and pedagogical application.

In efforts to enhance the effectiveness of interactive video technologies, Tang et al. (2021) noted that integrating video hashing invariant moments could substantially improve platform usability. Furthermore, Zhang et al. (2022) emphasised the need for additional study into the influence of peer feedback within interactive video environments, highlighting interactivity as a pivotal element in determining educational outcomes. Together, these findings underscore the crucial role of Hypertext video engagement features, which empower learners to navigate, explore, and interact with educational content in a more meaningful and dynamic way.

Besides technical concerns, learner-centred interaction has emerged as another underdeveloped area. In addition to platform-level challenges, learner engagement remains underexplored. Nevertheless, Palaigeorgiou et al. (2019) pointed out that most existing solutions predominantly assist teachers in creating annotations, while few studies address how students themselves can be empowered to engage meaningfully with interactive videos. This reveals a notable gap in both technical and pedagogical frameworks, emphasising the need for strategies that actively promote student engagement within hypertext interactive video learning environments. Taken together, these findings indicate a fragmented understanding of hypertext video integration in digital pedagogy.

Collectively, these limitations reveal a fragmented and insufficiently developed understanding of hypertext video integration in education. More importantly, they

highlight the absence of empirically grounded, context-sensitive frameworks capable of addressing both pedagogical and technological constraints in low-resource environments such as Yemen, for systematic study directions. These ongoing gaps collectively signal an urgent need. In summary, existing literature underscores the need for a comprehensive study that goes beyond the design and content of interactive videos to include their technical aspects, all to enhance educational quality. Considering the current ambiguity surrounding the integration of hypertext interactive videos in digital education, along with the challenges encountered in their implementation within Yemeni universities and the lack of a clear guiding framework, there is a pressing need for further investigation. Given the fragmented understanding and infrastructural limitations, such a study is essential for developing structured, scalable, and effective approaches to incorporating hypertext interactive video-based learning into educational systems.

The absence of a structured and contextually grounded framework leads to the formulation of Research Question 3, which focuses on developing a pedagogically informed model.

2.3 Technological Dimensions of Interactive Video

This section examines the technical factors influencing the implementation of interactive video, including video quality, compression techniques, bandwidth requirements, and infrastructure limitations in developing countries.

Even though Chiang et al. (2019) advocated for additional study into video compression techniques, particularly focusing on how file size affects the learning experience. This issue is especially critical in developing contexts such as Yemen, where limited internet infrastructure may significantly impede the effective use of hypertext interactive videos in education.

Video quality plays a critical role in shaping the effectiveness of interactive learning experiences. Factors such as sampling rate, frame quality, and compression directly influence user engagement, particularly in low-bandwidth environments where disruptions such as lag and frame loss can significantly hinder learning continuity, which directly impacts image quality. This is a significant factor contributing to optical disruptions like time freeze and missed frames. Additionally, the quality of the frames within the video itself can affect the overall image, introducing issues such as noise,

blurring, blocking, and ringing. (Murat Tekalp, 2015). One of the core factors influencing video performance is broadband speed.

Broadband Speed: defined by Kelly, Tim, and Rossotto (2012), refers to the amount of data transmitted over a network within a specific time frame, usually measured per second. It is often referred to as the data transfer rate or bandwidth capacity. This rate is crucial for determining the performance of end-user services, as well as for supporting advanced content and applications across the internet. In general terms, broadband speed functions as the essential driver for internet performance and capabilities (Kelly, Tim and Rossotto, 2012).

The digital divide is now increasingly defined by the quality of internet connectivity rather than just its availability, as slower speeds can hinder economic development. In developing countries, the extensive adoption of mobile phones indicates that mobile broadband is likely to play a pivotal role in promoting growth. As more complex applications emerge, broadband standards will need to evolve, with a shift from simply focusing on speed to also considering functionality, particularly in some regions. However, the full economic potential of broadband will remain constrained until there is alignment between supply, demand, and absorptive capacity (Kelly, Tim and Rossotto, 2012). Beyond compression and bandwidth, technical video parameters also matter. Additionally, there are other important factors to consider, such as **frames per second**, since each video second comprises 30 full images, or frames (Strauss, 2000), and the **platform**, which refers to the medium through which internet "video service providers" and television companies present their videos (Cha, 2013), among others.

Low internet speeds and poor network quality pose major challenges to the effective integration of interactive video in educational settings, especially in developing nations such as Yemen. According to reports from Yemen's Ministry of Telecommunication and Information Technology, national internet speeds typically range between 2 and 10 Mbps, a rate inadequate for supporting seamless interactive video streaming. In comparison, Malaysia's national telecommunications provider, Telekom Malaysia (TM), delivers internet speeds ranging from 30 Mbps to 800 Mbps, illustrating a stark contrast in digital infrastructure capabilities (Official Portal Ministry of Communications, 2025; Republic of Yemen, n.d.).

This disparity in infrastructure significantly impedes the adoption of interactive videos in educational settings, highlighting the critical need for enhanced internet services to improve learning experiences and outcomes in developing regions.

2.4 Hypertext Video in Art Education

This section examines the significance and implementation of hypertext video within visual and art education, emphasising how interactive design supports creative expression and visual learning through the example of colour theory.

In understanding the broader educational applications of hypertext video, it is also important to consider its relevance in times of disruption or crisis. The intersection of digital technologies and crises calls for further empirical investigation into how individuals engage with and respond to various crisis-related technological innovations. Watson (2025) contended that additional study on innovation and user behaviour is essential to uncover how sociotechnical imaginaries prioritise particular groups as urgent and how emerging technological frameworks incorporate shared subjective experiences into their development.

This viewpoint aligns with Mack (2024), who advocated for future research focused on aesthetic inquiry within virtual studio education. Mack suggested that future studies should consider the aesthetic dimensions of online studio practices to better understand their impact and potential.

To further exemplify the pedagogical potential of hypertext video in visual disciplines, this study focuses on colour theory as a representative case. This forms a basis for applying hypertext video in a practical, visual subject such as colour theory.

2.4.1 Justification for Using Colour Theory as the Learning Focus

Colour theory, with its inherently visual and interactive qualities, represents an ideal subject for evaluating the educational potential of hypertext video.

Colour theory, with its inherently visual and interactive nature, provides an ideal context for evaluating the pedagogical potential of hypertext video, particularly in supporting visual cognition and interactive learning.

It is adopted in this study as a representative case to investigate pedagogical affordances, particularly those related to interactivity, learner engagement, and visual

cognition. This choice aligns with both student needs and the methodological requirements of testing Hypertext video learning models in art and design education. As a foundational subject in graphic design and visual communication, colour theory requires both conceptual understanding and hands-on application. Unlike theoretical or text-heavy subjects, it demands dynamic visual engagement such as manipulating hues, contrasts, and spatial relationships, which aligns naturally with the capabilities of hypertext video for non-linear exploration and interactive experimentation. Prior studies (Cattaneo et al., 2019; Zhang et al., 2022) recommend that interactive visual tools significantly enhance learner comprehension, especially in disciplines where visual cognition is central. Therefore, by focusing on colour theory, this study seeks to evaluate the impact of hypertext video on strengthening both conceptual understanding and creative production in digital art and design education.

This subject offers unique affordances for evaluating visual, interactive pedagogies in a discipline-specific context. Together, these findings highlight the potential of hypertext video to bridge aesthetic, cognitive, and pedagogical needs in creative education.

However, realising this potential requires addressing the broader technological and contextual limitations, particularly those encountered in under-resourced regions like Yemen, as discussed in earlier sections.

2.4.2 Challenges in Digital Education in Developing Contexts

This section explores the infrastructural, socio-economic, and technological challenges facing the integration of hypertext interactive video in developing countries, with a specific focus on Yemen. These barriers hinder equitable access to digital learning and should be tackled to fully harness the potential of educational technology. Yemen serves as a representative case of the infrastructural and policy-based obstacles common in low-resource environments.

2.4.3 Limitations of Interactive Video Education

While interactive video education offers considerable potential, several critical challenges continue to limit its effectiveness. Accessibility remains a primary concern,

especially in developing regions where socio-economic and technological barriers restrict educational access (Webb, 2018). Fragile infrastructure further exacerbates these challenges, complicating the adoption of digital learning solutions (Kelly, Tim and Rossotto, 2012). In Yemen, the lack of structured digital education policies and insufficient digital tools hinders the development and implementation of interactive video-based learning. Moreover, technical shortcomings negatively influence student engagement and willingness to participate (AlMunifi & Aleryani, 2021).

Wei et al. (2022) Highlight the need for additional research on platform usability and content quality to enhance the effectiveness and long-term viability of interactive video-based education.

These challenges are further exacerbated by significant limitations in broadband infrastructure, particularly in the Yemeni context. To better understand the broader landscape of digital inequity in education, a number of comparative studies have examined structural barriers in various developing nations. Table 2.1 Presents a comparative analysis of selected studies on digital education barriers, outlining critical issues such as access inequality and gaps in digital literacy, while detailing the study objectives, methodologies, and identified limitations of each research. This structured overview provides insight into the evolving landscape of digital education and interactive learning, offering a synthesised comparison of how various studies have approached these complex issues.

Table 2.1

Comparative Analysis of Studies on Digital and Interactive Learning: Issues Related to Digital Education in Academic Literature

Source	Problems & Issues	Objective	Method & Theory	Limitations
(Lynn et al., 2022)	Digital divide Access inequality Digital literacy gaps Outcome uncertainty Institutional challenges	The document examines digital education's role, benefits, equitable access, challenges, and the integration of advanced technologies for improved outcomes.	Human capital theory Socio-cultural theory 21 st -century skills framework	Access inequality Digital divide Measurement challenges Teacher preparedness Outcome uncertainty
(Genç et al., 2025)	The study investigates whether structured digital-based education improves students' understanding and preparedness in digital art practices.	The objective is to assess whether structured Digital education can enhance students' disaster knowledge and preparedness.	Method: randomized controlled trial intervention Theory: Health Belief Model Application	Limited disaster type coverage, low perceived severity reliability, and only one earthquake simulation conducted.
(Ruiz & Gallagher, 2025)	Digital lagging Educational inequity Over-reliance on technological solutions Exclusion of rural imaginaries	The problems are digital lagging in rural Colombian education: insufficient technology, limited connectivity, poor appropriation, and weak monitoring, hindering innovation.	Method: a desk-based, post-structured policy analysis using Bacchi's WPR heuristic and thematic coding. Theory: Socio-technical and educational.	Limitations include a single policy document focus, reliance on desk-based post-structural analysis, and the absence of empirical data.
(Weng et al., 2025)	This study addresses challenges of AI adoption in entrepreneurship education, focusing on	Digital learners note that AI in entrepreneurship education poses	Method: task-based interviews analyzed via thematic SWOT analysis;	Limitations include a single-site, small, age-skewed sample within a specific

Source	Problems & Issues	Objective	Method & Theory	Limitations
	equity, technical issues, and learner engagement.	imprecise information, technical, ethical, and equity challenges.	Theory: frameworks on AI integration in entrepreneurship education.	course context, which limits broader generalizability.
(Al-Hattami, 2025)	Digital accounting education struggles to define the role of digital tools in fostering innovation, influenced by self-efficacy and literacy levels.	This study examines how digital accounting tools promote innovation, considering the moderating effects of technological self-efficacy and digital literacy.	The study employs a quantitative approach using SEM, grounded in self-efficacy and digital literacy frameworks, to examine innovation in digital accounting education.	Limitations include cross-sectional design, self-report bias, region-specific sample, and lack of context in tool usage.

These challenges underscore the importance of evaluating alternative interactive media formats, as discussed in the following section.

2.5 Comparative Analysis of Hypertext Video and Contemporary Interactive Learning Approaches

While other technologies, such as AR/VR, are discussed for contextual comparison, this study is strictly limited to hypertext interactive video as the primary instructional medium.

To better understand the unique position of hypertext video among other instructional technologies, this section presents a comparative perspective involving AR/VR and flipped learning models. Compared to hypertext video, AR/VR environments emphasise immersive sensory engagement, while flipped learning shifts instructional content outside the classroom. Table 2.2 presents a comparative summary of key instructional and technological models, adapted and synthesised by the researcher (2025), highlighting how hypertext video distinguishes itself in terms of interactivity, accessibility, and pedagogical flexibility, particularly in low-resource contexts.

Table 2.2
Comparison of Hypertext Video with Other Educational Media

Feature / Aspect	Hypertext Video	Traditional Video	Interactive	AR / VR-Based Learning	Flipped Classroom
Interactivity	Highly non-linear, with clickable overlays and branching paths (Cattaneo et al., 2019)	Moderate linear with quizzes or branching videos		Very high immersive 3D environments (Radianti et al., 2020)	Depends on pre-class preparation
Navigation Style	User-controlled, hyperlinked sections (Sauli et al., 2018)	Pre-set navigation or quiz-triggered		System/environment-driven (Radianti et al., 2020)	Teacher-planned
Bandwidth Requirement	Low to moderate (Ahmed & Md Zaini, 2022)	Moderate (Kamil et al., 2020)		High	Low to moderate
Device Compatibility	Standard devices (PC, mobile)	Standard devices		Requires headsets/sensors	Standard devices
Pedagogical Flexibility	Highly customizable to the user level and pace	Moderate (Demedts et al., 2024)		High, but less accessible	Depends on in-class engagement
Content Depth & Layering	Multi-level with optional paths and resources	Mostly surface-level or fixed branching		Context-rich but predefined scenarios	Based on the pre-class video quality
Accessibility in Low-Resource Areas	High (Ahmed & Md Zaini, 2022)	Moderate (Demedts et al., 2024)		Low (Radianti et al., 2020)	Moderate

These comparative insights provide a foundation for understanding the theoretical underpinnings of interactive video, as discussed in the next section. To consolidate the preceding discussion on interactive video media and their pedagogical affordances, this section introduces the theoretical frameworks that underpin the study. By situating the study within a socio-cultural paradigm, the following review lays the groundwork for the conceptual framework proposed in this study.

2.6 Relevant Theoretical Frameworks (Vygotsky and others)

This section presents a critical review of the existing literature on the use of interactive video in academic education. A thorough search was conducted across major databases, including Scopus, ScienceDirect, EBSCO, and Emerald, covering publications up to 2025. The search employed targeted keywords such as interactive video, design, aesthetics, arts, Colour, and components. Studies were selected based on strict inclusion criteria, requiring them to focus explicitly on interactive video and to be peer-reviewed, encompassing journal articles, books, patents, and scientific papers. Be published between 2010 and 2025, and be written in the English language. The research problem is examined through insights drawn from prior studies, which also provide key recommendations to guide future scholarly inquiry in this field.

This literature review addresses three fundamental dimensions of video-based interactive education. As depicted in Figure 2.1 These dimensions are: 1) the historical evolution of interactive video in education, 2) the inherent limitations of interactive video within educational contexts, and 3) strategies for effectively embedding interactive video into digital learning environments. Collectively, these elements provide a holistic framework for understanding the impact and potential of hypertext video-based interactive learning.

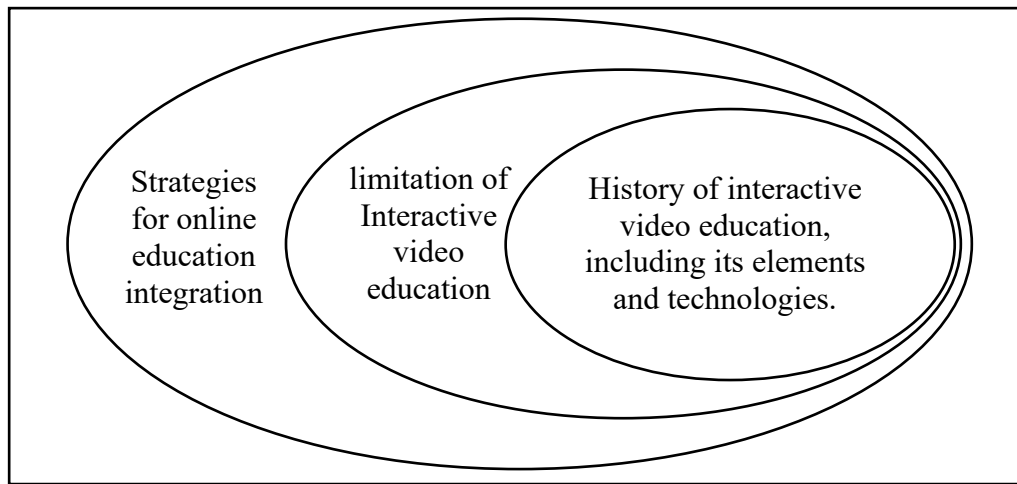


Figure 2.1 Key Aspects of Interactive Video-Based Education: History, Limitations, and Integration Strategies.

As Figure 2.1 illustrates the three principal elements explored in the literature review: the historical progression of interactive video in education, the challenges linked to its implementation, and the strategies for successfully integrating interactive video into digital learning environments.

2.6.1 Interactive Video Versus Linear Videos

Interactive videos distinguish themselves by promoting active viewer engagement, unlike linear videos, which are typically consumed passively from beginning to end without user interaction. Palaigeorgiou et al.(2019) observed that the absence of interactivity in linear video formats often leads to shallow learning and diminished knowledge retention. Although traditional educational videos are widely utilised in digital learning contexts, their passive structure limits learner involvement. As illustrated in Figure 2.2 Linear videos deliver content in a fixed sequence, providing limited scope for meaningful learner interaction. The figure also underscores the structural limitations of such videos, particularly their passive nature and absence of interactive elements that are crucial for deeper cognitive engagement.



Figure 2.2 Example of a Linear Educational Video from UITM

The example presented in Figure 2.2 documented by the researcher (2025), illustrates the limitations of conventional, non-interactive educational videos, where learners engage in passive viewing with minimal opportunities for real-time interaction or embedded feedback. This disconnection between content delivery and assessment often reduces motivation and cognitive engagement. By comparison, Figure 3.4 (Chapter 3) presents a Hypertext video model (Screenshot by the Author using Quizizz, 2025) that integrates assessment and navigation within the learning process, encouraging active participation and deeper conceptual understanding.

This stands in clear contrast to interactive video models that dynamically embed assessment and instructional components within the learning journey itself. Some educational platforms have made efforts to enhance engagement by incorporating assessment questions into the video playback experience. As illustrated in Figure 2.3 This semi-interactive method enables students to respond to questions during the video. Nevertheless, it still falls short of true interactivity, as learners cannot actively manipulate or influence the video's content and structure. Compared to Hypertext video, this approach offers only limited opportunities for learner engagement and flexibility, integrating assessment questions but lacking full interactive functionality, and not accepting low bandwidth.

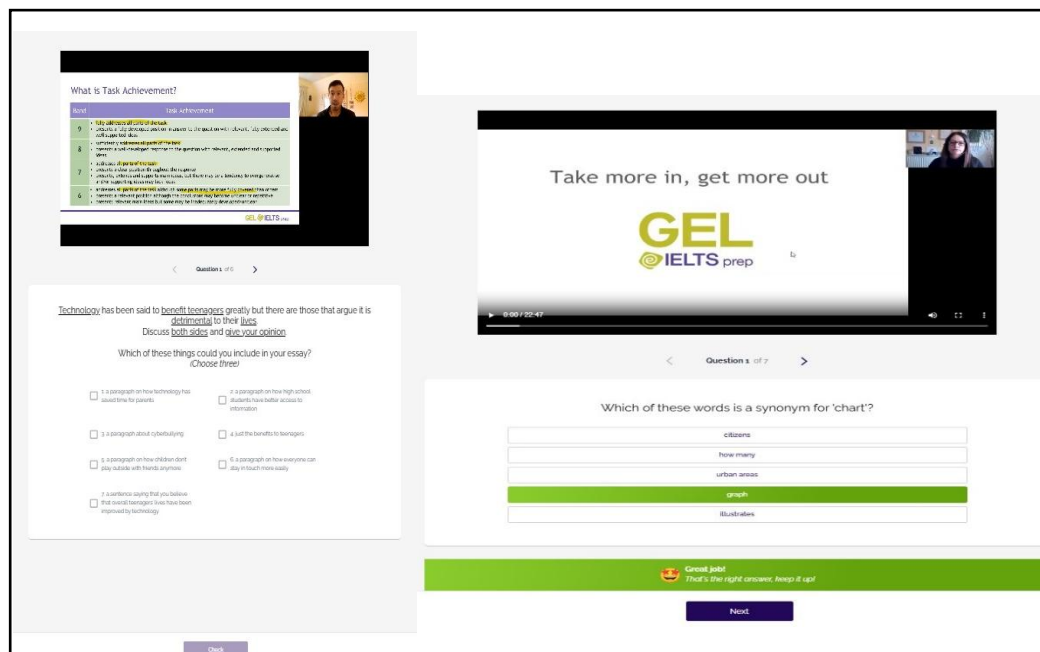


Figure 2.3 Educational Video by British Council with Embedded Assessments

Figure 2.3 illustrates an educational video produced by the British Council, documented by the researcher (2025), which incorporates assessment questions throughout the video. While learners can answer these questions during the video's playback, the overall content follows a linear structure and lacks the depth of interactive features. Unlike Hypertext video, this model does not offer dynamic navigation, personalised learning paths, or tailored feedback. This underscores the demand for more sophisticated interactive video designs that foster deeper engagement and learning.

Interactive videos contribute to improved memory retention and heightened focus by actively engaging viewers with the content (Chakrabarti & Blessing, 2014). Hyper videos advance this concept by integrating video elements with hypertext, enabling dynamic links to additional resources. This integration fosters a richer, more interactive, and immersive learning experience (Cattaneo et al., 2019).

2.6.2 Key areas of Literature Review

The reviewed literature reveals a dynamic intersection between artistic practice and digital educational technologies, emphasising the need to further explore the aesthetic dimensions of interactive video in learning environments.

2.6.2.1 History of Interactive Video in Education

The evolution of interactive video technologies over the centuries has been instrumental in shaping modern digital education. As early as 1734, Louis-Bertrand Castel devised an instrument that synchronised coloured light with musical compositions (Prestage & Peacock, 1988). The advent of video technology marked a turning point, propelling advancements that have led to the current use of interactive videos. These modern tools enhance learner engagement through multimedia integration, personalised learning pathways, and immersive educational experiences (Pan & Lee, 2024).

2.6.2.2 Strategies for Online Education Integration

Implementing interactive video-based education necessitates a departure from traditional, passive modes of learning. As illustrated in Figure 2.2, conventional educational videos typically adhere to a linear format, which constrains learner engagement and limits depth of understanding. Although platforms such as the British Council (Figure 2.3) have integrated embedded assessments, these features offer only a limited degree of interactivity, lacking the capacity for dynamic content navigation. In contrast, Hypertext video incorporates advanced functionalities such as overlays, clickable hotspots, and segmented chapters (Figures 3.4 and 3.5), which facilitate adaptive learning pathways. These elements significantly enhance interactivity and enable the provision of personalised feedback. Platforms like Quizizz exemplify this model, presenting a structured and effective approach to fully interactive video-based educational experiences.

2.6.3 Review of Relevant Theories

This study is informed by Vygotsky's Sociocultural Theory and Activity Theory, both of which emphasise the significance of social interaction and the influence of cultural context on the learning process (Kaptelinin & Nardi, 2012; Tappan, 1997). In comparison with Piaget's cognitive development theory, which conceptualises learning as an internally driven process (Lourenço, 2012). Vygotsky's "outside-in" perspective foregrounds the impact of external, socially mediated influences. Bulle (2021) further

highlights the importance of establishing structured frameworks to effectively support digital learning environments. Drawing upon these theoretical foundations, this study explores the pedagogical potential of hypertext interactive videos, with a particular focus on their applicability within developing country contexts.

2.6.4 Vygotsky Sociocultural Theory

In this study, Vygotsky's sociocultural theory is not only discussed conceptually, but is actively applied as an analytical lens. Learning in art and design is inherently social and mediated through tools and interaction. In this context, hypertext video functions as a mediating tool that guides students through structured exploration, interpretation, and creative meaning-making.

The interactive features of hypertext video (such as hotspots, segmentation, and embedded feedback) are aligned with the concept of scaffolding within the Zone of Proximal Development (ZPD), where learners move from assisted understanding to independent knowledge construction.

Since this study is grounded in socio-cultural, tool-based interaction, a qualitative design was adopted to capture students' lived experiences, perceptions, and meaning-making processes.

Furthermore, aesthetics in this study does not refer to visual beauty, but to structured visual organisation that guides perception, attention, and understanding in interactive learning environments.

Vygotsky's Activity Theory is based on two core concepts: the Zone of Proximal Development (ZPD) and the idea of More Knowledgeable Others. He critiqued the conventional educational system, which he believed contributed to persistent issues within learning communities (Azimi, 2019). Vygotsky viewed the mind as a system of internalised language and emphasised the pivotal role of shared communication in the learning process.

The ZPD represents the gap between what a learner can achieve on their own and what they are capable of accomplishing with suitable guidance. Mediating elements such as scaffolding, language, and educational tools are essential in bridging this gap. Vygotsky's framework aligns with the principles of social constructivism, focusing on three core dimensions: the formation of complex knowledge through language and social conventions, the variability of individual knowledge shaped by collaborative

experiences, and the influence of emotional factors on learning, as suggested by Looker (2021) Educators are encouraged to evaluate both the difficulty of learning tasks and the prior knowledge of students before facilitating collaborative learning experiences. Vygotsky also made influential contributions to social theory, especially in articulating the relationship between thought and speech. His ideas are often represented through mediation models that illustrate how meaning is constructed.

The relationship between word meaning and cognitive development is illustrated through the triangular mediation model shown in Figure 2.4 and Figure 2.5 (Daniels, 2008). Figure 2.4 presents an adaptation of Vygotsky's Social Development Theory, as interpreted by Pulido et al. (2021), emphasising the social and communicative foundations of learning. Figure 2.5 extends this concept by presenting a conceptual framework for the design and study of interactive video as a contemporary form of artistic and educational expression, drawing on the foundational ideas proposed by Le Blanc and Singer (1976). Together, Figure 2.4 and Figure 2.5 Highlight Vygotsky's mediation model and its relevance in enhancing student learning through interactive video.

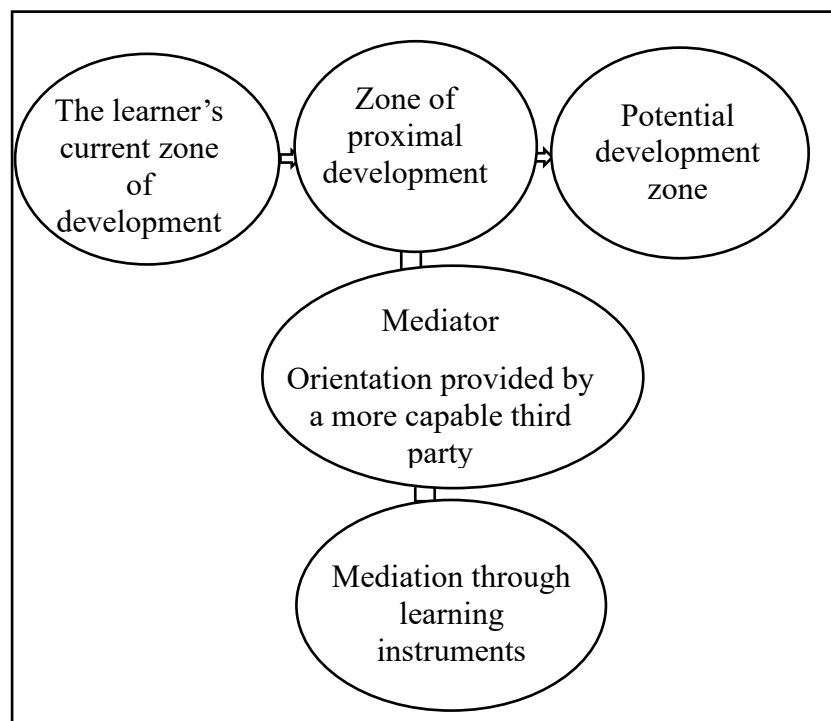


Figure 2.4 Vygotsky's Social Development Theory

(Pulido et al., 2021,p.27)

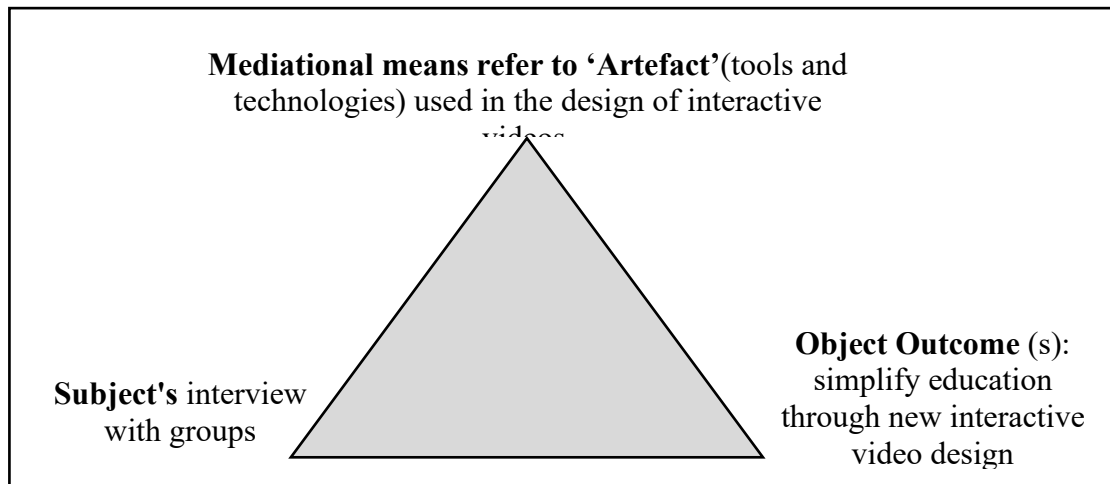


Figure 2.5 Triangular Mediation Model in Vygotskian Theory
(Daniels, 2008; Le Blanc & Singer, 1976)

Vygotsky emphasised the importance of analysing word meaning as a central unit of psychological inquiry, linking emotional experience and practical activity to broader socio-historical contexts. Central to his theory is the concept of mediation, particularly through the use of language as a cultural tool for communication. He stressed the need to distinguish between the various ways in which artefacts are employed to serve different functions, a concept further developed in Daniels’ typology (2008).

This aligns with Vygotsky’s notion of tertiary artefacts and connects to schema theory within cognitive psychology (Battista, 2017).

Overall, Daniels (2008) suggests that artefacts can fulfil a wide range of purposes depending on how they are applied within mediated activity.

In the context of digital art and design education, these artefacts extend beyond linguistic tools to include multimedia elements such as interactive videos, hypertext links, and visual interfaces. Such tools mediate creative cognition by enabling learners to explore, construct, and reinterpret meaning through multimodal artistic engagement.

Vygotsky’s sociocultural theory has been widely applied in digital learning contexts, particularly in studies that emphasise mediated interaction, collaborative learning, and tool-based knowledge construction, making it highly relevant to hypertext video-based learning environments.

Expanding upon this theoretical framework, Table 2.3 introduces a functional typology of artefacts within interactive video environments, demonstrating how these

artefacts can be employed to identify, interpret, and anticipate object behaviours as well as possible future outcomes.

Table 2.3
Functions Typology of Interactive Video Artefacts in Digital Education (Daniels, 2008, p.11)

Question	Artifacts	Function
What	interactive (hypertext)	Identification and description of objects
How	video	Employed to direct and guide activities and interactions occurring on, within, or between objects.
Why		Utilised to analyse and explain the evolution and behaviour of object properties.
Where		Applied to anticipate future states or potential developments of objects, including social systems and institutions.

This study investigates the interactive components of hypertext videos in Art and Design education, exploring their role in enhancing learning and the challenges related to their implementation in Yemeni universities. Furthermore, it considers the need for a structured framework to enhance their development and application, ensuring alignment with the educational context and technological limitations in Yemen. The study questions are as follows:

1. What is the current state and pedagogical use of hypertext interactive video in undergraduate Art and Design education in Yemen?
2. How do students and instructors perceive the pedagogical, aesthetic, and technological components of hypertext interactive video in teaching colour theory in Yemeni universities?
3. How can a contextually relevant and pedagogically grounded framework for hypertext interactive video be developed and proposed for higher education in Yemen?

HyperLearnX was not intended to replace human interaction, but rather to support mediated and scaffolded learning experiences under resource-constrained conditions. In line with Vygotsky's sociocultural perspective, the system was conceptualised as a guided learning support tool that facilitates learner engagement, interaction, and reinforcement through embedded prompts and interactive navigation.

2.7 Digital Education Strategies and Study Framework

Sauli et al. (2018) argue that Yemen, along with other developing nations, urgently needs advanced technological solutions that are specifically adapted to environments with limited technological infrastructure. They highlight the importance of leveraging interactive videos to support educational advancement, particularly within university contexts where the integration of educational technologies remains minimal. This underscores the necessity for affordable, accessible, and context-sensitive digital tools capable of narrowing the educational digital divide.

Pan and Lee (2024) underscore the critical need for studies that explore the aesthetic dimensions, emotional impact, and social interactions associated with interactive video design. They call for further inquiry into the creative production of multimedia content and the accessibility of digital educational materials, aiming to enhance our understanding of how digital aesthetics intersect with human perception in learning contexts. Advancing study in this domain could yield important insights into the potential of interactive videos to enrich and transform educational experiences.

Furthermore, Mack (2024) emphasises the continued need for study into the challenges surrounding the identification and accessibility of shared socio-material artefact creation within online learning environments. Addressing these concerns is essential for understanding how interactive technologies can foster more inclusive educational experiences and support equity across diverse socio-economic backgrounds.

However, these studies remain largely conceptual and lack empirical validation in real-world educational contexts.

In a related context, Wilkie (2024) advocates for deeper exploration into collaborative student engagement within artistic projects, proposing that such experiences may serve a crucial role in fostering both creativity and emotional well-being. This points to a valuable direction for future research, particularly regarding how interactive video technologies might act as catalysts for stimulating creative thought and supporting emotional development in educational contexts.

Furthermore, Hu et al. (2024) emphasise the increasing significance of promoting emotional analysis in video-based content, particularly in the context of short-form media. Gaining a deeper understanding of how viewers emotionally respond to video materials can offer valuable insights into the ways emotions influence learner

engagement, academic performance, and the overall impact of educational interventions.

While prior research highlights the benefits of interactivity, it fails to address implementation challenges in low-bandwidth environments.

Looking ahead, future research should place greater emphasis on enhancing the design and application of interactive video in educational settings (Hu et al., 2024). Key areas of focus should include improving accessibility, elevating aesthetic quality, fostering collaboration, and deepening emotional resonance. Progress in these domains can significantly contribute to more inclusive, stimulating, and effective pedagogical practices, especially in developing countries and other In a related context, challenged environments.

To support this investigation, a conceptual framework has been developed that integrates Vygotsky's sociocultural theory with core principles of hypertext video-based interactive learning. This framework identifies how specific interactive video features, such as overlays, segmented video chapters, clickable hotspots, and embedded assessments, contribute to student engagement and improved learning outcomes in digital education.

The conceptual framework presented in Figure 2.6 is developed directly from qualitative data analysis. The framework construction followed a systematic process, beginning with the identification of key themes derived from interview data. These themes were then grouped into meaningful conceptual clusters, which were subsequently translated into design principles aligned with learning theories, particularly Vygotsky's sociocultural theory. The framework integrates three core dimensions: aesthetic mediation, teaching guidance, and creative design response. These dimensions are operationalised into structured design components within the HyperLearnX framework, including structured visual design, guided interaction, and constraint-based design. To support implementation, the ADDIE model is incorporated as a procedural layer, guiding the application of the framework from analysis to evaluation. This ensures that the framework is not only conceptual but also applicable in real educational settings.

The study conceptually aligned with selected ADDIE phases. The Analysis phase focused on identifying learner needs and contextual challenges related to low-bandwidth educational environments in Yemen. The Design phase informed the structure of the interactive hypertext video and its pedagogical features, while the

Development phase involved the creation of a conceptual prototype for qualitative exploration. Full implementation and summative evaluation were beyond the scope of the present study.

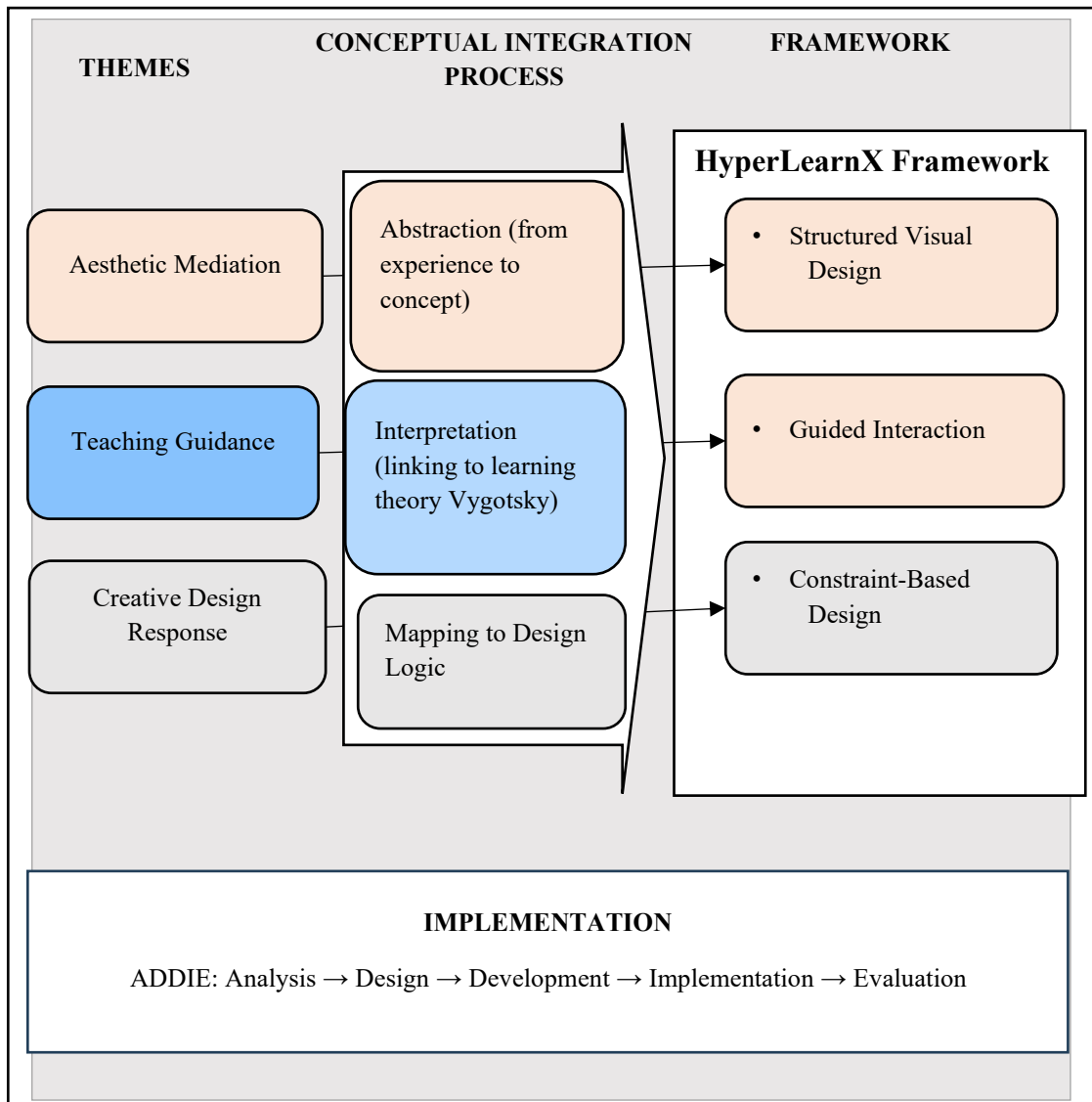


Figure 2.6 HyperLearnX Design Framework for Hypertext Video-Based Learning

This study proposes the HyperLearnX Design Framework, a data-driven and pedagogically grounded framework.

The evaluation of the proposed framework will be conducted through qualitative analysis of participant responses, focusing on usability, engagement, and perceived learning effectiveness. The findings will be interpreted using thematic analysis, guided by the conceptual framework and Vygotsky's theoretical principles.

2.8 Conclusion

Interactive video has been widely recognised for its potential to enhance learning outcomes, particularly within Art and Design education in low-resource contexts such as Yemen.

Most existing studies focus on general education, with limited attention to visually intensive disciplines such as Art and Design.

This literature review demonstrates that while interactive video has strong potential to enhance engagement and knowledge retention, its application in Art and Design education, particularly in low-resource contexts, remains underdeveloped and insufficiently explored. Previous studies consistently demonstrate that interactive videos enhance student engagement and improve knowledge retention. However, there is a notable gap in studies exploring the aesthetic features and usability of these videos in educational settings.

Future research should prioritise the development of visually engaging interactive videos and evaluate their effectiveness in digital education, particularly in resource-constrained contexts such as Yemen.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This study adopted an interpretive qualitative methodology to examine the integration of hypertext video-based interactive learning in the teaching of colour theory within Graphic Design. Employing qualitative approaches such as semi-structured interviews, focus groups, and direct observations, the study investigated the artistic and instructional value, user experiences, and implementation challenges of hypertext interactive videos, with particular attention to the higher education context in Yemen.

The study incorporated the perspectives of a broad spectrum of stakeholders ranging from interactive video designers and technical specialists to academic instructors, students, and governmental representatives. Their diverse insights were instrumental in examining the creation, deployment, and institutional acceptance of hypertext-enhanced learning in resource-constrained educational environments.

Thematic analysis was conducted using NVivo software, facilitating the detection of recurring patterns and meaningful insights in participants' responses. This analytical process enhanced data organisation, transparency, and interpretive depth. The primary aim was not to develop a grounded theory but rather to generate a practical, context-sensitive design framework that enhanced the effectiveness and inclusivity of interactive learning in developing countries, with a focus on design education.

3.2 Research Design

This study adopted a qualitative methodology designed to gather in-depth insights from a broad spectrum of participants, including interactive video developers, technical experts, academic lecturers, students, and officials from universities, ministries of higher education, and relevant educational bodies. Semi-structured interviews were employed as the main method for data collection, capturing qualitative information related to participants' academic experiences, technical challenges, and perceptions of interactive video use. The interviews were carried out through various

digital communication platforms, including Google Meet and Zoom, WhatsApp, or phone calls, depending on the preferences of each participant, with all sessions recorded to ensure data accuracy and reliability.

Participant feedback played a central role in shaping the direction and findings of the study. The ultimate goal was to propose a tailored framework for educational interactive video development that was responsive to the specific needs of developing countries, promoting both accessibility and contextual relevance for academic institutions and learners.

This chapter outlined the study methodology and clarified its purpose and the analytical structure underpinning the investigation. The study was guided by the ADDIE instructional design model, Vygotsky's sociocultural theory, and core elements of interactive video design to identify practical features that could effectively address the challenges facing digital education systems.

3.2.1 Qualitative Method

Qualitative study recognised the existence of multiple realities and the critical role of social construction in shaping meaning. It prioritised representing participants' viewpoints authentically and accurately (Lietz et al., 2006). While qualitative analysis incorporated scientific rigour, it also drew upon creativity, innovation, and interpretive imagination, essential elements for understanding the complexities of educational interactions (Sandelowski, 1995). This study adhered to systematic inquiry principles. To ensure the credibility, trustworthiness, and methodological rigour of its findings, this study followed systematic inquiry principles that were grounded in an interpretive qualitative paradigm, emphasising the co-construction of meaning through participants' lived experiences and contextual understanding.

3.2.2 Research Questions and Instrumentation

The research questions guiding this investigation were rooted in Vygotsky's theoretical framework and were closely aligned with the qualitative study approach. Interviews, focus groups, and observations served as key qualitative methods for examining the challenges and possibilities associated with implementing hypertext

interactive video-based learning within Yemeni universities. Participants were intentionally chosen based on their involvement in the development, deployment, and use of interactive video technologies in educational contexts. To promote rich and flexible dialogue, the research questions were adapted to suit each participant group, allowing for nuanced exploration of contextual dynamics. A comprehensive set of interview questions was included in Appendix A for further reference.

The interview questions were initially developed in English and subsequently translated into Arabic to accommodate participants' linguistic preferences. A back-translation process was conducted to ensure conceptual equivalence between both versions. This procedure was essential to preserve the validity and clarity of meaning across languages. The bilingual interview protocol was provided in Appendix C.

The interview questions were developed based on the study objectives, research questions, and relevant literature on interactive learning and hypertext video.

3.2.2.1 Expert Validation and Conceptual Review

The HyperLearnX content structure, interface logic, and interactive components were reviewed by academic specialists and expert participants in educational technology and digital learning design to ensure alignment with the study objectives, research questions, and pedagogical requirements of colour theory instruction within low-bandwidth learning environments. The review process was based on the conceptual framework and demonstrative hypertext-interactive video examples presented during the study sessions. Feedback obtained from this review contributed to refining the clarity, usability, contextual suitability, and instructional coherence of the proposed framework.

3.3 Research Sampling

This study adopted a qualitative strategy, utilising semi-structured interviews, focus groups, and observations to collect detailed insights from a range of stakeholders. A targeted sampling strategy was implemented to identify participants with relevant expertise or experience in the design, implementation, or use of hypertext interactive videos in educational contexts. Participants were selected based on predefined inclusion

criteria, such as active involvement in digital education initiatives or policymaking, to ensure relevance and diversity of perspectives.

A purposive sampling strategy was employed to select participants with relevant expertise and experience in digital education and interactive video. This approach ensured that data were collected from information-rich cases capable of providing deep insights into the research problem.

This section drew on data collected from 35 participants representing four key groups within Yemen's art and design education ecosystem. The sample included 6 government officials, 5 university academicians, 11 interactive-video developers and technical experts, and 19 university students, including those who participated in individual interviews and focus-group discussions. It should be noted that some participants occupied multiple professional roles (for instance, lecturer–technologist or academic–policy actor); therefore, the categorical counts reflected functional roles rather than mutually exclusive participant totals.

Since the study adopted a reflexive thematic analysis approach rather than statistical comparison across stakeholder groups, overlapping functional roles were interpreted contextually rather than quantitatively. Therefore, role multiplicity did not affect the interpretive validity of the themes.

A total of 35 participants were involved in the study, organised into two focus groups and individual in-depth interviews as follows:

The government officials included 3 participants in a Focus Group to discuss regulatory and policy perspectives, while the remaining 3 officials participated in individual in-depth interviews. Among university students, 15 participated in a Focus Group to examine user experience, accessibility, and engagement with hypertext video-based learning, and 4 students were interviewed individually to provide detailed personal insights. Creators and technicians of interactive videos, including technology experts and designers, were interviewed individually to explore technical challenges, design considerations, and strategic factors in implementing interactive video technologies, accounting for 11 participants. Finally, 5 lecturers and educators were engaged in individual interviews to examine their teaching practices, the challenges they faced, and effective strategies for applying interactive videos in educational contexts.

Comparative interpretation was therefore conducted thematically rather than statistically to avoid misleading quantitative representation of overlapping professional roles.

3.3.1 Inclusion and Exclusion Criteria

The inclusion criteria for participant selection were as follows:

- a) Participants had direct experience with digital education or interactive video.
- b) Participants were involved in teaching, development, or policy-making roles.

The exclusion criteria included:

- a) Individuals with no prior exposure to digital learning environments.
- b) Participants who were unable to meaningfully contribute to the research questions.

Focus groups encouraged dynamic exchanges among participants, allowing them to share experiences, debate ideas, and build upon each other's viewpoints (Lietz et al., 2006). This interactive setting enriched the depth and breadth of data, often revealing perspectives that might not surface through individual interviews. The study involved the following groups of participants:

3.3.1.1 Creators and Technicians of Interactive Videos

This participant group included technology experts and designers involved in the production and development of interactive videos. Their expertise offered valuable perspectives on the technical challenges, industry benchmarks, and strategic factors that shape the use of interactive videos within educational settings. While their primary focus was on the structural and operational aspects of interactive learning technologies, they also provided insights into aesthetic considerations, particularly when these influenced user engagement and educational effectiveness. Participants in this group were interviewed individually to allow for in-depth exploration of technical and design-related topics.

3.3.1.2 Academicians

Lecturers, as primary facilitators of interactive learning, played a central role in incorporating interactive videos into their teaching practices. This study aimed to explore their experiences, the challenges they encountered, and the effective approaches they employed when designing and applying interactive videos in educational contexts. These contributions offered essential context for identifying strategies to strengthen the impact of interactive videos, particularly within a digital learning framework informed by Vygotskian principles. Data were collected through individual interviews to capture detailed insights from their teaching experiences. Participants engaged in a combination of Focus Groups and individual interviews, allowing for both interactive discussion and in-depth personal insights into their experiences with hypertext video-based learning.

3.3.1.3 University Students

Students, as the primary beneficiaries of interactive video-based learning, were central to assessing its educational impact. Their engagement levels, feedback, and overall learning experiences provided first-hand insights into the usability and pedagogical effectiveness of hypertext video-based learning. This study explored students' perceptions of hypertext video, examining how they interacted with these tools and evaluating their accessibility, engagement quality, and contribution to their educational development.

3.3.1.4 Government Officials

Government officials, as key policymakers, were instrumental in shaping the landscape of digital education. Their involvement in this study offered valuable insights into the regulatory frameworks, policies, and infrastructure challenges that influenced the adoption of interactive videos in higher education. Through semi-structured interviews, their perspectives were explored, focusing on aspects such as platform accessibility, content regulation, and digital learning policies. This inclusion facilitated a thorough understanding of the wider educational landscape and its implications for the implementation of interactive learning technologies. Participants engaged in a combination of Focus Groups and individual interviews, enabling exploration of both

collective and individual perspectives on policy-level considerations and regulatory frameworks.

3.4 Data Collection Methods

To achieve an in-depth understanding of the research problem, this study employed semi-structured interviews, focus groups, and direct observations. These methods were intended to explore participants' experiences, perceptions, and interactions with hypertext video tools in real-world educational settings.

Online video communication tools such as Google Meet, WhatsApp, and Zoom were utilised for remote interviews, offering flexibility and ensuring accessibility for all participants. With participants' informed consent, all interviews and focus group sessions were recorded to support accurate and rigorous data analysis.

This qualitative approach aimed to produce detailed, contextual insights that directly contributed to the creation of a practical, context-aware framework for implementing hypertext interactive videos in higher education, especially in under-resourced environments such as Yemen.

In addition to primary qualitative data collected from participants, supplementary documents such as official government statements, educational policy reports, and precedent case studies were consulted where relevant. These materials served as contextual references to support and enrich the interpretation of findings, rather than as primary data sources. Each interview lasted approximately 30 to 60 minutes and followed a structured procedure, including an introduction, a demonstration of the sample hypertext video, and a guided discussion based on the interview protocol. In total, two focus group sessions and multiple individual interviews were conducted across all participant groups.

3.4.1 Ethical Approval and Compliance

Formal ethical approval for this study was obtained from the UiTM Research Ethics Committee under the code REC/08/2025 (PG/MR/474). All interviews, focus groups, and interactions were performed following UiTM ethical guidelines and stipulated conditions in the approved protocol. All participants provided informed consent and agreed for their real names to be used as part of the study.

Detailed documentation of the data collection process, including ethical approval, participant profiles, bilingual interview transcripts, and expert validation procedures, is presented in Appendix D to ensure procedural transparency and auditability.

All participants expressly requested or consented to the disclosure of their real names, professional identities, institutional affiliations, and political positions for attribution purposes. Such disclosure was permitted only after obtaining explicit written informed consent in accordance with the approved ethical procedures. In addition, some participants represented multiple professional categories; therefore, categorical frequencies may overlap, while the total number of individual participants remained 35.

3.5 Data Analysis

Data from semi-structured interviews, focus groups, and observations were analysed using Braun & Clarke's (2006) six-phase thematic analysis, selected for its flexibility and alignment with the study's interpretive qualitative approach, allowing for the identification of patterns and insights across diverse participant perspectives. Analysis started with familiarisation, involving repeated reading and annotation of transcripts to gain an initial understanding. During the coding phase, meaningful segments were labelled using NVivo software.

These codes were then examined and grouped into potential themes reflecting key concepts, experiences, and challenges related to hypertext interactive video-based learning.

During the theme review and refinement stages, codes and themes were compared across participant groups to ensure analytical consistency, coherence, and alignment with the research questions. The final themes were clearly defined and labelled, with representative quotes selected to substantiate the interpretation.

Throughout the process, attention was paid to ensuring rigor through strategies such as triangulation across data sources (educators, students, technicians, and policymakers), member checking where feasible, and maintaining a detailed audit trail within NVivo. This approach allowed the study to reflect the complexities of the educational and infrastructural context of Yemen while ensuring transparency and trustworthiness in the interpretation of findings.

The thematic analysis resulted in several key themes, namely Pedagogy, Interactivity, and Aesthetics, which informed the development of the proposed design framework. These themes are presented and discussed in detail in Chapter 4, where they are further analysed and translated into the components of the proposed design framework. In addition, the interview protocol and emerging themes were reviewed by an expert in the field of educational technology to enhance the validity of the findings. Feedback from the expert was used to refine the structure and clarity of the research instruments and analytical categories.

3.6 Design framework methodology

This study employed a systematic interpretive qualitative methodology to investigate the educational impact of hypertext video-based interactive learning and entailed gathering data via semi-structured interviews, focus groups, and observations from a range of stakeholders, including experts, educators, students, and government officials.

As depicted in Figure 3.1, the study framework outlined the major study phases, encompassing data collection, participant selection, thematic analysis, and validation processes. This structured design ensured a holistic investigation of the key components of hypertext video and their pedagogical relevance in digital education, particularly within developing country contexts. It illustrated the structured qualitative methodology framework adopted for this study, which delineated the key research phases, including participant selection and data collection. Data were gathered through a combination of semi-structured interviews, discussions in focus groups, and direct observations. The figure further depicts how thematic analysis was performed using NVivo software and the subsequent development of a practical framework informed by the participants' insights and contextual findings.

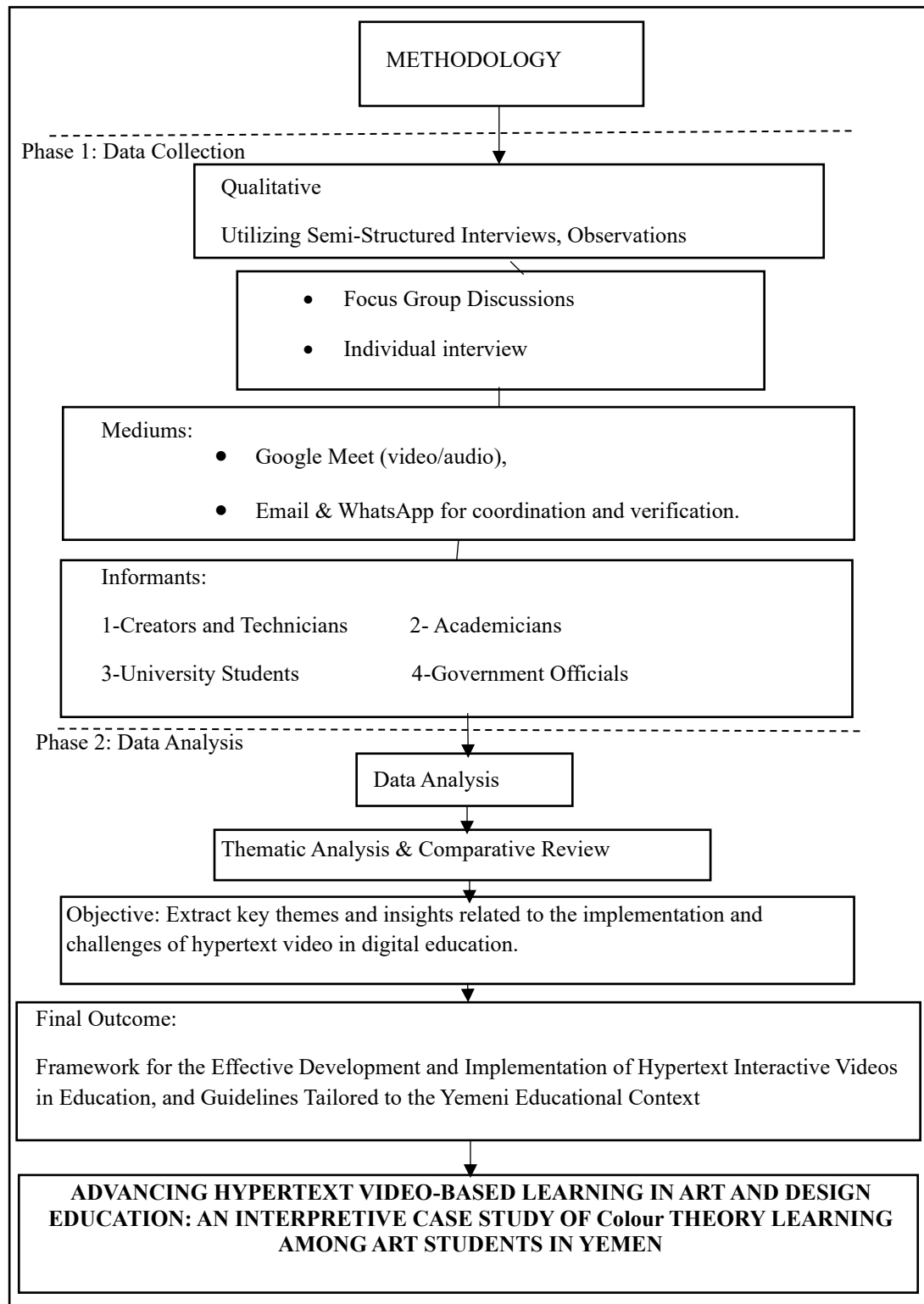


Figure 3.1 Methodology Framework for Research on Hypertext Video-Based Learning

This study applied the ADDIE model, which ensured that each phase of the process was interconnected and built systematically upon the previous one. The model

comprised five key stages: Analysis, Design, Development, Implementation, and Evaluation. This progression was visually represented in Figure 3.2

In this study, the ADDIE model was not applied as a full instructional cycle. Instead, it was used as a guiding framework to structure the development of the proposed design model. The study focused primarily on the Analysis and Design phases, while the Development phase remained at a conceptual prototype level. The Implementation and Evaluation phases were not fully executed, as the study aimed to explore perceptions and inform framework development rather than test a complete curriculum.

DEVELOPMENT	ACTIVITY	OUTPUT
Analysis	Identify problem statement Define objectives Define the scope of the research.	A clear problem statement Specific research objectives Defined research scope
Design	Prepare and conduct participant interviews. Design HyperLearnX system (copyrighted)	Flowchart/blueprint of hypertext video components Design specifications / reliable reference
Development	Develop a hypertext interactive video framework. Build interactive video prototypes (overlays, chapters, hotspots, quizzes) Pilot test / assess framework effectiveness	Framework model for hypertext video Working video prototypes Pilot evaluation report
Implementation	Conduct training workshops & forums, Deploy HyperLearnX in real academic settings, and monitor usage & collect qualitative feedback	Workshops delivered Pilot implementation Field usage report + quotes
Evaluation	Conduct interviews & focus groups to collect qualitative feedback Analyse data for themes related to interactive features & learning experience	Evaluation report with themes & insights Recommendations addressing low-bandwidth constraints (compression, access, training) Assessment of awareness among students & educators.

Figure 3.2 Framework of the ADDIE model (Kamil et al., 2020, p.892)

The inclusion of policy-level participants guaranteed that the resulting framework was academically sound as well as practically feasible within the institutional landscape of countries like Yemen. In addressing the infrastructural and technical limitations identified in the Yemeni context, this study moved beyond the evaluation of existing platforms by proposing an integrative, locally adaptable solution. The following section outlines how the incorporation of innovative technologies and engagement with local developers could support the practical implementation of the framework.

The study design adopted for this study followed a clearly structured methodology, ensuring a systematic and thorough investigation into hypertext video-based interactive learning. As depicted in Figure 3.3 The design mapped out the critical phases covering the study process, including participant selection, data collection through interviews, and the subsequent analysis of gathered findings. This systematic approach enabled a comprehensive understanding of the challenges and opportunities associated with implementing hypertext video technologies in digital art education, with a particular focus on the context of universities in Yemen.

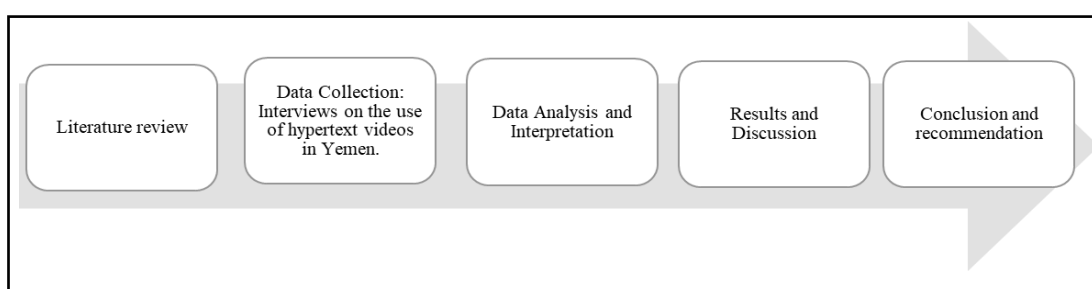


Figure 3.3 Research Design

3.6.1 Integration of HyperLearnX and Local Technical Expertise

In addition to analysing existing interactive video tools such as Edpuzzle, Quizizz, and YouTube Hyperlinks, this study proposed a novel direction by incorporating HyperLearnX, a lightweight, AI-enhanced compression system, currently under patent application. This innovation was specifically designed to optimise the delivery of high-quality hypertext videos in low-bandwidth contexts.

HyperLearnX utilised adaptive compression to minimise file sizes by intelligently reducing non-essential video segments while preserving instructional quality. This feature addressed a core infrastructural limitation in Yemen, where limited broadband capacity continued to hinder access to rich media content.

Rather than prescribing a rigid implementation pathway, the study invited local software developers and platform engineers who were also part of the interview participant pool to co-create context-specific technical solutions. These stakeholders were introduced to the HyperLearnX model and were asked to evaluate its feasibility for integration into locally developed educational platforms. Through this participatory approach, the study aimed to promote bottom-up innovation while fostering technological self-sufficiency in Yemeni universities.

Furthermore, the framework encouraged universities to engage in partnerships with non-profit organisations, educational technology providers, and international donors to facilitate infrastructure support and professional training for lecturers. This collaborative strategy ensured that the proposed system was not only pedagogically sound but also technically scalable and economically sustainable within the Yemeni educational ecosystem.

3.7 Design and Implementation of Hypertext Interactive Video

Insights from participants guided the development of the hypertext interactive video from interviews and focus groups. Analysing participant feedback helped shape the design of interactive features, ensuring that the resulting framework aligned with learner requirements and supported the intended educational outcomes.

3.7.1 Key Interactive Features in Hypertext Video-Based Learning

Hypertext interactive videos integrated various interactive features aimed at boosting engagement, navigation, and educational outcomes. Unlike conventional linear videos, hypertext videos offered learners the ability to interact with content in a dynamic way, supporting non-linear navigation, decision-making processes, and real-time feedback.

This section outlined the key interactive elements incorporated into the hypertext video framework developed for this study. These elements included overlays, video chapters, hotspots, and quizzes, each playing a distinct role in fostering learner autonomy, engagement, and knowledge retention. Other important components of hyperlinked videos included:

Overlays: These were interactive annotations embedded within the video that enabled viewers to click on specific options, directing them to additional content or targeted video segments. Overlays played a critical role in fostering interactivity without interrupting the flow of the video. For example, a clickable annotation might seamlessly link viewers to a supplementary video.

Video chapter with hyperlinks: Dividing videos into chapters facilitated easier navigation, especially for longer content. Each chapter could be hyperlinked, allowing users to access particular sections directly. For instance, a cooking tutorial might feature

chapters such as "Ingredients," "Cooking Process," and "Preparation," each linked to its respective part of the video.

Hotspots (Clickable Regions in the Video): Hotspots introduced a layer of interactivity by enabling viewers to click on designated areas within the video to access further information. For example, a promotional video for a product might contain clickable hotspots over different features, providing detailed descriptions when selected.

Quizzes and Choice-Based Navigation: This feature empowered users to influence the video's progression based on their responses or selections. For instance, an interactive training module might allow learners to choose from multiple scenarios, leading to different outcomes depending on their decisions.

Figure 3.4 and Figure 3.5 illustrated the structural and interactive components integrated into the hypertext video model developed for this study. To provide a structured and intuitive learning experience, the interactive hypertext video was designed with multiple layers of interactivity that facilitated both guided and self-directed learning.

Figure 3.4 presented the structural components essential for developing the interactive video prototype using the Quizizz platform. The prototype structure illustrated in the figure was designed and documented by the researcher using Quizizz (2025). These components included: (1) A linear video serving as the primary content, (2) A timeline that sequenced interactive elements, (3) Embedded questions to assess learner comprehension, (4) An option for inserting comments or inquiries, (5) A preview of comment integration, and (6) A display of how embedded questions appeared within the video. These features collectively formed the foundation for the interactive architecture of the hypertext video.

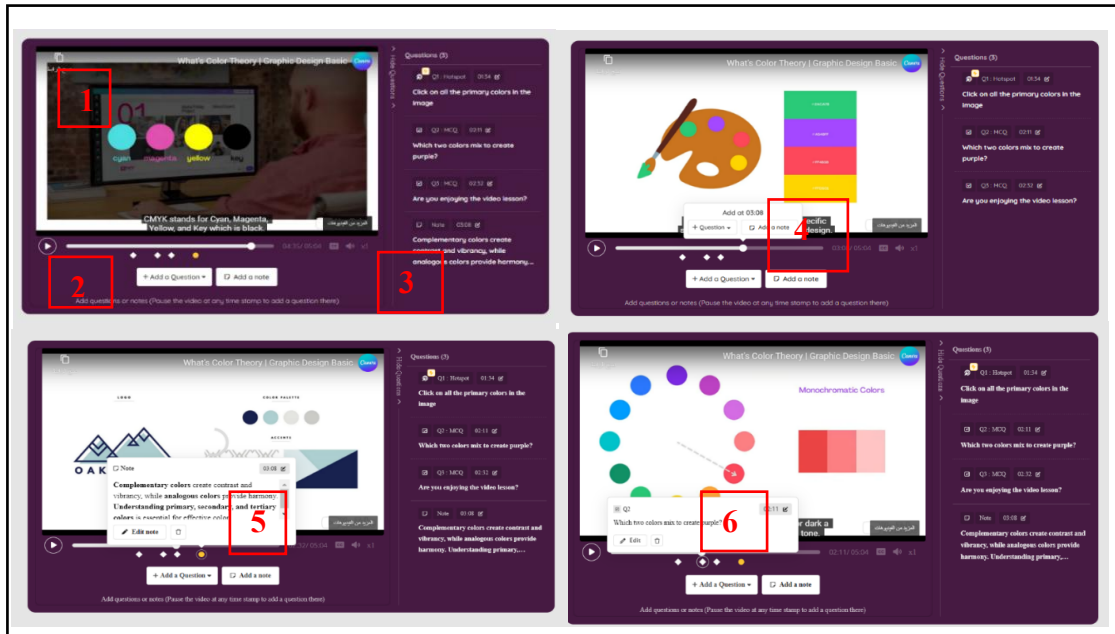


Figure 3.4 Structural Components of the Hypertext Interactive Video Prototype.

Beyond structural organisation, the hypertext video incorporated interactive features that enhanced learner engagement and fostered personalised learning pathways. Figure 3.5 demonstrated how clickable regions (hotspots) and choice-based navigation enabled learners to engage with the material interactively and responsively, reinforcing learning outcomes through decision-based exploration.

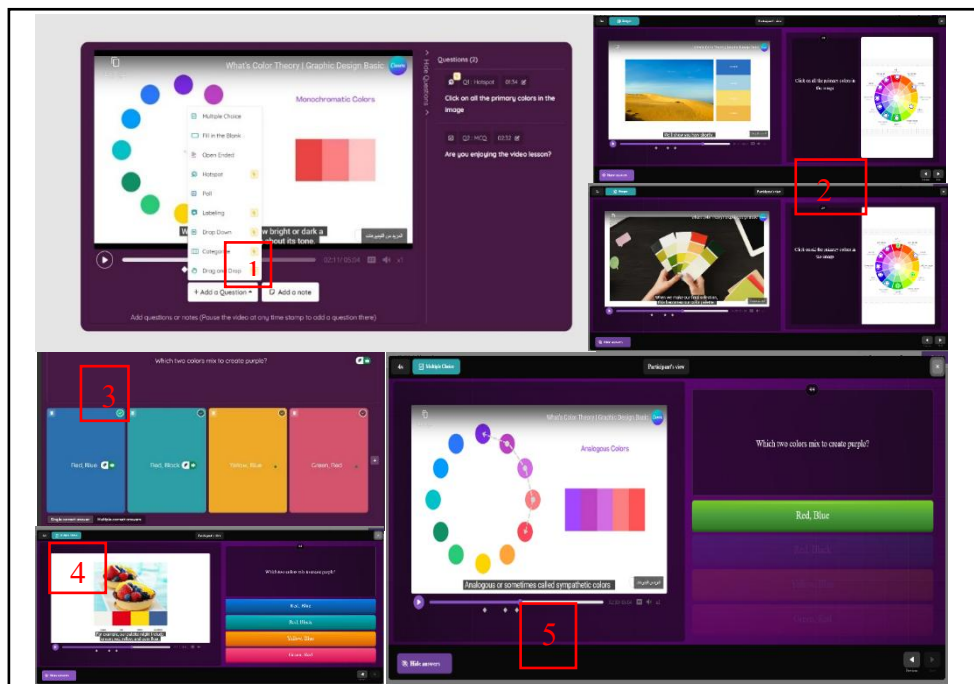


Figure 3.5 Interactive Features and Learner Engagement in Hypertext Video

Figure 3.5, documented by the researcher using Quizizz (2025), highlighted five key interactive elements: (1) Overlays menu with clickable annotations linking to supplementary content, (2) Hotspots that allowed users to access deeper material interactively, (3) Choice-based navigation (teacher view) presenting multiple correct pathways, (4) Student view displaying user interaction with embedded questions, and (5) Activation feedback providing immediate responses to enhance engagement. This example represented the learner's experience within the interactive environment. These figures provided an example of a learner's interaction within the interactive environment. The screenshot was taken from the Quizizz platform (2025) by a researcher.

3.7.2 Observation Procedure

Observational data were primarily used as supplementary contextual support during the interpretive phase of the thematic analysis rather than as a standalone analytical dataset. The observations focused on learners' navigation behaviour, interaction pauses, and responses to interactive video flow during demonstrative sessions.

3.8 Conclusion

This chapter presented the methodological approach adopted to explore the pedagogical influence and learner engagement associated with hypertext video-based interactive learning. A qualitative approach was adopted, utilising semi-structured interview sessions, facilitated group discussions, and systematic direct observation involving experts, educators, students, and policymakers.

The methodology framework Figure 3.1 ensured a systematic process for participant selection, data collection, and thematic analysis using NVivo. These approaches strengthened the overall credibility of the study, trustworthiness, and contextual depth. The integration of overlays, segmented video chapters, clickable hotspots, and interactive quizzes in hypertext video-based learning represented a significant shift toward adaptive, learner-centred digital education. These features fostered personalised interaction, real-time decision-making, and increased autonomy,

aligning with contemporary educational paradigms grounded in Vygotsky's socio-cultural theory.

To further address the technical limitations in Yemen, the chapter also introduced HyperLearnX, an AI-driven video compression system, and proposed it as a scalable solution for optimising interactive video delivery in low-bandwidth contexts. The next chapter presented and interpreted the empirical insights obtained from participants, highlighting how the interactive features shaped learner engagement and influenced educational outcomes within the context of Yemeni higher education.

CHAPTER 4

ANALYSIS AND INTERPRETATION OF FINDINGS

4.1 Introduction

This chapter offers an overview of the study's findings, interpreted through a reflexive thematic analysis conducted using NVivo qualitative analysis software. It provides an integrative understanding of how hypertext-interactive video mediates the aesthetic, pedagogical, and technological dimensions of art and design education in low-bandwidth contexts such as Yemen. In doing so, the chapter directly addresses the three research objectives by linking participants' lived experiences to the central research problem: the challenge of sustaining creative, inclusive digital learning under technological constraints.

To ensure analytic rigour, the chapter begins by outlining the data analysis process, highlighting how NVivo was used to facilitate systematic coding, categorisation, and visualisation of emerging patterns across interviews as well as focus group discussions. The incorporation of NVivo enhanced the clarity and auditability of the analytical process and trustworthiness of the qualitative analysis, enabling the identification of coherent themes that reflect both artistic and pedagogical interpretations of hypertext-interactive video.

The findings were interpreted through Vygotsky's sociocultural theory. These findings represent more than empirical results; they demonstrate how tools, aesthetic design, and collaboration work together to shape creative thinking. The analysis reflects how hypertext-interactive video operates simultaneously as a pedagogical tool and an artistic medium, enabling learners to construct meaning through multimodal, socially guided engagement.

This chapter is organised according to the study's three research questions. The first section addresses the current state of hypertext video use in Art and Design education, focusing on aesthetic, pedagogical, and technological mediation. The second section examines participants' perceptions of the HyperLearnX system, particularly in relation to engagement, creative resilience, and adaptation under infrastructural constraints. The third section presents the development and validation of the proposed

HyperLearnX framework, highlighting its pedagogical, aesthetic, and contextual dimensions within low-bandwidth educational environments.

Together, these themes illustrate how HyperLearnX, registered as a copyright-protected instructional design model (see Appendix B: HyperLearnX (Alshabi, Salim, & Ab Ghafa, 2025)), as both a conceptual model and an applied framework, bridges creativity, education, and technology to democratize art and design education. The chapter concludes by connecting these findings back to Vygotsky's sociocultural model, demonstrating how mediation, collaboration, and contextual creativity transform hypertext-interactive video into a sustainable pedagogical art, one capable of empowering inclusive and resourceful learning in developing educational environments.

4.1.1 Supporting Data Collection Documentation

Appendix D provides the supporting data collection materials and documentation used throughout the study. It includes bilingual interview excerpts, participant profiles, ethical approval documents, member-checking evidence, expert validation procedures, and supplementary qualitative records related to the data collection and verification process. The appendix supports procedural transparency, credibility, and the overall trustworthiness of the study.

Meanwhile, Appendix C presents the bilingual interview protocol (field version) used during the data collection process. The protocol includes both the original Arabic interview questions and their English translations to ensure conceptual equivalence, transparency, and methodological consistency. The appendix also enhances the trustworthiness of the study by documenting the semi-structured interview procedures applied across different participant groups.

4.1.2 Participant Overview

Appendix C presents the actual interview scripts used during the data collection phase. It complements Chapter Four by providing transparency into the research procedures, including participant briefing, ethical considerations, and the semi-structured questions used in the field. The appendix also reflects the use of a sample

hypertext video to support discussion. Both Arabic and English versions are included to ensure contextual accuracy and academic clarity.

Participants were coded based on their primary functional roles rather than unique identity counts. Some participants contributed multiple perspectives across professional roles; therefore, NVivo coding reflects role-based instances rather than individual duplication.

Some participants occupied multiple professional roles, for example, lecturer–technologist, and the counts reflect functional roles rather than mutually exclusive individuals. Figure 4.1 presents the distribution of participants across these categories and provides contextual grounding for the thematic analysis that follows.

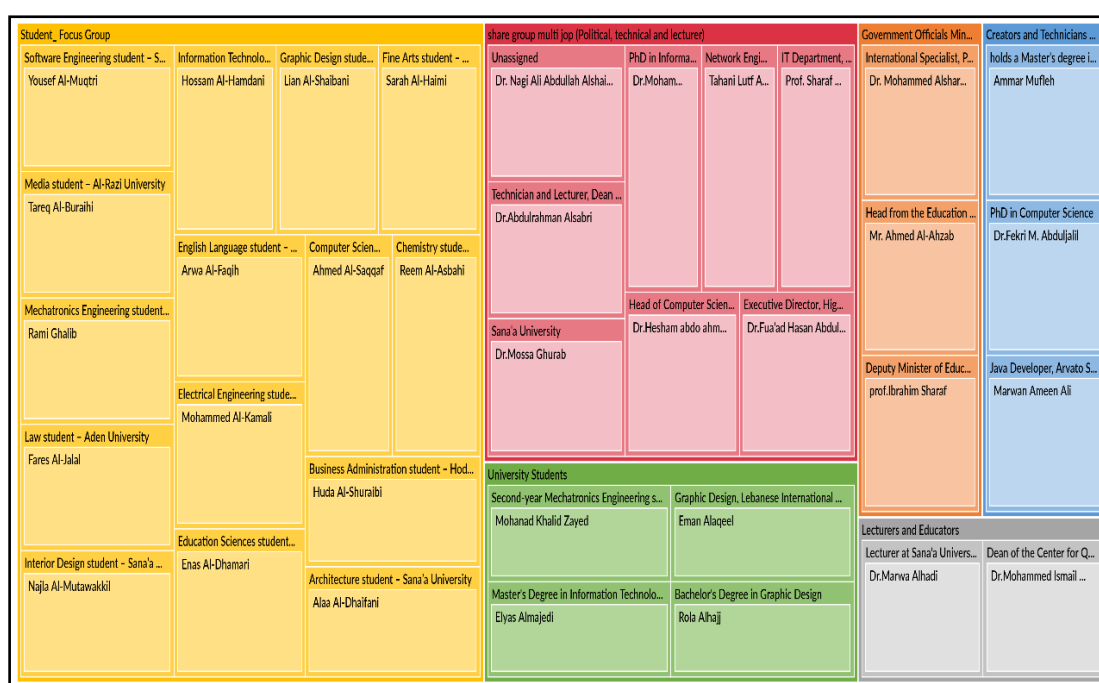


Figure 4.1 Distribution of Participants Across the Four informant Groups

The participants were divided into four key informant groups: Government Officials (n=6), Lecturers and Educators (n=5), Creators and Technicians (n=11), and University Students, with some participating in focus groups (n=19).

4.1.3 Data Saturation

Data saturation was reached after repetitive patterns emerged across the four participant groups, with no new codes identified after interview 32, indicating sufficient thematic redundancy across the dataset.

4.1.4 Role-based coding clarification

Participants were coded based on functional roles rather than unique individuals. Some participants contributed multiple perspectives across roles; therefore, NVivo coding reflects “role instances” rather than individual counts, ensuring analytical consistency across stakeholder groups. Comparative interpretation was therefore conducted thematically rather than statistically to avoid misleading quantitative representation of overlapping professional roles.

The findings were organised into three interconnected dimensions: Aesthetic Mediation, Creative Resilience, and Pedagogical Adaptation. Together, these themes explain how HyperLearnX supports visual learning, adaptive digital practices, and guided interaction within low-bandwidth art and design education contexts.

4.2 Overview of Data Analysis Process

The data analysis followed a systematic and reflexive qualitative process that progressed through four clearly defined stages:

Transcription → **Coding** → Thematic Categorisation → **Interpretation**.

Each stage was designed to ensure analytic transparency, theoretical alignment, and coherence with the study’s three research objectives. All interviews and focus-group discussions were first transcribed verbatim in Arabic to preserve participants’ original expressions.

As part of the reflexive analytic process, the researcher maintained researcher positionality memos to acknowledge how background, disciplinary training, and proximity to the Yemeni context informed interpretation.

NVivo 12 was used to support the organisation and interrogation of the qualitative data. The software facilitated the management of multilingual datasets (Arabic transcripts, English translations, and summaries), enabling systematic comparison across participant groups. Coding queries, node frequency counts, and matrix coding were used to explore patterns across roles (students, educators, technicians, and policymakers), strengthening analytic transparency and traceability. This analytical process enabled the researcher to move beyond descriptive coding

toward interpretive thematic understanding aligned with the study objectives and research questions.

Data saturation was achieved when no new codes emerged after interview 32, as similar patterns and themes were consistently repeated across all four participant groups.

4.2.1 Data Collection Procedures

Semi-structured interviews and focus group sessions served as the main sources of primary data collection. These were designed to foster dialogic exchange and deepen participants' reflections. Interview durations ranged from 30–60 minutes with university students, 45–60 minutes with lecturers and interactive-video developers, and 45–120 minutes with government officials. The interview protocol explored participants' prior experiences with traditional and video-based learning, their perceptions of hypertext-interactive video in visual and design education, aesthetic requirements for clarity (e.g., colour harmony, on-screen text, visual pacing), perceived infrastructural constraints, and low-tech adaptations relevant to the Yemeni context. Participants were encouraged to elaborate on personal experiences, contextual limitations, and pedagogical perceptions to generate rich qualitative insight relevant to the study objectives.

The transcripts were then translated into English and summarised, producing three parallel forms of data: full Arabic transcripts, English translations, and condensed analytical summaries.

All versions were loaded into NVivo, enabling an initial cycle of open coding to uncover repeated patterns and ideas, meaningful phrases, and emerging conceptual patterns. To ensure accuracy and credibility, selected portions of the translated transcripts and summaries were member-checked with participants.

The resulting codes were grouped into thematic categories; this thematic progression facilitated the interpretation of empirical patterns as broader conceptual dimensions relevant to hypertext video-based learning in low-resource environments, reflecting deeper connections among the pedagogical, aesthetic, and technological dimensions revealed in the data. An NVivo coding tree was developed to visualise these relationships, showing how descriptive codes evolved into higher-level analytical themes organised under:

1. Aesthetic Mediation, corresponding to Research Question One: Current State of Hypertext Video Use.
2. Creative Resilience, corresponding to Research Question Two: Perceptions of the HyperLearnX System.
3. Pedagogical Adaptation, corresponding to Research Question Three: Framework Development and Validation.

The analysis incorporated data from four participant groups: Creators and Technicians of Interactive Video, Lecturers and Educators, University Students, and Government Officials, thereby ensuring methodological triangulation and capturing a wide spectrum of perspectives. This multi-layered data corpus enhanced the trustworthiness of the thematic analysis and offered a comprehensive insight into how hypertext interactive video operates across aesthetic, instructional, technical, and institutional contexts.

Participants were coded based on functional roles rather than unique individuals. Some participants contributed multiple perspectives across roles; therefore, NVivo coding reflects “role instances” rather than individual counts, ensuring analytical consistency across stakeholder groups. This approach was adopted to maintain thematic consistency rather than numerical equivalence across overlapping roles.

Finally, the thematic structure was interpreted through Vygotsky’s sociocultural theory, linking the empirical findings to broader concepts of mediated learning, scaffolding, and collaborative meaning-making. This structure of codes and themes helped form a clear interpretation of how hypertext-interactive video supports learning in low-bandwidth environments. Triangulating four participant groups and using NVivo added rigour, credibility, and contextual sensitivity to the analysis. The resulting three overarching themes, Aesthetic Mediation, Creative Resilience, and Pedagogical Adaptation, form the basis of the findings presented in the next sections. Each theme represents a different aspect of mediated learning, but all remain interconnected within the study’s sociocultural framework.

4.2.2 Observational Notes

Observational notes were recorded during the explanatory and demonstration sessions conducted alongside the interviews. As no functional prototype or MVP of HyperLearnX had yet been developed, participants were verbally introduced to the

conceptual structure of the proposed hypertext video framework through illustrative examples from an existing interactive video platform.

The observations focused on participants' reactions to the explanation of intended interaction mechanisms, including click interactions, hyperlinked navigation, pause points, and adaptive learning pathways. Particular attention was given to participants' responses to the proposed low-bandwidth design considerations, such as caching and buffering strategies intended to support smoother navigation and reduce loading interruptions in constrained internet environments.

In addition, the demonstration and discussion sessions explored how hyperlinked responses could conceptually support guided learning continuity and alternative navigational pathways within hypertext video-based education. Although these observations were not treated as independently coded datasets, they provided contextual support that strengthened the interpretation and triangulation of interview findings.

These observations were used solely as contextual support for interpreting interview findings rather than as formal observational datasets for thematic coding.

The thematic analysis process involved the transformation of descriptive codes into higher-level analytical themes aligned with the study objectives and research questions. The final themes were systematically organised under three major dimensions:

4.3 Research Question One: Current State of Hypertext Video Use

The following section presents findings related to Research Question One, focusing on the current pedagogical and technological state of hypertext interactive video use in Yemeni Art and Design education. The findings presented in this section were interpreted through participants' descriptions, reflective experiences, and evaluative perceptions of hypertext-interactive video within Art and Design education contexts.

Aesthetic Mediation: visual, sensory, and meaning-making processes in hypertext-interactive video. This section examines how Hypertext video mediates aesthetic meaning-making in the setting of colour theory instruction. HyperLearnX, see index B, serves as more than just a technological resource; HyperLearnX acts as a visual pedagogical medium where colour, motion, hyperlinks, and interface cues guide

learners' perception and understanding. From a Vygotskian perspective, these aesthetic elements act as tools that guide attention, support interpretation, and shape students' emotional and conceptual responses.

4.3.1 HyperLearnX Features and Visual Expression

Participants interacted with a demonstrative simulation of HyperLearnX core features, rather than a fully implemented prototype. Although a full HyperLearnX prototype was not yet implemented during data collection, participants interacted with a demonstrative hypertext-interactive video that simulated its core visual and functional principles. Their responses revealed that the medium was experienced not merely as a delivery system but as a visually expressive environment structured around clarity, harmony, and guided interaction.

Across participants, especially designers and educators, aesthetic elements such as colour harmony, visual pacing, interface minimalism, and hyperlink transitions were consistently described as central to engagement. AC1 (senior academic & technical advisor) stated, "The choice of colours is very good, and the interface design is neat, which made the questions and answers clear and easy to read." In the same vein, GO3 noted that interactive summarisation "removes unnecessary repetition and keeps the video efficient." This response highlights the importance of aesthetic organisation in supporting usability and conceptual clarity within hypertext-interactive video environments. Participants consistently associated visual harmony and interface simplicity with improved readability, engagement, and instructional coherence.

These findings support Research Question One by demonstrating how aesthetic mediation contributes to the current pedagogical use of hypertext-interactive video in Art and Design education.

From a usability standpoint, CT6 (master's student in IT / AI) observed that "the links and texts enhanced understanding and saved time," pointing to the seamless interplay between Colour-coded cues and conceptual navigation. Such responses indicate how form and function intersect within hypertext-interactive video, where aesthetic refinement directly supports cognitive processing.

This statement illustrates how participants perceived hyperlinked navigation not merely as a technical feature but as a cognitive support mechanism that facilitated efficient learning and conceptual accessibility.

The finding contributes to Research Question One by revealing the relationship between technological interaction design and pedagogical usability within low-bandwidth educational environments.

The balance between minimalism and visual richness also emerged as a theme. Participants valued the absence of clutter, the predictability of transitions, and the intuitive placement of anchors, which collectively facilitated deeper attention to the Colour concepts being taught.

4.3.2 Voices from the Field: Aesthetic Perception as Learning Narrative

Participants' quotations reveal aesthetic mediation as a lived experience. Rather than evaluating the video only in technological terms, many framed their responses in emotional, sensory, or artistic language. AC7 (graphic design student) described the video as “engaging, offering both practical and theoretical perspectives at the same time,” explicitly linking visual presentation to pedagogical clarity.

In a group discussion, a student participant from the 15-member focus group commented, “Honestly, it was very engaging. Usually, videos are long and boring, but this one kept my attention.” Another student from the same focus group added: “The interactivity forces you to think, not just watch.” A comment that illustrates how interactive cues shift learners from passive viewing to active cognitive engagement. These focus-group voices illustrate how interactive pacing and on-screen cues transform passive viewing into active, reflective engagement.

Lecturers reinforced these impressions. AC5 (lecturer and head of the Graphics Department, Sana’a University) emphasised that HyperLearnX “saves time, they watch less but gain more information,” highlighting the convergence between aesthetic organisation and pedagogical efficiency. Such convergence was echoed by other faculty members who noted that clear visual sequencing and predictable interactive moments reduced cognitive load and improved recall.

Collectively, these responses demonstrate that aesthetic mediation functions as a pedagogical scaffold within hypertext-interactive video environments. Participants associated colour harmony, visual sequencing, and interactive pacing with improved concentration, reflective engagement, and conceptual understanding.

From a sociocultural perspective, these aesthetic and interactive elements operated as mediating tools that guided perception, supported meaning-making, and encouraged active participation rather than passive viewing.

These findings directly address Research Question One by illustrating how hypertext-interactive video is currently perceived and utilised as an aesthetic and pedagogical learning medium within Yemeni Art and Design education contexts.

4.3.3 Recommendations for Enhancing Aesthetic Mediation

The aesthetic recommendations below are derived from participants' reflections and align to refine hypertext-interactive video as a visually expressive learning tool:

Strengthen colour harmony and visual coherence to guide learners intuitively through conceptual sequences, especially in design-based subjects. Recommended by AC1 (senior academic and technical advisor). This recommendation indicates that participants perceived visual coherence as an essential pedagogical mediator rather than a purely aesthetic preference. The findings suggest that colour harmony and structured visual sequencing support intuitive navigation and conceptual continuity within hypertext-interactive learning environments.

This finding contributes to Research Question Two by demonstrating how aesthetic organisation directly shapes learners' perceptions of clarity, engagement, and cognitive accessibility in colour theory instruction.

Maintain interface minimalism to prevent perceptual overload while preserving the clarity of hyperlinks and interactive icons. Suggested by CT6 (Master's student in IT/AI). This response suggests that participants associated interface simplicity with cognitive efficiency and sustained attention. The findings indicate that minimalist interface structures reduce perceptual distraction and allow learners to focus more effectively on conceptual and interactive elements. This finding contributes to Research Question Two by illustrating how technological and aesthetic simplicity enhances usability and supports more accessible interaction within hypertext-video learning environments

Enhance sensory engagement through subtle visual cues (micro-animations, highlight transitions) that support focus without distracting from core content. Suggested by AC5 (Lecturer, Head of the Graphics Department). This recommendation reflects participants' understanding that subtle aesthetic motion can function as a

cognitive guide within digital learning environments. The findings suggest that controlled visual transitions help sustain attention and reinforce conceptual emphasis without increasing cognitive overload.

This finding contributes to Research Question Two by demonstrating how aesthetic interaction techniques influence learner engagement and perceptual focus in art and design education.

Provide upfront orientation notes explaining how hyperlinks, questions, and interactive pauses function, so students are not surprised by interactive moments. Recommended by AC7 (Graphic Design student). This response indicates that learners value procedural clarity before engaging with interactive educational systems. The findings suggest that orientation and guidance reduce uncertainty and help students adapt more confidently to non-linear learning structures.

This finding contributes to Research Question Two by showing how preparatory instructional support improves learners' acceptance and understanding of hypertext-interactive video environments.

Offer adjustable resolution options (user-set) to harmonise aesthetic experience across varying internet speeds. Requested by multiple students in the 15-participant focus group. This recommendation demonstrates that participants perceived technical flexibility as inseparable from aesthetic accessibility. The findings suggest that adaptive resolution settings help preserve continuity of learning and visual clarity under unstable bandwidth conditions.

This finding contributes to Research Question Two by highlighting the importance of low-bandwidth adaptability as both a technological and pedagogical requirement within Yemeni higher education contexts.

Participants' aesthetic responses were based on conceptual explanations and demonstrative interactions rather than prolonged real-use experience.

Integrate pedagogical buffering strategies, whereby short reflective questions or micro-activities are displayed during video loading intervals, allowing content segments to preload without interrupting the learning flow. This approach was recommended by CT4 (PhD in Computer Science, academic and technical consultant), who further emphasised that educational videos should be sourced from credible, peer-recognised, and academically validated platforms to ensure both technical reliability and instructional integrity. This recommendation reframes technical interruption as a potential pedagogical opportunity. The findings suggest that buffering periods can be

transformed into reflective learning moments through lightweight interactive prompts and micro-activities. This finding contributes to Research Question Two by demonstrating how technological constraints may stimulate adaptive pedagogical innovation rather than simply limiting learning effectiveness.

Include multiple expert viewpoints or narrative figures to enrich the visual conceptual narrative and enhance learner identification. Suggested by faculty members, including AC5. This recommendation suggests that participants associated multiple narrative perspectives with stronger learner identification and conceptual engagement. The findings indicate that diversified expert voices may enrich interpretive understanding and support broader learner connection with visual content. This finding contributes to Research Question Two by illustrating how narrative diversity enhances aesthetic mediation and learner-centred engagement in hypertext-interactive video.

These recommendations collectively demonstrate that aesthetic decisions within hypertext-interactive video function as pedagogical mediators rather than decorative enhancements. Participants consistently associated visual organisation, interaction clarity, and adaptive interface design with improved comprehension, sustained attention, and deeper meaning-making in colour theory learning.

This finding contributes to Research Question Two by showing how aesthetic, pedagogical, and technological dimensions operate interdependently within hypertext-video environments.

In summary, aesthetic mediation emerged not as a supplementary visual layer but as an active cognitive and pedagogical mechanism shaping learner perception, attention, and conceptual interpretation. Participants consistently described visual sequencing, hyperlink structures, and guided interaction as elements that supported reflective engagement rather than passive viewing.

These findings contribute to Research Question Two by demonstrating that HyperLearnX operates as an integrated aesthetic–pedagogical environment in which visual design and interaction collectively support meaning-making in colour theory education.

Building on this aesthetic foundation, the next section (4.4) examines Creative Resilience, how learners, educators, technicians, and institutions adapt and innovate in response to infrastructural constraints in Yemen. Given the reliance on simulated HyperLearnX features rather than a fully implemented prototype, participants’ aesthetic

responses were based on conceptual and demonstrative interactions rather than prolonged real-use experience.

4.4 Research Question Two: Perceptions of the HyperLearnX System

This theme is directly linked to Objective 2: Exploring challenges and opportunities in developing digital art learning in Yemen. Despite the aesthetic and pedagogical promise of hypertext-interactive video, participants consistently emphasised that meaningful adoption within Yemeni art and design education requires navigating profound infrastructural, economic, and institutional constraints. Instead of acting as barriers, these constraints often encourage creative resilience. They push learners and educators to innovate, adapt tools, and rethink digital pedagogy under real-world pressures.

4.4.1 Accessibility and Digital Inclusion

Consistent with the contextual challenges outlined in Chapters 1 and 2, participants reiterated familiar issues related to unstable bandwidth, limited device access, and the high cost of internet connectivity. However, in this study, these challenges were not described merely as obstacles; rather, they shaped how learners and educators creatively negotiated the use of hypertext-interactive video in real teaching environments.

Students repeatedly emphasised that connectivity issues interrupt not only access, but also the flow of aesthetic learning. A student from rural Taiz explained that internet access is “only available at night.” This response illustrates how infrastructural instability directly shapes learners’ educational routines and access patterns. The findings suggest that students adapt their learning behaviours around connectivity availability rather than around pedagogical preference.

This finding contributes to Research Question Two by demonstrating how technological limitations influence the practical experience of hypertext-interactive learning in Yemen. noting that materials must function offline for learning to continue. This perspective appeared across many student voices, revealing how infrastructural constraints directly influence the aesthetic–pedagogical experience.

Economic challenges were also significant. Several students reported that purchasing additional internet bundles was simply unaffordable. This concern was echoed by GO5, an international accreditation specialist, who stressed that “Infrastructure is limited to certain areas, and many of the target learners lack the necessary internet access.” His observation highlights a recurring theme: any digital learning model must adapt to the realities of low-resource environments rather than expect learners to adjust to the technology.

This statement indicates that digital inequality remains a structural challenge affecting educational participation. The findings suggest that successful hypertext-video implementation depends on contextual adaptation to socio-economic realities rather than reliance on high-resource technological assumptions.

This finding contributes to Research Question Two by highlighting how perceptions of educational technology are shaped by accessibility, affordability, and infrastructural distribution.

Despite these limitations, the data revealed strong evidence of creative resilience. Lecturers such as AC5, Head of the Graphics Department, proposed practical adaptation strategies, pre-caching visual content, using low-resolution modes, and designing lessons as short, interactive segments instead of long videos. These suggestions illustrate how teachers actively reconfigure digital tools to preserve aesthetic clarity while avoiding bandwidth overload.

These adaptive strategies demonstrate that participants did not perceive constraints solely as barriers, but also as catalysts for pedagogical innovation. The findings suggest that educators actively redesigned instructional approaches to preserve both aesthetic continuity and learning accessibility under low-bandwidth conditions.

This finding contributes to Research Question Two by illustrating how creative resilience emerges through context-sensitive adaptation and technological flexibility.

From a sociocultural standpoint, these adaptations represent mediated action shaped by local constraints.

Learners reorganised their study habits around connectivity windows; educators redesigned lessons to reduce data consumption; and technicians recommended lightweight design solutions. Together, these practices demonstrate that resilience emerges not despite constraints, but because of them, driving the development of more inclusive forms of hypertext-video learning.

Ultimately, this theme shows that accessibility in Yemen is not a purely technical matter. It is a socio-economic and pedagogical reality that directly influences how visual content is perceived, interacted with, and repurposed. The participants' responses highlight how digital inclusion requires flexible design principles, ones that can sustain aesthetic quality, reduce cognitive interruption, and remain functional under unstable conditions. Taken together, these accounts show that issues of access are not merely technical constraints but sociocultural conditions that directly influence how aesthetic learning unfolds. Connectivity failures interrupt not only the delivery of content but also the cognitive rhythm required for understanding Colour relationships and visual structure. From a Vygotskian perspective, this disruption limits the effectiveness of mediating tools, reducing opportunities for supported learning occurring within the Zone of Proximal Development. Yet, the adaptive strategies proposed by educators, such as pre-caching, low-resolution modes, and modular lesson structure, demonstrate strong creative resilience. These findings highlight that inclusive hypertext-video design in Yemen must prioritise low-bandwidth adaptability as a core aesthetic and pedagogical requirement, not an optional technical enhancement.

4.4.2 Policy and Institutional Dimensions

Institutional and governmental stakeholders provided a broader perspective on how macro-level constraints influence artistic and technological design choices. GO3 (Deputy Minister of Education) noted: "Higher education in Yemen suffers from the absence of clear strategies, We need official recognition, inter-ministerial coordination, and external support."

This response reflects participants' perception that technological innovation alone is insufficient without institutional coordination and policy support. The findings suggest that sustainable implementation of hypertext-interactive learning depends on systemic alignment between educational leadership, infrastructure planning, and pedagogical strategy.

This finding contributes to Research Question Two by demonstrating how institutional conditions shape the feasibility and long-term sustainability of digital art education initiatives.

University leaders echoed this, explaining in focus group discussions that even when a technology proves pedagogically effective, successful implementation requires “a clear framework, staff training, infrastructure, and equipment.”

These perspectives indicate that implementation is perceived as an organisational ecosystem rather than a standalone technological intervention. The findings suggest that staff readiness, training structures, and infrastructural preparedness are essential mediating conditions for successful adoption.

This finding contributes to Research Question Two by highlighting the institutional dimensions influencing perceptions of HyperLearnX implementation in higher education contexts.

These institutional realities translate directly into the design of hypertext-interactive video. Emphasis on interface simplicity, Arabic localisation, and predictable navigation arose not only from aesthetic preference but also from institutional capacity. Thus, creative resilience in Yemen includes institutional creativity, the reimagining of policy, training, and resource allocation to support digital art education.

4.4.3 Technical Dimensions and Creative Adaptation

Technical challenges such as compression, caching, server hosting, and device compatibility were highlighted by technical experts as decisive in shaping feasible hypertext-interactive video design. AC2 (Head of the Computer Science Department, Saba University) emphasised: “We need compression that works for mobile bandwidth; otherwise, students cannot even load the lecture.” Similarly, GO2 (IT Director, University of Sana’a) stressed the importance of caching: “Without caching, students in rural areas cannot continue when the network drops.”

This response demonstrates that technical optimisation is perceived as fundamental to educational accessibility rather than merely a backend engineering concern. The findings suggest that compression and caching mechanisms directly influence whether learners can participate consistently in hypertext-interactive learning environments.

This finding contributes to Research Question Two by illustrating how technological infrastructure shapes perceptions of usability, continuity, and inclusion.

These insights position technical frictions not as obstacles but as design drivers. They compelled the development of solutions that preserve visual integrity, such as

colour accuracy, hyperlink visibility, and rhythmic visual pacing, despite challenging infrastructure.

The HyperLearnX model embodies this necessity-driven innovation. Its features, including SmartZone Compression, adaptive streaming, and lightweight hypertext layers, were conceptualised specifically to maintain aesthetic–pedagogical coherence in low-bandwidth environments. These technical components are presented as conceptual framework features informed by participant perspectives, rather than validated engineering solutions (See Appendix B for copyright registration and full model description.)

These constraints became opportunities to improve the design, showing that efficiency and aesthetic clarity can reinforce each other.

In sum, creative resilience in Yemen emerges from the interplay of technical constraints, socio-economic realities, and institutional structures. Instead of diminishing digital art education, these challenges have compelled learners, educators, technicians, and policymakers to develop adaptive, innovative practices that reshape hypertext-interactive video into a sustainable medium for visual learning.

4.4.4 Implementation Pathways in Constrained Contexts: Creative Practice under Structural Limitations

Implementation within constrained contexts such as Yemen cannot be conceptualised as a linear or purely technical process of adoption. Instead, it manifests as a layered creative practice, continuously shaped by institutional constraints, infrastructural fragility, and the agency of human actors. Participants representing technical, educational, and governmental sectors consistently described implementation not as the straightforward “deployment” of hypertext-interactive video, but as an ongoing process of artistic and pedagogical negotiation. Within this process, design decisions were deeply intertwined with contextual realities rather than detached technological considerations.

For stakeholders operating in unstable and resource-limited digital environments, implementation pathways were articulated as adaptive ecosystems rather than fixed or standardised models. These pathways relied on incremental experimentation, collaborative improvisation, and a contextual redefinition of what constitutes “effective” digital learning under structural constraints. Consequently,

HyperLearnX was not perceived by participants as a finalised technological artefact. Rather, it was understood as a flexible design logic, one that remains open to evolution through situated practice and continuous contextual adaptation.

4.4.4.1 Implementation as Creative Negotiation

Dr Hesham, Head of the Computer Science Department at Saba University, articulated implementation as a balancing act between visual ambition and infrastructural feasibility. He emphasised that “any system we adopt must first survive the bandwidth reality before it can succeed pedagogically.” This statement reframes implementation as an act of creative filtering, where aesthetic intentions must pass through technical thresholds to remain viable.

This statement reflects the perception that implementation success depends first on contextual survivability before pedagogical sophistication. The findings suggest that technological feasibility operates as a prerequisite for meaningful educational interaction in constrained environments.

This finding contributes to Research Question Three by demonstrating how contextual realities informed the conceptual logic underlying HyperLearnX development.

Rather than perceiving this as a limitation, AC2 framed constraint as a productive design force. Compression, caching, and modularisation were not afterthoughts but foundational to the visual and interactive structure of hypertext-interactive video. This perspective aligns with design practices in constrained media environments, where form is shaped by scarcity and where clarity becomes an aesthetic necessity.

Similarly, GO2, IT Director at the University of Sana’a, stressed that implementation must prioritise continuity over perfection. “If the system cannot recover when the network drops,” he explained, “students simply disappear.” His emphasis on caching mechanisms and lightweight interaction highlights implementation as an invisible design layer, one that sustains learning flow even when visual engagement is intermittently interrupted. In this sense, implementation becomes a form of backstage artistry, preserving rhythm and coherence beneath unstable conditions. This response highlights how technical interruption can directly disrupt educational continuity and learner retention. The findings suggest that caching and lightweight interaction are not

merely technical optimisations but pedagogical safeguards supporting sustained engagement. This finding contributes to Research Question Three by illustrating how infrastructural realities shaped framework-level design priorities within HyperLearnX.

4.4.4.2 Institutional Pathways and Design Ecosystems

At the institutional level, implementation pathways were strongly shaped by organisational capacity and policy alignment. GO3, Deputy Minister of Education, framed digital implementation within a broader systemic vacuum. He noted that higher education institutions in Yemen often operate without unified digital strategies, making individual initiatives vulnerable despite their pedagogical value. “Without recognition and coordination,” he argued, “even the best systems remain isolated experiments.”

This insight reveals that implementation is not solely a technical or artistic matter but an institutional choreography involving policy endorsement, administrative support, and capacity building. University leaders echoed this view during focus group discussions, emphasising that implementation requires training ecosystems, not just tools. One senior administrator described successful digital initiatives as those that “grow inside the institution rather than being imported from outside.”

From this perspective, HyperLearnX’s implementation pathway was perceived as compatible with incremental institutional integration. Its modular structure allowed departments to adopt components gradually, first as supplementary visual resources, later as interactive learning modules without demanding immediate systemic overhaul. This gradualism was viewed as essential in contexts where institutional resilience is uneven.

4.4.4.3 Human Agency and Distributed Authorship

Beyond infrastructure and policy, participants repeatedly emphasised the central role of human agency in shaping implementation outcomes. Lecturers, technicians, and students were not passive recipients of the system but co-authors of its operational meaning.

AC5, Head of the Graphics Department at Sana’a University, highlighted the importance of lecturer-driven adaptation. She explained that instructors often re-sequence content, pause videos strategically, or supplement interactive segments with

live discussion to align with classroom realities. “The video does not teach alone,” she stated. “It becomes effective when the teacher reshapes it.”

This perspective suggests that participants viewed pedagogical adaptation as a collaborative and context-sensitive process rather than a fixed technological procedure. The findings indicate that the educational value of hypertext-interactive video depends not only on system design, but also on the instructor’s ability to reshape interaction according to classroom realities and learner needs.

This insight contributes to Research Question Three by demonstrating that the proposed HyperLearnX framework requires flexible educator-led adaptation mechanisms to remain pedagogically effective within diverse and resource-constrained learning environments.

This approach positions implementation as a form of distributed authorship, where pedagogical ownership is shared between designer, instructor, and learner. Rather than undermining the integrity of the system, this redistribution of control enhances its contextual relevance. It allows hypertext-interactive video to function as a living artefact responsive to human interpretation rather than fixed instruction.

Students also contributed to shaping implementation pathways. A student from the focus group described how peers shared downloaded segments offline via mobile devices, creating informal learning networks beyond institutional platforms. Such practices demonstrate how learners extend implementation beyond formal design intentions, transforming hypertext-interactive video into a social object circulating through peer economies.

These practices reveal that learners were not passive consumers of digital content, but active participants in extending the educational ecosystem beyond formal institutional structures. Informal peer-sharing practices illustrate how hypertext-interactive video can acquire social and collaborative dimensions in constrained environments.

This finding contributes to Research Question Two by showing how students perceive interactive video as a flexible and socially adaptable learning medium capable of sustaining engagement despite infrastructural limitations.

4.4.4.4 Design Decisions under Constraint

Implementation in constrained contexts requires constant artistic decision-making under pressure. Participants described these decisions as moments where aesthetic desire confronts technical reality.

AC1, a senior academic and technical advisor, reflected on the tension between visual richness and clarity. He noted that while designers may aspire toward complex visual layering, “clarity must come first when the screen is small and the connection weak.” This prioritisation reframes minimalism not as a stylistic preference but as an ethical design stance, one that respects the cognitive and material limits of learners. This response reflects how aesthetic decision-making within low-bandwidth environments becomes closely tied to usability and cognitive accessibility. Participants did not perceive minimalism as merely a visual style, but as a pedagogical necessity that supports clarity, readability, and sustained engagement under constrained conditions. This finding addresses Research Question Two by illustrating how aesthetic and technological considerations become interconnected in participants’ perceptions of hypertext-interactive video design.

Such decisions were echoed by CT6, a master’s student, who emphasised that “saving time and data” was as important as visual appeal. His observation underscores how implementation pathways are shaped by micro-level decisions about link density, colour contrast, and navigation logic. These choices collectively determine whether the system remains accessible or becomes exclusionary.

Importantly, participants did not advocate for the elimination of aesthetic ambition. Instead, they argued for a recalibration of artistic values, one where precision, rhythm, and intentional restraint replace visual excess. In this sense, constraint becomes an aesthetic framework rather than a barrier.

Rather than rejecting aesthetic richness, participants advocated for a recalibrated visual strategy in which restraint, pacing, and navigational clarity become part of the artistic language of digital learning itself. This reflects a shift from decorative aesthetics toward functional aesthetic mediation.

This interpretation contributes to Research Question Three by informing the design logic underlying the HyperLearnX framework, particularly in relation to adaptive visual design for low-resource educational settings.

4.4.4.5 Implementation as Process, Not Event

Across interviews, implementation was consistently described as an ongoing process rather than a one-time deployment. GO5, an international specialist in education quality and accreditation, emphasised that digital systems must evolve through feedback loops to remain pedagogically legitimate. He argued that implementation should be “auditable, adaptable, and aligned with outcomes,” particularly in creative disciplines where learning is experiential.

This perspective frames implementation as an iterative and continuously negotiated process rather than a finalised technological deployment. Participants emphasised that sustainability depends on ongoing refinement, evaluation, and contextual responsiveness. This insight contributes to Research Question Three by supporting the conceptualisation of HyperLearnX as an adaptive framework capable of evolving through institutional feedback and situated pedagogical practice.

This view aligns with HyperLearnX’s conceptual positioning as a framework rather than a static product. Participants perceived its implementation pathway as iterative, beginning with demonstrative simulations, followed by partial adoption, and eventually scaling through refinement. Such a trajectory mirrors artistic practice, where prototypes, critiques, and revisions are integral to creative development.

From a sociocultural perspective, this iterative implementation reflects mediated action unfolding over time. Tools are not simply introduced; they are domesticated, contested, and reshaped through use. In Yemen’s context, where educational continuity is frequently disrupted, this temporal flexibility becomes essential for sustainability. The findings suggest that technological tools acquire educational meaning gradually through interaction, adaptation, and contextual integration. In the Yemeni context, sustainability was perceived less as technological sophistication and more as the capacity for continuous pedagogical adjustment under unstable conditions. This interpretation reinforces Research Question Three by demonstrating how contextual adaptability became a foundational principle in the proposed framework development.

4.4.4.6 Contextualising Implementation within Creative Resilience

Ultimately, the implementation pathways described by participants exemplify creative resilience in action. Constraints related to bandwidth, policy, and resources did

not halt innovation; instead, they redirected it toward context-sensitive solutions. Implementation became a site where creativity, pragmatism, and collaboration intersected.

Rather than striving for technological parity with high-resource environments, participants articulated a different metric of success, one grounded in usability, continuity, and meaning-making. Hypertext-interactive video was valued not for its novelty but for its capacity to endure within instability.

Participants consistently reframed success in terms of continuity, usability, and contextual relevance rather than technological complexity. This indicates that educational innovation in constrained environments is evaluated according to sustainability and accessibility rather than visual sophistication alone.

This finding contributes to Research Question Two by revealing how participants perceived creative resilience as a practical response to infrastructural instability within digital art education.

This reframing positions implementation as an aesthetic–pedagogical practice embedded in lived conditions. It highlights how creative resilience is enacted through everyday decisions, institutional negotiations, and human improvisation. Within this ecosystem, HyperLearnX operates not as an external intervention but as a locally interpretable design logic, one that adapts as conditions evolve.

In this way, implementation pathways in constrained contexts reveal more than logistical strategies; they expose how digital art education can be reimaged through adaptive creativity. By foregrounding human agency, institutional dynamics, and artistic decision-making under constraint, this theme demonstrates that meaningful implementation is not achieved by overcoming limitations, but by designing with them.

Building on this foundation of resilience and adaptive design, the next section (4.5) examines pedagogical adaptation, how interactive video enables new forms of engagement, scaffolding, and collaborative meaning-making in art and design education.

4.5 Research Question Three: Framework Development and Validation

Linked to the third Objective, the Hypertext-interactive video operated in this study not merely as a digital medium but as a pedagogical aesthetic artefact that reorganises how learners perceive and interpret visual concepts. Participants repeatedly

emphasised that structured pacing, colour cues, and interactive decision points created a guided learning pathway similar to the scaffolding processes described in Vygotsky's sociocultural theory. Pedagogical adaptation in this context emerges from the interplay between cognitive mediation, aesthetic structuring, and guided interaction.

4.5.1 Vygotskian Scaffolding and Cognitive Mediation

Although participants did not reference Vygotsky explicitly, their descriptions strongly aligned with the principles of mediated learning and the Zone of Proximal Development (ZPD). HyperLearnX's segmented pacing, visual emphasis, and embedded questions acted as digital scaffolds that supported learners through complex visual tasks.

Lecturers noted that interactive checkpoints helped reduce hesitation common in physical classrooms. CT1(Dean, Faculty of Computer Science, Sana'a University) highlighted that students benefit from the ability to rewatch ambiguous sections, enabling self-paced progression within their ZPD. Similarly, AC2 (Head of Computer Science, Saba University) emphasised that concise explanations and integrated questions "guide students along a clearer path," reducing overload and supporting focused processing.

These responses indicate that participants perceived interactive video not simply as a content-delivery tool, but as a structured cognitive support system capable of guiding learners progressively through complex visual concepts. Segmentation and embedded prompts were understood as mechanisms that reduce cognitive overload while sustaining conceptual focus.

This finding contributes to Research Question Three by demonstrating how the proposed framework integrates scaffolding principles into hypertext-interactive learning design.

Students confirmed these effects. In the 15-student focus group, many described the video as "guiding me step by step" or "making me think, not just watch," signalling a shift from passive viewing to active cognitive mediation. Hyperlinks and micro-prompts acted as symbolic tools that directed attention and reinforced the conceptual clarity of the core functions of Vygotskian scaffolding. Immediate feedback also enhanced self-regulation.

Elyas Al-Majedi (Master of Science in Information Technology with a Specialisation in Artificial Intelligence) viewed real-time corrections as essential for refining understanding. ST1 (Mechatronics) described embedded questions as “measuring the student’s level of understanding,” mirroring formative assessment.

At the same time, ministry officials and several students stressed that such videos complement rather than replace the teacher, affirming Vygotsky’s view of the expert’s central role in guiding conceptual development.

Overall, HyperLearnX created a layered scaffolding environment: Aesthetic scaffolding, consistent Colour cues and visual hierarchy, cognitive scaffolding: segmentation, summarisation, and interactive prompts, and social scaffolding: teacher-embedded guidance and feedback loops.

This multimodal structure supported learners’ progression toward expert-like understanding in colour theory under low-bandwidth constraints.

These pedagogical insights reveal how hypertext-interactive video restructures the learning pathway by transforming explanations into guided, scaffolded steps. Students’ descriptions of “being guided” and “thinking, not watching” indicate a shift toward mediated cognitive engagement, an essential element of Vygotskian scaffolding. In Yemen’s learning environments, where teacher-student interaction is often constrained by large class sizes and limited resources, such digital scaffolding becomes a practical extension of expert guidance. This positions HyperLearnX not as a replacement for the instructor but as a complementary mediating artefact that enhances clarity, supports self-regulation, and reduces cognitive overload.

4.5.2 Educational Value and Artistic Learning Outcomes

Participants saw the educational value of hypertext-interactive video in its ability to integrate aesthetic design and pedagogical function, an essential combination in art and design education. AC5 (Head of Graphics Department, Sana’a University) observed that students pointed to the role of visual clarity and controlled pacing in deepening learning.

Students noted that hyperlinks enhanced visual comprehension by allowing fluid movement between theoretical and applied elements. AC7 (Graphic Design student) described the hyperlinks as a “mini-library inside the video,” offering immediate reference without cognitive disruption. Interactive features also boosted

motivation, attention, and creative curiosity. This description illustrates how participants perceived hyperlinks as extensions of conceptual exploration rather than interruptions to the learning process. The integration of supplementary visual references within the video environment supported continuity of attention and reduced cognitive fragmentation. This finding contributes to Research Question Two by demonstrating how learners perceived hypertext-interactive video as simultaneously informative, navigational, and aesthetically supportive.

ST2 (Graphic Design graduate) emphasised that questions “make students participate actively,” echoing Vygotskian ideas that engagement deepens through agency and exploration. From a broader academic and policy perspective, educational value was tied to outcome-based alignment.

Participants associated interactivity with increased agency, engagement, and exploratory learning behaviour. Rather than functioning as passive observers, learners became active contributors to meaning-making through guided interaction and reflective participation.

This interpretation supports Research Question Three by reinforcing the framework’s emphasis on participatory and scaffolded learning processes.

GO5 (International Specialist in Education Quality and Accreditation) stressed that digital learning models, HyperLearnX included, must link aesthetic and interactive features to clear learning outcomes, especially in creative fields where students must develop conceptual, perceptual, and expressive competencies. Together, these insights indicate that HyperLearnX supports:

1. Visual comprehension through aesthetic clarity and controlled visual rhythm.
2. Cognitive engagement through interactive questioning and structured segmentation.
3. Creative learning outcomes by stimulating exploration and reducing barriers to participation.
4. Aesthetic pedagogy, where artistic form and instructional design reinforce one another to support meaning-making in colour theory.

In summary, HyperLearnX represents a contemporary pedagogical approach where cognitive mediation, sociocultural interaction, and digital aesthetics converge, enabling equitable, motivating, and intellectually generative learning experiences in low-bandwidth contexts. These outcomes reflect Vygotsky's principle that learning increases when tools provide mediated guidance, enabling students to operate within their ZPD more effectively.

4.5.3 Pedagogical Choreography: Interaction as Artistic Guidance

Pedagogical adaptation within HyperLearnX was consistently described by participants as diverging from conventional instructional sequencing toward a model of guided interaction. This perspective was articulated most clearly by GO1, Executive Director of the Higher Education Information Technology Centre, who reflected on the limitations of traditional online delivery during the COVID-19 period. Drawing on that experience, he emphasised that effective digital learning technologies must move beyond linear transmission and instead actively structure learner engagement. His assessment positions HyperLearnX as a system where learning progression is shaped through interaction rather than continuous exposition.

This orientation was reinforced by AC6, a university lecturer, who described interactive video not as a substitute for teaching but as a pedagogical aid that enables instructors to guide students more effectively, particularly when learners struggle or are absent. His remarks suggest that interaction operates as a form of pedagogical steering, directing attention and reinforcing understanding at specific moments rather than delivering content in an uninterrupted flow.

4.5.3.1 Interaction as Temporal Guidance

The role of interaction as a temporal organiser was highlighted explicitly by CT5, Java Developer at Arvato Systems Malaysia. He identified buffering and loading interruptions as a critical source of learner frustration in Yemen's digital environment, arguing that uninterrupted playback is rarely feasible. Instead of treating these pauses as failures, he proposed transforming them into interactive moments through embedded questions that allow subsequent content to load in the background. This reframing situates temporal interruption as a deliberate pedagogical mechanism rather than a

technical flaw. This perspective reframes technical interruption as a pedagogically usable moment rather than a system failure. Participants perceived interaction during buffering periods as a strategy for preserving engagement and reducing frustration within unstable digital environments.

This finding contributes to Research Question Three by informing adaptive interaction strategies within the HyperLearnX framework for low-bandwidth contexts.

A similar perspective emerged from CT4, PhD in Computer Science, who conceptualised buffering periods as potential learning intervals. He suggested that interactive prompts presented during loading time could reduce frustration while simultaneously reinforcing conceptual understanding. His proposal redefines time not as lost instructional space but as an opportunity for cognitive engagement, aligning interaction with rhythm rather than speed.

Together, these accounts demonstrate that temporal pauses within HyperLearnX are not random or disruptive. Instead, they are positioned by design and by pedagogical intent at moments where learners are most likely to disengage. Interaction thus functions as temporal guidance, regulating pace, sustaining attention, and preventing cognitive overload.

4.5.3.2 Interaction as Creative Direction Rather than Evaluation

Several participants stressed that interaction becomes pedagogically effective only when it is not experienced as assessment. ST2, a Bachelor's student in Graphic Design, emphasised that embedded questions strengthened understanding precisely because they were integrated naturally into the learning flow rather than presented as formal tests. She described interaction as reinforcing information and reducing repetition, particularly in group learning contexts where students may hesitate to ask questions.

Similarly, feedback from the student focus group indicated that interaction “forces you to think, not just watch,” highlighting its role in activating cognition rather than measuring performance. These observations position interaction as creative direction, guiding learners toward reflection and decision-making without invoking the pressure typically associated with evaluation. Students perceived interaction as a reflective and cognitively activating process rather than a mechanism of surveillance or

formal testing. Interactive prompts encouraged attentional engagement and conceptual processing without disrupting the aesthetic continuity of the learning experience.

This interpretation contributes to Research Question Two by demonstrating how learners experienced interactive video as supportive, engaging, and cognitively stimulating.

From a pedagogical choreography perspective, these interactive cues operate like signals within a performance: subtle, timely, and purposeful. They guide attention and meaning-making without interrupting the aesthetic continuity of the learning experience.

4.5.3.3 Educator-Led Choreography and Adaptive Use

The adaptive nature of pedagogical choreography was particularly evident in the reflections of AC5, Head of the Graphics Department at Sana'a University. She emphasised that interactive videos are effective only when instructors actively reshape their use by pausing playback, re-sequencing segments, or integrating discussion. Her assertion that “the video does not teach alone” situates the educator as a choreographer who orchestrates interaction within broader pedagogical contexts. This response highlights the continued importance of instructor mediation within digitally supported learning environments. Participants viewed interactive video as most effective when integrated into broader pedagogical practices shaped by educator interpretation and contextual adaptation.

This finding contributes to Research Question Three by reinforcing the framework's hybrid pedagogical structure, where technological guidance remains interconnected with human instructional agency.

This view was echoed by AC1, who highlighted the importance of clarity, Colour choice, and interface simplicity in sustaining engagement, particularly in technical and digital arts disciplines. He noted that interactive videos reduce unnecessary repetition in live lectures, suggesting that choreography occurs not only within the video but across the entire teaching process.

These accounts collectively frame pedagogical choreography as a distributed practice. Interaction is designed into the system, but its educational impact is realised through instructor interpretation and contextual adaptation.

4.5.3.4 Interaction as Artistic Guidance in Constrained Contexts

Within Yemen's constrained digital environment, interaction was repeatedly valued for its ability to maintain engagement under instability. CT1, Dean of the Faculty of Computer Science at Sana'a University, emphasised that lightweight interactive videos enable students in low-bandwidth contexts to benefit without continuous connectivity. His focus on minimal file size while preserving interactivity underscores how pedagogical choreography must align with infrastructural realities.

Rather than pursuing uninterrupted visual spectacle, participants advocated for intentional restraint where interaction guides learning through precision and timing. This recalibration resonates strongly with digital arts practice, where minimalism and clarity are often necessary conditions for meaning to emerge.

4.5.3.5 Reframing Pedagogical Adaptation

Taken together, these participant accounts demonstrate that pedagogical adaptation within HyperLearnX operates as a form of choreographed guidance. Interaction functions as an artistic gesture directing attention, regulating rhythm, and supporting reflection rather than as a mechanism of control or assessment.

By grounding pedagogical choreography in named participant experiences, this theme illustrates how interaction becomes meaningful not through abstraction, but through situated practice. In contexts of constraint, HyperLearnX does not merely deliver content; it guides learning through design choices informed by human insight, technical reality, and creative pedagogy.

This finding reinforces Research Question Three by demonstrating that pedagogical adaptation within HyperLearnX emerges through the interaction between contextual realities, educator agency, and adaptive design logic.

From Pedagogical Adaptation to Human & Organisational Factors examined pedagogical adaptation as a design-driven and interaction-centred process, emphasising how learning guidance within HyperLearnX emerges through choreographed interaction, aesthetic restraint, and educator-led interpretation. However, participants' accounts consistently indicated that pedagogical effectiveness alone does not guarantee sustainable adoption.

As the analysis moves forward, it becomes evident that pedagogical choreography is inseparable from the human and organisational environments in which it is enacted. Decisions related to training, institutional support, leadership priorities, and policy alignment directly shape whether adaptive pedagogical models can be realised in practice. Consequently, the discussion now extends beyond instructional design to examine Human & Organisational Factors, focusing on how beliefs, capacities, institutional structures, and systemic constraints mediate the translation of pedagogical innovation into operational reality.

4.5.4 Adaptive Assessment as Reflective Practice

Assessment within HyperLearnX was framed by participants not as a terminal act of measurement, but as an adaptive process embedded within the learning journey. Rather than functioning as a summative endpoint, assessment emerged as a reflective mechanism that supports learning progression, alignment with outcomes, and pedagogical coherence.

This perspective was articulated by GO5, an international specialist in education quality and academic accreditation, who emphasised that digital learning systems must remain outcome-oriented while allowing for staged progression. Drawing on his experience with international accreditation standards, he argued that assessment should verify whether learners are achieving incremental learning objectives rather than merely assigning grades. His remarks position assessment as a diagnostic and developmental practice, one that informs both learner and instructor about the effectiveness of instructional design. This perspective positions assessment as an ongoing reflective process embedded within learning progression rather than as an isolated evaluative event. Participants emphasised the importance of adaptive assessment mechanisms that support continuous improvement, responsiveness to feedback, and alignment with intended learning outcomes. This finding contributes to Research Question Three by informing the framework's assessment logic as a pedagogically integrated and context-sensitive process.

From an instructional standpoint, AC1 highlighted that interactive video systems reduce unnecessary repetition common in traditional lectures. While his commentary focused on instructional efficiency, it also implies a shift in assessment logic: when learning content is already refined and focused, assessment becomes less

about repetition and more about confirming conceptual clarity. In this context, adaptive assessment supports pedagogical precision rather than content volume.

Several lecturers emphasised that assessment within interactive systems must remain lightweight and non-intrusive, particularly in constrained environments. AC6 noted that educational technologies become counterproductive when they impose additional cognitive or administrative burdens on instructors. His reflections suggest that adaptive assessment should be integrated seamlessly into the learning flow, enabling instructors to monitor understanding without disrupting teaching rhythm.

At the institutional level, focus group discussions with government officials revealed that assessment practices play a crucial role in legitimising digital education initiatives. Participants stressed that any mandated adoption of digital learning must be accompanied by clear assessment frameworks, staff training, and alignment with national regulations. In this sense, adaptive assessment operates not only at the classroom level but also as an organisational assurance mechanism signalling academic rigour and accountability. These responses indicate that assessment was also perceived as an institutional legitimacy mechanism capable of strengthening trust in digital learning implementation. Assessment, therefore, operated simultaneously at pedagogical and organisational levels. This interpretation contributes to Research Question Three by demonstrating how assessment practices support both instructional adaptation and institutional accountability within the proposed framework.

Importantly, participants did not conceptualise adaptive assessment as a replacement for formal evaluation systems. Instead, it was described as a complementary layer that prepares learners for institutional assessment while preserving pedagogical flexibility. This layered approach mirrors practices in creative disciplines, where formative critique and reflective iteration precede formal evaluation.

Within HyperLearnX, adaptive assessment thus functions as a reflective practice embedded in design. It enables learners to engage with content iteratively, allows instructors to adjust guidance responsively, and supports institutional confidence in digital delivery. By prioritising reflection over surveillance and alignment over control, assessment becomes an extension of pedagogical adaptation rather than an external imposition. Table4.1 presents the alignment between the literature review, empirical findings, and the development of the HyperLearnX framework components. The table demonstrates how themes identified in Chapter Two informed the analytical

interpretation of qualitative findings and subsequently contributed to the conceptual and pedagogical structure of the proposed framework.

Table4.1

Alignment Between Literature Review, Empirical Findings, and HyperLearnX Framework Components

Literature (Chapter 2)	Finding (Chapter 4)	Framework Element
Interactive video evolution and pedagogical limitations in digital education (Section 2.2, 2.2.1)	Hypertext video is currently used in a limited, semi-linear, and under-theorised manner in Art and Design education	Pedagogical Use Diagnosis
Interactive video in developing contexts (Yemen, infrastructure, accessibility issues) (Section 2.2.2, 2.4.2)	Strong digital divide, low bandwidth, and lack of structured digital policies affect usability and access	Contextual Constraint Layer
Hypertext video in Art & Design education and colour theory (Section 2.2.3, 2.4, 2.4.1)	Hypertext video enhances visual cognition, engagement, and conceptual understanding in colour theory	Aesthetic–Cognitive Engagement Layer
Research gaps in interactive video design, pedagogy, and learner interaction (Section 2.2.4, 2.4.3)	Lack of learner agency, weak interaction design, and missing engagement structures were identified	Interaction Design Gap Layer
Technological dimensions (bandwidth, compression, video quality, platform issues) (Section 2.3)	Technical constraints directly affect accessibility, interactivity, and learning continuity	Technical Infrastructure Layer
Vygotsky Sociocultural Theory + mediation tools (Section 2.6)	Learning is socially mediated; hypertext video functions as a scaffolding tool within ZPD	Theoretical Foundation (Sociocultural Mediation)
Interactive vs linear video comparison (Section 2.6.1, 2.5)	Hypertext video outperforms linear/embedded video in engagement and navigation flexibility	Interaction Design Principle
Digital education strategies in developing contexts (Section 2.7)	Need for low-cost, scalable, adaptive frameworks suitable for low-resource environments	Framework Context Adaptation Principle

Collectively, the analytical relationships presented in the table illustrate how empirical insights informed the conceptual refinement and structural organisation of the HyperLearnX framework.

4.6 Toward an Integrated Framework for Art and Design Education

4.6.1 Synthesising the Three Dimensions

The findings from the previous sections point toward a cohesive understanding of how hypertext-interactive video can support art and design education in low-bandwidth environments such as Yemen. Although the analysis was organised into three main dimensions: Aesthetic Mediation, Creative Resilience, and Pedagogical Adaptation, participants' experiences showed that these dimensions do not operate separately. Instead, they work together to form an interconnected learning environment where visual design, technical adaptation, and guided interaction reinforce one another. The findings suggest that HyperLearnX is not dependent solely on centralised institutional implementation. Rather, its modular and lightweight structure enables gradual educator-led adoption, allowing lecturers and small departments to adapt and apply components independently, even in the absence of large-scale policy support.

From an aesthetic perspective, participants consistently emphasised that visual clarity, Colour harmony, intuitive hyperlink placement, and the overall visual clarity of the interface played a major role in helping them understand colour theory. These visual qualities were perceived not simply as “design choices” but as essential elements that made the learning process smoother, more enjoyable, and more meaningful. Students and lecturers described how the visual pacing of brief segments, clear transitions, and minimal clutter reduced distraction and made complex ideas easier to grasp.

Alongside these aesthetic factors, the technical realities of the Yemeni context had a strong influence on how participants engaged with the video. As discussed earlier, bandwidth limitations affect engagement, particularly in rural areas, and variations in device quality were recurring concerns across interviews. Rather than weakening the experience, these constraints encouraged participants to approach digital learning creatively. They imagined versions of the hypertext-interactive video that could be accessed offline, compressed efficiently, or presented in short, modular units. These ideas reflect a broader form of creative resilience, where limitations become drivers for practical, context-aware innovation.

Pedagogically, the hypertext-interactive video helped learners move through content in a guided, step-by-step manner. Embedded questions, segmented explanations, and the ability to revisit specific points allowed students to regulate their own learning, which aligns closely with Vygotsky's concepts of the Zone of Proximal Development and scaffolding. Teachers echoed this, noting that the video supported attention, motivation, and conceptual clarity, particularly in a subject like Colour Theory, where visual examples and immediate feedback are essential.

When combined, these three dimensions form a holistic system. Aesthetic structure guides the learner's perception; pedagogical scaffolding supports cognitive progression; and creative resilience ensures that the system remains functional and accessible within the challenges of the local environment. Together, they illustrate how hypertext-interactive video can evolve into a comprehensive learning model that respects both the artistic nature of the subject and the technological realities of the context. This convergence suggests that participants did not perceive aesthetic quality, pedagogical structure, and technical feasibility as isolated design components. Rather, these elements were experienced as interdependent conditions that collectively shaped engagement, comprehension, and continuity of learning. The findings, therefore, indicate that effective hypertext-interactive video design in Yemeni higher education depends on balancing visual meaning-making with contextual adaptability, particularly in environments characterised by infrastructural instability.

This synthesis directly responds to the study's third objective, which calls for the development of a guiding framework for creating and applying hypertext interactive videos in higher education. By examining how participants interpreted and navigated the medium, the study offers a grounded foundation for proposing such a framework.

In cases of bandwidth constraints, the framework prioritises pedagogical continuity over aesthetic richness, ensuring learning integrity as the primary objective. Aesthetic elements are adapted rather than eliminated.

4.6.2 Framework Visualisation and Explanation

Building on the integrated findings, the proposed framework conceptualises hypertext-interactive video as a three-layered system, where each layer complements the others to support effective learning in colour theory.

As shown in Figure 4.2 The integrated framework visualises the intersection of aesthetic, pedagogical, and technical dimensions derived from the thematic analysis.

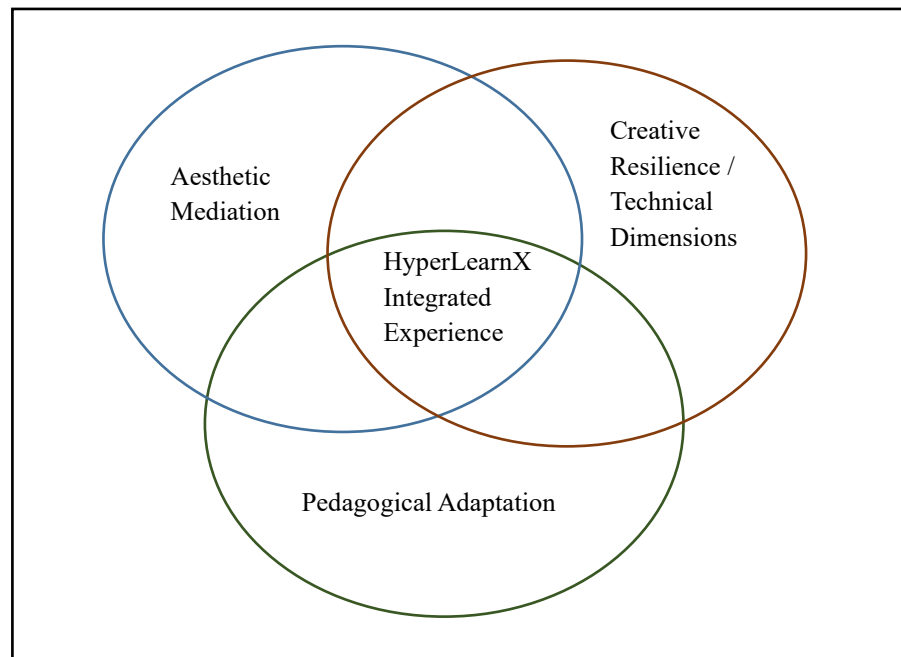


Figure 4.2 The Integrated Aesthetic–Pedagogical–Technical Framework

The overlapping areas in Figure 4.2 illustrate the interrelated and mutually reinforcing relationships among the three layers within the HyperLearnX framework.

Rather than functioning as separate operational categories, the three layers were interpreted by participants as dynamically interconnected dimensions of the learning experience. This overlap reflects how aesthetic decisions influence pedagogical engagement, while technical feasibility determines whether these pedagogical and visual strategies can be sustained in practice.

4.6.2.1 Aesthetic Layer: Visual Meaning-Making

This layer focuses on the artistic and perceptual elements that shape the learning experience. Elements such as Colour harmony, layout consistency, typography, pacing, and hyperlink visibility work together to create an environment that feels intuitive and visually coherent. In design-based subjects, these aesthetic qualities are not optional; they directly influence how learners interpret visual information and make sense of abstract concepts. Participants' reflections suggest that aesthetic organisation operates as a cognitive support mechanism rather than a decorative enhancement. Visual

consistency, controlled pacing, and interface clarity collectively assisted learners in navigating conceptual relationships within colour theory more confidently and intuitively.

4.6.2.2 Pedagogical Layer: Scaffolding and Guided Interaction

Here, interactive questions, segmented content, and immediate feedback form a structured pathway that supports the learner's cognitive development. The framework views the hypertext-interactive video as a pedagogical partner that gently guides learners through idea progression, offers opportunities for reflection, and reinforces key concepts. This layer aligns with sociocultural learning principles where understanding is built through mediated, collaborative, and reflective experiences. The findings indicate that interaction within HyperLearnX was perceived less as a testing mechanism and more as a form of guided participation. Embedded prompts, reflective pauses, and segmented explanations helped learners remain cognitively engaged while gradually building conceptual understanding through structured mediation.

4.6.2.3 Technical–Contextual Layer: Access, Feasibility, and Adaptation

The final layer responds to the technological and social conditions of the Yemeni context. It emphasises the need for lightweight design, efficient compression, offline capabilities, and compatibility with a wide range of devices. Rather than treating these requirements as limitations, the framework integrates them as essential design considerations that ensure equitable access and sustainable implementation. This perspective reframes technical constraint as an active design condition shaping both pedagogical delivery and aesthetic presentation. Participants consistently emphasised that accessibility features such as compression, modularity, and offline functionality were central to educational continuity rather than secondary technical additions.

4.6.2.4 Convergence of the Three Layers

The true strength of the framework lies in how these layers interact. Clear visuals enhance focus. Pedagogical structure enhances motivation and understanding.

Technical feasibility ensures that learners, even in areas with weak connectivity, can participate fully.

This convergence creates a learning environment where digital art education becomes inclusive, adaptive, and sustainable. The framework thus offers a practical guide for institutions, instructors, and developers seeking to implement hypertext-interactive video in Yemeni universities and similar contexts. The integrated nature of the framework demonstrates that sustainable digital learning in Yemen depends not on maximising technological complexity, but on harmonising aesthetic guidance, pedagogical clarity, and contextual feasibility. This balance enables hypertext-interactive video to function effectively within resource-constrained educational environments while preserving meaningful artistic engagement.

Figure 4.3 presents the NVivo coding tree generated during thematic analysis. The structure shows how initial open codes were progressively clustered into broader categories, ultimately forming the three overarching themes that guide this chapter.

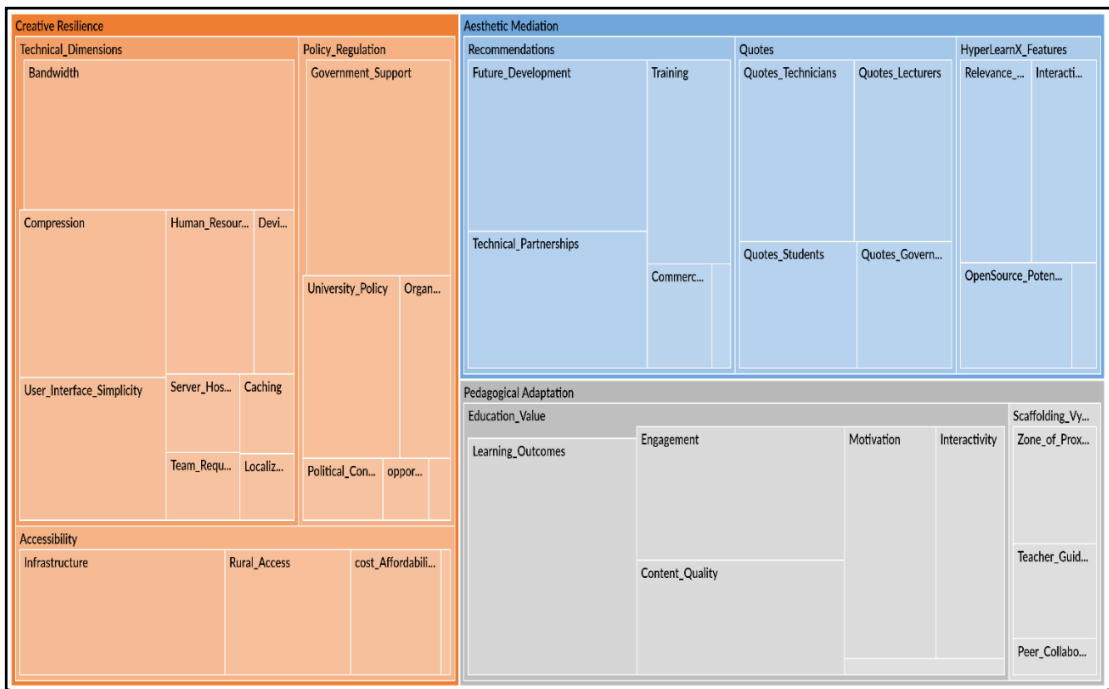


Figure 4.3 Coding Structure of Key Themes

The coding tree demonstrates the analytic coherence of the themes and highlights the recurring connections between aesthetic, pedagogical, and technical factors across participants. The progression from initial codes to broader thematic categories also reflects the iterative nature of the reflexive thematic analysis process. It

illustrates how participant experiences, although varied across institutional and technical backgrounds, repeatedly converged around interconnected concerns related to visual learning, accessibility, and guided interaction.

4.7 Contradictory Discourses in Digital Education Adoption

A recurring pattern across interviews was the presence of contradictory discourses surrounding digital education adoption in Yemen. On one hand, senior officials and institutional representatives consistently described digital transformation as an urgent national priority. On the other hand, the same participants acknowledged the absence of budgets, infrastructure, and operational capacity required to realise this vision.

This contradiction was articulated clearly by CT2, who explained that while the Ministry of Higher Education views digital transformation as a strategic necessity, implementation remains constrained by financial limitations, infrastructural instability, and fragmented national strategies. Her account reveals a gap between declarative commitment and material capability.

A similar tension emerged in focus group discussions with government officials, where participants expressed optimism about the future of interactive learning while simultaneously emphasising that existing regulations lack effective implementation mechanisms. Digital education was described as both inevitable and perpetually deferred. This contradiction reflects a recurring tension between aspirational digital policy discourse and the operational realities of implementation within fragile educational systems. Participants' accounts suggest that institutional enthusiasm for digital transformation often exceeds the material and administrative capacities required for sustainable execution.

At the institutional level, AC3 highlighted that universities often operate without dedicated budgets for digital development, focusing instead on maintaining minimum functionality amid ongoing instability. This reinforces the contradiction between long-term digital aspirations and short-term survival priorities.

Within this context, universities appear to operate through adaptive prioritisation, where immediate institutional continuity frequently takes precedence over long-term technological investment. As a result, innovation is often pursued incrementally rather than through comprehensive systemic transformation.

Spatial disparities further complicate this discourse. Several participants implicitly contrasted conditions in Sana'a with those in peripheral regions. While some institutions in the capital demonstrate relative connectivity and experimentation, rural and marginalised areas remain largely excluded from digital initiatives. This centre–periphery divide produces uneven adoption pathways, where innovation clusters coexist with widespread exclusion.

Crucially, these contradictions are not framed here as political critique, but as contextual realities shaping design feasibility. For a study situated within digital arts and creative pedagogy, acknowledging these tensions strengthens analytical credibility. It situates HyperLearnX within the lived contradictions of its environment, where desire for transformation coexists with structural constraint.

4.8 Underrepresented and Absent Themes

While participants addressed numerous technical, pedagogical, and institutional challenges, certain themes remained underrepresented or implicitly present rather than explicitly discussed. One such theme is gender.

Although rural women were mentioned as potential beneficiaries, particularly in relation to mobile learning, gendered experiences of access, time, and digital agency were not deeply explored. This absence may reflect broader social norms where women's educational engagement is discussed instrumentally rather than analytically.

The limited visibility of gendered experiences within participant discussions suggests that certain sociocultural dimensions of digital learning remain insufficiently articulated within institutional discourse. This absence points toward the need for future research that examines how gender intersects with access, participation, and creative engagement in digital art education.

Similarly, learners in highly marginalised or conflict-affected regions were often referenced indirectly, without detailed accounts of their specific constraints. The absence of these voices highlights the limits of institutional and expert-centred perspectives, particularly in contexts where access itself determines visibility.

This finding is analytically significant because it demonstrates how structural exclusion can shape not only educational participation but also research representation itself. Learners facing the greatest infrastructural barriers may simultaneously become the least visible within formal educational narratives.

Another underrepresented theme concerns emotional and psychological dimensions of learning under instability. While technical and infrastructural issues were frequently discussed, less attention was given to learner motivation, fatigue, or anxiety factors that significantly influence digital engagement.

Rather than representing analytical weaknesses, these absences are themselves meaningful findings. These underrepresented dimensions also suggest possible directions for future refinement of the HyperLearnX framework. Future iterations could incorporate emotionally responsive and gender-sensitive design considerations, including flexible pacing options, mobile-first accessibility pathways, and psychologically supportive interaction patterns tailored for learners operating within unstable or marginalised educational contexts. They reveal whose experiences are foregrounded in digital education discourse and whose remain peripheral. For a study rooted in creative and digital arts, acknowledging these silences aligns with critical design practice, making visible what is omitted as well as what is articulated.

4.9 Summary

This chapter examined how hypertext-interactive video mediates aesthetic, pedagogical, and technical transformation in resource-constrained creative education. Through reflexive thematic analysis, the findings revealed three interwoven dimensions: aesthetic mediation as a catalyst for visual cognition, pedagogical adaptation as a pathway for scaffolded and collaborative learning, and creative resilience as a response to technological scarcity. Together, these dimensions illustrate how HyperLearnX operates as an integrated sociocultural–aesthetic ecosystem, aligning Vygotskian mediation with contemporary digital design.

Collectively, the chapter demonstrates that hypertext-interactive video in Yemen cannot be understood solely as a technological innovation. Instead, it emerges as a context-sensitive educational ecosystem shaped by the interaction between aesthetic mediation, pedagogical guidance, infrastructural adaptation, and human agency. The findings, therefore, reinforce the importance of designing digital learning systems that remain pedagogically meaningful while responsive to contextual realities.

These insights form the foundation for the next chapter, which translates the thematic relationships identified here into a structured framework for implementing Hypertext-Interactive Video in art and design education. Chapter 5 synthesises these

findings into a practical and theoretically grounded model that articulates how aesthetic coherence, adaptive pedagogy, inclusive contextual accessibility, and technical accessibility can be operationalised within creative higher education, particularly in low-bandwidth environments.

CHAPTER 5

DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

Chapter Four provided a detailed analysis of the study's findings, highlighting how hypertext-interactive video mediates aesthetic understanding, fosters creative resilience, and supports pedagogical adaptation in teaching colour theory in Yemen. While that chapter focused on documenting participants' experiences, Chapter Five extends this by linking the findings directly to the research objectives, translating insights into actionable conclusions and a practical framework.

This chapter synthesises the aesthetic, technological, and pedagogical dimensions of hypertext-interactive video, revealing how they converge to enable inclusive, adaptive, and creative learning in low-bandwidth educational environments. Emphasising strategic interpretation and applied recommendations, Chapter Five offers a structured pathway to operationalise hypertext-interactive video as a sustainable pedagogical tool, consolidating the study's contributions and presenting a theoretically grounded model for enhancing digital art and design education in resource-constrained contexts.

The discussion presented in this chapter is interpreted in relation to the theoretical and empirical literature reviewed in Chapter 2, particularly studies concerning sociocultural mediation, aesthetic learning, interactive video pedagogy, and adaptive digital learning in low-resource environments. This integration strengthens the analytical linkage between the study's empirical findings and the broader scholarly discourse surrounding hypertext-interactive learning.

This chapter is structured around the three research objectives, with each section discussing, interpreting, and concluding based on the corresponding objective.

5.2 Discussion of Findings: Research Objective One – Current Situation in Yemen

5.2.1 Summary of Key Findings

The current situation in Yemen highlights critical gaps in access to digital media for art and design education, where interactive and Hypertext video could play a transformative role. According to Mousa Ghorab, a lecturer at Sana'a University and a political figure, infrastructure limitations, including low internet bandwidth, unstable electricity, and the absence of local hosting servers, significantly restrict the delivery of high-quality visual content. Similarly, CT3, a Data Analyst and EdTech researcher, explains that human resources with expertise in multimedia design, digital arts, and interactive content creation remain scarce, limiting the development of pedagogically and visually rich hypertext videos. Furthermore, CT2, a Network Engineer at the Ministry of Higher Education, emphasises that policy instability and inconsistent e-learning regulations prevent universities from adopting innovative digital tools systematically.

These challenges were identified through NVivo qualitative analysis of participant responses. The findings indicate that the integration of hypertext-interactive video in Yemeni digital arts education is primarily constrained by infrastructural limitations, fragmented institutional support, and inconsistent e-learning policies. Bandwidth instability and limited digital access emerged as the most significant technical barriers, particularly affecting students and lecturers. Institutional and policy-related challenges further hinder systematic adoption, while concerns regarding content quality highlight a misalignment between technological implementation and pedagogical design. Overall, the findings suggest that these challenges are systemic, underscoring the need for coordinated technological, institutional, and policy-level interventions to support sustainable digital arts education in low-resource contexts.

By reframing these challenges through a critical design lens, the current situation in Yemen can be understood not only as a deficit narrative but as a site of potential pedagogical reinvention. The structural limitations identified by participants create conditions for alternative models of digital art education that privilege lightweight design, creative resilience, and sociocultural mediation over technological excess. This interpretation strengthens the analytical depth of the findings and aligns them more closely with the study's creative and theoretical foundations.

5.2.2 NVivo Themes Supporting Research Objective One

Based on NVivo analysis, three main clusters emerged:

5.2.2.1 Accessibility & Infrastructure

Weak local server hosting increases latency, which negatively affects the streaming of media-rich content, as noted by the Ministry of Communications official, AC3. In addition, low connectivity, frequent outages, and limited device availability hinder students' access to interactive videos. Recommendations include implementing distributed cache servers and establishing partnerships with local telecommunications providers to support low-bandwidth content delivery, as highlighted by AC4 from academic institutions and IT support.

5.2.2.2 Technical & Human Resource Limitations

Developing hypertext interactive videos for digital arts requires a genuinely multidisciplinary effort. This work brings together software engineers, multimedia specialists, visual designers, and psychologists to ensure strong learner engagement and to prevent cognitive overload, as emphasised by CT3, Head of the Computer Science Department at Saba University. Although AI tools and low-bandwidth optimisation techniques can provide valuable technical support, successful implementation ultimately depends on sustained institutional commitment and the availability of skilled personnel, as underscored by GO1, Executive Director of the Higher Education IT Centre.

5.2.2.3 Policy & Institutional Constraints

E-learning policies remain largely fragmented, with only limited official recognition of online learning within visual disciplines, as noted by AC5, Head of the Graphics Department at Sana'a University. The adoption of interactive video technologies is often contingent on ministerial directives and their alignment with broader national digital strategies, a point emphasised by CT2. Although several pilot initiatives have demonstrated encouraging results, expanding these efforts to a wider

scale will require formalised institutional frameworks and clear resource allocation, as highlighted by GO2, Vice President of the IT Sector at the Chamber of Commerce.

As illustrated in Figure 5.1 The horizontal axis represents key accessibility and infrastructural challenges, while the vertical axis reflects the frequency with which these challenges were associated with different adaptive design strategies. The matrix demonstrates how responses such as adaptive streaming and compression functioned as enabling mechanisms, allowing visual and interactive components to remain effective under bandwidth constraints. In contrast, future-oriented development strategies were more closely tied to learning outcomes, highlighting the role of thoughtful design adaptation in sustaining engagement and meaning within digital art learning contexts.

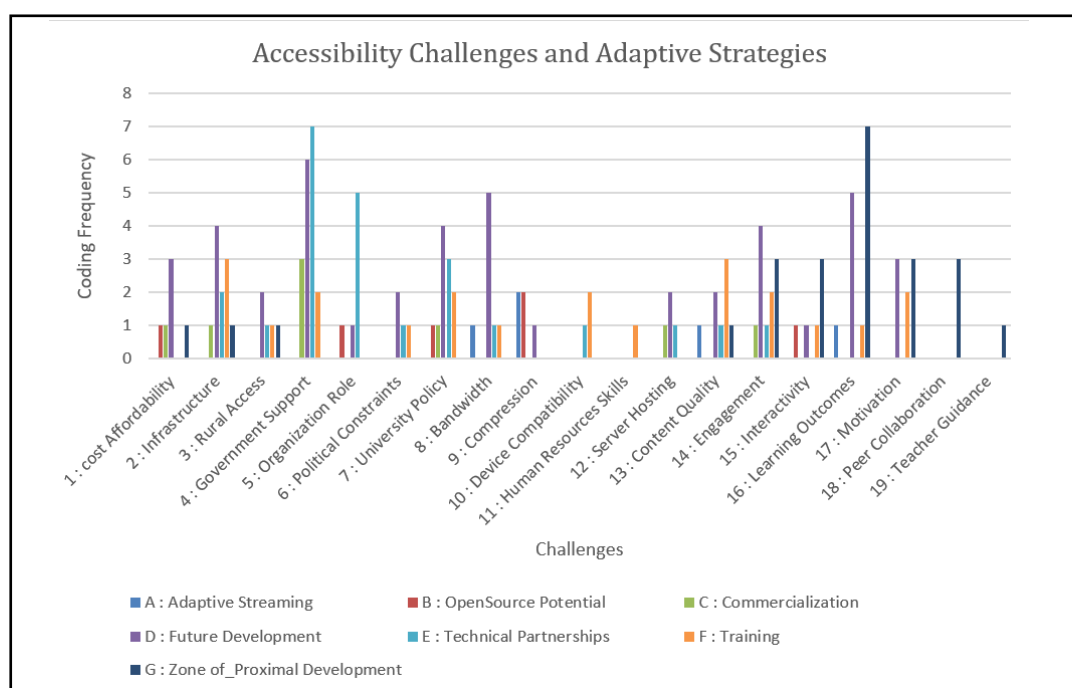


Figure 5.1 Matrix Coding of Accessibility Challenges and Adaptive Design Strategies

5.2.3 Interpretation of the Situation

The findings suggest that while hypertext interactive video holds significant potential for visual learning in art and design, the Yemeni context presents systemic barriers. The combination of weak infrastructure, scarce specialised human resources, and unstable institutional policies explains why interactive videos are not widely used. For key stakeholders, including researchers, university administrators, and policymakers, these results indicate the need for holistic interventions that integrate

low-bandwidth, visually optimised content, trained creative personnel, and clear institutional mandates. Table 5.1 presents a structured overview of recommended interventions across three key areas: Infrastructure, Team Composition, and Policy Support to enhance the implementation of digital and interactive learning. Each category includes concise, actionable recommendations, accompanied by references to relevant experts and their positions. The inclusion of multidisciplinary experts highlights the breadth of perspectives and ensures that the suggested interventions are grounded in practical experience, technical expertise, and academic insight. This table serves as a reliable reference point for both policy-making and educational planning in digital learning contexts.

Table 5.1
Summary of Recommended Interventions and Expert References for Digital Learning Implementation

Category	Recommended Interventions (Condensed)	Experts Referenced (with Positions)
Infrastructure	Prioritise low-bandwidth design (mobile-first, lightweight, and compressed video). Improve national connectivity (4G expansion, fibre upgrades, and reducing outages). Deploy local university servers and distributed caching nodes to reduce latency. Ensure compatibility with low-end smartphones and limited devices.	AC3 (Sana'a University); AC5 (Lecturer, Head of Graphics Department, Sana'a University, Head of Control Unit); ST2 (Bachelor's in Graphic Design); GO5 (International Specialist, PhD in Computer Science, Expert in Education Quality); CT1 (Technician & Lecturer, Dean of the Computer College, Sana'a University); GO2 (PhD in IT, President of Yemeni Union); AC1 (IT Department, FCIT, Sana'a University); AC4 (Academic and IT expert); AC2 (Head of Computer Science Department, Saba University)
Team Composition	Build multidisciplinary teams (programmers, multimedia specialists, visual designers, psychologists). Include network engineers, cloud specialists, hardware/IT experts, and cybersecurity personnel. Add video-production and digital-media experts to maintain content quality. Ensure academic staff collaboration in adapting materials. Establish structured roles (product owner, tech lead, architect, business analyst, QA). Strengthen institutional support for sustainability and long-term planning.	CT3 (Master's in Data Science, APU); CT1 (Technician & Lecturer, Dean of the Computer College, Sana'a University); GO1 (Executive Director, Higher Education IT); CT2 (Network Engineer, Master of IT, Malaysian University); AC2 (Head of Computer Science Department, Saba University); CT5 (Java Developer, Arvato Systems Malaysia Technical Consulting); GO2 (PhD in IT, President of Yemeni Union)

Policy Support	Issue ministerial decisions enabling interactive and online learning models. Formally recognise e-learning in visual disciplines within the national education policy. Align adoption with digital-transformation strategies. Expand institutional approval for blended delivery (around 25% online). Allocate resources and frameworks to scale pilot initiatives. Encourage government–university–industry partnerships. Provide subsidised data packages for educational platforms. Apply bandwidth-management policies to reduce unnecessary traffic.	CT1 (Technician & Lecturer, Dean of the Computer College, Sana’a University); AC5 (Lecturer, Head of Graphics Department, Sana’a University, Head of Control Unit); CT2 (Network Engineer, Master of IT, Malaysian University); AC4 (Academic and IT expert); GO2 (PhD in IT, President of Yemeni Union); GO5 (International Specialist, PhD in Computer Science, Education Quality Expert); AC1 (IT Department, FCIT, Sana’a University)
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5.2.4 Connection to Research Problem

These findings directly address the research problem concerning the unclear status of hypertext interactive video in Yemeni digital education. They confirm that the pedagogical role, design, and application of such media are poorly defined in practice. By highlighting infrastructure, human resources, and policy gaps, the study justifies the necessity for a contextually grounded framework for hypertext video, particularly for visual disciplines in underserved regions. The results additionally support the adoption of low-bandwidth, adaptive, and culturally sensitive solutions for art and design students in Yemen.

These interrelated challenges associated with Research Question 1, which focuses on understanding the current digital education situation, are visually synthesized in Figure 5.2, which maps the core problem, the associated gaps, and the corresponding objective, providing a clear conceptual view of the current digital education situation in Yemeni universities.

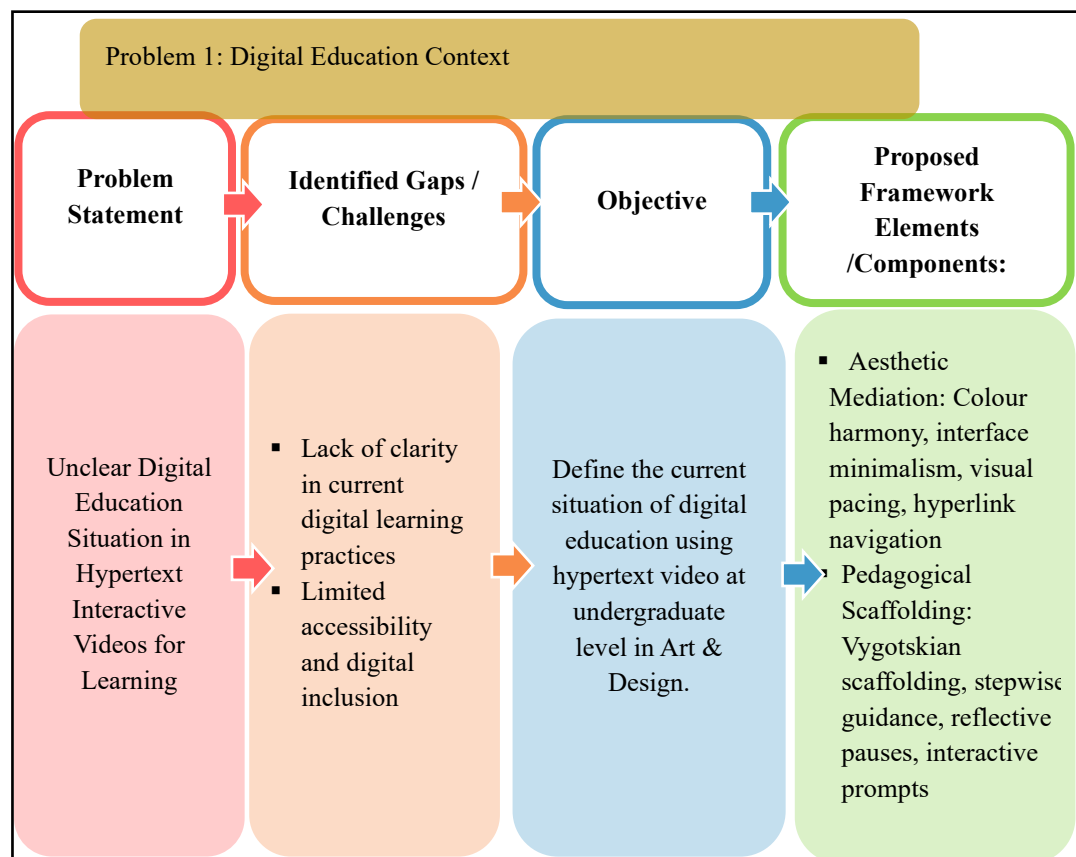


Figure 5.2 Conceptual Diagram of the Digital Education Situation

5.3 Discussion of Findings: Research Objective Two

The Role and Design Components of Hypertext Interactive Videos in Teaching colour theory

5.3.1 Summary of Key Findings for Research Objective Two

The findings related to Research Objective Two demonstrate that interactive hypertext video, when designed with adaptive compression, integrated hyperlinks, and minimal user interface complexity, significantly enhances students' conceptual understanding of colour theory, particularly within low-bandwidth and resource-constrained environments such as Yemen. Across creators, lecturers, and students, four interrelated design components emerged as central: adaptive technical design, aesthetic clarity of interface, pedagogical scaffolding, and interactive mechanisms that maintain learner engagement without imposing cognitive overload.

Experts in computer science and educational technology, including CT3 (Data Analyst, APU) and CT1 (Dean, College of Computer Science, Sana'a University), consistently emphasised that HyperLearnX's combination of lightweight video delivery and embedded interactive questions addresses the persistent infrastructural limitations that hinder digital learning in Yemen. This perspective was strongly reinforced by GO1 (Executive Director, Higher Education IT Centre), who described HyperLearnX as an "innovative societal achievement" precisely because it bridges the gap between pedagogical needs and technological constraints.

From the pedagogical side, lecturers such as AC1 (Faculty of Computer and IT, Sana'a University) and AC5 (Head of Graphics Department, Sana'a University) recognised that Hypertext video facilitates students staying focused, reduces repetition, and promotes self-directed learning, a particularly important advantage in visually intensive subjects comparable to colour theory. Their evaluations align with students' feedback: CT6 (MA in AI, Al-Razi University) and AC7 (Graphic Design, LIU Yemen) noted that the hyperlinks, visual cues, and embedded questions improved clarity, saved time, and compensated for the lack of hands-on access to physical colour-mixing environments.

Furthermore, the NVivo coding revealed a strong preference among all groups for simplicity of interface, open-source integration with LMS platforms, and compatibility with weak 3G/4G networks, features that directly support accessible art

and design education in Yemen. In summary, the findings confirm that HyperLearnX's design components align with real pedagogical, aesthetic, and technological demands, demonstrating clear potential for improving the teaching of colour theory by merging visual clarity, interactive structure, and adaptive streaming within a single, cohesive learning model.

To address Research Objective Two, the NVivo matrix-coding query was used to compare how each participant group referenced the key themes related to HyperLearnX adoption, including technological features, pedagogical adaptation, and Vygotskian scaffolding. The results revealed clear variations in emphasis across groups, particularly in learning outcomes, engagement, interactivity, and contextual relevance. These differences are summarised in Table 5.2.

Table 5.2
NVivo-Coded Thematic Distribution of HyperLearnX Adoption Factors Across Participant Groups.

Cluster	Group→ NVivo Codes↓	Government Officials, Ministry of Education, Ministry of Communications	Lecturers and Educators	Student Focus Group	Creators and Technicians of Interactive Video	University Students
HyperLearnX Features	Adaptive Streaming	0%	0%	0%	3.72%	0%
	Interactive Questions as a link	0%	7.58%	0%	27.26%	8.32%
	Opensource Potential	0%	0%	0%	19.28%	0%
	Relevance to Context	3.43%	9.44%	0%	12.9%	11.21%
	Content Quality	17.28%	14.37%	16.78%	11.04%	12.31%
Pedagogical Adaptation	Easy to use	0%	0%	3.97%	0%	0.96%
	Engagement	25%	12.57%	8.39%	5.98%	16.46%
	Interactivity	0%	3.31%	17.22%	7.85%	6.54%
	Learning Outcomes	40.93%	20.14%	15.23%	11.97%	25.56%
	Motivation	3.06%	16.96%	22.74%	0%	7.41%
Scaffolding Vygotsky	Peer Collaboration	0%	2.41%	3.97%	0%	0%
	Teacher Guidance	9.68%	4.03%	4.86%	0%	1.4%
	Zone of Proximal Development	0.61%	9.2%	6.84%	0%	9.83%

5.3.2 NVivo Themes Supporting Research Objective Two

A. HyperLearnX Features (Adaptive Streaming, Interactive Links, Open-Source Potential) The NVivo analysis illustrated that participants with technical and educational backgrounds strongly endorsed the core design elements of HyperLearnX, particularly its adaptive compression, hyperlinked interaction, and open-source compatibility. These features were consistently perceived as essential for delivering visual content, such as Colour harmony, gradients, and light–shadow relationships, in a bandwidth-limited environment.

5.3.2.1 Adaptive & Lightweight Streaming

Technical experts emphasised that adaptive compression is not merely a convenience but a fundamental requirement for viable digital learning in Yemen.

For illustration, CT1, Dean of the College of Computer Science at Sana’a University, stated that interactive video becomes “highly effective when designed to produce lightweight videos with minimal file size while preserving interactivity.” He highlighted that such optimisation allows art and design students, many of whom rely on weak 3G networks to access high-quality instructional content that would otherwise be inaccessible.

Similarly, AC1, a senior academic in IT, affirmed that “as long as the video is compressed and its size reduced, it is suitable for the Yemeni environment,” underscoring the infrastructural necessity of this feature.

From the creators’ perspective, GO1 noted that AI-supported compression is now sufficiently advanced to reduce redundant visual elements without harming educational clarity, aligning closely with the researcher’s SmartZone Compression model. Within the scope of this qualitative study, these technical components are presented conceptually as proposed framework features derived from participant-informed design considerations rather than empirically validated engineering solutions.

5.3.2.2 Interactive Links and Embedded Questions

Across the dataset, interactivity emerged as a central functional and pedagogical asset. Technical creators such as CT1 emphasised that hyperlinks and embedded

questions “promote self-directed learning” and transform linear video into a structured understanding pathway.

This was echoed by CT3 (Data Analyst, APU), who associated HyperLearnX with interactive technologies used in advanced platforms such as Netflix or game-based narratives, calling the model “a brilliant idea” due to its non-linear design. Students strongly validated this view.

CT6 (MA, AI) praised the immediate feedback mechanism, noting that “answering a question and getting instant responses enhances understanding and saves time.” Similarly, AC7 (Graphic Design) emphasised that hyperlinks are essential in visual subjects, owing to “Colours require practical, hands-on steps that linear videos cannot provide.” Such reflections directly support the relevance of hypertext interaction in teaching colour theory, where iterative exploration of hue, saturation, and contrast is central.

5.3.2.3 Open-Source Integration and Cost Reduction

A recurring theme across interviews was the preference for open-source implementation, both to minimise institutional costs and to ensure scalability.

Experts such as GO1 and GO2 (President, Yemeni Union for ICT) highlighted that those tools, similar to Moodle and OpenCV, offer viable infrastructure for deployment, reducing dependence on expensive commercial platforms. CT5, a Java Developer at Arvato Systems Malaysia, explained that open-source microservices could support handling interactive components (e.g., embedded questions) while keeping server costs minimal, an important factor for universities with limited budgets.

AC4, an academic and IT expert, further emphasised that HyperLearnX is particularly suitable for local server deployment within universities, enabling fast access even under weak internet conditions and supporting future scalability to other developing regions.

5.3.2.4 Synthesis of Theme

Collectively, these insights reveal that HyperLearnX’s technical design, its adaptive streaming, interactive structure, and open-source potential are perceived as both feasible and highly relevant to teaching the subject of colour theory in Yemen.

Participants viewed the system not simply as a technological tool, but as a strategic response to infrastructural constraints, pedagogical gaps, and the requirement for accessible visual learning in underserved communities.

5.3.2.5 Pedagogical Value

(Learning Outcomes, Engagement, Motivation, Contextual Relevance) The pedagogical value of HyperLearnX emerged as one of the strongest NVivo themes supporting research objective two, highlighting how interactive hypertext video aligns with outcome-based education, reduces cognitive load, and responds directly to the contextual learning demands of Yemeni students. Three major dimensions shaped participants' evaluations: learning outcomes, learner engagement, and contextual relevance to low-bandwidth environments and social constraints.

Firstly, alignment with learning outcomes and outcome-based education Senior governmental and academic experts emphasised that effective digital learning must be firmly grounded in outcome-based instructional design.

GO5, an international specialist in academic accreditation, stressed that “learning outcomes are the foundation of everything: content, strategies, activities, assessments, even the platform design itself.” His perspective closely aligns with global OBE standards, which view digital tools not as content repositories, but as structured learning environments supporting measurable competencies.

HyperLearnX's structure, short segments, embedded checkpoints, intentional pauses, and hyperlinked clarifications create a scaffolded learning environment consistent with Vygotsky's Zone of Proximal Development (ZPD), in which step-by-step supports allow students to progress from basic Colour identification to a deeper understanding of harmony, contrast, and perceptual relationships.

CT1 (Dean, College of Computer Science) reinforced this alignment, noting that interactive video “allows students to rewatch unclear sections and supports practical understanding, especially in subjects such as computer graphics.” This rewatchability reflects Mayer's Cognitive Theory of Multimedia Learning, enabling students to control cognitive load by revisiting Colour concepts at their own pace.

Secondly, engagement, motivation, and overcoming participation barriers interviews revealed strong pedagogical benefits related to learner motivation and

engagement, particularly among students who struggle with traditional classroom dynamics.

For instance, CT6 highlighted the motivational effect of receiving “immediate feedback following answering each question,” which transforms passive observation into active cognitive processing. Female students, especially those facing social or familial constraints, expressed similar motivations.

AC7 (Graphic Design) explained that interactive video would have allowed her to continue learning during periods when she could not attend face-to-face classes due to childcare demands, noting:

“This technology makes learning much easier and more accessible. For someone like me, it is not just useful, it is necessary.” Educators, moreover, recognised motivational gains. CT1 reported that interactivity assists “in overcoming the hesitation and embarrassment students feel when asking questions during in-person classes.” Similarly, AC1 described how embedded questions and visual cues “reduce repetition and make the learning process more efficient.”

Students in the 15-member focus group strongly reinforced this point:

“Interaction prevents distraction; you have to respond.” “The video guides you step by step; it saved my time and kept me focused.” These responses demonstrate that HyperLearnX promotes active learning, higher engagement, and self-paced exploration, all essential for understanding complex visual concepts such as hue shifts, neutralisation, warm–cool contrasts, and simultaneous contrast in Colour Theory.

Thirdly, contextual relevance to Yemen’s digital and social reality, the pedagogical benefits of HyperLearnX are magnified by its responsiveness to Yemen’s unique constraints. Experts such as AC4 (Academic and IT Expert) emphasised that students often rely on lengthy, unfocused YouTube videos that exceed their bandwidth and patience, whereas concise hypertext videos “are far more effective for low-bandwidth contexts.”

Government officials, including participants from the Ministry of Higher Education, affirmed that interactive video could support students in remote areas, female learners with mobility limitations, and those displaced by conflict or economic hardship. GO1 (Higher Education IT Centre) called HyperLearnX “a major societal achievement” precisely because it responds to such real constraints.

In summary, the pedagogical value of HyperLearnX lies in its alignment with learning outcomes, activation of student motivation, and addressing contextual

inequities, making it an effective tool for teaching colour theory in environments where traditional resources are limited or inaccessible.

5.3.2.6 Interactivity

The Central Mechanism of Learning in colour theory

Interactivity emerged as the core driver of learning, repeatedly identified by students, lecturers, and technical experts as the element that transforms HyperLearnX from a passive video tool into a dynamic learning system. In colour theory, where conceptual understanding depends on visual experimentation, perceptual judgment, and iterative comparison, hypertext interaction becomes not just valuable but essential.

Firstly, hyperlinks as cognitive scaffolds hyperlinks embedded within the video, allow learners to instantly access clarifications on Colour harmony, complementary schemes, warm–cool dynamics, or gradient formation. AC7, a Graphic Design student, emphasised that in Colour -related subjects, “it is almost impossible to rely on linear video. You necessitate hands-on steps, and the links provide exactly that.” Similarly, CT6 noted that hyperlinks function similarly to “a mini-library inside the video”, allowing him to connect theoretical explanations with practical demonstrations without leaving the platform. This aligns with retrieval-based learning principles, where linked resources reduce cognitive friction and enhance the integration of new visual knowledge.

Secondly, embedded questions and immediate feedback. Across all participant groups, embedded questions were cited as the most impactful feature. Focus group students reported: “The interactivity forces you to think, not just watch.” “I understood faster; the video guided me step by step.” Lecturers confirmed similar observations. AC1 highlighted that interactive questions “alert students and enhance the learning process, especially in practical subjects.” Meanwhile, AC2 (Saba University) emphasised how the combination of “short length, attractive Colours, and variety of questions” makes the video highly effective for student learning.

In the context of Colour Theory, these interactive checkpoints assist students in testing their understanding of complementary relationships, value contrast, saturation shifts, and harmony principles, preceding moving forward effectively operationalising Vygotsky’s scaffolding inside the video itself.

Thirdly, interactivity is a solution to distraction and cognitive overload.

Many students expressed that they lose focus in traditional video learning: “I usually lose focus after 5 minutes; nevertheless, here I stayed engaged.” “Interaction prevents distraction; you have to respond.” This supports the Cognitive Load Theory, which states that active, segmented learning minimises extraneous load and enhances schema-building. HyperLearnX’s interactive structure ensures that learners do not become passive recipients yet remain cognitively invested, especially important in complex visual reasoning tasks such as distinguishing subtle Colour temperature shifts or identifying analogous schemes.

Fourthly, interactivity and social equity

For marginalised groups, rural learners, female students, and working youth, interactivity becomes an alternative to traditional classroom participation. ST2 (Graphic Design) explained that interactive questions allowed her to “ask” the video questions she would hesitate to ask in class, facilitating her to overcome social and academic barriers.

Thus, interactivity in HyperLearnX supports equitable access to practical Colour-learning experiences otherwise unavailable due to infrastructural, social, or economic constraints.

5.3.2.7 User Interface & Aesthetic Simplicity (Visual Design, Minimalism, Colour Harmony).

User interface simplicity emerged as a critical aesthetic and functional factor, influencing students’ comprehension, engagement, and overall learning satisfaction. Since Colour Theory inherently requires precise visual perception, the interface design becomes not merely decorative but a pedagogical asset.

Firstly, a minimalist interface and cognitive clarity. Participants repeatedly stressed the importance of clear, uncluttered design. AC1 praised the HyperLearnX interface as “neat, with Colours that made the questions and answers clear and easy to read.” This aligns with minimalist design principles, reducing extraneous stimuli and enabling students to focus on essential Colour relationships, gradients, and visual contrasts.

Similarly, CT2 (Network Engineer) highlighted that the interface should remain “simple and efficient to meet the requirements of students with limited technological experience.” This is especially important in Yemen, where digital literacy varies widely.

Secondly, Colour harmony is an instructional element. The intentional use of harmonious Colour schemes in the interface supports perceptual learning, demonstrating colour theory concepts within the learning environment itself. Students responded positively to this design choice:

AC2 described the Colour choices as “attractive,” while AC5, Head of the Graphics Department, noted that the removal of visual noise and repetitions “supports students in extracting information quicker.” The UI thus functions as both aesthetic guidance and pedagogical reinforcement, modelling good design practice while maintaining perceptual clarity for Colour demonstrations.

Thirdly, ease of navigation and accessibility. Many students emphasised usability as a core value: “It was very easy, and anyone can use it.” ST2 “The video is simple and does not require extra guidance.” Mohanad Khalid “The links made the information clearer and easier to follow.” Focus group feedback. This reflects the principles of user-centred design, ensuring that learners, regardless of background, can navigate Colour lessons intuitively.

Fourthly, supporting low-bandwidth environments without sacrificing aesthetic quality. Experts such as AC1 and AC4 emphasised that interface minimalism is especially critical in Yemen, where device limitations, weak connectivity, and low processing power require visually clean, lightweight UI designs. By maintaining visual harmony while reducing interface complexity, HyperLearnX fulfils both aesthetic and infrastructural demands, demonstrating that even in constrained environments, digital Colour education can remain visually rich and pedagogically effective.

To complement the matrix-coding results, an NVivo-generated visualisation was developed to illustrate the overall frequency of RO2 themes across the dataset. Figure 5.3 summarises how often each thematic category, HyperLearnX features, pedagogical adaptation, interactivity, and Vygotskian scaffolding was referenced by participants. The distribution highlights the dominant weight of *Learning Outcomes* and *Content Quality*, followed by strong references to engagement, interactivity, and motivation.

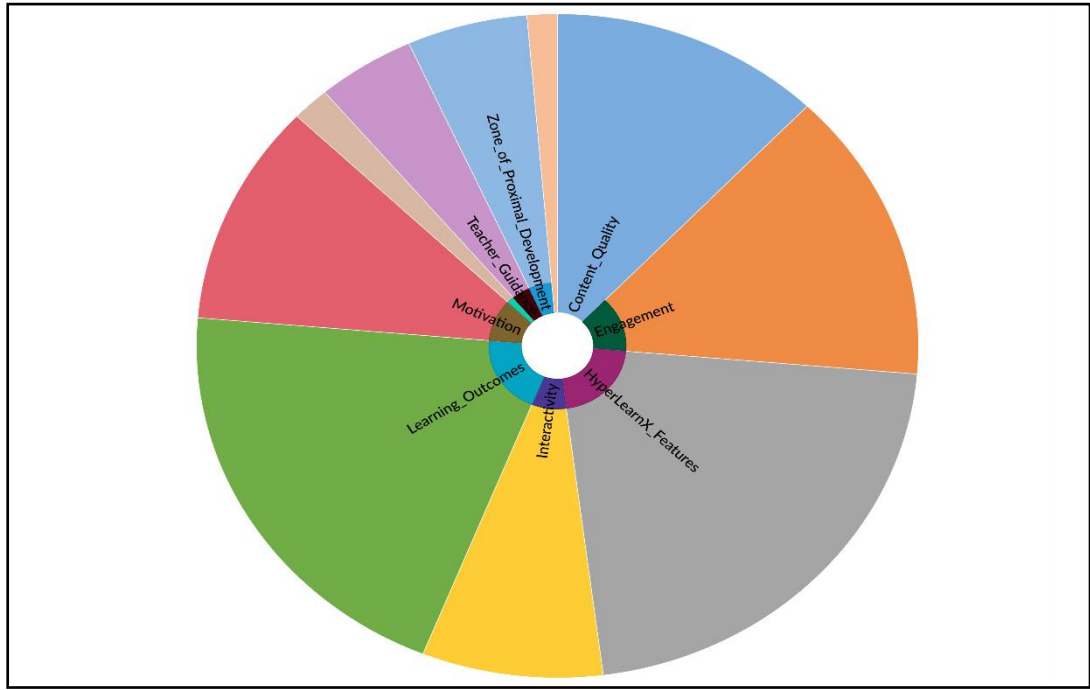


Figure 5.3 Visual Distribution of RO2 Thematic Frequencies Across NVivo-Coded Categories

5.3.3 Interpretive Discussion (Interpretation of Research Objective Two)

The Aesthetic–Interactive–Pedagogical Synthesis in Hypertext Interactive Video for colour theory. The interpretive analysis of the second research objective demonstrates that the pedagogical value of hypertext interactive video in teaching colour theory arises from a dynamic interplay between aesthetic clarity, interactive scaffolding, contextualised pedagogy, and lightweight technological design. Rather than functioning independently, these elements converge into a unified learning ecology that responds directly to the cognitive, social, and infrastructural realities of Yemeni higher education.

Based on the cross-theme interpretation, a conceptual model was developed to illustrate how the four major second research objective categories interact to influence learners’ understanding of colour theory. The model positions aesthetics, interactivity, and pedagogy as mutually reinforcing dimensions, while technical constraints act as a limiting factor that shapes how these elements function in practice. Collectively, these relationships contribute to explaining how HyperLearnX supports improved lessons, such as colour theory understanding. The conceptual structure is illustrated in Figure 5.4.

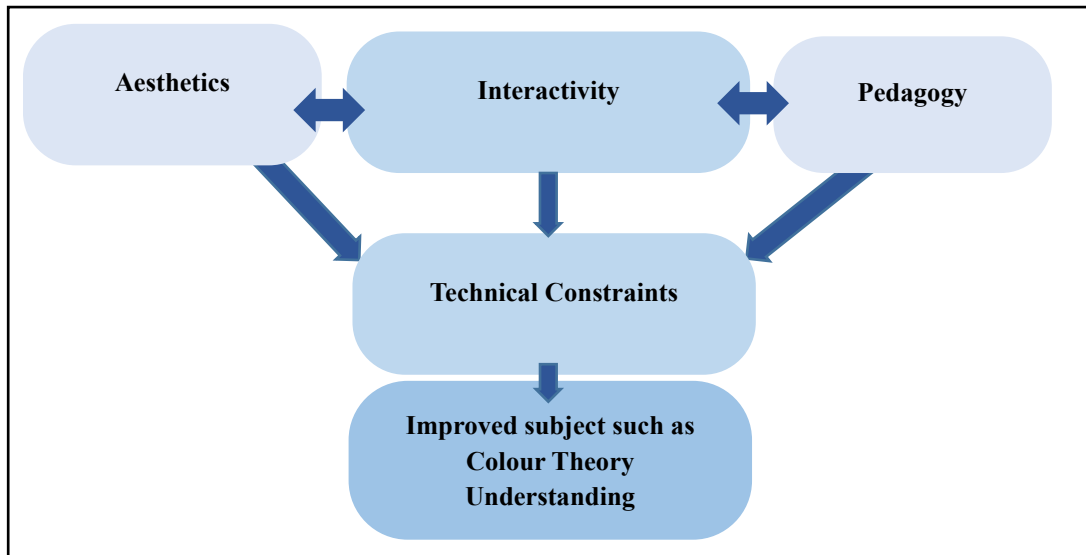


Figure 5.4 The Aesthetic Interactive Pedagogical Technical Convergence in Hypertext-Interactive Video for Colour Theory.

This model illustrates how the four dimensions identified in the second research objective interact to form an integrated learning ecology that supports visual understanding under Yemeni infrastructural constraints. Aesthetic simplicity emerged as a central thread across responses, consistently described by participants as a form of “visual minimalism that acts as a cognitive aid.” AC1, Professor of Computer Science and technologist, emphasised that the clean interface, harmonious Colours, and balanced typography “made the questions and answers clear and easy to read,” turning the visual layer itself into a pedagogical support. Students echoed this sentiment, with one describing the experience as “short, attractive, and easier to understand,” particularly when dealing with visually complex topics such as hue interaction and saturation. In Yemen’s context, where many students rely on low-end smartphones, small screens, and unstable networks, this aesthetic minimalism functions not merely as a design choice; nevertheless, as a cognitive filter that reduces visual noise and directs attention to core Colour relationships.

Interactivity furthermore emerged as a powerful scaffold aligning with Vygotsky’s Zone of Proximal Development. Hyperlinked definitions, in-video branching questions, and adaptive feedback structured learning into manageable conceptual steps. CT1, technologist and lecturer, described these features as “stimulating and promoting self-directed learning,” while the Student Focus Group reported that “the video guides me step by step.” ST1, a mechatronics student, highlighted the value of immediate comprehension checks, noting that such questions

“facilitate measuring understanding instantly.” Government official GO5, a specialist in education quality and accreditation, similarly affirmed that these interactive mechanisms align with progressive learning design frameworks. In the context of colour theory, where understanding shifts gradually from hue to harmony to contrast, this scaffolding becomes essential in supporting incremental mastery and preventing cognitive overload.

These interactive functions take on deeper significance when situated within Yemen’s educational constraints. Lecturers emphasised that students often avoid asking questions in class due to shyness or lack of confidence; thus, embedded questions and hyperlinked explanations quietly democratize participation. AC5, Lecturer and Head of the Graphics Department at Sana’a University, described HyperLearnX as “very practical and time-saving,” especially for students who usually “fast-forward through long videos.” Students, in turn, viewed the interactive video as “a mini library inside the video,” a compelling metaphor in a setting where books, studio resources, and reliable internet are limited. This pedagogical mediation, therefore, compensates for structural inequalities, allowing students to progress autonomously through conceptual material that might otherwise require face-to-face instruction.

The technical dimension of mediation further shaped learning outcomes by transforming infrastructural limitations into design opportunities. Interviewees repeatedly described weak internet as the most formidable barrier, noting that effective learning depends on lightweight, adaptive video formats. A government official in the ministerial focus group explained that “a two-hour lecture can be compressed into fifteen minutes with questions inside, and it works even with weak internet,” reflecting the importance of compression and adaptive delivery. CT4, PhD in Computer Science and senior academic expert, stressed that instructional content must be developed from credible texts and not “random online videos,” underscoring the necessity for scholarly integrity alongside technical efficiency. For a visually sensitive subject such as colour theory, where accurate perception of gradients and contrasts is fundamental, the technical architecture becomes pedagogical: compression, buffering, chapter-based streaming, and microservices directly influence perceptual clarity and conceptual understanding.

Collectively, the second research objective reveals that in the Yemeni context, technical design is pedagogical design. The aesthetic, interactive, and technological layers do not merely support learning; they constitute the learning process by enabling

students to engage with visual knowledge under real-world constraints. Hypertext interactive video thus emerges as a culturally, cognitively, and infrastructurally resonant instructional modality for teaching colour theory.

5.3.4 Proposed Design Implications for Colour Theory Learning

The implications of the second research objective point toward an integrated set of design principles that can guide the development of hypertext interactive video for colour theory in Yemen. Given the cognitive and aesthetic demands of the subject, as well as the infrastructural limitations faced by learners, the design of such videos must balance visual precision, pedagogical scaffolding, and technological efficiency.

Aesthetically, the videos should employ minimalist layouts that foreground essential visual elements while suppressing distractions. Harmonious Colour palettes and clear, high-contrast typography are necessary to ensure readability on low-quality screens commonly used by Yemeni students. Static backgrounds and uncluttered compositions assist in maintaining Colour accuracy under compression, preventing artefacts that could distort the perception of hue or contrast. These choices are not decorative by contrast; pedagogically aligned with the visual discipline of colour theory itself, where clarity of form and precision of Colour are integral to comprehension.

Pedagogically, the structure of each video must follow an outcome-based sequence, with every segment mapped to a specific learning objective to exemplify, identifying complementary pairs, distinguishing saturation levels, or analysing harmony schemes. Hyperlinked terms and on-demand definitions can provide micro-scaffolds at key conceptual transitions, enabling students to revisit foundational ideas without disrupting the flow of learning. Embedded questions should be positioned at meaningful junctures, prompting learners to reflect on their understanding before progressing. Incorrect answers can trigger brief explanatory clips to address misconceptions, a strategy supported by both lecturers and students as a means of strengthening retention and accountability. However, as AC5 cautioned, excessive hyperlinks may become overwhelming; therefore, interactivity should remain purposeful, concise, and cognitively aligned.

Culturally relevant examples can further enhance engagement. Given the limited availability of global design resources, integrating Yemeni textiles, architectural motifs,

and local Colour traditions supports anchoring abstract concepts in familiar visual contexts, making learning both accessible and meaningful.

Technologically, videos must be engineered for low-bandwidth environments. Modular, chapter-based encoding improves buffering on unstable networks, while adaptive delivery mechanisms ensure continuity of playback on 3G connections. Integration with existing learning management systems, including Moodle, provides opportunities for analytics, assessment, and structured progression. Interfaces should remain lightweight, responsive, and fully functional on low-end Android devices, which constitute the primary learning tools for most university students in Yemen.

These implications form a cohesive design blueprint for transforming colour theory education through hypertext interactive video in a way that is pedagogically robust and contextually sensitive.

5.3.5 Connection to the Research Problem

The interpretive insights of research object two offer a direct contribution to Research Problem 2, which centres on the challenges of implementing hypertext interactive video in Yemeni universities. The infrastructural constraints documented across interviews, weak internet, limited access to computers, costly data bundles, and reliance on basic smartphones, reveal that the proposed instructional modality must be deliberately engineered for minimal bandwidth consumption. Rather than treating these limitations as external obstacles, the findings position them as foundational design parameters that shape how educational videos should be produced, compressed, and delivered.

Pedagogically, the social and cultural environment further reinforces the necessity of guided, scaffolded video design. Many Yemeni students lack prior exposure to structured digital learning, leading to difficulties in navigating long or complex visual material without support. Research object two demonstrates that features such as embedded questions, adaptive feedback, hyperlinked clarifications, and chapter-based progression are not optional enhancements; by contrast, essential mechanisms that enable autonomous learning. This is particularly critical in colour theory, where conceptual understanding depends on iterative visualisation and cumulative reasoning. The integration of contextual examples, such as local textiles or

Colour traditions, supports grounded abstract concepts in culturally meaningful visual references.

Institutional challenges add another layer of complexity. Lecturers, administrators, and government officials repeatedly emphasised that effective implementation requires more than introducing an isolated tool; it demands alignment with existing learning management systems, staff training, and supportive policies. AC1 and technologist CT1 both highlighted that HyperLearnX would be most effective when embedded within an LMS such as Moodle, where assessment, interaction, and analytics can be integrated into a broader pedagogical process. Institutional incentives, such as grades, certificates, or participation marks, also shape student engagement, a point reinforced by government official GO5, who noted that structured incentives are critical in environments where students may otherwise passively watch videos without deep involvement.

The social realities of Yemeni learners, including displacement, rural isolation, high connectivity costs, motherhood, and part-time work, further underscore the need for flexible, self-paced learning modalities. Students' testimonies about the value of "short videos that save time" and the ability to revisit interactive content at their own pace reinforce that hypertext interactive video can mitigate barriers to education that extend beyond the classroom. By offering concise, visually guided, cognitively scaffolded, and mobile-friendly learning, the technology aligns with the lived circumstances of students who cannot reliably attend face-to-face sessions or access consistent online resources.

Thus, RO2 provides a comprehensive response to the research problem by demonstrating how aesthetic design, interactivity, pedagogy, and technological optimisation together address the multi-layered challenges of education in Yemen. Hypertext interactive video does not merely supplement existing instruction; it restructures the learning environment to accommodate infrastructural, institutional, pedagogical, and social realities, offering a viable pathway for equitable access to visual education. The technical and pedagogical challenges identified are summarised in Figure 5.5, highlighting the necessity for adaptive and context-sensitive design solutions.

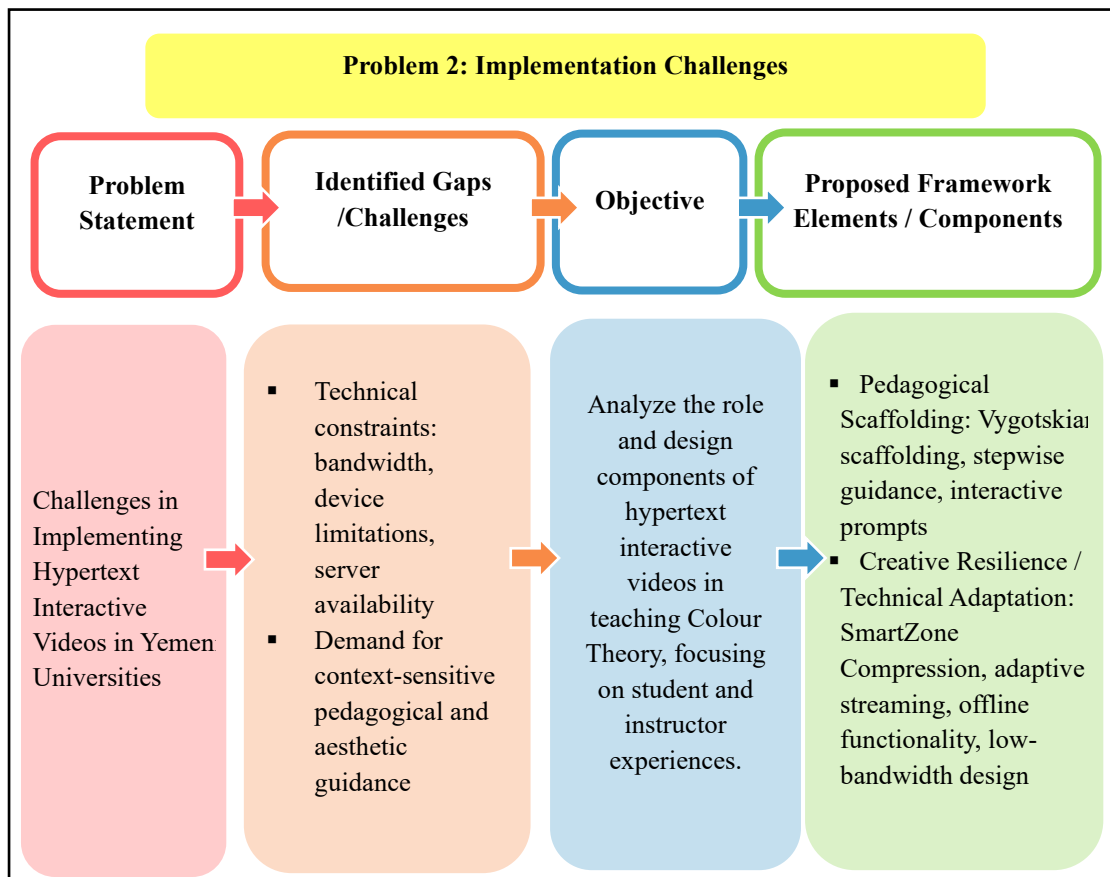


Figure 5.5 Conceptual Diagram for Problem 2: Implementation Challenges in Yemeni Universities

5.4 Discussion of Findings for Research Objective Three

Research Objective 3: To propose a practical framework for applying hypertext-interactive videos in Yemen.

This section presents the findings related to the third research objective by synthesising NVivo themes, interview evidence, institutional perspectives, and technical considerations. The analysis identifies core requirements for a national framework to guide the implementation of hypertext video technologies such as HyperLearnX in Yemeni higher education.

5.4.1 Summary of Findings

5.4.1.1 The Need for a National Framework

The findings reveal strong consensus across government officials, accreditation experts, and university leaders about the urgent need for a coherent national framework for digital and interactive learning.

GO5, an international accreditation expert, emphasised that “the future of education is inevitably digital” and that Yemen requires structured standards aligned with global accreditation criteria. Similarly, higher education officials such as AC3 reported the absence of a clear national plan and stressed that the Ministry of Higher Education has not fully operationalised its regulations on e-learning.

Political fragmentation also contributes to inconsistent adoption. According to GO2 (Chamber of Commerce), Yemeni institutions operate under “different authorities with competing priorities,” making national coordination difficult. These findings highlight a shared need for a unified policy roadmap that transcends regional divisions and ensures systematic adoption of digital tools.

5.4.1.2 Components Required for the Framework

Interview data identified several interrelated components that must be integrated into a national implementation framework for hypertext-interactive video to function effectively within Yemen’s higher education system. At the infrastructural level, weak bandwidth, high data costs, and limited device compatibility emerged as persistent structural barriers. Experts such as CT1 (Dean, Faculty of Computer Science, Sana’a University) and AC2 (Head of Computer Science Department, Saba University) emphasised that hypertext video technologies must remain extremely lightweight to be viable in this context. From a design and digital arts perspective, this requirement reframes lightweight design not as a technical compromise, but as a foundational aesthetic and pedagogical principle that directly shapes how visual content, colour fidelity, and interaction are experienced by learners.

At the institutional level, policy-related factors were identified as critical enablers for systematic adoption. The requirement for approximately 25–30% online learning, mentioned by multiple officials, including GO1 (Higher Education IT Centre), represents a strategic entry point for institutionalising hypertext-interactive video within

formal curricula. However, participants stressed that such policy directives can only become meaningful if they are actively enforced and supported through infrastructure, staff training, and administrative alignment. Without these supporting mechanisms, online learning requirements risk remaining symbolic rather than operational, limiting their impact on pedagogical practice.

Localisation and accessibility were also highlighted as central to successful implementation. Experts such as CT3 (Data Analyst) stressed the importance of Arabic localisation, noting that many digital systems fail in Yemen due to inadequate language adaptation and culturally misaligned interfaces. In visually oriented disciplines such as art and design, language and cultural accessibility are not peripheral concerns; they directly influence learners' engagement, comprehension, and sense of inclusion. Effective localisation, therefore, functions as both a technical and aesthetic requirement, ensuring that hypertext-interactive video resonates with learners' linguistic and cultural realities.

Finally, quality assurance and accreditation alignment emerged as essential for legitimising digital learning initiatives. Accreditation officials emphasised the necessity of meeting recognised standards, such as Quality Matters, to ensure content quality, pedagogical coherence, and meaningful interactivity. This alignment positions hypertext-interactive video not merely as an experimental or supplementary tool, but as a formally recognised instructional modality. From a critical perspective, accreditation alignment also serves as a protective mechanism, ensuring that innovation in low-bandwidth environments does not occur at the expense of academic rigour, but instead supports sustainable, high-quality digital art and design education.

5.4.1.3 Foundations for Implementation

Analysis revealed three interrelated foundations for successful implementation. First, capacity building was identified as essential across lecturers, faculty members, administrators, and students. Government officials frequently referenced low digital literacy and institutional resistance to technological change, indicating that human and cultural factors represent significant barriers alongside technical ones. While previous studies emphasised interactivity primarily from a technological perspective, the present study expands this understanding by demonstrating how aesthetic mediation and infrastructural adaptability jointly shape learning experiences in low-resource visual

education contexts. These findings suggest that training must address not only operational skills, but also attitudes toward digitally mediated teaching and learning.

Second, institutional partnerships were consistently framed as critical for sustainable adoption. Collaboration between ministries, telecommunications companies, universities, non-government organisations, and international organisations such as UNESCO was explicitly highlighted by CT4, PhD, and CT2 (Government Official). These partnerships were described as necessary for aligning policy, infrastructure, and implementation support, reducing fragmentation across the higher education ecosystem.

Third, experts emphasised the importance of gradual rollout strategies. Dr Fuad Abdulrazak specifically recommended “introducing HyperLearnX gradually, similar to how universities adopted LMS platforms.” This recommendation reflects concerns about institutional resistance and capacity limitations, and supports a staged implementation model that allows for iterative adjustment, staff adaptation, and risk mitigation

5.4.1.4 Roles of Key Stakeholders

Interviews highlighted the roles of multiple actors:

- 1. Government Ministries:** Set policy, provide subsidies, and regulate digital transformation.
- 2. Universities:** Host the system locally, apply accreditation standards, and train staff.
- 3. Telecommunications Sector:** Provide affordable data packages and collaborate on caching infrastructure.
- 4. Private Sector / NGOs:** Support funding, innovation adoption, and pilot programs.
- 5. Technical Teams:** Develop compression algorithms, Arabic interfaces, UI simplification, and security protocols.

5.4.2 NVivo Themes Supporting Research Objective Three

NVivo analysis yielded five thematic clusters that collectively justify and support the proposed framework.

5.4.2.1 Policy and Regulation

Codes: Government_Support, Political_Constraints, University_Policy, Organization_Role, future-oriented.

This theme reflects the need for coordinated national strategies, regulatory clarity, and institutional mandates for digital learning.

5.4.2.2 Technical Requirements

Codes: Bandwidth, Compression, Caching, Device_Compatibility, Server_Hosting, Localization_Arabic.

Interviewees perceived that HyperLearnX's lightweight design and the proposed SmartZone Compression approach could potentially address Yemen's infrastructural limitations within low-bandwidth educational contexts.

5.4.2.3 Institutional Capacity and Human Resources

Codes: Human Resources Skills, Team Requirements, OpenSource Potential, Adaptive Streaming.

Developing local expertise and multidisciplinary teams is essential for sustainable implementation.

5.4.2.4 Expert Recommendations

Codes: Training, Future_Development, Evaluation, Technical_Partnerships, Commercialisation.

Many experts recommended pilot testing, cross-institutional collaboration, and integration within LMS platforms such as Moodle.

5.4.2.5 Community and User Readiness

Codes: Engagement, Motivation, Interactivity, Learning Outcomes, easy to use. Students and lecturers reported that lightweight, interactive video improves clarity, engagement, and accessibility.

Table 5.3 brings together the key NVivo themes and codes related to Research Objective 3, reflecting the creative, technical, and contextual elements that informed the development of a practical framework for hypertext video-based learning.

Table 5.3
NVivo Themes Related to Research Objective Three

NVivo Theme	Key Codes	Relevance to Framework
Policy & Regulation	Government Support, University Policy	Enables national adoption
Technical Requirements	Bandwidth, Compression, Hosting	Ensures feasibility
Institutional Capacity	Human Resources, Teams	Sustainability
Expert Recommendations	Training, Evaluation	Implementation guidance
User Readiness	Engagement, Ease of Use	Adoption success

5.4.3 Discussion: Why These Elements Form a Framework

The study also contributes contextually by positioning Yemen not as a passive site of technological limitation, but as an active environment of adaptive pedagogical innovation and creative resilience.

5.4.3.1 *Necessity of the Framework*

The complex interplay of political, infrastructural, and institutional challenges makes a structured national framework essential. Without it, digital initiatives remain fragmented and unsustainable, as evidenced by inconsistent LMS adoption after COVID-19.

5.4.3.2 *Integration of Aesthetic, Pedagogical, and Technical Dimensions*

The proposed framework emerges from the intersection of three dimensions:

1. Aesthetic Dimension:

Interview feedback highlighted UI simplicity and clear visual guidance as essential for usability. This supports the artistic component of HyperLearnX as a visual communication tool.

2. Pedagogical Dimension (Vygotsky):

The framework incorporates scaffolding, adaptive questions, and meaningful interaction, aligning with Vygotsky's Zone of Proximal Development. Interactive questions embedded within videos function as checkpoints that strengthen student learning progression.

3. Technical Dimension:

SmartZone Compression, caching, local hosting, and Arabic localisation were conceptually proposed as mechanisms intended to improve the feasibility of hypertext-interactive video use under bandwidth-constrained conditions.

5.4.3.3 Theoretical Basis for Framework Formation

The framework is informed by:

- a) Sociocultural learning theory (Vygotsky)(Vygotsky, 1978)
- b) ICT4D (Information and Communication Technologies for Development)(Alshabi, Salim, & Ab Ghafa, 2025)
- c) Design-based research traditions in educational technology(Alshabi, Salim, & Cob, 2025a)
- d) Digital transformation frameworks adapted to conflict-affected countries

Together, these foundations justify the need for a structured, context-sensitive model for Yemen.

5.4.4 Linking to the Proposed Model (HyperLearnX)

The empirical findings strongly support the conceptual suitability of HyperLearnX as a context-sensitive model for Yemen.

1. Technical Fit:

Experts such as CT4, Dr Hesham, and CT3 confirmed that compression, Arabic localisation, and simple UI design align with Yemen's technical constraints.

2. Pedagogical Alignment:

Lecturers and students praised the interactive questions and reduced repetition, confirming the pedagogical value of the hypertext structure.

3. Policy Compatibility:

Government officials noted that HyperLearnX supports the Ministry's goal of 25–30% online learning adoption, aligning with national digital transformation strategies.

Thus, HyperLearnX embodies the exact technical and pedagogical attributes required for the proposed national framework.

5.4.5 National Implications

Findings indicate that implementing hypertext-interactive video at scale will:

1. Improve access to education for marginalised groups, including rural students and working learners.
2. Support digital transformation efforts across the Ministry of Higher Education.
3. Contribute to national resilience during crises such as conflict or pandemics.
4. Strengthen quality assurance systems through structured digital content delivery.
5. Reduce educational inequality between urban and rural areas.

Figure 5.6 visually summarises the potential educational impact of hypertext video-based learning, highlighting its role in expanding access, supporting learning quality, and fostering inclusive digital education in Yemen.

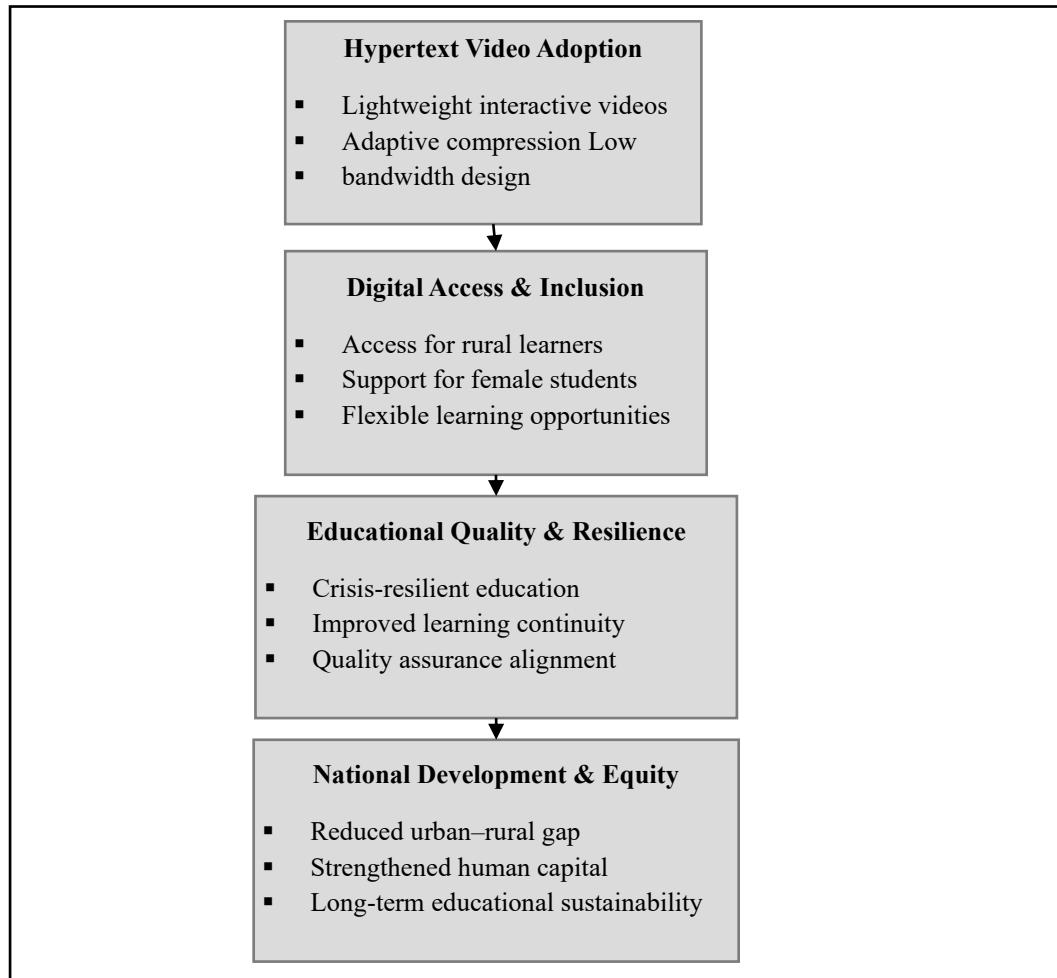


Figure 5.6 National Implications of Hypertext Video-Based Learning Adoption in Yemen

Based on the findings, a practical framework is proposed to guide the development and application of hypertext interactive videos, as depicted in Figure 5.7.”

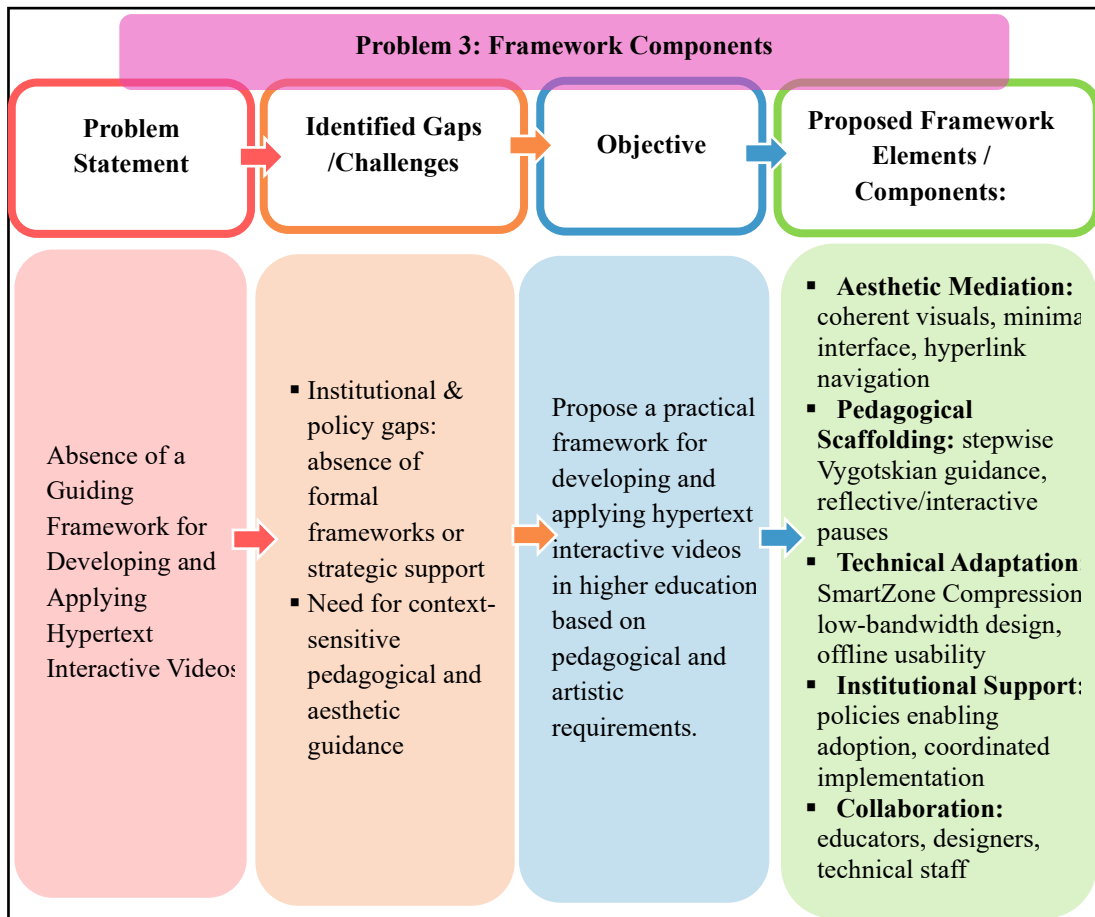


Figure 5.7 Conceptual Diagram for Problem 3: Proposed Guiding Framework for Hypertext Interactive Videos

5.5 Overall Synthesis Across All Objectives

This thesis addressed three interconnected objectives:

Research objective one: Identifying contextual barriers to digital arts education in Yemen revealed infrastructural, socioeconomic, and policy-related constraints.

Research objective two: Evaluating HyperLearnX demonstrated its feasibility and pedagogical suitability under weak bandwidth conditions.

Research objective three: Synthesising stakeholder perspectives and NVivo themes resulted in a practical framework for national implementation.

Together, these findings present a coherent narrative: Yemen faces significant challenges but possesses substantial opportunities and readiness for interactive digital learning. HyperLearnX bridges the gap between limitations and potential, offering a scalable model for future transformation.

This integrated synthesis demonstrates the researcher’s ability to “connect the whole picture,” aligning empirical evidence with theoretical foundations and producing a contextually informed digital learning model.

5.6 Contributions

5.6.1 Theoretical Contributions

This study contributes theoretically by extending Vygotsky’s sociocultural theory into the context of hypertext-interactive video within low-resource digital learning environments. It reconceptualises digital arts education as an adaptive and mediated learning process (Alshabi, Salim, & Cob, 2025b), where interaction, cultural relevance, and learner agency play central roles in knowledge construction (Daniels, 2008). Furthermore, the study bridges digital arts education with educational technology frameworks, offering a contextualised theoretical perspective that supports inclusive, creative, and resilient learning practices in bandwidth-constrained settings such as Yemen.

The study further contributes conceptually by positioning hypertext-interactive video not merely as a technological delivery tool, but as an integrated aesthetic–pedagogical–technical mediation environment. In this regard, the HyperLearnX framework synthesises sociocultural learning, aesthetic guidance, and adaptive digital interaction into a context-sensitive model for creative higher education in low-resource environments.

5.6.2 Practical Contributions

From a practical perspective, this research provides a contextualised digital education framework tailored to the Yemeni higher education environment, integrating pedagogical, technical, and policy considerations. It introduces a low-bandwidth hypertext-interactive video model (HyperLearn) designed to function effectively in infrastructure-limited contexts. Additionally, the study demonstrates practical compression and optimisation strategies that support the delivery of interactive multimedia content, offering actionable guidance for educators and content developers operating in resource-constrained digital learning environments.

5.6.3 Methodological Contributions

Methodologically, the study employs a mixed qualitative approach that integrates semi-structured interviews with government officials, lecturers, creators, and students, providing a multi-stakeholder perspective on digital education challenges. It utilises NVivo qualitative analysis to systematically code and interpret complex educational data, contributing a structured analytical model for ICT4D educational research. The research also advances design-based research principles by bridging theoretical inquiry with prototype development and applied evaluation in real-world educational contexts.

5.6.4 Industry and Future Educational Relevance

Beyond the immediate context of Yemeni higher education, the HyperLearnX framework responds to broader transformations occurring within contemporary digital education environments. The increasing reliance on adaptive, low-bandwidth, learner-centred, and flexible educational systems following global digital acceleration has created growing demand for context-sensitive learning models capable of functioning under infrastructural instability. In this regard, the framework contributes not only as a localised educational solution but also as a conceptual response to emerging challenges in sustainable digital pedagogy, resilient learning design, and equitable technology-mediated education within resource-constrained environments.

5.7 Recommendations

5.7.1 Policy-Level Recommendations

At the policy level, the study recommends the establishment of a national digital transformation strategy for higher education that prioritises accessible and inclusive e-learning systems. This includes defining minimum online learning requirements, ensuring policy alignment across institutions, and providing subsidised educational data packages for students to reduce digital access disparities. Such coordinated policy interventions are essential for enabling the sustainable integration of interactive digital learning technologies within Yemeni universities.

5.7.2 Technical Recommendations

Technically, the findings highlight the need to deploy scalable learning platforms that function effectively in low-bandwidth environments. Implementing adaptive streaming, localised content delivery, and culturally relevant interface design can significantly enhance usability and learner engagement. The integration of interactive video systems with national learning management platforms, alongside the adoption of open-source infrastructure solutions, is recommended to reduce operational costs and support long-term sustainability.

5.7.3 Institutional Recommendations

At the institutional level, universities should prioritise capacity building by providing targeted training for faculty, administrators, and students in digital pedagogy and interactive media design. Establishing clear institutional policies for e-learning implementation and strengthening infrastructure through public–private partnerships are critical steps toward improving digital readiness. The study also recommends the creation of innovation units within universities to support the development and maintenance of interactive educational technologies.

5.7.4 Community-Level Recommendations

At the community level, raising awareness of the educational value of interactive learning technologies is essential for fostering acceptance and engagement. Encouraging collaboration among educators, students, and local communities can support the contextual adaptation of digital content. Additionally, establishing continuous feedback mechanisms allows institutions to refine digital learning practices based on learner experiences and evolving community needs.

5.8 Limitations and Theoretical Considerations

Despite its contributions, this study has several limitations. The research was conducted with a limited sample of institutions and governmental stakeholders, which may affect the generalizability of the findings. The data reflect current infrastructural

and policy conditions, which are subject to change in unstable contexts. Furthermore, the HyperLearnX prototype was evaluated at a framework level rather than through nationwide deployment, and the impact of extreme electricity instability on long-term system performance remains underexplored. Observational data within this study functioned primarily as contextual and supportive field observations rather than systematic behavioural tracking data. Consequently, the thematic analysis relied more heavily on interview and focus group narratives than on interaction analytics or formal usability observation protocols.

While HyperLearnX incorporates scaffolded interaction inspired by Vygotskian sociocultural principles, the framework does not claim to replicate the full complexity of human-mediated learning or the adaptive responsiveness of a human “More Knowledgeable Other.” Rather, the system functions as a supportive mediating artefact that facilitates guided interaction, reflection, and structured progression within digitally constrained learning environments. Human instructors remain central to contextual interpretation, emotional support, collaborative meaning-making, and adaptive pedagogical decision-making processes. Accordingly, HyperLearnX should be understood as a complementary pedagogical support system rather than a replacement for the human educator.

5.9 Future Directions and Design Implications for HyperLearnX

This section articulates a forward-looking, design-driven vision for HyperLearnX as an evolving digital-art pedagogy ecosystem rather than a fixed technological product. Building on the empirical findings, this vision reframes HyperLearnX as a living design logic shaped by aesthetic intentionality, sociocultural mediation, and technical pragmatism. The future of HyperLearnX is therefore not defined solely by software upgrades, but by how artistic values, pedagogical ethics, and infrastructural realities coalesce into a sustainable learning ecology for low-bandwidth contexts.

From a digital arts perspective, HyperLearnX can be understood as a form of pedagogical design practice, where instructional structure itself becomes an artistic medium. Participants’ reflections, particularly those from creators, technicians, and senior academics, suggest that the system’s future lies in its capacity to translate constraint into aesthetic principle. Compression, modularity, and minimalism are not

merely technical responses; they represent an emergent design language in which clarity, rhythm, and restraint function as aesthetic virtues. In this sense, HyperLearnX can be interpreted as reflecting a form of “constraint-based creativity,” where technological scarcity may generate alternative artistic and pedagogical possibilities rather than solely functioning as a limitation (Alshabi, Salim, & Ab Ghafa, 2025).

Several participants implicitly pointed toward this future by emphasising that adaptive compression, lightweight interaction, and caching mechanisms should not be treated as invisible background processes, but as core components of the learning experience. CT1 and Dr Hesham, for example, framed compression and caching as prerequisites for any viable system in Yemen. When interpreted through a design lens, these technical requirements become aesthetic conditions: they shape how colour fidelity, motion, and pacing are rendered, and therefore how visual meaning is perceived. The future HyperLearnX system can intentionally integrate these constraints into its visual grammar, ensuring that efficiency and beauty are co-produced rather than positioned in tension.

5.9.1 Design Decision Principles under Technical Constraints

In situations of severe bandwidth limitation or unstable connectivity, the HyperLearnX framework prioritises pedagogical continuity over aesthetic richness. This prioritisation ensures that learning integrity, conceptual understanding, and guided interaction remain the primary objectives, while aesthetic elements are simplified rather than eliminated. Within this approach, visual clarity, instructional pacing, and cognitive scaffolding are preserved even when advanced visual effects or high-resolution media cannot be sustained. This principle reflects the framework’s context-sensitive design philosophy for low-resource educational environments.

A key design-driven direction for HyperLearnX lies in the development of modular micro-learning artefacts. Rather than relying on long-form linear videos, the future system can be structured as a constellation of short, hyperlinked visual units that function as design objects in their own right. Participants such as CT5 and CT4 highlighted buffering and loading time as unavoidable realities. Their recommendations to transform these interruptions into interactive or reflective moments suggest a reimagining of time itself as a design material. In this future vision, pauses are not

failures but intentional temporal spaces for reflection, critique, and micro-assessment, echoing studio-based pedagogical practices in art and design education.

From an aesthetic standpoint, this design-driven future also implies a deeper integration of visual narrative and interaction. Rather than presenting interaction as a functional add-on, HyperLearnX can evolve toward a model where hyperlinks, prompts, and decision points operate as narrative devices. These elements guide learners through conceptual storylines in colour theory, such as journeys through hue relationships, contrast dynamics, and emotional colour associations, transforming learning into an exploratory visual experience. Such an approach aligns with participants' descriptions of interaction as something that "forces you to think, not just watch," positioning learners as active co-authors of meaning rather than passive recipients of content.

The vision for HyperLearnX also extends into the realm of collaborative and socially distributed learning. Although peer collaboration was underrepresented in explicit NVivo coding, several accounts pointed to informal sharing practices, such as students exchanging downloaded content offline. These practices reveal an emergent peer-based learning economy. A future iteration of HyperLearnX can intentionally design for such social circulation by embedding features that support offline sharing, peer annotation, and collaborative critique. In digital arts education, critique and dialogue are central to learning; embedding these practices into the hypertext-interactive architecture can transform HyperLearnX into a socio-aesthetic platform rather than a one-way delivery system.

Institutionally, the future of HyperLearnX depends on its capacity to function as a scalable design framework rather than a localised experiment. Participants from governmental and administrative backgrounds repeatedly emphasised the absence of unified strategies and sustainable funding. In response, this design-driven vision proposes that HyperLearnX be positioned as a flexible, open framework that institutions can adopt incrementally. Its open-source compatibility, as emphasised by GO1 and Dr GO2, enables universities to customise, localise, and extend the system according to their capacities. This adaptability is not only technical but also cultural and pedagogical, allowing HyperLearnX to reflect local artistic traditions, visual languages, and educational priorities.

5.9.2 Positioning the HyperLearnX Framework within Context-Constrained Digital Education

HyperLearnX is designed as a hybrid model combining top-down institutional adoption with bottom-up educator-driven adaptation, ensuring both policy alignment and contextual flexibility in low-resource contexts. While institutional support remains important for long-term scalability and sustainability, the framework is intentionally structured to remain pedagogically functional even in decentralised or educator-led implementation contexts. This flexibility enables gradual adoption according to local infrastructural realities, institutional readiness, and instructional needs.

From a critical design perspective, this future vision also acknowledges the ethical dimensions of digital pedagogy. The formal copyright registration of HyperLearnX establishes it as a creative research artefact, but its ethical value lies in how it mediates access, inclusion, and agency. Participants repeatedly referenced rural learners, marginalised regions, and economically constrained students. A design-driven future for HyperLearnX must therefore prioritise ethical minimalism, designing not for technological spectacle but for dignity, continuity, and equitable participation.

5.9.3 Contextual Extensions of the HyperLearnX Framework

Future refinements of the HyperLearnX framework may further strengthen inclusive and context-sensitive learning by integrating additional adaptive design considerations. These may include gender-inclusive accessibility pathways, emotionally responsive interaction patterns, and rural low-bandwidth accessibility modes. In practice, this could involve mobile-first access options for learners with limited device ownership, flexible pacing structures that reduce emotional fatigue during unstable learning conditions, and micro-learning segmentation to support concentration in interrupted environments. The framework may also incorporate simplified offline learning pathways specifically designed for geographically marginalised regions where continuous connectivity cannot be guaranteed. Rather than functioning as supplementary features, these contextual extensions reinforce the framework's commitment to equitable, sustainable, and human-centred digital art education in resource-constrained settings.

In this framework, design becomes an ethical act: decisions about colour resolution, file size, and interface complexity directly shape who can participate and who is excluded.

Moreover, this future-oriented vision reframes HyperLearnX as a research-informed design laboratory. Rather than treating the current model as a finished solution, participants implicitly positioned it as a prototype open to critique and evolution. This aligns with creative research methodologies in digital arts, where iterative prototyping, user feedback, and reflective practice are integral to knowledge production. Future development of HyperLearnX can therefore incorporate continuous user testing, co-design with students and lecturers, and design-based research cycles. Such an approach strengthens both the artistic integrity and the pedagogical legitimacy of the system.

Importantly, this design-driven vision situates HyperLearnX within a broader philosophical shift in digital education. Instead of aspiring to replicate high-bandwidth, high-resource learning environments, HyperLearnX articulates an alternative paradigm grounded in appropriateness, sustainability, and contextual intelligence. Participants' accounts suggest that success in Yemen is not measured by technological parity with global platforms, but by continuity, usability, and meaningful engagement. In this sense, HyperLearnX represents a counter-model to dominant narratives of digital transformation. It proposes that innovation in low-resource contexts can generate original pedagogical and aesthetic forms that are globally relevant.

In summary, the future of HyperLearnX is best understood as a design-driven ecosystem where aesthetic mediation, pedagogical choreography, and technical adaptation are inseparable. This vision positions HyperLearnX not only as a tool for teaching colour theory, but as a platform for reimagining how digital arts education can function under constraint. By embracing limitation as a design principle, prioritising ethical accessibility, and fostering collaborative and narrative interaction, HyperLearnX can evolve into a sustainable, culturally resonant, and artistically grounded model for digital learning in Yemen and comparable contexts.

5.9.3.1 Contextual Positioning of HyperLearnX

While existing interactive learning platforms such as Edpuzzle, Quizizz, and conventional LMS-based video systems primarily focus on engagement and content

delivery within relatively stable digital infrastructures, the HyperLearnX framework was conceptually developed for educational environments characterised by infrastructural instability and limited connectivity. Rather than treating low bandwidth and technological constraints as purely technical limitations, the framework reframes these conditions as design considerations that require adaptive pedagogical strategies, simplified aesthetic mediation, and resilient interaction structures. In this sense, HyperLearnX extends beyond conventional interactive video models by integrating pedagogical continuity, contextual accessibility, and technical adaptability into a unified framework tailored for resource-constrained and conflict-affected higher education environments. This positioning situates the framework within broader discussions surrounding ICT4D, adaptive digital pedagogy, and context-sensitive educational technology design.

5.10 Future Research

Future research should extend this work by empirically testing hypertext-interactive video systems across diverse regions in Yemen to assess scalability and contextual adaptability. Further studies may explore the integration of artificial intelligence, adaptive feedback mechanisms, and culturally responsive multilingual interfaces to enhance learner engagement.

Future studies may also explore emotionally responsive interaction design, gender-sensitive accessibility models, and adaptive micro-learning structures tailored for unstable and low-bandwidth educational environments. Additional research could investigate how offline-first learning pathways and mobile-based interaction patterns influence learner continuity and engagement in marginalised regions.

Comparative research across other developing and low-resource countries would also provide valuable insights into the broader applicability of interactive video-based digital learning models. Additionally, future studies may quantitatively evaluate the HyperLearnX framework through prototype deployment and learner-performance assessment in low-bandwidth educational settings.

5.11 Summary

The theoretical contribution of this study lies in repositioning hypertext-interactive video not merely as a digital instructional tool, but as a context-sensitive

aesthetic–pedagogical mediation framework shaped through sociocultural interaction, creative resilience, and adaptive digital practice. This study provided a holistic exploration of hypertext-interactive video as an innovative pedagogical tool in Art and Design education within resource-constrained environments in Yemen. By investigating technological feasibility, pedagogical effectiveness, and cultural appropriateness, the research addressed three primary objectives: understanding contextual challenges, evaluating the implementation of HyperLearnX, and proposing a structured framework for sustainable digital learning.

The findings demonstrate that, despite infrastructural, political, and socio-cultural limitations, Yemen’s higher education ecosystem is increasingly receptive to digital transformation. Participant perceptions suggested that HyperLearnX, as a proposed AI-supported hypertext-interactive video platform, has the potential to enhance visual cognition, support scaffolded and collaborative learning, and foster creative resilience among students and educators. The evidence underscores the potential of interactive hypertext-interactive videos to overcome barriers such as low bandwidth, limited digital infrastructure, and cultural restrictions, enabling access to marginalised communities, including girls and students in conflict-affected regions.

The study contributes both theoretically and practically. Theoretically, it advances understanding of the interplay between aesthetic mediation, pedagogical adaptation, and technological innovation in constrained educational contexts. Practically, it offers actionable guidance for educators, academic institutions, technical teams, and policymakers to design, implement, and scale hypertext-interactive video digital learning interventions. The proposed national framework provides a structured roadmap for integrating interactive videos into Art and Design curricula, emphasising interface design, visual coherence, interactivity, and accessibility.

In conclusion, this research not only validates the efficacy and cultural suitability of HyperLearnX in Yemen but also lays a foundation for future innovation in digital arts education. By bridging technological, pedagogical, and creative dimensions, it provides a replicable model for enhancing inclusive and engaging learning in resource-limited settings, offering valuable insights for both local and international stakeholders.

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APPENDICES

APPENDIX A

Interview Protocol and Question Sets for Semi-Structured Interviews

This appendix presents the interview protocol and semi-structured question sets used to guide data collection in this qualitative study. The questions were developed with reference to sociocultural perspectives on artistic learning and knowledge construction, emphasising interaction, guided exploration, and meaning-making within digital art environments. The protocol was adapted for four participant groups:

1. Government Officials
2. University Lecturers
3. University Students
4. Technical Experts (Developers / Digital Media Specialists)

Each group received a tailored set of questions framed in direct alignment with the research objectives, focusing on patterns of use of **hypertext interactive video within art and design education**, particularly in contexts with limited digital infrastructure, such as Yemen.

A.1 Interview Protocol

1. Introductory Script (General Version)

At the beginning, each interview commenced with a briefing on the study objectives, confidentiality protocols, and a demonstration of a sample hypertext interactive video used to illustrate the concept. They were also informed that **HyperLearnX is a registered creative-educational concept**, and that the demonstration video serves only as an illustrative example.

2. Video Demonstration

A short (approx. 3-minute) sample hypertext-interactive video showcasing interactive elements such as layered information, branching paths, and visual cues was shown to familiarise participants with the artistic and educational possibilities of the medium.

3. Interview Closing Note

Each session concluded with an appreciation message, reiterating confidentiality and thanking participants for their contribution to advancing digital art education research.

A.2 Semi-Structured Question Sets

Interview Questions for Government Officials

Section 1: Arts and Cultural–Educational Landscape

What challenges do art and design institutions in Yemen face when integrating digital media into studio-based learning?

Are there current national initiatives supporting digital creativity or interactive art tools?

Section 2: Perceptions of hypertext-interactive video in the Arts

3. In your view, can interactive media such as hypertext-interactive video enhance learning and creativity in the arts?

4. Which artistic disciplines (e.g., digital arts, design, visual communication) might benefit most from such tools?

Section 3: Policy and Implementation

5. To what extent can tools like HyperLearnX be incorporated into higher education strategies in the arts?

6. What requirements (infrastructure, policy, training) are needed for implementation at a national level?

7. How can researchers collaborate with cultural or educational authorities to support sustainable adoption?

Section 4: Future Vision

8. How do you envision the future of digital arts education in Yemen?

9. Could low-bandwidth-compatible creative tools expand access to artistic learning?

Interview Questions for University Lecturers

Section 1: General Perceptions

What is your initial impression of the interactive video demonstrated?

Do you believe such media can support learning in art and design contexts? Why?

Section 2: Artistic and Pedagogical Use

3. Which interactive features enhance artistic understanding or student engagement?

4. How could lecturers integrate this tool into studio teaching or theory-based courses?

5. Do hypertext links and embedded information support exploratory or self-directed artistic learning?

Section 3: Feasibility in Yemen

6. What challenges may arise when using these tools in Yemeni art and design programs?
7. How might limited infrastructure or digital literacy affect students' creative engagement?

Section 4: Artistic Pedagogy and Theory

8. What role should the lecturer play when students use interactive media for artistic exploration?
9. Does this interactivity resonate with artistic learning theories such as scaffolding or collaborative meaning-making?

Section 5: Recommendations

10. What design or content improvements could make such videos more effective in teaching multimedia?
11. What adaptations would you recommend for Yemeni learners or studio environments?

Interview Questions for University Students

Section 1: First Impressions

How was your experience engaging with the interactive video?

Did it help you understand artistic concepts better than regular videos?

Section 2: Interaction and Creativity

3. Were the embedded links and visual cues helpful in exploring the content? Why?
4. Did you feel the need for additional explanation from your lecturer?

Section 3: Ease of Use

5. Did you face any technical challenges (loading, navigation, interaction)?
6. Does this type of video suit your learning environment, tools, and internet access?

Section 4: General Feedback

7. Would you prefer learning some art or design subjects with this method? Why?
8. What suggestions would make such creative–educational videos more effective?

Interview Questions for Technical Experts (Digital Media / Developers)

Section 1: Perception of the Technology

What is your general opinion on using hypertext-interactive video for digital arts education in low-bandwidth settings?

Is it technically feasible on 3G or limited-speed networks?

Section 2: Technical Considerations

3. What development challenges might arise when producing interactive art videos like HyperLearnX?

4. Which compression or optimisation techniques best support smooth interaction in low-speed environments?

5. Are there open-source creative frameworks suitable for reducing production costs?

Section 3: User Experience and Aesthetics

6. What factors most influence the user experience of interactive media in low-bandwidth contexts?

7. How can loading delays or interruptions be minimised?

8. What UI/UX elements are essential for art students unfamiliar with interactive media tools?

Section 4: Sustainability and Creative Development

9. Could the system later integrate with learning or digital-portfolio platforms?

10. What skills are essential for the technical team developing such a creative educational tool?

11. What partnerships or collaborations would support realistic implementation?

Summary

These question sets guided all interviews and the focus groups involved in the study. Their design aimed to:

C1. Generate rich, role-specific insights

C2. Explore artistic, technological, and policy dimensions

C3. Align with the qualitative, interpretive nature of digital art education research

C4. Support systematic thematic analysis using NVivo

APPENDIX B

Copyright Registration Documents for HyperLearnX

Introduction: This appendix presents the official copyright registration and technical documentation of HyperLearnX: Adaptive hypertext-interactive video for Low-Bandwidth Education, a system and instructional design model developed by the researcher to support accessible and interactive visual learning in constrained digital environments. As referenced in Chapter 4 (Sections 4.1 and 4.4), HyperLearnX functions as the conceptual framework guiding the design, interpretation, and pedagogical analysis of hypertext video within this study. The model was voluntarily registered through the Malaysian Intellectual Property Corporation (MyIPO) as stipulated under Section 26B of the Malaysian Copyright Act 1987, ensuring formal recognition of authorship and intellectual ownership. HyperLearnX integrates adaptive video compression, AI-based semantic analysis, and non-linear hypertext interaction to provide an educational solution tailored for 2G/3G environments and underserved communities, especially in developing countries.

Copyright Registration Documents (MyIPO)

The following documents verify the legal status of HyperLearnX as copyrighted intellectual property: Title of Work: HyperLearnX: Adaptive Hypertext Video for Low-Bandwidth Education.

Author: Elham Mohammed Kaid Alshabi. Category: Literary / Digital Media. Date of Creation: 15 June 2025. Date of Notification: 05 August 2025. Notification Number: CRLY2025W07508. Application Number: LY2025070605

Issuing Authority: Malaysian Intellectual Property Corporation (MyIPO), Ministry of Domestic Trade and Cost of Living. The appendix includes:

B.1: Official Notice of Copyright Registration

B.2: Certificate of Copyright Notification

B.3: Authorship and Co-ownership Details

	PERBADANAN HARTA INTELEK MALAYSIA INTELLECTUAL PROPERTY CORPORATION OF MALAYSIA (Agensi di bawah KPDN) Aras LG, G, 2-5, 11-13 & 15-23, Menara MyIPO, PJ Sentral, Lot 12, Persiaran Barat, Seksyen 52, 46200 PETALING JAYA, SELANGOR, MALAYSIA	 Tel : +603 – 7496 8900 Faks(Fax) : +603 – 7496 8999 Laman Sesawang : www.myipo.gov.my
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ELHAM MOHAMMED KAID ALSHABI
UITM SHAH ALAM
40450 SHAH ALAM, SELANGOR,
MALAYSIA.

LCR01



NOTIFIKASI PEMBERITAHUAN HAK CIPTA
(Seksyen 26A(3) Akta Hak Cipta 1987)

Tuan/Puan

Sukacita dimaklumkan, maklumat butiran Pemberitahuan Sukarela Hak Cipta tuan/puan telah direkodkan ke dalam Daftar Hak Cipta sebagaimana diperuntukkan di bawah Seksyen 26B Akta Hak Cipta 1987. Butiran Pemberitahuan Hak Cipta adalah seperti berikut:

BUTIRAN KARYA

TAJUK KARYA	: HYPERLEARNX: ADAPTIVE HYPERTEXT VIDEO FOR LOW-BANDWIDTH EDUCATION
KATEGORI KARYA	: SASTERA
TARIKH KARYA DICIPTA	: 15 JUN 2025
TEMPAT PENERBITAN YANG PERTAMA	: TIDAK BERKAITAN
NO. PEMBERITAHUAN	: CRLY2025W07058
NO. PERMOHONAN	: LY2025W07058
TARIKH PERMOHONAN	: 05 OGOS 2025

BUTIRAN PENCIPTA

NAMA PENCIPTA	: ELHAM MOHAMMED KAID ALSHABI
NRIC / NO. SYARIKAT	: 142613
WARGANEGARA	: YEMEN
NAMA PENCIPTA	: NEESA AMEERA BINTI MOHAMED SALIM
NRIC / NO. SYARIKAT	: 84013705003
WARGANEGARA	: MALAYSIA

(Agensi di bawah Kementerian Perdagangan Dalam Negeri dan Kos Sara Hidup)

Figure B 1 Official Notice of Copyright Registration (MyIPO)

NAMA PENCIPTA : SAIFUL AKRAM CHE COB @ AB GHAFAR
NRIC / NO. SYARIKAT : 790806035405
WARGANEGARA : MALAYSIA

BUTIRAN PEMILIK

NAMA PEMILIK : UNIVERSITI TEKNOLOGI MARA (UITM)
NRIC / NO. SYARIKAT : TIDAK BERKAITAN
ALAMAT : UNIVERSITI TEKNOLOGI MARA (UITM),
40450 SHAH ALAM, SELANGOR,
MALAYSIA.
WARGANEGARA : TIDAK BERKAITAN

BUTIRAN PEMEGANG LESEN

PEMEGANG LESEN : TIDAK BERKAITAN

Sijil Pemberitahuan Hak Cipta yang dikeluarkan oleh MyIPO boleh dijadikan satu keterangan *prima facie* di Mahkamah mengenai butiran yang direkodkan. Sebarang perubahan kepada maklumat di atas, tuan/puan boleh mengisi borang-borang berkaitan untuk direkodkan dalam Daftar Hak Cipta.

****AKHIR NOTIS****

Pengawal Hak Cipta

Tarikh: 05 Ogos 2025

Notis Pemberitahuan Hak Cipta dihasilkan oleh komputer. Tiada tandatangan diperlukan.

Figure B 2 Details of Authorship and Registration Record



Figure B 3 Certificate of Copyright Notification

These documents confirm that the HyperLearnX framework used throughout this dissertation is a legally protected instructional design model.

Technical Background of the HyperLearnX System

HyperLearnX is positioned at the intersection of digital video compression, AI-based content analysis, and interactive hypertext pedagogy. It addresses a fundamental global problem: the inability of conventional streaming technologies (e.g., H.264, VP9) to support educational video delivery in low-bandwidth regions such as Yemen (Hoang & Zhou, 2021; UNESCO, 2020)

Educational videos typically require stable broadband, which excludes learners who rely on: 2G or intermittent 3 G networks, rural or conflict-affected areas, costly mobile-data bundles, unstable infrastructure.

Existing research also highlights the pedagogical advantage of hypertext video, yet such formats consume additional bandwidth (Rouet, 2006; Mittal et al., 2024). HyperLearnX resolves these limitations through an adaptive compression algorithm capable of preserving meaningful visual information while drastically reducing file size.

SmartZone Compression for Mobile Networks (SZCM)

At the core of HyperLearnX is SmartZone Compression for Mobile Networks (SZCM), a selective, semantic-aware compression engine that:

Detects Zones of Interest (ZOIs) using deep learning, such as YOLOv3 (Redmon & Farhadi, 2018) preserves essential regions (faces, diagrams, instructional text), applies aggressive compression to background or redundant areas, and adjusts bitrate based on predicted or real-time bandwidth (Balachandran et al., 2013; Khan, 2024) supports partial offline caching, reduces file sizes by 40–70% while maintaining perceptual clarity (Liu et al., 2019, 2021)

This selective compression aligns with semantic-aware coding models proposed in recent literature (Wu, J., Xiong, Y., Yu, S., Lin, 2018), which prioritise educationally relevant regions to maintain learning integrity.

System Architecture and Workflow

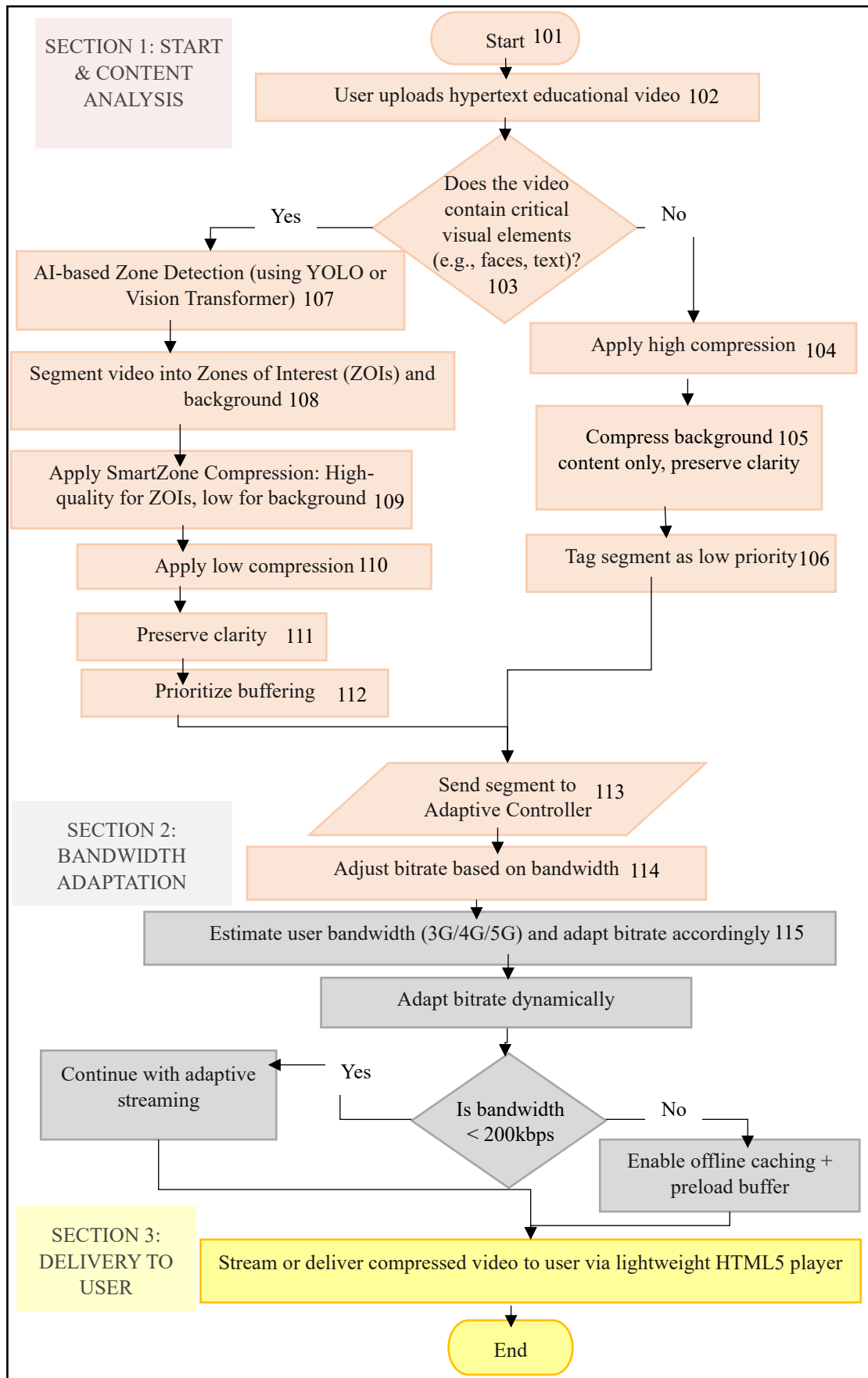


Figure B 4 System Flowchart of the HyperLearnX SmartZone Compression Workflow

The workflow consists of three main stages:

Stage 1: Content Ingestion & AI Zone Detection. Hypertext-enhanced video is uploaded by the educator. AI analyses frames to detect critical visual content (ZOIs). Segmentation distinguishes between: educationally meaningful zones (301), background regions (302), and AI-guided masks (303). See Figure B5: Example of Semantic Segmentation

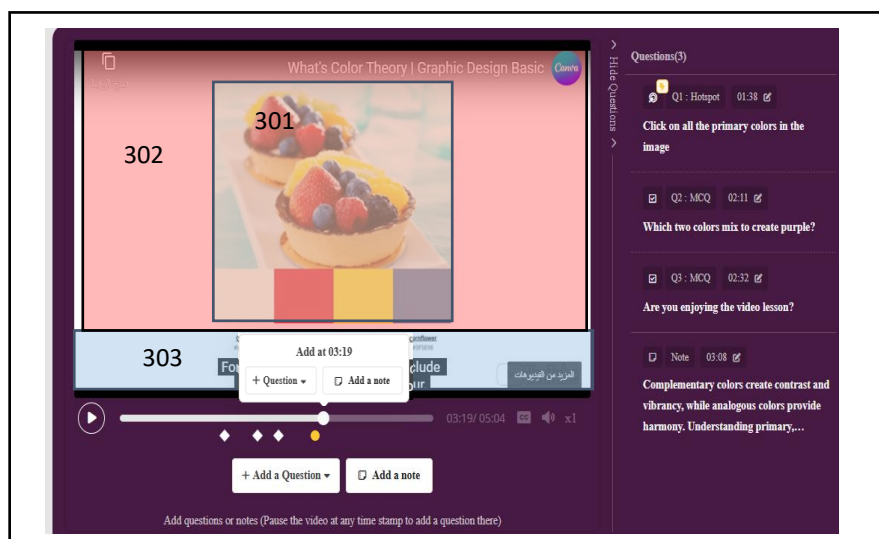


Figure B 5 AI-Based Semantic Segmentation Mask for Zones of Interest (ZOIs)

Stage 2: Smart Compression & Bandwidth Adaptation. Compression rates are distributed according to semantic importance. Bandwidth estimator predicts network degradation. Adaptive Controller chooses optimal bitrate and delivery mode. Offline caching is triggered if bandwidth <100 kbps.

Stage 3: Interactive Delivery & Playback (Conceptual Stage)

At this stage, HyperLearnX is conceptually designed to be delivered through a lightweight HTML5 player capable of supporting adaptive streaming and hypertext navigation. While the system architecture has been defined (see Figures B5 and B6), the researcher has not yet developed a working prototype or interface. Therefore, no user interface (UI) is presented as part of HyperLearnX in this appendix.

To illustrate the conceptual idea of hypertext interaction, a sample interface from an existing educational platform (non-proprietary and not part of this invention) is included for explanatory purposes only. Figure B6: Conceptual Example of a Hypertext Video Interface (This figure is not part of HyperLearnX. It is provided solely to demonstrate

how hypertext interaction works in general, as explained during participant interviews.)

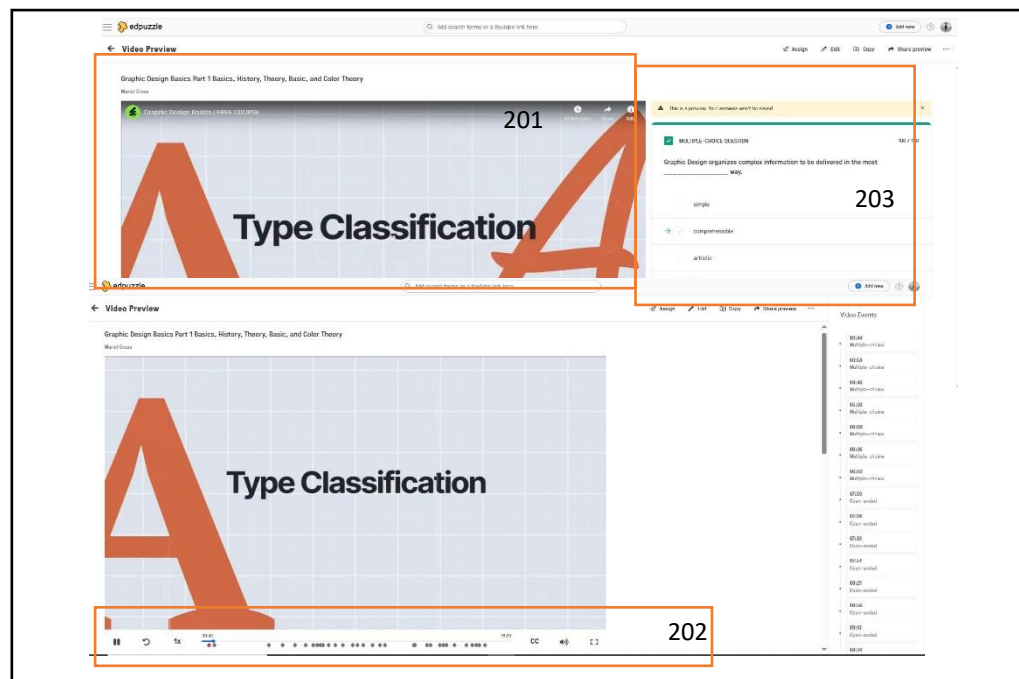


Figure B 6 Conceptual Interface Example of a Hypertext Video (Illustrative Only)

Pedagogical Relevance and Integration into This Study

HyperLearnX is used in this dissertation in three ways: As a conceptual model supporting the interpretation of Hypertext video learning. As a pedagogical artefact demonstrating how interactive video supports scaffolding, multimodal perception, and creative cognition (Vygotsky). As a technical–aesthetic framework illustrating how low-bandwidth constraints can be transformed into innovations for art and design education. These connections are essential to the findings discussed in Chapter 4, especially regarding: Aesthetic Mediation, Creative Resilience, Pedagogical Adaptation

Summary

This appendix documents the legal and technical foundation of HyperLearnX. It establishes: formal copyright protection, technical legitimacy, theoretical relevance, integration with low-bandwidth educational needs, and alignment with the broader sociocultural framework adopted in the study. HyperLearnX is not merely a technological artefact; it is a conceptual, aesthetic, and pedagogical model that supports equitable access to art and design education in constrained environments.

APPENDIX C

Bilingual Interview Protocol (Field Version)

Note: The interview questions were originally developed in English and translated into Arabic for field implementation. A back-translation process was conducted to ensure conceptual equivalence between both versions. For clarity and academic transparency, both English and Arabic versions of selected questions are presented below.

This appendix presents the actual interview scripts used during the data collection phase of this qualitative study. These scripts reflect the real procedures, introductory statements, and semi-structured questions applied in the field with each participant group.

All interviews were conducted in accordance with ethical research guidelines. Participants were informed about the purpose of the study, assured of confidentiality, and notified that their participation was voluntary. Interviews were conducted primarily in Arabic, as this was the most appropriate language for participants in the Yemeni context. English versions are provided here for academic documentation and transparency.

A short sample hypertext interactive video (approximately three minutes) was shown during each interview session to demonstrate the concept of hypertext video. The demonstrated video was sourced from an existing platform and used solely for illustrative purposes. At the time of data collection, no prototype or minimum viable product (MVP) of a proposed conceptual model (HyperLearnX) had been developed.

في بداية المقابلة

السلام عليكم ورحمة الله وبركاته،

بدايةً أشكركم على تخصيص هذا الوقت الثمين للمشاركة في هذه المقابلة.

معكم إلهام محمد قائد الشعبي، طالبة ماجستير بجامعة UITM في ماليزيا، وأقوم بإجراء دراسة بحثية بعنوان:

"تطوير التعلم القائم على الفيديو النصّي التفاعلي في مجال الفنون والتصميم: حالة تعليم نظرية اللون في اليمن".

تهدف دراستي إلى استكشاف كيف يمكن لتقنيات الفيديو التفاعلي، وخاصة ما يُعرف بـ "Hypertext Video"، أن تُستخدم بشكل فعال في تدريس الفنون والتصميم أو الحاسوب عن بعد بالذات للفئات المحرومة من التعليم أو الفتيات مع التركيز على أحد المواد كدراسة حالة واختيار عنوان نظرية اللون، في ظل التحديات التي تواجهها مؤسسات التعليم العالي في اليمن من حيث ضعف البنية التحتية الرقمية.

كجزء من هذا المشروع، قمت بتطوير تقنية تعليمية مبتكرة مسجلة بحقوق ملكية فكرية، تُدعى HyperLearnX، والتي تتيح عرض فيديو تفاعلي عالي الجودة عبر شبكات الجيل الثالث منخفضة السرعة، وهي مصممة خصيصاً لتناسب السياقات النامية مثل اليمن.

يسعدني اليوم أن أستمع إلى وجهة نظركم الكريمة حول هذا الموضوع من منطلق خبرتكم في التخطيط أو السياسات أو التعليم العالي. جميع الإجابات سنُعامل بسرية تامة، وسيتم استخدامها فقط لأغراض أكاديمية.

(لم أطور بعد نموذجًا أوليًا Minimum Viable Product)

(MVP)، ولكن سأعرض مثالاً تجريبياً لفيديو تفاعلي نصي من منصة قائمة لتوضيح المفهوم فقط".

Actual Interview Script – Government Officials

Introductory Statement

السلام عليكم, and thank you sincerely for taking the time to participate in this interview.

My name is Elham Mohammed Kaid Alshabi, and I am a Master's student at Universiti Teknologi MARA (UiTM), Malaysia. I am currently conducting a research study entitled:

"Advancing Hypertext Video-Based Learning in Art and Design Education: An Interpretive Case Study of Colour Theory Learning Among Art Students in Yemen."

This study explores how interactive video technologies, specifically hypertext video, can support teaching and learning in art, design, and related disciplines, particularly in higher education contexts facing limited digital infrastructure, such as Yemen. The study focuses on colour theory as a representative course.

As part of this research, I have developed a registered creative-educational concept known as HyperLearnX, designed to deliver interactive educational videos compatible with low-bandwidth (3G) environments. At this stage, no prototype has been developed; therefore, a sample hypertext video from an existing platform will be shown solely to illustrate the concept.

All information shared during this interview will be treated with strict confidentiality and used exclusively for academic purposes.

Interview Questions

Section 1: Understanding the Educational and Technological Landscape

From your perspective, what are the main challenges faced by higher education institutions in Yemen in terms of using technology in teaching?

Are there any current trends, strategies, or plans supporting digital education or interactive learning tools in Yemeni universities?

Section 2: Engagement with Hypertext Video

3. Do you think interactive video technologies such as hypertext video can contribute to improving the quality of education, particularly in the arts and design fields?

4. In your opinion, which student groups or academic disciplines would benefit most from such tools?

Section 3: Practical and Policy Aspects

5. To what extent could interactive tools like HyperLearnX be integrated into national higher education strategies or projects?

6. What essential requirements (infrastructure, policy frameworks, training) are needed to implement such initiatives at a national level?

7. How can researchers and developers collaborate effectively with governmental or educational authorities to ensure sustainable adoption?

Section 4: Impact and Future Policies

8. How do you envision the future of interactive or digital education in Yemen?

9. Do you believe that low-bandwidth-compatible educational tools could significantly improve access to higher education?

Closing Note

Thank you very much for your valuable time and insights. Your contribution is greatly appreciated and will support the development of practical recommendations aimed at improving higher education in Yemen. All responses will remain confidential and will be used solely for academic research purposes.

أسئلة المقابلة للمسؤولين الحكوميين (وفقاً لأهداف البحث)

القسم 1: فهم الواقع التعليمي والتقني

من وجهة نظركم، ما التحديات الرئيسية التي تواجهها مؤسسات التعليم العالي في اليمن فيما يتعلق باستخدام التكنولوجيا في التدريس؟

هل هناك توجهات أو خطط حالية لدعم التعليم الرقمي أو أدوات التعلم التفاعلي في الجامعات؟

القسم 2: التفاعل مع الفيديو التفاعلي النصي

هل ترون أن تقنيات مثل الفيديو التفاعلي (Hypertext Video) يمكن أن تساهم في تحسين جودة التعليم، خصوصاً في تخصصات مثل التصميم والفنون؟

برأيكم، ما الفئات الطلابية أو التخصصات التي يمكن أن تستفيد أكثر من هذا النوع من الأدوات؟

القسم 3: الجوانب التطبيقية والسياسات

ما مدى إمكانية دمج أدوات تفاعلية مثل HyperLearnX ضمن خطط أو مشاريع التعليم العالي الرسمية؟

ما المتطلبات أو الشروط التي يجب توفرها لتطبيق مثل هذه المبادرات على نطاق وطني؟

كيف يمكن للباحثين والمطورين التعاون مع الجهات الرسمية لضمان تبني هذه التقنيات بشكل مستدام؟

القسم 4: الأثر والسياسات المستقبلية

كيف ترون مستقبل التعليم التفاعلي في اليمن؟ وهل هناك سياسات وطنية يمكن أن تدعم التوسع في هذا المجال؟

هل تعتقدون أن توفير أدوات تعليمية متوافقة مع شبكات الإنترنت الضعيفة يمكن أن يحدث تحولاً حقيقياً في الوصول إلى التعليم؟

Actual Interview Script – University Lecturers (Art & Design)

Introductory Statement

السلام عليكم, and thank you for participating in this research interview.

My name is Elham Mohammed Kaid Alshabi, a Master's student at Universiti Teknologi MARA (UiTM), Malaysia. This research examines the potential of Hypertext video to support teaching and learning in art and design education, using colour theory as a case study within the Yemeni higher education context.

HyperLearnX is a registered educational concept designed to deliver interactive learning content in low-bandwidth environments. As no prototype has yet been developed, a sample hypertext video from an existing platform will be shown to illustrate the concept.

Interview Questions

Section 1: General Perceptions

What is your initial impression of the interactive video demonstrated?

Do you believe this type of video can support learning in art and design courses? Why?

Section 2: Educational Potential

3. Which features of the video stood out in terms of supporting understanding or engagement?

4. How could lecturers integrate such interactive videos into studio-based or theoretical courses?

5. Do hypertext links and embedded information enhance students' exploratory or self-directed learning?

Section 3: Feasibility in the Yemeni Context

6. What challenges may arise when implementing such tools in Yemeni art and design programs?

7. How might limited digital infrastructure or students' digital literacy affect effectiveness?

Section 4: Pedagogical and Theoretical Dimensions

8. What role should the lecturer play when students use interactive video for learning?

9. Does this form of interactivity align with pedagogical concepts such as scaffolding or collaborative learning?

Section 5: Recommendations

10. What improvements would you suggest to enhance the effectiveness of such videos?

11. What adaptations would be necessary for Yemeni learners or institutional contexts?

Closing Note

Thank you for your valuable academic insights. Your contribution will inform the pedagogical and design recommendations of this study.

ما رأيكم الأولي في الفيديو التفاعلي الذي شاهدتموه؟

هل تعتقدون أن هذا النوع من الفيديوهات يمكن أن يدعم تعلم الطلاب لمادة مثل التصميم الجرافيكي؟ ولماذا؟

القسم 2: الإمكانيات التعليمية

ما المميزات التي لفتت انتباهكم في الفيديو من ناحية دعم الفهم أو التفاعل؟

كيف يمكن للمحاضر الجامعي أن يوظف مثل هذه الأداة في محاضراته أو أنشطته التعليمية؟

هل ترون أن استخدام النصوص الفائقة والروابط داخل الفيديو يُعزز من التعلم الذاتي لدى الطلبة؟

القسم 3: قابلية التطبيق في السياق اليمني

ما التحديات المحتملة التي ترونها أمام استخدام هذا النوع من الفيديوهات في مؤسسات التعليم العالي باليمن؟

هل تعتقدون أن بنية الإنترنت أو مهارات الطلاب قد تعيق فعالية استخدام الفيديو التفاعلي؟ كيف يمكن التغلب على ذلك؟

القسم 4: البعد البيداغوجي والنظري

كيف ترون دور المحاضر في دعم تعلم الطلاب من خلال فيديو تفاعلي مثل HyperLearnX ؟

هل ترون أن هذا النوع من التفاعل يتماشى مع مبادئ مثل الدعم التدريجي (Scaffolding) أو التعلم الاجتماعي؟

القسم 5: الاقتراحات والتوصيات

ما التحسينات التي تقترحونها لتطوير هذا الفيديو ليكون أكثر فعالية في تدريس الفنون الرقمية؟

هل لديكم توصيات لتكييف هذه التقنية بما يتناسب مع خصائص الطلبة أو بيئات الجامعات اليمنية؟

Actual Interview Script – University Students

Introductory Statement

Thank you for agreeing to participate in this interview.

This study explores a new way of learning using interactive educational videos that allow learners to engage with content through links and additional information, even with limited internet access. You will be shown a short sample video, after which your feedback as a student will be requested.

Interview Questions

Section 1: First Impressions

How was your experience watching the interactive video?

Did it help you understand the content better compared to regular videos?

Section 2: Interaction and Support

3. Were the embedded links and visual cues helpful? Why?

4. Did you feel the need for additional explanation or guidance while watching?

Section 3: Ease of Use

5. Did you face any technical difficulties while using the video?

6. Does this type of video suit your learning environment and internet conditions?

Section 4: General Feedback

7. Would you prefer to learn some subjects using this interactive method? Why?

8. What suggestions would improve this type of educational video?

Closing Note

Thank you for your participation. Your feedback is essential for improving educational tools designed for learners in challenging contexts.

Actual Interview Script – Technical Experts (Developers / Digital Media Specialists)

Introductory Statement

Thank you for participating in this interview.

This research investigates the feasibility of delivering interactive educational video content in low-bandwidth environments through hypertext video technology.

HyperLearnX is a registered concept aimed at addressing technical and educational challenges in underserved contexts such as Yemen. A short sample hypertext video was shown during the interview solely to illustrate the concept.

Interview Questions

Section 1: General Perception of the Technology

What is your initial opinion on using hypertext video for educational purposes in low-bandwidth environments?

Is such a system technically feasible on 3G or limited-speed networks?

Section 2: Technical and Practical Aspects

3. What development challenges might arise when producing interactive educational videos like HyperLearnX?

4. What compression or optimisation techniques could support smooth interaction?

5. Are there open-source frameworks that could reduce development costs?

Section 3: User Experience and Performance

6. What factors most influence user experience in low-bandwidth interactive video?

7. How can loading delays or interruptions be minimised?

8. What UI/UX considerations are essential for users unfamiliar with interactive media?

Section 4: Sustainability and Future Development

9. Could such a system be integrated with learning management or digital portfolio platforms?

10. What skills are essential for the technical development team?

11. What partnerships would support sustainable implementation?

Closing Note

Thank you for your valuable technical insights. Your contribution supports the practical feasibility and sustainability considerations of this research.

القسم 1: الانطباع الأول

كيف كانت تجربتك في مشاهدة الفيديو التفاعلي؟

هل شعرت بأنك فهمت المعلومة بشكل أفضل مقارنة بالفيديوهات العادية؟

القسم 2: التفاعل والدعم

هل وجدت الروابط والنصوص داخل الفيديو مفيدة؟ لماذا؟

هل شعرت أنك بحاجة إلى دعم إضافي (مثل وجود معلم) أثناء المشاهدة؟

القسم 3: سهولة الاستخدام

هل واجهت أي صعوبة تقنية أثناء مشاهدة الفيديو (تحميل، تشغيل، فهم التفاعل)؟

هل تعتقد أن هذا النوع من الفيديو مناسب لبيئتك التعليمية وظروف الإنترنت لديك؟

القسم 4: الرأي العام والاقتراحات

هل تحب أن تتعلم موادك بهذه الطريقة التفاعلية؟ ولماذا؟

ما الاقتراحات التي تقدمها لتحسين الفيديو أو جعله أكثر فائدة لك كطالب/ة؟

رسالة شكر بعد المقابلة

شكراً جزيلاً لك/لك على مشاركتك في هذه المقابلة.

لقد كانت ملاحظاتك مهمة جداً وسنساعد في تطوير أدوات تعليمية مناسبة لك ولزملائك، خصوصاً في البيئات التي يصعب فيها الوصول للتعليم الجيد.

جميع مشاركتك سيتم استخدامها فقط لأغراض أكاديمية، وبسرية تامة.
أتمنى لك كل التوفيق في دراستك، وشكرًا مرة أخرى.

APPENDIX D

Data Collection Instruments and Protocols

Introduction

This appendix presents the complete set of instruments and procedures used for data collection in this study, including expert validation processes, semi-structured interview protocols, focus group discussion (FGD) guidelines, observation checklists, and participant profiles.

The data collection was conducted using qualitative methods to ensure depth of understanding and triangulation of perspectives across different stakeholder groups, including experts, educators, government officials, creators, technicians, and students.

Participants were initially assigned unique identification codes for organisational and analytical purposes in accordance with ethical standards of the University Research Ethics Committee.

Ethical Approval

This study received ethical approval from the Universiti Teknologi MARA (UiTM) Research Ethics Committee.

Approval Details:

- a) Approval Code: REC/08/2025 (PG/MR/474)
- b) Title: *Advancing Hypertext Video-Based Learning in Art and Design Education: An Interpretive Case Study of Colour Theory Learning Among Art Students in Yemen*

The official approval notification was received via email from the UiTM RED System and is attached in this appendix.

All participants were recruited only after obtaining this ethical approval, and informed consent was secured before their participation.

All participants explicitly requested that their professional identities and contributions be acknowledged within the study. Written and verbal consent was obtained before participation and documentation. The disclosure of participant identities was therefore conducted in accordance with participant approval and institutional ethical procedures.



Reference : UiTM.800 - 1/1/9
 Our reference : REC/08/2025 (PG/MR/474)
 Date : 1447H 28
 22 August 2025

Pejabat
 Timbalan Naib Canselor
 (Penyelidikan dan Inovasi)

Mr Elham Mohammed Kaid Ahmad Alshabi – 2024684182
 (Supervisor: Dr Neesa Ameerah Mohamed Salim)
 Faculty of Art and Design
 Universiti Teknologi MARA (UiTM)
 40000, Shah Alam
SELANGOR

والسلام عليكم ورحمة الله وبركاته and Greetings

Mr

APPROVAL LETTER - UiTM RESEARCH ETHICS COMMITTEE

Thank you for submitting your research proposal to the Research Ethics Committee (REC). After considering your application, the Committee approved your proposal titled "Advancing Hypertext Video-Based Learning in Art and Design: A Case of Color Theory in Yemen" in Yemen. Details of the approval are as follows:

Ref. number:	REC/08/2025 (PG/MR/474)
Approval Period:	22 August 2025 until 31 December 2025
Authorised personnel:	1. Elham Mohammed Kaid Ahmad Alshabi 2. Dr Neesa Ameerah Mohamed Salim

The UiTM Research Ethics Committee operates in accordance with ICH Good Clinical Practice Guidelines, Malaysian Good Clinical Practice Guidelines and the Declaration of Helsinki. The approval of this project is conditional upon your continuing compliance with these guidelines and declaration.

We draw to your attention the requirement that a report on this research, must be submitted every 12 months from the date of the approval or on the completion of the project, whichever occurs first. Failure to submit reports will result in withdrawal of consent for the project to proceed. Amendments, if any, to the study documents are to be submitted to the REC for approval.

If you require further information, please contact the REC Secretariat at 03-55442846/03-55442737 or email at recsecretariat@uitm.edu.my.

اوسها، تقوى، موليا

"MALAYSIA MADANI"
"BERKHIDMAT UNTUK NEGARA"

Yours sincerely,

(EMERITUS PROFESSOR DATO' DR RAYMOND AZMAN ALI)
 Chairman
 UiTM Research Ethics Committee

c.c.: Deputy Dean (PJI), Faculty of Art and Design, UiTM

Page 1 of 1

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Figure D 1 Research Ethics Approval Letter (UiTM RED System)

This section presents selected excerpts from the semi-structured interviews and focus group discussions conducted with participants.

The interviews were originally conducted in Arabic to ensure participants' comfort and depth of expression. The transcripts were later translated into English by the researcher.

To ensure translation accuracy and credibility, the English versions were returned to the respective participants for verification (member checking). Participants reviewed and confirmed the accuracy of the translated content through direct communication.

The verified transcripts were then used for thematic analysis.

Although participant identification codes were initially assigned for organisational purposes, all participants explicitly consented to the use of their real names in reporting their contributions. Therefore, interview excerpts in this appendix are presented using participants' names along with their professional roles.

Expert Validation of HyperLearnX Content and UI

Before data collection, the HyperLearnX content and user interface (UI) were reviewed by selected experts in the fields of information technology, education, and interactive media.

The purpose of this validation was to ensure alignment with the research questions and to confirm the suitability of the system as a research stimulus.

Experts provided feedback on usability, clarity, pedagogical relevance, and technical feasibility. Minor refinements were made based on their feedback before proceeding with the data collection phase.

This is a summary of all the participants' interviews:

Section 1: Government Officials

Focus group with minister (Arabic language summary. Participant details are presented in Table D.1.

مجموعة تركيز

المدير التنفيذي لمركز تقنية المعلومات الدكتور فؤاد حسن عبد الرزاق، ابراهيم شرف وكيل وزارة التربية والتعليم، الأستاذ أحمد الأحزاب – من مكتب التربية

السلام عليكم ورحمة الله وبركاته، وشكرًا جزيلاً لكم على تخصيص هذا الوقت الثمين للمشاركة في هذه المقابلة.

أنا إلهام الشعبي، طالبة ماجستير في جامعة – UiTM ماليزيا. أقوم بدراسة بعنوان: تطوير التعليم القائم على الفيديو النصي التفاعلي في مجال الفنون والتصميم.

طورت تقنية لضغط الفيديو بحيث يصبح حجمه صغيراً جداً، فبدلاً من أن تكون المحاضرة ساعتين مثلاً، تُضغَط لتصبح حوالي 15 دقيقة، مع إدخال أسئلة تفاعلية داخل الفيديو، بحيث يعمل حتى على الإنترنت الضعيف كما هو حال اليمن.

المشكلة البحثية التي أتناولها هي أن التعليم في اليمن أحياناً لا يكون متاحاً لبعض الفئات، مثل الفتيات في الأرياف أو الأشخاص غير القادرين على الحضور وجهاً لوجه.

سعيدة جداً بلقائكم جميعاً اليوم:

الدكتور فؤاد حسن عبد الرزاق –المدير التنفيذي لمركز تقنية المعلومات.

الأستاذ إبراهيم شرف –وكيل وزارة التربية والتعليم.

الأستاذ أحمد الأحزاب –من مكتب التربية.

أشركم على وقتكم، وهذه فرصة ثمينة أن نكون جميعًا معًا في جلسة واحدة.

عرض الفكرة

قدمت للضيوف مثالًا قصيرًا (دقيقة واحدة) لشرح مفهوم الفيديو التفاعلي:

"هذا ليس النموذج الأولي النهائي، وإنما مجرد توضيح للفكرة. الفيديو العادي يمكن أن يُضغَط، ويُختَصَر، ويُضاف داخله أسئلة مرتبطة بالمحتوى. إذا أجاب الطالب بشكل صحيح يستمر الفيديو، وإذا أخطأ يعود إلى النقطة التي لم يفهمها. بذلك يصبح الفيديو أكثر تفاعلية، حجمه أصغر، ويمكن تشغيله مع الإنترنت الضعيف".

الحوار

مداخلة الدكتور فؤاد:

"أستاذة إلهام، تشرحين بسرعة. هل المقصود أنكِ تصنيفين أسئلة داخل الفيديو بحيث يتفاعل الطالب معها؟"

الباحثة:

"نعم، فيديو بداخله أسئلة مرتبطة بالمحتوى. إذا أجاب الطالب بشكل صحيح يستمر العرض، وإذا لم يجب يعود إلى نفس النقطة. الفكرة أيضًا أن المحاضرات الطويلة غالبًا مملة وتحتوي على تكرار، لذلك أضفتُ أكواد بالذكاء الاصطناعي لحذف التكرارات غير الضرورية، فيصبح الفيديو أقصر بكثير، بجودة عالية، ويعمل مع الإنترنت الضعيف".

تعقيب الدكتور فؤاد:

"لكن التدخل في المحتوى باستخدام الذكاء الاصطناعي قد يُفقد بعض المعلومات".

الباحثة:

"لا، لا يُحذف أي شيء أساسي. فقط الجمل المكررة. مثلاً، عندما يكرر المحاضر نفس الفكرة مرات عديدة. الهدف أن يصبح الفيديو أكثر تركيزًا".

سؤال الباحثة:

"من وجهة نظركم، ما أبرز التحديات التي تواجه مؤسسات التعليم العالي عند استخدام التكنولوجيا في التدريس؟"

إجابة الوكيل إبراهيم شرف:

"التكنولوجيا مهمة جدًا في التعليم إذا وُظِّفَت بالشكل الأمثل. لكن لا بد أن نكون واعين بمحاذيرها. لا ينبغي أن يلغى دور المعلم والجانب البشري. خلال كوفيد-19 كان التعليم الإلكتروني ضرورة، واستخدمنا Google Classroom و وسائل أخرى. وزارة التعليم العالي بادرت وقتها وأصدرت معايير للتعليم الإلكتروني عبر مجلس الاعتماد الأكاديمي، لتضمن أن الجامعات التي تملك إمكانيات تستطيع التدريس إلكترونياً".

النقاش حول السياسات:

الدكتور فؤاد: "الوزارة أصدرت لوائح ومعايير واضحة للتعليم الإلكتروني، لكنها لم تُنفذ بشكل كامل بعد. بعض الجامعات بادرت بتجهيز استوديوهات خاصة، وأخرى أدرجت أهدافًا مرتبطة بالتعليم الإلكتروني في توصيف برامجها. هناك أيضًا خطة لهيكلية إدارات مختصة لمتابعة هذا الملف".

الأستاذ إبراهيم شرف: "بعض الجامعات التزمت بأن يكون على الأقل مقرر واحد يُدرس إلكترونياً تحسباً لأي أزمة مستقبلية. هذا موجود في اللوائح ويجب تنفيذه".

النقاش حول مشروع HyperLearnX:

سؤال الباحثة:

"هل ترون أن تقنية مثل HyperLearnX يمكن أن تحسّن جودة التعليم، خصوصاً في تخصصات مثل الحاسوب أو التصميم أو الجرافيكس؟"

الإجابات:

"كل التخصصات يمكن أن تستفيد بدرجات متفاوتة. حتى التخصصات العلمية والنظرية. لكن هناك برامج تعليمية تحتاج تفاعلاً مباشراً ولا يمكن الاستغناء فيها عن التعليم وجهًا لوجه".

"إذا ثبتت فعالية التقنية، يمكن أن تُلزم الجامعات باستخدامها. لكن لا بد من إطار واضح، وتدريب الكادر، وتجهيز البنية التحتية والمعدات، مع تعريف الطلاب بكيفية التعامل مع هذه التقنيات".

"أي مبادرة قابلة للتطبيق ميدانياً يمكن أن تتبناها الجهات الرسمية. لكن المشاريع التي تكون مكلفة أو غير واقعية يصعب تنفيذها".

المستقبل:

إجماع المشاركين:

مستقبل التعليم التفاعلي في اليمن واعد رغم التحديات.

هناك لوائح قائمة تحتاج إلى تنفيذ فعلي.

مؤتمرات عُقدت بالفعل وضعت توصيات لبناء قدرات المعلمين وتحسين البنية التحتية.

إدخال التعليم الإلكتروني بنسبة ولو 25% سيساعد الطلاب على التكيف مع التحول الرقمي مستقبلاً.

توفير أدوات تعليمية تعمل مع الإنترنت الضعيف سيكون تحولاً حقيقياً.

الخاتمة

أعرب المشاركون عن شكرهم، وأكدوا دعمهم لفكرة البحث:

"نحن سعداء بالمشاركة في هذه المجموعة المركزة، ونأمل أن ينجح مشروعك لأنه يقدم حلاً حقيقياً لمشكلة التعليم في اليمن".

رد الباحثة:

"أقدم بخالص الشكر والتقدير لسعادتكم جميعاً على تخصيص وقتكم. لقد أثرت مداخلتكم الحوار وأضافت أبعاداً مهمة لفهم التحديات والفرص. أؤكد لكم أن هذه المعلومات ستستخدم بسرية ولأغراض أكاديمية فقط، وأمل أن يسهم البحث في تقديم نموذج عملي لتحسين جودة التعليم العالي في اليمن".

Translation to English

Dr Fuad Hasan Abdul Razzak, Ibrahim Sharaf, Deputy Minister of General Education, and Ahmed Al-Ahzaab

Introduction

Greetings and peace be upon you. Thank you very much for dedicating this valuable time to participating in this interview.

My name is Elham Al-Shaabi, a Master's student at UiTM – Malaysia. I am currently conducting a study titled: *Advancing Hypertext Video-Based Learning in Art and Design Education: An Interpretive Case Study of Colour Theory Learning Among Art Students in Yemen*

I have developed a technique for compressing video so that its size becomes very small. For example, instead of a lecture lasting two hours, it can be compressed into about 15 minutes, with interactive questions inserted inside the video. This makes it possible to work even with weak internet connections, as in Yemen.

The research problem I am addressing is that education in Yemen is sometimes not accessible to certain groups, such as girls in rural areas or individuals who cannot attend face-to-face.

I am very glad to meet you all today:

Dr Fuad Hasan Abdulrazzaq – Executive Director of the IT Centre.

Mr Ibrahim Sharaf – Deputy Minister of Education.

Mr Ahmed Al-Ahzab – from the Education Office.

Thank you for your time; this is truly a precious opportunity to have you together in one session.

Presentation of the Idea

I presented the guests with a short one-minute example to explain the concept of interactive video:

“This is not the final prototype, just a demonstration of the idea. A normal video can be compressed, shortened, and questions can be embedded inside it. If the student answers correctly, the video continues; if not, it goes back to the point they did not understand. In this way, the video becomes interactive, smaller in size, and can run with weak internet.”

Dialogue

Dr Fuad's comment:

“Ms Elham, you are explaining quickly. Do you mean that you insert questions inside the video so that the student interacts with it?”

Researcher:

“Yes, exactly. A video with questions related to the content. If the student answers correctly, the presentation continues; if not, it goes back to the same point. Another thing is that long lectures are often boring and repetitive, so I have added AI codes to remove

unnecessary repetitions. This way the video becomes much shorter, with high quality, and works even with weak internet.”

Dr Fuad’s concern:

“But interfering with the content using AI might result in losing some information.”

Researcher:

“No, nothing essential is removed. Only repeated sentences. For example, when the lecturer says the same point many times. The goal is to make the video more focused.”

Researcher’s Question

“In your opinion, what are the main challenges facing higher education institutions in using technology in teaching?”

Answer – Deputy Minister Ibrahim Sharaf:

“Technology is very important in education if it is employed in the right way. But we need to be aware of its limitations. The role of the teacher and the human aspect should not be eliminated. During COVID-19, e-learning became a necessity, and we used Google Classroom and other platforms. The Ministry of Higher Education took the initiative and issued standards for e-learning through the Accreditation Council, to ensure that universities with capabilities could teach electronically.”

Policy Discussion

Dr Fuad: “The ministry has issued clear regulations and standards for e-learning, but they have not been fully implemented yet. Some universities took the initiative to prepare special studios, and others included goals related to e-learning in their program specifications. There is also a plan to establish specialised units to follow up on this matter.”

Mr Ibrahim Sharaf: “Some universities have committed to teaching at least one course electronically, in preparation for any future crisis. This is already in the regulations and must be applied.”

Discussion on HyperLearnX Project

Researcher’s Question:

“Do you think that a technology like HyperLearnX can improve the quality of education, especially in majors such as computer science, design, or graphics?”

Answers:

“All fields can benefit, to varying degrees. Even scientific and theoretical subjects. However, some programs require direct interaction and cannot replace face-to-face learning.”

“If the technology proves effective, universities can be required to adopt it. But there must be a clear framework, staff training, infrastructure, and equipment, along with introducing students to how to use these technologies.”

“Any practically applicable initiative can be adopted by official bodies. But projects that are too costly or unrealistic are difficult to implement.”

Future Prospects

Participants’ consensus:

The future of interactive learning in Yemen is promising despite the challenges.

Regulations already exist, but need actual implementation.

Conferences have been held that issued recommendations for building teachers’ capacity and improving infrastructure.

Introducing e-learning at least at a 25% level will help students adapt to digital transformation in the future.

Providing educational tools that work with weak internet will be a real breakthrough.

Conclusion

Participants expressed their appreciation and support for the research idea:

“We are happy to take part in this focus group, and we hope your project succeeds because it provides a real solution to the education problem in Yemen.”

Researcher’s closing remarks:

“I extend my sincere thanks and appreciation to all of you for giving your time. Your contributions enriched the discussion and added important dimensions to understanding the challenges and opportunities. I assure you that this information will be used confidentially and only for academic purposes, and I hope that the research will present a practical model to improve the quality of higher education in Yemen.”

Mossa Ghurab Sana, see Table D.1 for participant details

بصفته مسؤول حكومي / سياسي

مقدمة

تحدث الدكتور موسى غراب أيضًا من زاوية عمله كمشارك في السياسات التعليمية وكمسؤول على تواصل مع وزارة التعليم العالي، حيث ركز على التحديات المؤسسية والسياسية التي تواجه تطبيق تقنيات التعلم الرقمي والفيديو التفاعلي في اليمن.

واقع التعليم العالي

قال: "التعليم العالي في اليمن يعاني من غياب استراتيجيات واضحة. الحرب أوقفت كثير من المشاريع، وأصبح التركيز فقط على الحد الأدنى لتسيير الجامعات. لا توجد ميزانيات مخصصة لتطوير التعليم الرقمي".

وأضاف: "هناك محاولات فردية من أساتذة يستخدمون أدوات مجانية مثل Google Classroom أو WhatsApp، لكن لا يوجد نظام وطني شامل".

دور وزارة التعليم العالي والاتصالات

أوضح: "وزارة التعليم العالي ليس لديها خطة واضحة للتحول الرقمي. حتى التنسيق مع وزارة الاتصالات ضعيف جدًا. والوزارة الأخيرة تركز على توفير خدمات الاتصالات الأساسية، وليست معنية مباشرة بالتعليم".

وأشار: "أي مشروع مثل الفيديو التفاعلي يحتاج قرار سياسي ودعم حكومي، لكن في الوقت الحالي الأولويات تذهب للحرب والأمن وليس للتعليم".

التحديات المؤسسية والسياسية

ذكر: "التحديات ليست تقنية فقط، بل مؤسسية أيضًا. لا توجد لوائح تنظم التعليم الإلكتروني بشكل رسمي. بعض الجامعات جربت حلولاً بدائية أثناء كورونا، لكنها لم تستمر".

وأضاف: "السياسات التعليمية في اليمن غير مستقرة. كل وزير يأتي بسياسة جديدة ثم يرحل. لا توجد استدامة".

أثر الحرب

قال بوضوح: "الحرب أثرت على كل شيء: الميزانية، الاستقرار، حتى الرواتب. كيف يمكن أن نستثمر في منصات تعليمية بينما الأستاذ الجامعي لا يتقاضى راتبه بانتظام؟"

الإمكانيات المستقبلية

رغم الصعوبات، أشار إلى وجود فرص: "اليمن عنده شباب مبدع، وإذا توفر دعم دولي أو شراكات مع جامعات خارجية، ممكن نطبق أنظمة مثل الفيديو التفاعلي تدريجيًا. البداية ممكن تكون على مستوى كليات معينة مثل التصميم أو الإعلام".

وأضاف: "أي نجاح سيحتاج إلى شراكات، دعم دولي، وخطة تدريجية تبدأ صغيرة ثم تتوسع".

خلاصة

اختتم قائلًا: "لو أردنا تطبيق الفيديو التفاعلي على مستوى وطني، نحتاج إلى ثلاث خطوات: أولاً، اعتراف رسمي بالتعليم الرقمي ضمن لوائح التعليم العالي. ثانيًا، تنسيق بين وزارة التعليم العالي ووزارة الاتصالات. ثالثًا، دعم مالي وفني من شركاء دوليين لأن اليمن وحده لا يستطيع".

Translation to English

Mossa Ghurab Sana'a University

Interview Two: As a Government / Policy-Making Official

Introduction

Dr Mossa Ghurab also spoke from the perspective of his involvement in educational policy and his connections with the Ministry of Higher Education. He highlighted the institutional and political challenges facing the implementation of digital learning technologies and interactive video in Yemen.

The Reality of Higher Education

He said: “Higher education in Yemen suffers from the absence of clear strategies. The war has halted many projects, and the focus has shifted only to ensuring the minimum operation of universities. There are no dedicated budgets for developing digital education.”

He added: “There are individual efforts by lecturers who use free tools such as Google Classroom or WhatsApp, but there is no comprehensive national system.”

The Role of the Ministry of Higher Education and Telecommunications

He explained: “The Ministry of Higher Education does not have a clear plan for digital transformation. Even coordination with the Ministry of Telecommunications is very weak. The latter focuses on providing basic telecom services and is not directly concerned with education.”

He pointed out: “Any project like interactive video requires political decision-making and government support, but at present, priorities go to war and security rather than education.”

Institutional and Political Challenges

He mentioned: “The challenges are not only technical but also institutional. There are no regulations to officially govern e-learning. Some universities tried basic solutions during COVID-19, but they did not continue.”

He added, “Educational policies in Yemen are unstable. Each minister comes with a new policy and then leaves. There is no sustainability.”

The Impact of War.

He clearly stated: “The war has affected everything: the budget, stability, even salaries. How can we invest in educational platforms when university lecturers do not receive their salaries regularly?”

Future Potential

Despite the difficulties, he pointed to opportunities: “Yemen has creative youth, and if international support or partnerships with foreign universities become available, we could implement systems such as interactive video gradually. The beginning could be at the level of specific faculties, like design or media.”

He added: “Any success will require partnerships, international support, and a gradual plan that starts small and then expands.”

Conclusion

He concluded: “If we want to implement interactive video at a national level, we need three steps: first, official recognition of digital education within higher education regulations; second, coordination between the Ministry of Higher Education and the

Ministry of Telecommunications; and third, financial and technical support from international partners, because Yemen cannot do it alone.”

Tahani Lutf Alswari, participant details are presented in Table D.1 (summary in Arabic)

الصفة الحكومية / السياسية

العربية

المهندسة تهاني السواري، مدير عام التخطيط والعلاقات الدولية في وزارة الاتصالات، حاصلة على ماجستير تقنية معلومات من جامعة OUM.

أوضحت أن التحديات الرئيسية التي تواجه مؤسسات التعليم العالي في اليمن تتعلق أولاً بغياب البنية التحتية الرقمية؛ إذ إن المدارس، خصوصاً الحكومية، لا تزال تفتقر إلى إدماج الإنترنت كوسيلة تعليمية. لذلك، هناك حاجة لتأسيس بنية تحتية رقمية في المدارس والجامعات والمعاهد، بما يتيح للطلاب التفاعل مع الأساتذة والوصول إلى المحتوى التعليمي عبر الإنترنت.

وأضافت أن هناك توجهاً حكومياً نحو التحول الرقمي في جميع مؤسسات الدولة، بما في ذلك التعليم. هذا التحول يتطلب تأسيس البنية التحتية للإنترنت، توفير الأجهزة، وزيادة وعي الموظفين، الطلاب، وأعضاء هيئة التدريس بأهمية التعليم الرقمي. وأكدت أن الدولة ترحب بمثل هذه المبادرات، مشيرة إلى وجود دعم للابتكارات والمشاريع الطلابية من خلال وزارة الاتصالات وهيئة الابتكار.

فيما يتعلق بدمج أدوات مثل HyperLearnX، رأت أنه يمكن تجربتها أولاً على عينة محدودة من الطلاب، وإذا أثبتت جدواها يمكن تعميمها على نطاق أوسع كجزء من مشاريع التحول الرقمي. كما شددت على أن الوضع السياسي والانقسام بين الحكومات المختلفة في اليمن يشكل عقبة أمام تعميم أي مبادرة وطنية، لكن في صنعاء هناك تقبل وتشجيع كبير لمثل هذه المشاريع.

أما عن السياسات الوطنية لدعم التعليم التفاعلي، فقد أوضحت أن الصعوبات حالياً تكمن في البنية التحتية والظروف الاقتصادية، لكنها أكدت أن التوجه العام نحو الرقمنة قد يفتح المجال لمثل هذه المبادرات في المستقبل.

Translation to English:

Interview with Tahani Lutf Alswari

Network engineer

Master of Information Technology

Malaysian University OUM– Governmental Perspective (Policy Focus)

Dr Tahani Al-Suwari, serving in a governmental role, emphasised the strategic importance of integrating interactive and hypertext-based video tools into Yemen’s higher education. She highlighted that adopting such technologies requires not only technical readiness but also alignment with governmental policies and institutional strategies.

According to her, 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. She explained

that any educational technology initiative must consider regulations, budgetary allocations, and institutional policies to ensure sustainability.

Dr Al-Suwari further noted that, while faculty and students show enthusiasm toward digital innovations, systemic barriers often hinder progress. She stressed that partnerships between universities, the private sector, and governmental bodies are essential for overcoming these barriers.

Associate Professor Nagi Ali Abdullah Alshaibany, Academic in Information Technology IT, summary in the Arabic language:

المقابلة الأولى – (كأستاذ جامعي)

الاسم والصفة:

الأستاذ المشارك ناجي علي عبد الله الشيباني – أكاديمي في مجال تقنية المعلومات (IT)

ملخص المقابلة بعد التنقيح:

التحديات الرئيسية:

أشار إلى أن أبرز الصعوبات التي تواجه مؤسسات التعليم العالي في اليمن تتمثل في ضعف البنية التحتية للاتصالات وغياب الإنترنت المستقر، إضافة إلى ارتفاع تكلفته بشكل كبير. كما أكد أن هناك بعض الخطط والأفكار لدعم التعليم الرقمي، لكنها تظل غير عملية لغياب التنفيذ الفعلي.

إمكانية الاستفادة من تقنيات الفيديو التفاعلي:

رأى أن فكرة استخدام الفيديو التفاعلي النصي مثل HyperLearnX فكرة جيدة، خصوصاً إذا جرى دمجها بالتعليم التقليدي. لكنه شدد على ضرورة وجود حوافز أكاديمية (مثل الدرجات والشهادات) حتى يلتزم الطلاب، لأن غياب الحافز يجعل الطلاب يتعاملون بسطحية (مثل تشغيل الفيديو دون متابعته بجدية).

التخصصات المستفيدة:

ذكر أن أكثر التخصصات التي يمكن أن تستفيد من هذه التقنية هي تخصصات تقنية المعلومات والهندسة والطب، بالإضافة إلى التصميم والفنون الرقمية كحالة أساسية. أما التخصصات الأدبية ففرصها أقل بسبب عزوف سوق العمل عنها.

إمكانية الدمج المؤسسي:

يرى أن نجاح هذه التقنية يتطلب اعترافاً رسمياً من وزارة التعليم العالي، وأن يتم إدماجها في الخطة التعليمية عبر قرار وزاري، مع تعاون وثيق مع وزارة الاتصالات ومركز تقنية المعلومات.

التحديات السياسية:

أوضح أن الانقسام السياسي لا يشكل عائقاً كبيراً، حيث إن كل طرف يسعى لتقديم إنجازات للشعب. المهم أن تُعرض الفكرة بشكل جذاب وواقعي لتتال الدعم.

الرؤية المستقبلية:

يتوقع أن يكون للتعليم التفاعلي مستقبل في اليمن، مستنداً إلى إقبال الشباب على التطبيقات التفاعلية مثل TikTok، لكنه شدد على ضرورة وجود سياسات وطنية وتشريعات داعمة لضمان الاستدامة.

Translation to English:

Main Challenges: The most critical challenges facing higher education institutions in Yemen are the lack of reliable internet infrastructure and high connectivity costs. While there are ideas and discussions about supporting digital learning, practical implementation remains absent.

Potential of Interactive Video:

He considered HyperLearnX a promising idea, especially if integrated with traditional education. However, he stressed the necessity of academic incentives (grades, certificates) to ensure student engagement, as many students tend to play videos passively without actual attention.

Beneficiary Disciplines:

He highlighted IT, engineering, and medical sciences as the most suitable fields, while also recognising design and digital arts as particularly relevant. Humanities, however, are less likely to benefit due to limited job market opportunities.

Institutional Integration:

Official recognition from the Ministry of Higher Education is essential. Adoption should be facilitated through a ministerial decision and coordinated with the Ministry of Telecommunications and the IT Centre.

Political Factors:

The existence of multiple governments does not represent a significant obstacle, since each authority seeks to showcase achievements. What matters is presenting the idea in an appealing and practical way.

Future Outlook:

He believes interactive learning has strong potential in Yemen, given youth engagement with platforms like TikTok. Yet, success depends on developing national policies and legislative frameworks to ensure sustainability.

Dr Mohammed Al-Riyashi, First Vice President of the Information Technology Sector at the Chamber of Commerce:

المقابلة الثانية: مع مسؤول حكومي/سياسي

الضيف: د. محمد الرياشي النائب الأول لرئيس قطاع تقنية المعلومات في الغرفة التجارية.

الباحثة: من وجهة نظركم، ما هي أبرز التحديات التي تواجه مؤسسات التعليم العالي في اليمن فيما يتعلق باستخدام التكنولوجيا في التدريس؟

الضيف: من أهم التحديات هجرة الكفاءات إلى الخارج بسبب الظروف السياسية والاقتصادية. هذا الأمر أدى إلى فقدان الكوادر المتخصصة وضعف الرغبة في تطوير الذات داخل البلاد، ما انعكس سلبًا على قطاع التعليم.

الباحثة: هل هناك خطط أو توجهات لدعم التعليم الرقمي وأدوات التعليم التفاعلي في الجامعات؟

الضيف: نعم، هناك اهتمام كبير بالتحويلات الرقمية سواء من وزارة الاتصالات أو وزارة التعليم العالي. على سبيل المثال، نظمنا مؤخرًا معرضًا تقنيًا تناول موضوعات مثل الشمول المالي والتحول الرقمي، مما يعكس وجود توجه وطني في هذا المجال.

الباحثة: هل تعتقد أن تقنيات الفيديو التفاعلي يمكن أن تساهم في تحسين جودة التعليم في مجالات مثل الفنون أو التصميم أو الحاسوب؟

الضيف: بالتأكيد، أي أداة تساهم في خدمة التعليم نحن في أمس الحاجة إليها.

الباحثة: ما هي التخصصات أو الفئات الطلابية الأكثر استفادة من هذه الأدوات؟

الضيف: التخصصات التقنية والرقمية هي الأكثر حاجة واستفادة من هذه الأدوات، خاصة في ظل التحديات الراهنة.

الباحثة: ما مدى إمكانية دمج هذه الأدوات التفاعلية ضمن خطط التعليم العالي الرسمية؟

الضيف: هناك توجه واضح من وزارة التعليم العالي نحو تطوير التعليم باستخدام هذه الأدوات وخدمة المتخصصين في هذا المجال.

الباحثة: ما هي المتطلبات الأساسية لتطبيق هذه المبادرات على نطاق وطني؟

الضيف: توفير بنية تحتية ملائمة وتوطين الكفاءات المتخصصة هو الشرط الأساسي.

الباحثة: كيف يمكن للباحثين أو المطورين التعاون مع الجهات الرسمية لضمان تبني هذه التقنيات؟

الضيف: لا يوجد مانع إذا كانت هذه التقنيات تلبي احتياجات واقعية. الجهات الرسمية ستتبناها وتدعمها.

الباحثة: كيف ترون مستقبل التعليم التفاعلي في اليمن؟

الضيف: هناك توجه وطني منذ عام 2022 نحو تطوير التعليم الرقمي والتقني. نحن نعمل باستمرار مع جهات متعددة في الدولة لدعم هذا التوجه وتوطينه في الجامعات.

الباحثة: هل ترون أن ضعف الإنترنت يشكل حجرة عثرة أمام إتاحة التعليم الرقمي للجميع؟

الضيف: بالطبع، غياب بيئة افتراضية قوية يعيق الباحثين عن الوصول إلى المعارف الحديثة ويؤثر سلبيًا على التعليم.

الباحثة: هل تؤثر الانقسامات السياسية وتعدد الحكومات على توحيد الجهود في دعم التعليم؟

الضيف: نعم، الصراعات السياسية سببت انقسامًا في التعليم العالي بين الشمال والجنوب، وهو أمر يعرقل التطوير. من المفترض أن يبقى التعليم، والصحة، والقطاع التقني بعيدًا عن التجاذبات السياسية.

الباحثة: أشركم جزيل الشكر على وقتكم الثمين وعلى مشاركتكم القيّمة.

الضيف: أهلاً وسهلاً، أتمنى لكم التوفيق والنجاح.

Translation to English:

Governmental/Political Figure

Guest: Dr Mohammed Al-Riyashi, First Vice President of the Information Technology Sector at the Chamber of Commerce.

Researcher: From your perspective, what are the main challenges that higher education institutions in Yemen face regarding the use of technology in teaching?

Guest: One of the main challenges is the migration of skilled professionals abroad due to political and economic conditions. This has led to a loss of specialized expertise and a weakened desire for self-development within the country, which has negatively affected the education sector.

Researcher: Are there any plans or orientations to support digital education and interactive learning tools in universities?

Guest: Yes, there is significant interest in digital transformation, whether from the Ministry of Telecommunications or the Ministry of Higher Education. For example, we recently organised a technology exhibition that addressed issues such as financial inclusion and digital transformation, reflecting a national trend in this field.

Researcher: Do you think interactive video technologies could help improve the quality of education in fields such as arts, design, or computing?

Guest: Absolutely. Any tool that serves education is urgently needed.

Researcher: Which disciplines or student groups would benefit the most from these tools?

Guest: Technical and digital disciplines are the ones most in need and would benefit the most from such tools, especially given the current challenges.

Researcher: To what extent can these interactive tools be integrated into official higher education plans?

Guest: There is a clear orientation from the Ministry of Higher Education toward developing education using such tools and serving specialists in this field.

Researcher: What are the basic requirements for implementing these initiatives on a national scale?

Guest: The availability of suitable infrastructure and the localisation of specialised expertise are the essential requirements.

Researcher: How can researchers or developers collaborate with official institutions to ensure the adoption of these technologies?

Guest: There is no objection, provided these technologies meet real needs. The official institutions will adopt and support them.

Researcher: How do you see the future of interactive education in Yemen?

Guest: Since 2022, there has been a clear national orientation toward developing digital and technological education. We are constantly working with multiple state entities to support this direction and embed it in universities.

Researcher: Do you think weak Internet access is a stumbling block to making digital education available to all?

Guest: Of course. The absence of a strong virtual environment prevents researchers from accessing modern knowledge and negatively impacts education.

Researcher: Do political divisions and multiple governments affect the unification of efforts to support education?

Guest: Yes, political conflicts have caused a division in higher education between the North and the South, which hinders development. Education, health, and the technology sector should remain outside political disputes.

Researcher: Thank you very much for your valuable time and contribution.

Guest: You are most welcome. I wish you success and all the best.

Fua'ad Hasan Abdulrazzak Senior Official, Ministry of Higher Education and Scientific

مقابلة مسؤول حكومي/سياسي (بصفته قياديًا في وزارة التعليم العالي والبحث العلمي).

المقابلة السياسية مع: د. فؤاد حسن عبدالرزاق قيادي بوزارة التعليم العالي والبحث العلمي

المقابل: دكتور، بداية نشكرك على وقتك. ما أبرز التحديات التي تواجه مؤسسات التعليم العالي في اليمن فيما يتعلق باستخدام التكنولوجيا؟

المجيب: أهم التحديات هي محدودية الموارد التي توفرها وزارة الاتصالات وتقنية المعلومات، وضعف الثقافة التكنولوجية لدى أعضاء هيئة التدريس، سواء في التعليم الأساسي أو الجامعي. هذا الأمر يولد مقاومة للتغيير، وقد واجهنا ذلك خلال جائحة كوفيد-19، حيث كان من الصعب التكيف مع أنظمة إدارة التعلم الإلكترونية. لهذا أصدرت الوزارة قرارًا بأن لا يقل التدريس عبر الإنترنت عن 30% من محتوى كل مقرر، لكن الالتزام ما يزال محدودًا.

المقابل: هل هناك خطط حالية لدعم التعليم الرقمي في الجامعات؟

المجيب: نعم، أحد شروط الاعتماد الأكاديمي حاليًا هو وجود LMS فعال في الجامعة، واستخدامه بشكل جزئي على الأقل في التدريس.

المقابل: كيف ترون دور الفيديو التفاعلي (HyperLearnX) في تحسين التعليم الجامعي؟

المجيب: بالتأكيد سيكون له دور كبير. هذه التقنية تمنح الطلاب مرونة أكبر في التعلم، وتتيح لهم التكرار والتفاعل مع المدرس. وهي مفيدة بشكل خاص في التخصصات العملية مثل الهندسة، الحاسوب، والتصميم. لكن حتى التخصصات الإنسانية يمكن أن تستفيد من التفاعل المباشر بالصوت والصورة.

المقابل: ما هي الشروط اللازمة لتطبيق التقنية على المستوى الوطني؟

المجيب: لا بد من وجود استراتيجية وطنية لتقنية المعلومات في التعليم، مع تكامل بين وزارة الاتصالات وبقية الوزارات. يجب تحسين خدمات الإنترنت خاصة في المناطق الريفية، وتوفير أسعار مناسبة للطلبة، وكذلك تدريب أعضاء هيئة التدريس والطلاب على التعليم الرقمي. والأهم أن تكون هناك سياسات إلزامية واضحة.

المقابل: كيف يمكن للباحثين التعاون مع الجهات الرسمية لتبني هذه التقنيات؟

المجيب: الباب مفتوح للتعاون، لكن التواصل هو الأساس. على الجامعات والباحثين أن يبادروا بالتواصل مع مؤسسات الدولة لإيجاد فرص حقيقية لتعزيز التحول الرقمي.

المقابل: ما هو مستقبل التعليم التفاعلي في اليمن من وجهة نظرك؟

المجيب: المستقبل واعد جدًا. صحيح أن السياسات الوطنية ما تزال محدودة، لكن التجارب التي طبقناها في جامعة ذمار كانت ناجحة وأظهرت أثرًا إيجابيًا على تفاعل الطلاب. أعتقد أن التوسع في هذا المجال قادم لا محالة.

المقابل: كلمة أخيرة؟

المجيب: أوصي بتطوير الموارد والبنية التحتية للاتصالات، ورسم سياسات واضحة للتحويل الرقمي في التعليم. كما أوصي الباحثين والجامعات بعدم الانتظار، بل المبادرة بالتطبيق والتجربة، لأن التجربة العملية هي المعيار الحقيقي لنجاح أي تقنية.

Translation to English:

Governmental Policy Perspective

Interviewee: Dr Fua'ad Hasan Abdulrazzak, Senior Official, Ministry of Higher Education and Scientific Research

Interviewer: Thank you, Dr Fua'ad, for your time. What do you see as the main challenges facing higher education institutions in Yemen regarding the use of technology?

Interviewee: The key challenges are, first, the limited resources provided by the Ministry of Telecommunications and Information Technology, and second, the weak technological culture among faculty members across schools and universities. This often leads to resistance to adopting new tools. We witnessed this clearly during the COVID-19 pandemic, when adapting to e-learning management systems was very difficult. To address this, the Ministry issued a policy requiring at least 30% of every course to be taught online, though compliance has been inconsistent.

Interviewer: Are there any current plans to support digital and interactive learning in universities?

Interviewee: Yes. One of the accreditation requirements, whether for public or private universities, is the availability of a functional Learning Management System (LMS). Universities must demonstrate their use as part of the teaching process.

Interviewer: How do you see interactive video, such as HyperLearnX, contributing to higher education?

Interviewee: Without doubt, such tools enhance both teaching and learning. They allow students to interact at their own pace, repeat material as needed, and clarify issues directly with instructors. They are especially valuable in practical fields such as engineering, computer science, and design. Even students in the humanities can benefit, as these tools provide more direct engagement between lecturer and student.

Interviewer: What conditions must be met for implementing such technologies nationwide?

Interviewee: A national strategy for educational technology must be established. There also needs to be coordination between the Ministry of Telecommunications and other government bodies to ensure better infrastructure, including affordable internet

packages for students. Furthermore, both faculty and students require training to improve digital literacy. Importantly, policies must be not only advisory but mandatory, particularly for rural areas where services need expansion.

Interviewer: How can researchers and developers collaborate with official institutions to ensure sustainable adoption of these technologies?

Interviewee: Collaboration is possible and, in fact, necessary. I do not believe there are strict barriers, but success depends on proactive communication. Researchers, universities, and cultural attachés abroad should connect with national institutions to create opportunities for advancing digital education.

Interviewer: How do you view the future of interactive learning in Yemen?

Interviewee: I am optimistic. While national policies are still limited, when we introduced e-learning at Dhamar University, the outcomes were positive, and both students and teachers benefited. I believe the future of interactive learning in Yemen will expand significantly.

Interviewer: Any final recommendations?

Interviewee: I recommend further investment in resources and telecommunications infrastructure, as well as clear policies to support digital transformation in education. Researchers should take initiative and not wait for government action alone. Practical application and experimentation are the real measures of success.

Dr Mohammed Alshargabi, International Specialist, PhD in Computer Science, Expert in Education Quality and Academic Accreditation, and member of various accreditation boards

Peace be upon you, and thank you for dedicating your valuable time to participate in this interview.

As part of this project, I have developed an innovative educational technology, registered as intellectual property, called HyperLearnX. This system enables high-quality interactive videos to be delivered over low-speed 3G networks and is specifically designed for developing contexts such as Yemen.

I would be delighted to hear your insights today, drawing on your expertise in planning, policy, and higher education. All responses will be kept strictly confidential and used only for academic purposes.

(Note: “I have not developed a prototype or Minimum Viable Product (MVP) yet. However, I will present a sample hypertext video from an existing, less-known platform as a demonstration to explain the concept.”)

1. From your perspective, what are the main challenges facing higher education institutions in Yemen in relation to the use of technology in teaching?

From my perspective, the challenges fall into four key elements:

IT infrastructure: Access is limited to certain areas, such as Sana'a, and mainly for those who can afford it. For example, I personally use 4G because I pay YER 32,000 (around USD 70). But if we consider the actual target population of your idea, which is excellent, they unfortunately lack the necessary IT or internet infrastructure. This is the biggest challenge.

Outcome-based design: When designing lessons or educational content, whether digital or face-to-face, the entire system should be built on an outcome-based approach to ensure proper learning outcomes.

Digital literacy: We need to address digital illiteracy, both among university lecturers and among students.

Financial capacity: The affordability of distance and e-learning solutions remains a major obstacle.

2. Are there current initiatives or plans to support digital education or interactive learning tools in universities?

Yes. We worked on a project where I, as Chair of the Accreditation Board, discussed standards. According to Quality Matters (the leading international body for e-learning accreditation), there are 8 major standards with 42 sub-standards. Any electronic course must comply with these standards.

I was involved in adapting these standards for technical and vocational education. The future of education, whether we like it or not, is moving toward digital learning. Unfortunately, while we developed these standards, they have not yet been implemented, though some work is ongoing.

3. Do you think technologies like interactive video (Hypertext Video) can contribute to improving education quality, especially in fields like design and the arts?

Absolutely, especially if linked to learning outcomes. The global trend today is toward outcome-based education. At every level, lessons, assessments, strategies, and everything must be aligned with learning outcomes.

HyperLearnX is truly creative and excellent because:

It reduces video size, addressing a real community need.

It supports progressive learning design.

Ultimately, the system must always aim at achieving learning outcomes. Assessments, therefore, should measure whether students achieve these staged outcomes.

4. In your opinion, which student groups or disciplines would benefit most from such tools?

I believe all disciplines can benefit, but the key lies in the design of lessons and assessments.

In logical/technical fields, assessments tend to be objective.

In creative fields like the arts, assessments are more subjective.

Regardless, all courses should follow a structured design. A digital course should be built on five main pillars:

Learning Outcomes the foundation of everything: content, strategies, and platform design.

Learning Content must be aligned with learning outcomes.

Teaching Strategies built on the “Quality Matters” hierarchy; these vary by discipline.

Learning Environment/Activities tailored to outcomes.

Assessments objective or subjective, depending on the discipline, but always outcome-driven.

5. To what extent can tools like HyperLearnX be integrated into official higher education projects or plans?

The potential is very high and very important. Personally, I am currently leading a large-scale project for curriculum design that includes integrating additional resources via QR codes.

6. What requirements must be in place for such initiatives to be implemented nationally?

Strong infrastructure

Comprehensive training

Learning resources aligned with learning outcomes

Wide-scale digital literacy programs

7. How can researchers and developers collaborate with official bodies to ensure sustainable adoption of these technologies?

This depends on top management commitment and institutional strategic transformation.

The most important factor is having decision-makers who believe in and recognise the need for the technology. Only then will they collaborate with researchers or developers to bring it into reality. Otherwise, the idea will remain just research papers and not reach implementation.

8. How do you see the future of interactive learning in Yemen? Are there national policies to support its expansion?

Digital education will inevitably arrive, whether we like it or not. Hiding from it is like an ostrich burying its head in the sand.

We have already tried to push initiatives, for example, with Dr Fuad Abdulrazzaq, we organised several conferences that produced many recommendations. Progress has been slow, but there is at least a starting point.

9. Are political conditions a factor in preventing the adoption of certain technologies?

In my personal opinion, it is not the main factor, but it is an influencing one.

Regardless of political divisions or conflicts, if there is a strong belief in a technology or idea, it will be applied. Politics may indirectly delay it, but it is not the primary obstacle.

10. Do you believe that providing educational tools compatible with low-speed internet could truly transform access to education?

Certainly. I see it as a powerful and highly suitable solution.

Closing

I sincerely thank you for dedicating your valuable time to this interview, which contributes to my research:

“Advancing Hypertext Video-Based Learning in Art and Design Education: An Interpretive Case Study of Colour Theory Learning Among Art Students in Yemen.”

Your valuable insights have enriched this discussion and added important dimensions that deepen our understanding of the educational reality and its challenges.

Section 2: Creators and Technicians of Interactive Video

Mossa Ghurab, Sana'a University, more details Error! Reference source not found.
illustrates participants description

بصفته خبير تقني / مطور

أوضح الدكتور موسى غراب، خبير تقني وعضو هيئة تدريس في جامعة صنعاء، أن التحديات في مجال التعليم الرقمي في اليمن ليست محصورة في غياب البنية التحتية فقط، بل تمتد إلى مشاكل برمجية، وهندسية، وأيضًا في مستوى الكفاءات البشرية المؤهلة للتعامل مع التقنيات الحديثة.

البنية التحتية والاتصال

قال: "المشكلة الجوهرية في اليمن أننا لا نملك شبكة مستقرة. أغلب المستخدمين يعتمدون على الجيل الثالث (3G)، وهو بطيء جدًا وأحيانًا ينهار كليًا. أحيانًا يستغرق تحميل مقطع قصير بضع دقائق. لا يوجد انتشار حقيقي للجيل الرابع (4G)، والجيل الخامس (5G) غير مطروح أساسًا".

وأضاف: "حتى الكهرباء غير مستقرة، وهذا يؤثر على أي منصة تعليمية تحتاج تشغيل فيديو تفاعلي أو محتوى متعدد الوسائط".

التحديات البرمجية والهندسية

أشار " لدينا مشكلة في غياب أنظمة محلية لمعالجة الفيديو. معظم الحلول المستوردة لا تناسب ظروف اليمن. على سبيل المثال، منصات مثل YouTube أو Vimeo تستهلك بيانات عالية جدًا، بينما الطلاب هنا لا يملكون سوى باقات إنترنت صغيرة".

كما أوضح: "حتى على مستوى السيرفرات، لا توجد استضافة محلية قوية، وكل شيء مرتبط بسيرفرات خارجية، وهذا يزيد من بطء الخدمة".

الكفاءات التقنية

قال: "عندنا مطورون شباب ممتازون، لكن يشتغلون فرادى وبإمكانات محدودة. لا توجد بيئة حاضنة، ولا مسرعات أعمال قادرة على دعم مشاريع مثل أنظمة ضغط الفيديو أو واجهات الوسائط التفاعلية".

وأضاف: "الهجرة مشكلة أخرى، فالكفاءات تغادر للبحث عن فرص أفضل".

الحلول المقترحة

ضغط الفيديو: "الحل الأساسي هو تطوير خوارزميات ضغط مخصصة، مثل فكرتكم في SmartZone Compression. هذا سيكون ثوريًا لأنه يقلل من استهلاك البيانات ويجعل الفيديو قابلاً للتشغيل حتى في ظروف الإنترنت الضعيفة".

الاعتماد على مفتوح المصدر: "لا نستطيع دفع ملايين الدولارات لشركات برمجيات. الأنسب هو استخدام تقنيات مفتوحة المصدر وتطويرها محليًا بما يتناسب مع الواقع".

التخزين المؤقت: "يمكن التفكير أيضًا في حلول caching (التخزين المؤقت) بحيث الطالب يحمل جزء من الفيديو مسبقًا ويكمله لاحقًا بدون انقطاع".

تجربة المستخدم

شدد: "واجهة الاستخدام لازم تكون أبسط ما يمكن. الطالب ما عنده وقت يضيع بين قوائم معقدة. يكفي أزرار واضحة: تشغيل، إيقاف، اختيار مسار، الرجوع، التقدم. أي تعقيد إضافي سيجعل التجربة تفشل".

وأضاف: "الهاتف الذكي هو المنصة الرئيسية، وليس الكمبيوتر، وبالتالي أي تصميم يجب أن يكون mobile-first".

خلاصة: أنهى حديثه: "لو أردنا نجاح مشروع الفيديو المعتمد على النص الفائق في اليمن، لازم نركز على ثلاثة أشياء: أولًا، التكيف مع البنية التحتية الضعيفة عبر ضغط وتخزين بديل. ثانيًا، تطوير حلول محلية مفتوحة المصدر تقلل التكاليف. ثالثًا، واجهة استخدام بسيطة تناسب عقول الطلاب وأجهزتهم البسيطة".

المحاور: تقصد الآن أنه لو عملنا خيارات للفيديو نفسه؟ ما هي الخيارات المتاحة لضغط الفيديو وتقليل حجمه مع الحفاظ على التفاعل؟

الخبير: الخيارات الموجودة مثلًا أن تقلل عدد الفريمات في اللقطة الواحدة. عادةً الفيديو عالي الجودة يكون 30 إلى 60 فريم في الثانية. الآن لو قلصت العدد، مثلًا "فريم نعم، فريم لا"، فأنا أقلص حجم الفيديو إلى النصف تقريبًا، مع الحفاظ على جودة جيدة. وأيضًا يمكن عمل نوع من الـ summarization، أي أخذ فيديو مدته ساعتين ومحاولة اختصار بعض المقاطع بسبب تكرارها. كذلك يمكن حذف بعض الأجزاء أو تقليل الفريمات باستخدام أكواد برمجية.

أيضًا من الخيارات تقليل الـ Resolution. مثلًا بدل ما يكون 400×600 يمكن تقليله إلى 200×300. وإذا كان الفيديو تعليميًا، فالـ background عادة تكون صورة ثابتة أو شبه ثابتة، وهذه لا تأخذ مساحة كبيرة أثناء عملية الضغط.

المحاور: إجابتك ممتازة ومفيدة جدًا. طيب، هل توجد أطر أو تقنيات مفتوحة المصدر يمكن الاعتمادها لتقليل التكلفة في مرحلة التطوير؟

الخبير: أنا أدرس مواد مرتبطة بـ Computer Vision و Image Processing بالنسبة لعمليات الضغط ستجدين دراسات كثيرة، لكن لن تجدي إطارًا عامًا واحدًا للضغط. كل باحث يضغط بطريقة مختلفة لتقليل الحجم. لكن فكرتك أنت ليست فقط تقليل الحجم، وإنما حذف المحتوى المكرر، وهذه تتطلب خوارزميات خاصة. بصراحة، لم أرها من قبل ضمن الأبحاث التي أشرف عليها مع الطلاب. ربما استخدمت مكتبات جاهزة، لكن لا يوجد إطار واضح يمكن الاعتماد عليه. من المكتبات الشهيرة والمفتوحة المصدر: OpenCV :

المحاور: يعني حتى لو لم يكن إطارًا كاملاً، مجرد تقنيات مفتوحة يمكن استخدامها؟

الخبير: نعم، لكن معظم الأبحاث في Computer Vision الآن تستخدم Deep Learning المشكلة أن هذه الخوارزميات تحتاج إلى موارد قوية جدًا مثل GPU الأجهزة المتوفرة عندنا لا تتحملها، بينما في الخارج لديهم إمكانيات مناسبة. لذلك أقول لك لا توجد بنية تحتية قوية هنا، وأفضل شيء هو العمل على المستوى الأدنى الذي يمكن تشغيله على الأجهزة الموجودة في اليمن.

المحاور: فهمت عليك يا دكتور. من وجهة نظرك، ما العوامل التي تؤثر أكثر على تجربة المستخدم عند مشاهدة فيديو تفاعلي في بيئة إنترنت ضعيفة؟

الخبير: برأيي إذا الإنترنت ضعيف والفيديو بدأ يتقطع، كثير من المستخدمين يغلقونه مباشرة. لأن التقطع والتعليق المتكرر يسبب ملل وإرهاق. مثلاً في ماليزيا، يوتيوب عندكم يفتح بجودة HD أو p1080، بينما هنا في اليمن ينزل مباشرة على أقل جودة.

المحاور: صحيح، طيب كيف يمكن تحسين سرعة التحميل أو تقليل الانقطاعات في الفيديوهات التفاعلية باليمن؟

الخبير: الحل أن تكون السيرفرات داخلية. أقصد أن يتم تعزيز البنية التحتية للسيرفرات السحابية (cloud servers) داخل اليمن. إذا كانت السيرفرات موجودة محلياً، فإن زمن التحميل سيكون أقل. حتى على مستوى يوتيوب، لديهم سيرفرات في اليمن تعمل كـ cache servers. عندما يطلب المستخدم فيديو موجود فيها، يفتح بسرعة. أما لو طلب فيديو غير موجود في الكاش، يستغرق وقتاً أطول.

Translation to English:

Mossa Ghurab ,Sana'a University. Interview One: As a Technical Expert / Developer

Introduction

Dr Mossa Ghurab, a technical expert and faculty member at Sana'a University, explained that the challenges of digital education in Yemen are not limited to the absence of infrastructure but also extend to programming issues, engineering constraints, and the limited capacity of qualified human resources to deal with modern technologies.

Infrastructure and Connectivity

He stated, "The core problem in Yemen is that we do not have a stable network. Most users rely on third-generation (3G), which is very slow and sometimes collapses completely. Sometimes it takes several minutes just to load a short clip. There is no real deployment of 4G, and 5G is not even on the horizon."

He added: “Even electricity is unstable, and this affects any educational platform that requires interactive video or multimedia content.”

Programming and Engineering Challenges

He noted: “We face a problem due to the absence of local systems for video processing. Most imported solutions are unsuitable for Yemen’s conditions. For example, platforms like YouTube or Vimeo consume a very high amount of data, while students here only have small internet packages.”

He further explained: “Even at the server level, there is no strong local hosting, and everything is tied to external servers, which increases service latency.”

Technical Competencies

He said: “We have excellent young developers, but they work individually with limited resources. There is no nurturing environment and no accelerators capable of supporting projects such as video compression systems or interactive media interfaces.” He added: “Migration is another issue, as skilled professionals leave in search of better opportunities.”

Proposed Solutions

Video compression: “The fundamental solution is to develop customised compression algorithms, such as your SmartZone Compression concept. This would be revolutionary because it reduces data consumption and makes video playable even under weak internet conditions.”

Open-source adoption: “We cannot afford to pay millions of dollars to software companies. The most suitable approach is to use open-source technologies and adapt them locally to fit the reality.”

Caching: “We can also consider caching solutions, where the student pre-downloads part of the video and continues later without interruption.”

User Experience

He emphasised: “The user interface must be as simple as possible. Students do not have time to waste navigating through complex menus. Clear buttons are enough: play, pause, select path, back, forward. Any additional complexity will make the experience fail.”

He added: “The smartphone is the main platform, not the computer, so any design should be mobile-first.”

Conclusion

He concluded: “If we want the hypertext video project to succeed in Yemen, we need to focus on three aspects: first, adapting to weak infrastructure through compression and alternative storage; second, developing local open-source solutions to reduce costs; and

third, creating a simple user interface that matches the students' needs and their modest devices."

Follow-Up Discussion

Interviewer: So, if we implement video options, what are the available methods to compress video and reduce its size while maintaining interactivity?

Expert: "For example, one option is reducing the number of frames per second. Typically, high-quality video has 30 to 60 frames per second. If you cut it—say, 'one frame yes, one frame no' you almost halve the video size while keeping acceptable quality. Another method is summarisation: taking a two-hour video and trimming repeated parts. We can also reduce resolution, say from 600×400 to 300×200. If the video is educational, the background is usually static or semi-static, which does not take much space during compression."

Interviewer: Excellent and very useful. Are there open-source frameworks or technologies that could reduce development costs?

Expert: "I teach courses related to Computer Vision and Image Processing. For compression, you will find many studies, but not a single universal framework. Each researcher uses a different method. Your idea is not only to reduce size but also to eliminate duplicate content. That requires special algorithms. Honestly, I haven't seen that in the research I supervise. You might use existing libraries, but there is no complete framework. A well-known open-source library is OpenCV."

Interviewer: So, even if not a full framework, just open-source techniques could be used?

Expert: "Yes, but most Computer Vision research now relies on Deep Learning. The problem is that these algorithms require powerful resources such as GPUs. The devices we have here cannot handle them, whereas abroad, they have suitable facilities. That's why I say: there is no strong infrastructure here, and the best option is to work at the lowest possible level that can run on the devices available in Yemen."

Interviewer: From your perspective, what factors most affect the user experience when watching interactive video under weak internet conditions?

Expert: "In my opinion, if the internet is weak and the video keeps buffering, many users simply close it. Repeated buffering and lag cause frustration. For example, in Malaysia, YouTube starts at HD or 1080p, while here in Yemen, it defaults to the lowest quality."

Interviewer: True. So, how can loading speed be improved or buffering reduced for interactive videos in Yemen?

Expert: "The solution is to have local servers. I mean, enhancing cloud infrastructure inside Yemen. If servers are local, load time will be shorter. Even YouTube has cache servers in Yemen. When a user requests a video that is already cached, it loads quickly;

if not, it takes longer. The idea is to have multiple cache servers across Yemen, distributed across different nodes. For example, if the user is in Sana'a, they stream from servers in Sana'a; if in Taiz, from servers in Taiz. This reduces pressure on the network and makes streaming faster.”

Prof. Sharaf Abdulhak Alhomdy, see Table D.1 for participant details:

المقابلة الثانية: مع الأستاذ الدكتور شرف عبد الحق الحمدي – كخبير تقني

المحاور: كخبير تقني، ما هو رأيك الأولي في فكرة استخدام الفيديو التفاعلي النصي لتقديم محتوى تعليمي في بيئات منخفضة السرعة مثل اليمن؟

الأستاذ الدكتور شرف: طالما أن الفيديو مضغوط وأصبح حجمه صغيراً، فهو مناسب للبيئة اليمنية، خصوصاً مع ضعف الإنترنت.

المحاور: هل تعتقد أن هذا النموذج قابل للتنفيذ ضمن بيئات الجيل الثالث أو الإنترنت الضعيف؟

الأستاذ الدكتور شرف: الأمر يعتمد على حجم الفيديو. إذا ضغط من ساعتين إلى 15 دقيقة بجودة جيدة، مع حذف العناصر غير الضرورية، فسيكون مناسباً جداً.

المحاور: ما هي التحديات البرمجية أو الهندسية المحتملة؟

الأستاذ الدكتور شرف: المشكلة الأساسية في اليمن هي نقص الكفاءات الهندسية والبرمجية المتخصصة في هذا المجال.

المحاور: برأيك، ما العوامل الأكثر تأثيراً على تجربة المستخدم عند التعامل مع فيديو تفاعلي في بيئة الإنترنت الضعيف؟

الأستاذ الدكتور شرف: أبرز العوامل:

ضعف البنية التحتية.

محدودية الأجهزة لدى الطلاب.

ضعف مهارات استخدام التكنولوجيا لدى بعض الفئات.

غياب التدريب الكافي.

المحاور: كيف يمكن تحسين سرعة التحميل أو تقليل الانقطاعات؟

الأستاذ الدكتور شرف: هذه مشكلة ترتبط بالشركة المزودة للإنترنت (يمن نت) والسياسات الحكومية. الحل يكمن في تحديث البنية التحتية، إدخال سيرفرات إضافية، أو فتح خيارات الإنترنت عبر الأقمار الصناعية.

المحاور: ما هي توصياتك حول تصميم واجهة استخدام فعالة للطلاب الذين ليست لديهم خبرة تقنية كافية؟ الأستاذ الدكتور شرف: يجب أن تكون الواجهة واضحة وسهلة، مع تعليمات مبسطة ومباشرة، بحيث يستطيع الطالب التعامل معها دون تعقيد.

المحاور: هل يمكن دمج هذه التقنية مع أنظمة إدارة التعلم (LMS)؟

الأستاذ الدكتور شرف: نعم. من الأفضل أن يكون HyperLearnX جزءاً من نظام تعليمي شامل (LMS). هذا يتيح دمج الفيديو هات التفاعلية مع أنظمة قائمة بالفعل مثل Moodle أو غيره من الأنظمة مفتوحة المصدر.

المحاور: ما المتطلبات الضرورية للفريق التقني الذي سيطور مثل هذا النظام؟

الأستاذ الدكتور شرف: يجب أن يكون فريقًا متكاملًا، يجيد التعامل مع البرمجيات، المنصات التعليمية، التحميل والتحليل، وليس فقط ضغط الفيديو.

المحاور: وأخيرًا، ما توصياتك لبناء شراكات فنية لإنجاح هذا المشروع؟

الأستاذ الدكتور شرف: أوصي بإنتاج فيديو عالي الجودة وقليل التكلفة، قابل للترجمة إلى عدة لغات، وتقديمه كخدمة تعليمية ذات قيمة مضافة للجامعات. ثم الانطلاق نحو شراكات مع الجامعات والمطورين المحليين والدوليين.

سؤال: دكتور، من وجهة نظرك هل تعتقد أن هناك أطرًا أو تقنيات مفتوحة المصدر يمكن اعتمادها لتقليل التكلفة في مرحلة التطوير؟

إجابة: لم أتعامل كثيرًا مع الفيديو تحديدًا.

سؤال: طبيب يا دكتور، أقصد بشكل عام منصات أو صفحات إنترنت، هل توجد تقنيات مفتوحة المصدر يمكن اعتمادها لتقليل التكلفة في مرحلة التطوير؟

إجابة: لا أعرف.

سؤال: برأيك، ما العوامل التي تؤثر أكثر على تجربة المستخدم عند التعامل مع فيديو تفاعلي في بيئة إنترنت ضعيف؟

إجابة: أهم عامل هو ضعف البنية التحتية. فالمستخدم قد لا يمتلك جهازًا مناسبًا، أو قد يمتلك جهازًا بسيطًا يواجه صعوبة في تشغيل الخدمات التعليمية. أيضًا غياب التدريب اللازم للطلاب يشكل عائقًا.

سؤال: كيف يمكن تحسين سرعة التحميل أو تقليل الانقطاعات في هذا النوع من الفيديوهات؟

إجابة: المشكلة الأساسية في اليمن هي ضعف الإنترنت نتيجة احتكار الخدمة من قبل الشركة الوطنية (يمن نت). لا يمكن للمؤسسات أو الأفراد حل المشكلة بمفردهم، حتى وإن كان الاتصال عبر الألياف البصرية، فالخدمة تبقى ضعيفة.

سؤال: وما هي نصيحتك إذا؟

إجابة: من الحلول الممكنة:

إيقاف بعض المواقع غير الضرورية من قبل يمن نت لتخفيف الضغط.

توفير التجهيزات اللازمة لتوسيع الخدمة.

لكن المشكلة أن إدخال أدوات جديدة يواجه صعوبات بسبب الوضع السياسي والحصار. حتى حلول الإنترنت عبر الأقمار الصناعية (ستالايت) واجهت معارضة سياسية، رغم أنها توفرت في بعض محافظات الجنوب.

باختصار، وضع الإنترنت في اليمن حاليًا صعب جدًا، والحل هو الضغط لزيادة السرعة وتطوير البنية التحتية.

سؤال: دكتور، ما هي نصيحتك حول تصميم واجهة استخدام فعالة لطلاب قد لا يكونون معتادين على تقنيات التعليم الحديث؟

إجابة: يجب أن تكون الفيديوهات واضحة، سهلة الاستخدام، مع توفير تعليمات مبسطة وكافية للطلاب حتى يتمكن من الاستفادة.

سؤال: هل تعتقد أن النظام يمكن تطويره لاحقًا ليتكامل مع أنظمة إدارة التعليم (LMS)، مثل اتفاقية بين وزارة الاتصالات ووزارة التعليم العالي؟

إجابة: نعم، هناك أنظمة تعليمية مفتوحة المصدر مثل أنظمة إدارة التعلم (LMS) متوفرة بالفعل وتُستخدم في بعض الجامعات. يمكن لنظام HyperLearnX أن يتكامل مع هذه الأنظمة ليكون جزءاً منها، مما يسهل تطوير بروتوكولات فعال.

سؤال: ما هي المتطلبات الضرورية في الفريق التقني الذي سيشرف على بناء النظام وتطويره؟ هل يكفي ضغط الفيديو فقط؟

إجابة: لا، ضغط الفيديو مع إضافة الأسئلة التفاعلية هو مجرد جزء من نظام تعليمي شامل. لا بد أن يكون HyperLearnX مدمجاً داخل نظام إدارة تعلم (LMS). لذلك يجب أن يكون الفريق متكاملًا، يمتلك خبرة في: البرمجة وتطوير البرمجيات.

إدارة المنصات التعليمية.

تحميل وتحليل البيانات.

Translation to English:

Second Interview: With Professor Dr Sharaf Abdulhaq Al-Hamdi as a Technology Expert

Interviewer: As a technology expert, what is your initial opinion on the idea of using interactive hypertext video to deliver educational content in low-speed environments such as Yemen?

Prof. Dr Sharaf: As long as the video is compressed and its size reduced, it is suitable for the Yemeni environment, especially considering the weak internet.

Interviewer: Do you think this model is feasible in third-generation networks or weak internet environments?

Prof. Dr Sharaf: It depends on the size of the video. If it is compressed from two hours to 15 minutes with good quality and unnecessary elements removed, then it would be very suitable.

Interviewer: What are the potential programming or engineering challenges?

Prof. Dr Sharaf: The main problem in Yemen is the lack of specialised engineering and programming expertise in this field.

Interviewer: In your opinion, what are the most influential factors affecting user experience when dealing with interactive video in weak internet environments?

Prof. Dr Sharaf: The main factors are:

Weak infrastructure.

Limited availability of devices among students.

Low digital literacy among some groups.

Lack of sufficient training.

Interviewer: How can loading speed be improved or interruptions reduced?

Prof. Dr Sharaf: This is an issue tied to the internet provider (YemenNet) and government policies. The solution lies in upgrading the infrastructure, adding more servers, or allowing satellite internet options.

Interviewer: What are your recommendations for designing an effective user interface for students with little technical experience?

Prof. Dr Sharaf: The interface should be clear and simple, with straightforward instructions so students can use it without difficulty.

Interviewer: Can this technology be integrated with Learning Management Systems (LMS)?

Prof. Dr Sharaf: Yes. It would be best if HyperLearnX were part of a comprehensive LMS. This allows interactive videos to be integrated with existing systems such as Moodle or other open-source platforms.

Interviewer: What are the essential requirements for the technical team that will develop such a system?

Prof. Dr Sharaf: The team must be well-rounded, with expertise in software development, educational platforms, uploading and analysing data, not just video compression.

Interviewer: Finally, what are your recommendations for building technical partnerships to ensure the success of this project?

Prof. Dr Sharaf: I recommend producing high-quality, low-cost videos that can be translated into multiple languages and offered as a value-added educational service for universities. From there, partnerships can be established with universities and local and international developers.

Question: From your perspective, do you think there are open-source frameworks or technologies that could be adopted to reduce development costs?

Answer: I haven't dealt much with video specifically.

Question: Well, Doctor, I mean more generally, internet platforms or websites. Are there open-source technologies that can be used to reduce development costs?

Answer: I don't know.

Question: In your opinion, what factors most affect the user experience when interacting with video in weak internet environments?

Answer: The most important factor is weak infrastructure. A user may not own a suitable device, or may only have a simple one that struggles to run educational services. Also, the lack of proper training for students is a major barrier.

Question: How can loading speed be improved or interruptions reduced in this type of video?

Answer: The main issue in Yemen is weak internet due to a monopoly by the national provider (YemenNet). Institutions or individuals cannot solve this alone. Even with fibre optic connections, the service remains weak.

Question: What is your advice then?

Answer: Possible solutions include:

Blocking unnecessary websites by YemenNet to reduce traffic.

Providing the equipment needed to expand the service.

But introducing new tools faces challenges due to the political situation and blockade. Even satellite internet solutions faced political opposition, although they became available in some southern governorates.

In short, the internet situation in Yemen is currently very difficult, and the solution is to push for higher speeds and infrastructure development.

Question: Doctor, what is your advice for designing an effective user interface for students who may not be accustomed to modern educational technologies?

Answer: Videos should be clear, easy to use, and supported with simple, sufficient instructions so that students can benefit.

Question: Do you think the system can later be developed to integrate with Learning Management Systems (LMS), such as an agreement between the Ministry of Telecommunications and the Ministry of Higher Education?

Answer: Yes, there are open-source LMS platforms already in use at some universities. HyperLearnX can integrate with these systems and become part of them, which makes developing an effective prototype easier.

Question: What are the necessary requirements for the technical team that will oversee building and developing the system? Is video compression enough?

Answer: No, video compression with interactive questions is only one part of a complete educational system. HyperLearnX must be embedded within an LMS. Therefore, the team must be comprehensive, with expertise in:

Programming and software development.

Managing educational platforms.

Uploading and analysing data.

Tahani Lutf Alswari, Network engineer, Master of Information Technology, Malaysian University OUM (See Table D.1 for participant details)

بصفتها مهندسة متخصصة في شبكات وتقنية المعلومات، رأت تهاني السواري أن تقنية HyperLearnX يعتبر حلاً مناسباً لبيئات الإنترنت الضعيف مثل اليمن. حيث يمكنها تقليل حجم الفيديو مع الحفاظ على جودته وإضافة عناصر تفاعلية مثل الأسئلة المرتبطة بالمحتوى.

أوضحت أن تجربة هذه التقنية تتطلب اختباراً عملياً لمقارنة الفيديو قبل وبعد المعالجة، من حيث الحجم، سرعة التحميل، وجودة العرض. إذا كانت النتائج إيجابية، فإنها ستساهم في تحسين تجربة الطلاب بشكل ملموس.

من الناحية التقنية، ترى أن هناك حاجة إلى فريق متكامل يضم مبرمجين، مهندسي شبكات، وأخصائيي أمن معلومات لتطوير المنصة وضمان استدامتها وحمايتها من الاختراقات. أشارت كذلك إلى أن تجربة المستخدم في بيئات الإنترنت الضعيف تتأثر أساساً بسرعة الشبكة، تكلفة الباقات، وجودة التحميل.

ذكرت أن هناك منصات تعليمية محلية مثل منصة ميون Meyon تقدم محتوى مجاني، ورأت أنه من المهم التعاون مع شركات الاتصالات لتوفير باقات مدعومة أو مجانية لدعم التعليم الرقمي.

كما أكدت أن النظام يمكن تطويره ليتكامل مع أنظمة إدارة التعليم (LMS) في حال نجاح التجربة الأولية، وأن تصميم واجهة المستخدم يجب أن يكون بسيطاً وفعالاً ليستوعب احتياجات الطلاب الذين قد لا يكون لديهم خبرة كبيرة بالتقنيات الحديثة.

وأخيراً، أوصت ببناء شراكات مع هيئة الابتكار في اليمن لتبني المشروع، ورأت أن هناك إمكانية لاعتبار HyperLearnX كابنكر وطني وربما تسجيله كبراءة اختراع.

هناك صعوبة في أن يكون الفيديو طويل جداً، فالطالب لا يستطيع تحمل التكلفة العالية للتعليم عبر الإنترنت بشكل عام. لذلك يضطر للبحث عن بديل للدراسة أونلاين. هنا تأتي فائدة التقنية التي عرضتها HyperLearnX، فهي تساعده كثيراً في تقليل الوقت مع الحفاظ على جودة رائعة، وتتيح له الوصول إلى هذه الفيديوهات للتعليم والاستفادة منها.

طبيب، برأيكم ما هي الفئات الطلابية والتخصصات التي يمكن أن تستفيد أكثر من هذا النوع من الأدوات التعليمية؟ ممكن مثلاً في المدارس، هناك طلاب لا يستطيعون الذهاب إليها لظروف معينة. حينها يمكن للمدرسة إعداد فيديوهات كهذه للطلاب، سواء كانت حالة مرضية أو بسبب السفر أو أي ظروف أخرى. والفيديوهات نفسها يمكن عرضها للطلاب الحاضرين بشكل مباشر، ثم تسجيلها وعرضها للطلاب الآخرين ليستفيدوا منها أيضاً.

طبيب أستاذة، هل تفضلين أن أجري معك المقابلة بصفتك مسؤولة حكومية، أو مهندسة وتقنية، أو محاضرة جامعية؟ لا، مختصة مهتمة بمجال التحول الرقمي وإدخال التقنيات الحديثة للطلاب بشكل خاص.

ما مدى إمكانية دمج أدوات تفاعلية مثل هذه التقنية التي عرضتها عليك، وسميتها HyperLearnX، ضمن خطط مشاريع التعليم العالي الرسمية؟ هل هناك إمكانية لذلك؟

تقصدين أن تكون تقنية تُستخدم في المدارس والجامعات؟ يمكن تجربة ذلك أولاً على عينة معينة من الطلاب، وإذا نجحت التجربة فلماذا لا تُعمم على البقية؟

طبيب، ما هي المتطلبات أو الشروط التي يجب توافرها لتطبيق مثل هذه المبادرات على نطاق وطني؟

أول شيء، لو ترسلين لي فيديو كنموذج، بعدها نفحص الجودة، والاختصارات، والـ Hyperlink. ثم نجرب على عينة من الطلاب ونرى مدى استفادتهم. إذا كانت هناك استفادة حقيقية يمكن عرضه كمشروع للتحول الرقمي.

كيف يمكن للباحث أو المطور التعاون مع جهات رسمية لضمان تبني هذه التقنيات بشكل مستدام؟

الآن هناك توجه لدعم مشاريع الطلاب وابتكاراتهم. يمكن عرض فكرة HyperLearnX على وزارة الاتصالات كمشروع ابتكار، ودراسة إمكانية دمجه مع التوجهات الجديدة.

طبيب، كيف ترين مستقبل التعليم التفاعلي في اليمن؟ وهل هناك سياسات وطنية قد تدعم التوسع فيه؟
حاليًا أعتقد أن هناك صعوبات، لكنها تبقى فكرة مستقبلية ممكنة. إذا توفرت الإمكانيات للمدارس والمعاهد، فبالأكيد سيكون هناك تقبل لها.

هل هذه الصعوبات سياسية أم مرتبطة بالبنية التحتية؟

لا، ليست سياسية. بالعكس، الدولة الآن تتجه نحو التحول الرقمي والتعليم أونلاين. المشكلة الحقيقية هي البنية التحتية والوضع الاقتصادي.

أيضًا لا يمكن تعميم أي تقنية على مستوى الوطن كاملاً بسبب الانقسامات السياسية بين أكثر من جهة حاكمة في اليمن. لكن مثلاً في صنعاء هناك ترحيب كبير بالتحول الرقمي، وكان مؤخرًا هناك منتدى لعرض مشاريع تخرج من كليات الهندسة والحاسوب، ولاحظنا انبهارًا كبيرًا بإبداعات الطلاب. الدولة مرحبة جدًا بهذه المبادرات، وقد تتبناها، خصوصًا إذا اطلعوا على حقوق الملكية الفكرية لتقنية HyperLearnX كبراءة اختراع.

هل تعتقدين أن توفير أدوات تعليمية متوافقة مع الإنترنت الضعيف يمكن أن يحدث تحولًا حقيقيًا في الوصول إلى التعليم؟

صحيح أن الوضع صعب الآن، لكن هناك توجه لدعم التعليم الرقمي مستقبلاً إن شاء الله.

طبيب، ما هو نوع الإنترنت المتاح لديكم الآن؟ G3 أو G4؟

نحن نعمل على G4 حاليًا، وهو السائد في البلاد.

من وجهة نظرك التقنية، ما رأيك في فكرة استخدام الفيديو النصي لتقديم محتوى تعليمي في بيئات منخفضة السرعة (Low Bandwidth)؟

ممكن أن يساعد كثيرًا في تطوير التعليم. إذا طبقت هذه التقنية، سيكون هناك تطور ملحوظ.

هل ترين أن هذا النموذج قابل للتنفيذ تقنيًا ضمن بيئات الجيل الثالث أو الإنترنت الضعيف جدًا؟

نعم، لكن يجب أولاً عمل تجربة لمقارنة حجم الفيديو الأصلي قبل تطبيق HyperLearnX وبعده، ومعرفة الفارق في السرعة والجودة. إذا كان الفارق واضحًا، فسيكون مفيدًا جدًا للطلاب.

هل هناك تحديات برمجية أو هندسية قد تواجه تطوير نظام مثل HyperLearnX؟

حتى الآن لم أسمع عن تجارب مماثلة في اليمن. قد نحتاج لمعرفة إن كانت هناك تطبيقات أو مشاريع مشابهة في دول أخرى، لكن بما أن لديك حقوق الملكية الفكرية، فهذا يعني أنها فكرة جديدة وفريدة.

هل تفكرين أن يكون المشروع مجرد بحث أكاديمي أم أنك ترغبين في تطبيقه على أرض الواقع؟

أكيد أريده أن يُطبق على أرض الواقع، وليس فقط بحثًا علميًا.

ما هي الخيارات المتاحة لضغط الفيديو مع الحفاظ على التفاعل الداخلي (النصوص، الروابط، التوقيت... إلخ)؟

إذا كان المحتوى يخدم المجتمع ولا يشكل تهديدًا، فبالعكس سيكون هناك دعم رسمي وربما يُعمم كمنصة تعليمية وطنية.

هل يوجد أطر أو تقنيات مفتوحة المصدر يمكن اعتمادها لتقليل التكلفة في مرحلة التطوير؟

أنا مختصة بالشبكات أكثر من البرمجة، لذلك قد تحتاج هذه الجزئية لمهندسين برمجيات متخصصين.

ما هي العوامل الأكثر تأثيرًا على تجربة المستخدم عند التعامل مع فيديو تفاعلي في بيئة إنترنت ضعيف؟

العوامل الأبرز: سرعة الإنترنت، تكلفة الباقية، جودة التحميل، واحتمال حدوث تقطع في العرض.

هل يجب التواصل مع شركات الاتصالات مثل يمن موبايل لتبني مثل هذه المبادرات؟

نعم. لدينا مثلاً منصة تعليمية اسمها ميون، وكل محتواها مجاني. مثل هذه المبادرات يمكن أن تُعتمد وتُدعم من الجهات المعنية لتكون مجانية ومتاحة للجميع.

كيف يمكن تحسين سرعة التحميل أو تقليل الانقطاعات؟

من خلال إعطاء هذه المنصات أولوية لدى شركات الاتصالات لتسهيل الوصول إليها.

ما هي نصيحتك حول تصميم واجهة استخدام فعالة للطلاب غير المعتادين على تقنيات التعليم الحديثة؟

أن تكون سهلة وواضحة، مع تفاعل مباشر بين الطالب والمعلم مثل إرسال الاستفسارات عبر الشاشة التفاعلية.

هل يمكن تطوير النظام لاحقاً ليتكامل مع أنظمة إدارة التعليم (LMS) ؟

نعم، إذا نجحت التجربة مع عينة من الطلاب، فبالأكيد سيكون هناك دعم لدمجه مع أنظمة التعليم القائمة.

ما هي المتطلبات الضرورية للفريق التقني الذي سيشرف على بناء النظام؟

يجب أن يكون فريقاً متكاملًا يضم: مبرمجين لتطوير النظام، مهندسي شبكات للدعم الفني، خبراء أمن معلومات لحماية المنصة، ومحللين للأنظمة.

أخيراً، ما توصيتك لبناء شراكات فنية مع الجامعات أو المطورين لتنفيذ هذه التقنية بشكل واقعي؟

نتمنى أن تكون هناك شراكات حقيقية بينك وبين الجهات المختصة مثل هيئة الابتكار، بحيث يتم دعم الفكرة وتطويرها لتخرج إلى النور.

Translation to English:

As a network and IT engineer, Tahani Al-Suwari believes that HyperLearnX represents a suitable solution for low-bandwidth environments such as Yemen. The technology can reduce video size while maintaining quality and adding interactive elements such as content-linked questions.

She explained that testing this technology requires a practical trial comparing the video before and after processing in terms of file size, loading speed, and display quality. If the results are positive, it could significantly enhance students' learning experiences.

From a technical standpoint, she emphasised the need for a comprehensive team including programmers, network engineers, and cybersecurity specialists to develop the platform, ensure sustainability, and protect it from breaches. She also highlighted that user experience in low-bandwidth environments is primarily affected by network speed, data costs, and download quality.

She mentioned local educational platforms such as Meyon, which provide free content, and stressed the importance of collaborating with telecommunications companies to offer subsidised or free data packages in support of digital education.

She also affirmed that the system could be developed to integrate with Learning Management Systems (LMS) if the initial trials succeed, and that the user interface

should be simple and efficient to meet the needs of students who may lack extensive experience with modern technologies.

Finally, she recommended building partnerships with the Innovation Authority in Yemen to adopt the project, noting that HyperLearnX could potentially be recognized as a national innovation and even registered as a patent.

There is a challenge when videos are too long, as students often cannot afford the high cost of online learning. This forces them to seek alternatives to studying online. Here lies the value of HyperLearnX: it helps significantly reduce learning time while maintaining excellent quality, giving students easier access to educational videos.

Interviewer: In your opinion, which groups of students or disciplines could benefit most from such educational tools?

Tahani: For example, in schools, there are students who cannot attend due to specific circumstances. Schools could prepare such videos for them, whether due to illness, travel, or other reasons. The same videos can also be shown to present students in class and then recorded and shared with those who are absent ones so they too can benefit.

Interviewer: Do you prefer that I conduct this interview with you as a government official, as a technical engineer, or as a university lecturer?

Tahani: As a specialist particularly interested in digital transformation and introducing modern technologies to students.

Interviewer: To what extent could interactive tools like HyperLearnX be integrated into official higher education projects?

Tahani: You mean as a tool for schools and universities? It could be piloted first with a sample group of students, and if successful, why not extend it more broadly?

Interviewer: What requirements or conditions are necessary to apply such initiatives on a national scale?

Tahani: First, you could send me a sample video. Then we evaluate the quality, shortcuts, and hyperlinks. After that, we try it with a group of students and assess their benefit. If the results are meaningful, it could be proposed as a digital transformation project.

Interviewer: How can researchers or developers collaborate with official bodies to ensure sustainable adoption of such technologies?

Tahani: There is now a strong trend to support student projects and innovations. The HyperLearnX idea could be presented to the Ministry of Telecommunications as an innovation project, exploring ways to align it with new directions.

Interviewer: How do you see the future of interactive education in Yemen? Could national policies support its expansion?

Tahani: At present, there are challenges, but it remains a viable idea for the future. If resources become available to schools and institutes, there would certainly be acceptance.

Interviewer: Are these challenges political or infrastructure-related?

Tahani: No, not political. On the contrary, the government is now moving toward digital transformation and online education. The real issues are infrastructure and economic conditions.

It's also difficult to generalise any single technology nationwide because of the political divisions between different governing bodies in Yemen. But for instance, in Sana'a, there is strong enthusiasm for digital transformation. Recently, a forum showcased graduation projects from engineering and computer science faculties, and there was great admiration for the students' innovations. The government is very supportive of such initiatives and may adopt them, especially if they are tied to intellectual property rights like a patent for HyperLearnX.

Interviewer: Do you think providing educational tools adapted to weak internet could bring real change in access to education?

Tahani: The situation is difficult now, but there is a trend to support digital education in the future, God willing.

Interviewer: What type of internet is currently available 3G or 4G?

Tahani: We are using 4G now, and it is the most common in the country.

Interviewer: From your technical perspective, what do you think of using hypertext-based video to deliver educational content in low-bandwidth settings?

Tahani: It could greatly help in developing education. If this technology is applied, there will be noticeable progress.

Interviewer: Do you think this model is technically feasible in 3G or very weak internet environments?

Tahani: Yes, but first, there should be a trial comparing the original video with the HyperLearnX version, checking differences in speed and quality. If the difference is clear, it will be very useful for students.

Interviewer: Are there programming or engineering challenges that may arise in developing a system like HyperLearnX?

Tahani: So far, I haven't heard of similar trials in Yemen. We might need to check if such applications exist elsewhere, but since you hold the intellectual property rights, this indicates it is a unique and original idea.

Interviewer: Do you want this project to remain academic research or be implemented in practice?

Tahani: I definitely want it to be implemented in reality, not just remain a research study.

Interviewer: What are the available options for compressing video while preserving interactive elements (texts, links, timestamps, etc.)?

Tahani: If the content benefits society and does not pose a threat, there would actually be official support, and it could even be generalised as a national educational platform.

Interviewer: Are there open-source frameworks or technologies that could be adopted to reduce costs during development?

Tahani: I specialise more in networking than programming, so this part may require software engineers.

Interviewer: What factors have the greatest impact on user experience when using interactive video in low-bandwidth environments?

Tahani: The key factors are internet speed, data cost, download quality, and potential interruptions during playback.

Interviewer: Should telecom companies like Yemen Mobile be engaged to support such initiatives?

Tahani: Yes. For example, we already have an educational platform called Meyon, and all its content is free. Similar initiatives could be adopted and supported by relevant authorities to make them free and widely accessible.

Interviewer: How can loading speed be improved or interruptions reduced?

Tahani: By giving such platforms priority with telecom providers to facilitate easier access.

Interviewer: What is your advice on designing an effective user interface for students not familiar with modern educational technologies?

Tahani: It should be simple and clear, with direct interaction between teacher and student, for example, allowing students to send questions through the interactive screen.

Interviewer: Can the system later be integrated into LMS platforms?

Tahani: Yes. If the trial with a sample group succeeds, there will definitely be support to integrate it with existing educational systems.

Interviewer: What are the essential requirements for the technical team developing the system?

Tahani: It must be a full team, including programmers for system development, network engineers for technical support, cybersecurity experts to protect the platform, and system analysts.

Interviewer: Finally, what is your recommendation for building technical partnerships with universities or developers to implement this technology?

Tahani: We hope to see genuine partnerships between you and relevant bodies such as the Innovation Authority, so that the idea can be supported, developed, and brought to reality.

Professor Nagi Ali Abdullah Al-shaibany, Academic and IT Expert.

الاسم والصفة:

الأستاذ المشارك ناجي علي عبد الله الشيباني – أكاديمي وخبير في تقنية المعلومات (IT).

ملخص المقابلة بعد التدقيق:

الرأي العام بالتقنية: أكد أن فكرة الفيديو التفاعلي النصي تمثل حلاً مناسباً جداً لبيئات الإنترنت الضعيفة، مشيراً إلى أن الطلاب غالباً يلجأون إلى فيديوهات طويلة على YouTube يصعب استيعابها، مما يضعف العملية التعليمية.

قابلية التطبيق: أوضح أن التقنية قابلة للتنفيذ على مستوى الجامعات اليمنية، بل ويمكن استضافتها على سيرفرات محلية في الكليات لتجاوز ضعف الإنترنت، كما يمكن توسيعها مستقبلاً إلى دول نامية أخرى مثل بلدان إفريقيا وجنوب آسيا.

التحديات التقنية: يرى أن التحديات ستتضح بشكل أكبر عند التطبيق العملي، لكن من المهم البداية ثم التعلم من التجربة. كما أشار إلى إمكانية الاستفادة من البرمجيات مفتوحة المصدر أو تطوير نسخة Open Source لتقليل التكلفة.

العوامل المؤثرة على تجربة المستخدم: أبرز عامل هو سرعة الإنترنت، حيث أن الانقطاع المتكرر يؤدي إلى عزوف الطلاب. وأوصى بواجهة استخدام بسيطة باللغة العربية، مع حوافز مثل المسابقات والأنشطة التفاعلية القريبة من الألعاب (Gamification).

إمكانية التكامل: ذكر أن HyperLearnX يمكن أن يشكل نواة لأنظمة إدارة التعلم (LMS)، سواء لأغراض أكاديمية أو حتى لتعريف الطلاب بالتخصصات الجامعية عبر فيديوهات قصيرة تفاعلية.

التجربة أثناء كوفيد-19: أوضح أنه اضطر إلى التدريس عبر ملفات صوتية ومقاطع مرسله عبر WhatsApp، مما يبرز الحاجة الماسة لنظام تعليمي أكثر تنظيماً.

التوصيات: اقترح تكوين فريق تقني مؤمن بالفكرة، يضم مبرمجين محترفين وخبراء أعمال لضمان الاستمرارية. كما أوصى ببناء شراكات دولية (مثل ماليزيا) لتعزيز المصادقية، مع ضرورة الحصول على دعم وزاري أو سياسي لتبني الفكرة محلياً.

Translation to English:

Name & Title:

Associate Professor Nagi Ali Abdullah Al-shaibany – Academic and IT Expert.

Key Insights: General Perception: He found the hypertext video concept highly relevant for low-bandwidth contexts. He noted that students often struggle with lengthy YouTube tutorials, making interactive and concise formats much more effective.

Feasibility: He affirmed the model's applicability in Yemen, suggesting deployment on local university servers to bypass poor internet. The approach could later extend to other developing regions such as Africa or South Asia.

Technical Challenges: Challenges will become clearer during real implementation, but starting early is crucial. Open-source frameworks could also reduce costs and foster broader adoption.

User Experience Factors: The main barrier is slow and unstable internet. He recommended simple Arabic-language interfaces and the use of gamification elements (competitions, rewards) to motivate students.

System Integration: HyperLearnX could serve as the foundation for Learning Management Systems (LMS), supporting online lectures, course materials, or even career guidance videos to help students understand academic programs.

COVID-19 Experience: During the pandemic, he resorted to sharing audio files and recorded lectures via WhatsApp, reflecting the urgent need for more structured digital learning solutions.

Recommendations: He emphasised building a dedicated, skilled team of programmers and business experts. Partnerships with international institutions (e.g., Malaysian universities) would enhance credibility, while ministerial or political support is essential for nationwide adoption.

Dr.Abdulrahman Alsabri see Table D.1 for participant details:

خبير تقني dr.Abdulrahman Alsabri ومحاضر عميد كلية الحاسوب جامعة صنعاء

اللغة العربية (ملخص مرتب):

رأيه الأولي: الفيديو التفاعلي ممتاز لأنه يتيح إدخال عناصر تفاعلية على أي فيديو (أسئلة، روابط، إعادة للمحتوى).

المميزات: ضغط الفيديو باستخدام تقنيات الذكاء الاصطناعي (مثل HyperLearnX) يقلل الحجم من ساعات إلى دقائق مع الحفاظ على الجودة، وإضافة التفاعلات تجعل الفيديو أكثر فائدة.

التحديات: أكبر عائق هو البنية التحتية للإنترنت في اليمن (ضعف السرعة، غياب الفاير في القرى، 4G غير متوفر في أماكن كثيرة).

الحفاظ على التفاعل الداخلي مع تقليل حجم الفيديو يحتاج تقنيات ضغط فعالة (تقليل عدد الفريمات، تقليل ال-transfer للبيانات).

التحسينات المقترحة: جعل الفيديو خفيف جدًا ليعمل مع شبكات ضعيفة.

اعتماد منصات مفتوحة المصدر (مثل Moodle) لتقليل التكلفة.

ضرورة قرار سياسي من وزارة التعليم العالي ووزارة الاتصالات لدعم البنية التحتية.

الفريق المطلوب للتطوير: مهندسون برمجيات، خبراء وسائط متعددة، إعلاميون، متخصصون في تحويل المقررات إلى محتوى رقمي.

التوصيات: بناء شراكات مع الجامعات.

عمل تجارب تجريبية قبل التعميم.

إقناع صانعي القرار بأهمية التعليم التفاعلي لبيئات الأزمات مثل اليمن.

يمكن استخدام هذه التقنية في التعليم عن بُعد، خاصة وأن بعض الطلاب يفضلون هذا النمط من التعليم على التعليم الوجاهي. بالنسبة لي، أرى أنها مفيدة جدًا، إذ أن رسالتي للدكتوراه كانت في مجال التعليم عبر الهاتف المحمول (Mobile Learning)، وركزت على تطوير نموذج تقني يمكن توظيفه في التعليم عن بُعد.

هذا النوع من الفيديوهات التفاعلية له أهمية كبيرة، فهو يساعد الطالب على فهم المواد العملية مثل الجرافيكس الحاسوبي. ومن أبرز مزاياه أنه يتيح للطالب إعادة مشاهدة المقاطع أكثر من مرة، ما يعزز الفهم ويخفف من الحرج أو الخوف من طرح الأسئلة في الصف.

من وجهة نظر أكاديمية، يمكن للمحاضر الجامعي أن يوظف هذه الأداة في المحاضرات والأنشطة التعليمية عبر الفيديو الرقمي والمحتوى التفاعلي، بما يساعد على توصيل المعلومات بشكل أوضح وأكثر جاذبية. كذلك، استخدام الروابط والنصوص الفائقة داخل الفيديو يجعل العملية أكثر تشويقًا، ويعزز التعلم الذاتي لدى الطلبة مقارنة بالفيديو الخطي التقليدي مثل يوتيوب.

أما أبرز التحديات التي تواجه تطبيق هذه التقنية في مؤسسات التعليم العالي باليمن، فهي تتعلق بالبنية التحتية، وخاصة ضعف الاتصال بالإنترنت وارتفاع تكلفته. فالكثير من المناطق، خصوصًا الريفية، تعاني من انعدام التغطية أو محدودة سرعة الإنترنت، وهو ما يعيق وصول الفيديو للطلاب. ومع ذلك، هناك تطور تدريجي من شبكات الجيل الرابع إلى خدمات ADSL والفايبر، مما قد يحسن الوضع مستقبلاً.

دور المحاضر في هذا السياق أساسي، إذ لا بد من المزج بين المحاضرات الوجيهة (Face to Face) والمحاضرات عبر الإنترنت بنسبة 25% إلى 30% على الأقل، بما يتماشى مع متطلبات الاعتماد الأكاديمي الدولي والاستعداد للأزمات مثل جائحة كورونا.

التقنية المقترحة (HyperLearnX) يمكن أن تكون فعالة إذا صُممت بطريقة تجعل الفيديو خفيفًا وقليل الحجم مع الحفاظ على التفاعل، حتى يتمكن الطلاب في البيئات ذات البنية التحتية الضعيفة من الاستفادة منه. من بين الحلول الممكنة: ضغط الفيديو، تقليل عدد الإطارات (Frames)، والاعتماد على منصات تعليمية مفتوحة المصدر مثل Moodle لتقليل التكاليف.

لتنفيذ هذه التقنية واقعياً في اليمن، هناك حاجة إلى قرار سياسي من مؤسسات التعليم العالي ووزارة الاتصالات لتبني نموذج يُخصص 25% من المقررات للتعليم عبر الإنترنت. كما أن نجاح النظام يتطلب فريقاً تقنياً متكاملًا يضم:

مهندسين مختصين في البرمجة والشبكات.

خبراء في إنتاج ومعالجة الفيديوهات الرقمية.

أكاديميين لتحويل المقررات إلى محتوى تفاعلي.

فريق إعلامي للترويج والتوعية.

أخيرًا، نجاح المشروع يتطلب شراكات مع الجامعات والمطورين المحليين والدوليين، إضافة إلى حملات إقناع للجهات المعنية بجدوى تبني هذا النوع من المحاضرات، بما يفتح المجال لتعليم إلكتروني أكثر مرونة وتكيفًا مع الواقع اليمني.

Translation to English:

Initial impression: The interactive video is excellent because it allows the integration of interactive elements (questions, hyperlinks, content review).

Advantages: Video compression with AI technologies (e.g., HyperLearnX) reduces duration from hours to minutes while maintaining quality. Interactivity makes the video more effective.

Challenges:

The main barrier is Yemen's weak digital infrastructure (slow internet, lack of fiber, limited 4G coverage).

Maintaining interactivity while keeping the video lightweight requires efficient compression methods (reducing frames, minimising data transfer).

Suggested improvements:

Keep videos extremely lightweight to run on low bandwidth.

Use open-source platforms (e.g., Moodle) to reduce costs.

Require political decisions from higher education and telecommunication authorities to support infrastructure.

Required team: Software engineers, multimedia experts, media specialists, and instructional designers to convert curricula into digital formats.

Recommendations:

Build partnerships with universities.

"I have not developed a prototype or MVP yet. However, I will present a sample hypertext video from an existing, less-known platform as a demonstration to explain the concept."

Convince policymakers about the importance of interactive learning for crisis-affected contexts like Yemen.

Edited English Version:

This technology can be effectively used in distance learning, especially since some students prefer online learning over face-to-face instruction. From my perspective, it is highly beneficial. In fact, my doctoral research focused on Mobile Learning, particularly on developing a technical model that could be applied in distance education.

Interactive videos of this type are highly significant, as they support students in understanding practical subjects such as computer graphics. One of their key advantages is that students can rewatch the content multiple times, which enhances comprehension and reduces the hesitation or embarrassment often associated with asking questions during in-person classes.

From an academic standpoint, university lecturers can integrate this tool into their teaching and learning activities through digital video and interactive content. This approach makes the delivery of information clearer and more engaging. Moreover, the

use of hyperlinks and embedded questions within the video makes the learning process more stimulating and promotes self-directed learning among students, compared to traditional linear videos such as those on YouTube.

The main challenges to implementing this technology in Yemeni higher education institutions are primarily infrastructural. Weak internet connectivity and high costs hinder access, particularly in rural areas where coverage is limited or nonexistent. However, gradual improvements are underway, including the expansion from 4G networks to ADSL and fibre-optic services, which may enhance the situation over time.

In this context, the lecturer's role is crucial. A blended approach combining face-to-face teaching with 25% to 30% of courses delivered online is essential to meet international accreditation requirements and to ensure readiness for crises such as the COVID-19 pandemic.

The proposed technology (HyperLearnX) can be highly effective if designed to produce lightweight videos with minimal file size while preserving interactivity, enabling students in low-bandwidth environments to benefit. Possible solutions include video compression, reducing frame rates, and leveraging open-source educational platforms such as Moodle to minimise costs.

For practical implementation in Yemen, a political decision is required from higher education institutions and the Ministry of Telecommunications to adopt a model where 25% of university courses are delivered online. Furthermore, the success of such a system requires a multidisciplinary technical team that includes:

Engineers specialising in programming and networking.

Experts in video production and digital media processing.

Academics to adapt course materials into interactive formats.

Media specialists to promote and raise awareness.

Finally, the sustainability of this initiative depends on building partnerships with universities and local or international developers, as well as conducting awareness campaigns to convince decision-makers of the value of adopting interactive lectures. This would pave the way for a more flexible and adaptive e-learning ecosystem in the Yemeni context.

**Dr. Fua'ad Hasan Abdulrazzak Executive Director, Higher Education
Information Technology Center**

مقابلة تقني Dr. Fua'ad Hasan Abdulrazzak بصفته خبير تقني ومدير تنفيذي لمركز تقنية المعلومات في التعليم العالي.

المقابلة مع: د. فؤاد حسن عبدالرزاق – المدير التنفيذي لمركز تقنية المعلومات في التعليم العالي

المقابل: بداية، دكتور فؤاد، حدثنا عن رؤيتك التقنية حول مبادرة HyperLearnX التي نعمل عليها.

المجيب: حاليًا لم يتم تطبيق HyperLearnX بشكل عملي بعد، وإنما ما عُرض كان نموذجًا أوليًا بسيطًا كدراسة حالة. أنا أرى أن الفكرة مبتكرة جدًا، خصوصًا وأنا عانينا كثيرًا أثناء جائحة كوفيد-19 بسبب محدودية أدوات التعليم الإلكتروني. لذلك فإن وجود تقنية مثل HyperLearnX سيكون بمثابة إنجاز مجتمعي كبير.

المقابل: في رأيك، ما أبرز التحديات التقنية لتطبيق هذه الأداة في اليمن؟

المجيب: البيئة اليمنية تواجه تحديًا أساسيًا، وهو محدودية الأجهزة. معظم الناس لا يملكون حواسيب، لكن لديهم هواتف ذكية حتى في القرى. لذلك، إذا استطعنا جعل التقنية متوافقة مع الهواتف الذكية ومع الإنترنت الضعيف، فسوف تساهم بشكل كبير في التعليم، خصوصًا للنساء في الأرياف اللواتي يستخدمن تطبيقات مثل واتساب لأغراض بسيطة، بينما يمكن استغلال نفس الإمكانيات في التعلم المفيد.

المقابل: من الناحية البرمجية والهندسية، هل هناك تحديات قد تواجه تطوير النظام؟

المجيب: بيئة التنفيذ في اليمن متاحة من حيث أنظمة التشغيل والبرمجيات. التحدي الأساسي يكمن في الموارد المحدودة، أما من الناحية التقنية فالأنظمة والبرامج يمكنها دعم هذه المبادرة. ما يهم هو أن يكون النظام سهل الاستخدام للمدرس والطالب. بالنسبة للفيديو، تقنيات الضغط اليوم متقدمة جدًا، ويمكننا الاستفادة من الذكاء الاصطناعي لتحسين الجودة وتقليل حجم الملفات مع الحفاظ على التفاعلية.

المقابل: ما هي المتطلبات الأساسية لتشكيل فريق تقني قادر على بناء النظام؟

المجيب: يجب أن يمتلك الفريق خبرة في هندسة البرمجيات، معرفة باللغات البرمجية الحديثة المرتبطة بالذكاء الاصطناعي، بالإضافة إلى خبرة في أمن المعلومات. هذه عناصر أساسية لنجاح أي نظام تفاعلي تعليمي.

المقابل: ما الأدوات المفتوحة المصدر التي يمكن أن تساعد في تخفيض التكلفة؟

المجيب: جربنا سابقًا منصات مثل Moodle وGoogle Classroom، وكانت فعالة إلى حد ما. لكن بالنسبة للمحاضرات التفاعلية بالفيديو كانت محدودة. هناك أيضًا منصات مدفوعة مثل Blackboard لكنها مكلفة. يمكن الاعتماد على المصادر المفتوحة لتقليل التكلفة في البداية.

المقابل: ما العوامل الأهم التي تؤثر على تجربة المستخدم في الفيديو التفاعلي؟

المجيب: العامل الرئيسي هو ضعف الإنترنت. غالبًا ما تكون التجربة الأولى للطلاب محبطة بسبب بطء التحميل والانقطاعات. لذلك من المهم تحسين الخوارزميات وتقنيات الضغط، وكذلك تصميم واجهة استخدام بسيطة وسهلة.

المقابل: ما نصيحتك الأخيرة حول دمج هذه التقنية بشكل عملي؟

المجيب: أنصح بأن تكون البداية تدريجية، مع إلزام الجامعات بنسبة معينة من المحاضرات عبر الإنترنت كما حصل سابقًا (30%). كما يجب أن تكون هناك مبادرات من الباحثين أنفسهم للتواصل مع الجامعات والجهات الرسمية، دون انتظار تحرك الحكومة وحدها.

Translation to English:

Interviewee: Dr Fua'ad Hasan Abdulrazzak, Executive Director, Higher Education Information Technology Center

Interviewer: Dr Fua'ad, could you start by sharing your perspective on the HyperLearnX initiative?

Interviewee: At this stage, HyperLearnX has not yet been fully implemented. What you have seen is a simplified prototype presented as a case study. In my view, the concept is highly innovative, especially considering how much we struggled during the COVID-

19 pandemic due to the limitations of online learning tools. Having a technology like HyperLearnX would represent a major societal achievement.

Interviewer: In your opinion, what are the main technical challenges for implementing this tool in Yemen?

Interviewee: The Yemeni context faces a major challenge: limited access to computers. Most people do not own personal computers, but almost everyone, even in rural areas, has smartphones. Therefore, if we ensure that the system works effectively on mobile phones and under weak internet conditions, it could have a significant impact. For example, rural women who currently use WhatsApp for social communication could instead use these technologies for meaningful learning.

Interviewer: From a software engineering perspective, what potential challenges do you foresee?

Interviewee: The execution environment in Yemen is feasible in terms of operating systems and software. The real challenge is resource limitations, but technically, it is possible. The priority should be making the system simple and user-friendly for both teachers and students. As for video compression, current technologies are very advanced. We can also employ artificial intelligence to reduce unnecessary elements, optimise file sizes, and improve delivery while maintaining interactivity.

Interviewer: What are the essential requirements for forming a technical team to build this system?

Interviewee: The team should have expertise in software engineering, be familiar with modern programming languages, especially those related to artificial intelligence and possess strong knowledge of information security. These are fundamental skills for successfully developing an interactive learning platform.

Interviewer: Which open-source frameworks could help reduce development costs?

Interviewee: We have previously used platforms such as Google Classroom and Moodle. They were relatively efficient, although limited when it came to interactive video lectures. There are also commercial platforms like Blackboard, but these are costly. Relying on open-source solutions is a good option to reduce costs, particularly at the initial stages.

Interviewer: What factors most affect the user experience with interactive video in low-bandwidth environments?

Interviewee: The primary factor is poor internet connectivity. Often, students' first experience is frustrating due to slow loading and frequent interruptions. This is why we need better algorithms, improved video compression, and a simple, intuitive user interface.

Interviewer: Finally, what advice would you give for integrating this technology into practice?

Interviewee: My advice is to start gradually. For instance, when universities were mandated to deliver at least 30% of lectures online, it significantly encouraged adoption. Similarly, HyperLearnX should be introduced step by step. Researchers themselves must also take the initiative and collaborate directly with universities and institutions, rather than waiting for the government alone to take the lead.

Head of Computer Science Department, Saba University, Dr Hesham, more details Error! Reference source not found. illustrates participants' description.

مقابلة الدكتور هشام القسم الأول: كتقني

المحاور: بالبداية، أحب أوضح أن الفيديو الذي أعرضه الآن مجرد مثال مبسط لفكرة الفيديو التفاعلي) وليس الـ prototype النهائي. (هل يمكن أن تعطيني رأيك الأولي حول فكرة استخدام فيديو نصي تفاعلي لتقديم محتوى تعليمي في بيئات منخفضة السرعة مثل اليمن والأرياف؟

الدكتور هشام: والله رأيي أنها فكرة رائعة، لكن يجب أن تأخذ في الاعتبار الإمكانيات الموجودة في البيئة نفسها. الفيديوهات يجب أن تكون بكواليتي ضعيف حتى يتمكن المستخدمون من الاستفادة. إذا كان الفيديو بجودة عالية جداً، قد لا يستفيد المستخدمون أو المستخدمون مثل ما هو الحال في بلدان لديها إنترنت جيد.

المحاور: صحيح يا دكتور، لكن أنا عملت التقنية HyperLearnX بحيث تجعل الفيديو مضغوطاً جداً مع الحفاظ على الجودة العالية. مثلاً فيديو مدته ساعتين يصير 15 دقيقة فقط. هل ترى أن هذا ممكن يخدم اليمن؟

الدكتور هشام: نعم، هذا تغيير جذري وثورة حقيقية. إذا كانت الجودة نفسها والسرعة نفسها ومع إنترنت ضعيف، فسيكون مذهباً ويفيد مجتمعات كانت محرومة من التعليم الرقمي. هذه ميزة هائلة للفيديوهات التعليمية.

المحاور: بالنسبة للقيود في اليمن، وزارة الاتصالات تسمح بمواقع معينة وتحجب أخرى، مثل اليوتيوب يُسمح به، بينما منصات أخرى تُحجب. فهل ترى أن النموذج ممكن يُنفذ تقنياً في بيئة G3؟

الدكتور هشام: نعم، في اليمن يتم استخدام تقنية الـ buffering أكثر من الـ live streaming مثلاً اليوتيوب عندما يُشاهد مرة، يخزن في السيرفر المحلي ويُتاح للمستخدمين الآخرين بسرعة. إذا طبقت تقنيتك لتقليل حجم الفيديو فهذا سيوفر حتى على وزارة الاتصالات.

المحاور: ما التحديات البرمجية والهندسية المحتملة التي يمكن أن تواجه تطوير HyperLearnX ؟

الدكتور هشام: التحديات مرتبطة بالـ 3G web generation لا يدعم Web 4.0 الذي يدخل في الذكاء الاصطناعي وتقنيات متقدمة مثل data mining و AI classification. اليمن رسمياً تعلن وجود G4، لكن الحقيقة أن الـ 4G ليس بالمستوى المطلوب بسبب محدودية الـ bandwidth والأجهزة.

المحاور: ما هي الخيارات المتاحة لضبط الفيديو مع الحفاظ على التفاعل الداخلي (أسئلة، نصوص، روابط توقيت... إلخ)؟

الدكتور هشام: في اليمن الحل الحالي هو buffering.

المحاور: هل هناك تقنيات مفتوحة المصدر (open-source) يمكن الاعتماد عليها لتقليل التكلفة؟

الدكتور هشام: شخصياً استخدمت أحياناً تقنيات للتعرف على النصوص من الفيديو، لكن resizing للفيديو مع الحفاظ على الجودة لم أجده بسهولة. توجد أدوات online لكنها لا تحفظ الجودة. كـ open-source في اليمن الوضع محدود جداً.

المحاور: برأيك، ما هي العوامل التي تؤثر أكثر على تجربة المستخدم عند التعامل مع فيديو تفاعلي في بيئة إنترنت ضعيف؟

الدكتور هشام: العوامل تشمل الهاردوير (أجهزة قديمة أو second hand وأيضاً السوفت وير) كثير منه crack وليس (original). هذه كلها تؤثر على الأداء.

المحاور: كيف يمكن تحسين سرعة التحميل أو تقليل الانقطاعات في الفيديو؟

الدكتور هشام: الإنترنت في اليمن له أوقات ذروة (peak hours) الصباح إلى العصر سريع نسبياً، وبعد ذلك يصبح أبطأ. الحلول تشمل توزيع الـ traffic أو حجب بعض البرامج الثقيلة أثناء الذروة.

المحاور: ما هي نصيحتك حول تصميم واجهة استخدام فعالة للطلاب غير المعتادين على التعليم الرقمي؟

الدكتور هشام: شاركت في web quiz شبيه من قبل (كنص فقط). أنصح بأن يكون النظام سهل الاستخدام، يعتمد على أسئلة عشوائية، يعطي نتائج نهائية تساعد الطالب على معرفة مستواه. بالفيديو سيكون أكثر فعالية.

المحاور: هل تعتقد أن النظام يمكن تطويره لاحقاً ليتكامل مع أنظمة إدارة التعليم (LMS) ؟

الدكتور هشام: أكيد، هذا سيكون من أفضل الأنظمة. أنا شخصياً معجب بتقنيك HyperLearnX ، وأتمنى العمل بها، لكن في اليمن الإمكانيات محدودة والوقت ضيق.

المحاور: من وجهة نظرك، ما المتطلبات الضرورية للفريق التقني لتطوير هذا النظام؟

الدكتور هشام: تحتاجون إلى خبراء في الهاردوير والشبكات، خصوصاً أن الكلاود كمبيوترتج في صنعاء ما له وكيل.

المحاور: ما توصياتك لبناء شراكة مع جامعات أو مطورين لتنفيذ هذه التقنية؟

الدكتور هشام: أوصي بمواكبة العالم في تطوير الأجهزة والاتصالات، وتحديث البرامج التعليمية للطلاب. إذا لم نواكب العالم سنظل متأخرين.

Translation to English:

Interview with Dr Hesham Part One: As a Technical Expert

Interviewer: To begin, I would like to clarify that the video I am showing now is only a simplified example of the interactive video concept (not the final prototype). Could you please share your initial opinion about the idea of using hypertext-based interactive video to deliver educational content in low-bandwidth environments such as Yemen and rural areas?

Dr Hesham: Honestly, I think it is a wonderful idea. But you need to consider the actual resources available in the local environment. The videos must be of low quality so that users can benefit from them. If the video has very high resolution, then the users may not be able to use it effectively, unlike in countries with strong internet infrastructure.

Interviewer: That is true, Doctor. However, my technique, HyperLearnX, is designed to compress videos while still maintaining high quality. For example, a two-hour video can be reduced to just 15 minutes. Do you think this could benefit Yemen?

Dr Hesham: Yes, that would be a radical change, a real revolution. If the quality remains the same and the speed is preserved, even with weak internet, it will be amazing and will benefit communities that have long been deprived of digital education. This is a huge advantage for educational videos.

Interviewer: Considering the restrictions in Yemen, where the Ministry of Telecommunications allows certain websites and blocks others—for instance, YouTube is permitted, but other platforms are restricted—do you think the model could be technically implemented under a 3G environment?

Dr Hesham: Yes. In Yemen, buffering is used more than live streaming. For example, when a YouTube video is watched once, it is cached on the local server and then made available for other users to access quickly. If your technology is applied to reduce video size, this will save data usage, even for the Ministry of Telecommunications.

Interviewer: What are the potential programming or engineering challenges that could arise in developing HyperLearnX?

Dr Hesham: The challenges are related to web generation. Our 3G networks do not support Web 4.0 technologies, which involve artificial intelligence and advanced techniques like data mining and AI classification. Although Yemen officially claims to have 4G, in reality, the 4G services are not at the required level due to limited bandwidth and device capabilities.

Interviewer: What are the possible options to optimise video while still keeping the internal interactivity (questions, texts, time-linked references, etc.)?

Dr Hesham: In Yemen, the current solution is buffering.

Interviewer: Are there any open-source technologies that could be used to reduce costs?

Dr Hesham: Personally, I have sometimes used tools for text recognition from videos. But resizing a video while maintaining quality is not easily available. There are online tools, but they do not preserve quality. As for open-source solutions, the options in Yemen are very limited.

Interviewer: In your view, what factors most influence the user experience when dealing with interactive videos in low-internet environments?

Dr Hesham: The factors include hardware (many students use outdated or second-hand devices) and software (a lot of it is cracked versions, not original). These issues directly affect performance.

Interviewer: How can video loading speed be improved, or interruptions reduced?

Dr Hesham: In Yemen, the internet has peak hours. From morning until afternoon, the connection is relatively fast, but later it becomes much slower. The solutions could include managing traffic distribution or blocking heavy applications during peak times.

Interviewer: What advice would you give regarding designing an effective user interface for students who are not familiar with digital learning?

Dr. Hesham: I once participated in a web quiz system (text-based only). My advice is to keep the system very simple to use, include random questions, and provide final results to help students know their level. With video, it will be even more effective.

Interviewer: Do you think the system could later be developed to integrate with Learning Management Systems (LMS)?

Dr Hesham: Definitely. That would make it one of the best systems. Personally, I am impressed with your HyperLearnX technology. I hope to see it applied, but in Yemen, the resources are limited, and time is always a challenge.

Interviewer: From your perspective, what are the essential requirements for the technical team to develop this system?

Dr Hesham: You will need experts in hardware and networks, especially since cloud computing in Sana'a has no local providers.

Interviewer: Finally, what are your recommendations for building partnerships with universities or developers to implement this technology?

Dr Hesham: My recommendation is to keep pace with global developments in devices and telecommunications, and to update students' educational programs accordingly. If we do not keep pace with the world, we will always remain behind.

Section 3: Lecturers and Educators

Dr Abdulrahman Alsabri for more details, Table D.1 presents the description:

بصفته محاضر جامعي

رأيه الأولي: الفيديو التفاعلي مشوق ويمنح الطالب فرصة لإعادة المحاضرة وفهمها أكثر.

المميزات: الطالب يعيد مشاهدة المقاطع التي لم يفهمها.

الفيديو يشجع التعليم الذاتي ويكسر حاجز الحياء عند طرح الأسئلة.

التفاعل (روابط، أسئلة) يجذب الطالب أكثر من فيديو خطي عادي.

كيف يستخدمه المحاضر: إدخاله في التعليم عن بُعد، خاصة للطالبات في الأرياف أو الطلاب الذين يفضلون التعليم المرن.

يساعد في حالات الطوارئ مثل كورونا أو الحروب.

التحديات: ضعف الإنترنت في اليمن (2-4 ميجا فقط، انقطاع متكرر).

دور المحاضر: استخدام الفيديو بنسبة 25-30% من المقرر، مع مزج التعليم الوجيه.

تحفيز الطلاب على الحضور والمشاركة من خلال الأنشطة التفاعلية داخل الفيديو.

التحسينات المقترحة:

أن يكون الفيديو قصيرًا وجاذبًا.

إضافة تقييمات، منتديات، ونشرات داخل المنصة.

التوصيات: الجامعات بحاجة إلى استعداد تقني لتبني 25% من المقررات أونلاين.

بناء منصات جذابة لتشجيع الطلاب على التفاعل المستمر.

Translation to English:

English Translation (as a University Lecturer):

Initial impression: The interactive video is engaging and allows students to rewatch parts for better understanding.

Advantages: Students can revisit unclear sections.

Encourages self-directed learning and overcomes shyness in asking questions.

Interactivity (links, quizzes) is more attractive than linear videos.

How lecturers can use it: Integrate into distance education, especially for rural female students or those preferring flexible learning.

Useful during emergencies such as pandemics or conflicts.

Challenges: Weak internet in Yemen (2–4 Mbps, frequent disruptions).

Role of lecturers: Use interactive video for 25–30% of the curriculum, blended with face-to-face learning.

Motivate students with interactive activities and participation grades.

Suggested improvements: Keep videos short and engaging.

Add assessments, forums, and chat features.

Recommendations: Universities should prepare to adopt 25% of courses online.

Platforms should be designed to attract and retain student engagement.

Head of Computer Science Department, Saba University

PhD in Artificial Intelligence

Head of Computer Science Department, Saba University, Dr Hesham Abdo

Ahmed Aqlan, see Table D.1 for participant details:

مقابلة الدكتور هشام القسم الثاني: كمحاضر جامعي

المحاور: كأستاذ جامعي، ما رأيك في الفيديو التفاعلي الذي شاهدته؟

الدكتور هشام: الفكرة رائعة جداً، ومع التقنية التي أضفيتها تصبح أروع لأنها توفر سهولة وسرعة للطلاب.

المحاور: هل يمكن أن يدعم هذا النوع من الفيديوهات تدريس مواد مثل الحاسوب والجغرافيا؟ ولماذا؟

الدكتور هشام: أكيد. الطلاب يفضلون المحتوى المختصر والمخلص. إذا كان PowerPoint tutorial بسيط يرفع تقييم الدكتور عندهم، فما بالك بفيديو تفاعلي؟ سيكون مذهلاً.

المحاور: ما المميزات التي لفتت انتباهك في الفيديو؟

الدكتور هشام: قصر الفيديو، جمال الألوان، تنوع الأسئلة، والاختصار.

المحاور: كيف يمكن للمحاضر الجامعي توظيف هذه الأداة في محاضراته؟

الدكتور هشام: يمكن أن تكون مادة داعمة بعد الشرح النظري، أو كمكمل للـ assignments. المحاور: في حالات اضطرارية (مثل الحروب أو الكورونا) هل يمكن أن يعزز هذا الفيديو التعليم الذاتي؟ الدكتور هشام: أكيد، لو كان موجود وقت الكورونا كان بيوفر علينا كثير. وقتها كنا نرسل المحاضرات عبر Google Classroom بحجم ثقيل جدًا. تقنيك HyperLearnX كانت ستوفر وقت وتكلفة.

المحاور: ما المواد التي درستها ويمكن أن تستفيد من هذا النوع من الفيديوهات؟ الدكتور هشام: درست مواد مثل Operating System, Computer Architecture, Logic Design, Computer Ethics. بعض المواد مثل Digital Design تحتاج فيديو توضيحي. لو كان هناك HyperLearnX كان سيساعد كثيرًا.

المحاور: ما التحديات المحتملة أمام استخدام الفيديو التفاعلي في التعليم العالي باليمن؟ الدكتور هشام: التحديات: الإنترنت الضعيف، الوضع الاقتصادي، صعوبة شراء كمبيوتر حديث، الأجهزة ضعيفة، والبرامج غالبًا غير أصلية.

المحاور: كيف يمكن التغلب على هذه التحديات؟ الدكتور هشام: الحل بتوفير هذه الفيديوهات في مكاتب الجامعة أو المختبرات ليستفيد الطلاب منها داخل الجامعة بدلًا من البيت.

المحاور: هل ترى أن الفيديو التفاعلي يتماشى مع مبادئ التعليم الاجتماعي والدعم التدريجي؟ الدكتور هشام: نعم، لو الجامعات تبنت هذا سيكون دعم مجتمعي كبير.

المحاور: ما التحسينات التي تقترحها لتطوير الفيديو ليكون أكثر فعالية؟ الدكتور هشام: التوافق مع كروت الشاشة والإنترنت، والحصول على شهادات توافق رسمية.

المحاور: هل لديك توصيات لتكييف التقنية بما يتناسب مع بيئة الجامعات اليمنية؟ الدكتور هشام: نعم، أوصي بأن هذه التقنية HyperLearnX ستكون نقلة نوعية للطلاب لأنها توفر سهولة ووفرة اقتصادية وتعلم سريع مع الحفاظ على مستوى تعليمي.

Translation to English:

Interview with Dr Hesham Part Two: As a University Lecturer

Interviewer: As a university lecturer, what is your opinion about the interactive video you just watched?

Dr Hesham: The idea is really excellent. With the technology you added, it becomes even better because it provides both convenience and speed for the students.

Interviewer: Do you think this type of video could support the teaching of subjects like computer science and graphics? Why?

Dr Hesham: Absolutely. Students prefer content that is short and summarised. If a simple PowerPoint tutorial can raise a lecturer's evaluation in their eyes, imagine how they would respond to an interactive video. It would be remarkable.

Interviewer: What features in the video caught your attention the most?

Dr Hesham: The short length of the video, the attractive colours, the variety of questions, and the conciseness.

Interviewer: How could a university lecturer employ this tool in their teaching practice?

Dr Hesham: It could be used as a supplementary material after theoretical lectures, or as a complement to assignments.

Interviewer: In urgent situations, such as wars or COVID-19, do you think this type of video could enhance self-learning?

Dr Hesham: Certainly. If it had been available during COVID-19, it would have saved us a lot. At that time, we shared lectures through Google Classroom, but the files were very heavy. Your HyperLearnX technology would have saved both time and cost.

Interviewer: What courses have you taught that could benefit from this type of video?

Dr Hesham: I have taught courses like Operating Systems, Computer Architecture, Logic Design, and Computer Ethics. Some courses, like Digital Design, really need video explanations. If HyperLearnX had been available, it would have helped a lot.

Interviewer: What challenges might arise in using interactive videos in higher education in Yemen?

Dr Hesham: The challenges include weak internet, the economic situation, the difficulty of purchasing modern computers, the weakness of available devices, and the fact that most software is not original.

Interviewer: How can these challenges be overcome?

Dr Hesham: One solution is to make these videos available in university offices or computer labs, so that students can benefit from them inside the university rather than at home.

Interviewer: Do you think interactive video aligns with the principles of social learning and scaffolding?

Dr Hesham: Yes, if universities adopt this approach, it will provide strong community support.

Interviewer: What improvements would you suggest to make the video more effective?

Dr Hesham: Compatibility with graphics cards and internet speeds, as well as obtaining official certification for compliance.

Interviewer: Do you have recommendations for adapting the technology to suit the Yemeni university context?

Dr Hesham: Yes. I recommend HyperLearnX as a transformative tool for students. It offers convenience, cost savings, and faster learning while maintaining academic standards.

Prof. Sharaf Abdulhak Alhomdy, for more details For further details, Table D.1 provides a comprehensive description:

المقابلة الأولى: مع الأستاذ الدكتور شرف عبد الحق الحمدي – كمحاضر جامعي

المحاور: ما هو رأيك الأولي في الفيديو التفاعلي الذي شاهدته؟

الأستاذ الدكتور شرف: أراه فيديو رائع، فهو يدخل في طور النص. لكن ما لاحظته هو أنه أقرب إلى فيديو تقييمي، أي أن الطالب يطّلع على السؤال ثم يقيّمه.

المحاور: هل تعتقد أن هذا النوع من الفيديوهات يمكن أن يدعم تعليم الطلاب في المواد العملية مثل الحاسوب والتصميم الجرافيكي؟ ولماذا؟

الأستاذ الدكتور شرف: نعم، بالتأكيد. أي فيديو يحتوي على نصوص مدمجة أو صور وأسئلة، فهو يدعم الطلبة بشكل كبير وخاصة في الجانب العملي. مثلاً، عندما يتعرض الطالب لصور أو أسئلة كما في هذا الفيديو، فإن ذلك يعزز من عملية التعلم.

المحاور: ما هي المميزات التي لفتت انتباهك من ناحية دعم الفهم أو التفاعل؟

الأستاذ الدكتور شرف: أولاً، اختيار الألوان رائع جداً، وتنسيق الواجهات متقن، مما جعل الأسئلة والإجابات واضحة وسهلة القراءة.

ثانياً، مثل هذه الفيديوهات تقلل من التكرار الذي يحدث عادة في المحاضرات المباشرة، حيث يقوم المحاضر بتكرار بعض النقاط. الفيديو التفاعلي، وخاصة بتقنية HyperLearnX والذكاء الاصطناعي، يحذف التكرارات ويجعل الفيديو أقصر وأكثر كفاءة.

المحاور: من وجهة نظرك، كيف يمكن للمحاضر الجامعي أن يوظف مثل هذه الأداة في محاضراته وأنشطته التعليمية؟

الأستاذ الدكتور شرف: إذا كان الفيديو يعمل بهذا الشكل، فهو حل رائع. يمكنه تنبيه الطالب من خلال أسئلة متعددة الخيارات أو روابط نصية داخل الفيديو. هذا مفيد جداً في المواد العملية. أما في المحاضرات النظرية فقد يحتاج المحاضر إلى أسلوب سردي أكثر، مثل الفيديو الخطي.

المحاور: هل ترى أن النصوص الفائقة داخل الفيديو تعزز فعلياً التعليم الذاتي لدى الطلبة؟

الأستاذ الدكتور شرف: نعم. عندما نطرح صوراً أو شرائح تقديمية للطلاب، فإنها تساعد على الفهم أكثر من مجرد النصوص. فالطالب يربط بين المعلومات والصور أو الأسئلة. لذلك، أرى أن الفيديو التشعبي فكرة رائعة لتعزيز التعليم الذاتي.

المحاور: ما هي التحديات التي تراها أمام استخدام هذا النوع من الفيديوهات في الجامعات اليمنية؟

الأستاذ الدكتور شرف: التحديات كثيرة:

أولاً، الإنترنت الضعيف وصعوبة استدعاء الروابط داخل القاعات الدراسية.

ثانياً، ضعف البنية التكنولوجية في الجامعات.

ثالثاً، الكادر التدريسي؛ حيث يحتاج المحاضرون إلى تدريب وتأهيل لاستخدام هذه التقنيات. هذه التقنية تناسب التخصصات التقنية مثل الفنون الرقمية والحاسوب أكثر من العلوم الإنسانية.

المحاور: كيف يمكن التغلب على هذه التحديات؟

الأستاذ الدكتور شرف: أقترح ثلاث خطوات:

توفير الأدوات التكنولوجية داخل القاعات وربطها بسيرفر داخلي.

توفير الإنترنت على مستوى القاعات التعليمية، وليس فقط الإدارات.

تدريب أعضاء هيئة التدريس من خلال حقائب تدريبية إجبارية لتأهيلهم على استخدام التقنيات.

المحاور: ما توصياتك لتطوير الفيديو ليكون أكثر فعالية في تدريس مواد مثل الفنون الرقمية والحاسوب؟

الأستاذ الدكتور شرف: أقترح أن يتضمن الفيديو صورًا وروابط ملونة ورموزًا تفاعلية تعزز التشويق. كما ينبغي أن يكون سهل الاستخدام، وأن يتم إشراك الطلاب في تقييمه من خلال استبيانات لمعرفة آرائهم بجانب تقييم المحاضرين.

Translation to English:

1: Prof. Sharaf Abdulhak Alhomdy, as a University Lecturer

Interviewer: What is your initial impression of the interactive video you watched?

Prof. Sharaf: I find it an excellent video; it incorporates hypertext. However, I noticed that it is closer to an evaluative video, where the student views a question and then evaluates it.

Interviewer: Do you think this type of video can support student learning in practical subjects such as computer science and graphic design? Why?

Prof. Sharaf: Yes, certainly. Any video that includes embedded texts, images, or questions greatly supports students, especially in the practical aspect. For example, when students encounter images or questions, as in this video, it enhances the learning process.

Interviewer: What features stood out to you in terms of supporting understanding or interaction?

Prof. Sharaf: First, the choice of colours is very good, and the interface design is neat, which made the questions and answers clear and easy to read.

Second, such videos reduce the repetition that usually happens in live lectures, where the lecturer repeats certain points. Interactive video, especially with HyperLearnX and artificial intelligence, removes repetitions and makes the video shorter and more efficient.

Interviewer: From your perspective, how could a university lecturer use such a tool in lectures and teaching activities?

Prof. Sharaf: If the video works in this way, it is a great solution. It can alert students through multiple-choice questions or hyperlinked texts inside the video. This is very useful in practical subjects. For theoretical lectures, however, the lecturer may need a more narrative style, such as a linear video.

Interviewer: Do you think hypertext elements in the video actually enhance self-learning among students?

Prof. Sharaf: Yes. When we show students images or presentation slides, they help them understand better than just text. The student connects information with images or questions. Therefore, I see hypertext video as a great idea to support self-learning.

Interviewer: What challenges do you see in using this type of video in Yemeni universities?

Prof. Sharaf: There are many challenges:

Weak internet and the difficulty of accessing links inside classrooms.

Poor technological infrastructure in universities.

Teaching staff, since lecturers need training and preparation to use these technologies. This tool is more suitable for technical fields such as digital arts and computer science than for the humanities.

Interviewer: How can these challenges be overcome?

Prof. Sharaf: I suggest three steps:

Provide technological tools inside classrooms and connect them to an internal server.

Provide internet access at the classroom level, not just in administrative offices.

Train faculty members through mandatory training packages to prepare them to use these technologies.

Interviewer: What are your recommendations for developing the video to be more effective in teaching subjects such as digital arts and computer science?

Prof. Sharaf: I suggest that the video should include images, colored links, and interactive icons to increase engagement. It should also be easy to use, and students should be involved in evaluating it through surveys to gather their opinions alongside lecturers' evaluations.

**Dr. Mohammed Ismail Ahmed Faya Dean of the Center for Quality Assurance
Lebanese International Uni**

المقابلة : يتم عرض الفيديو في بيئات ذات الإمكانيات المحدودة، كالسياق اليمني.

يسعدني اليوم عرض نموذج من هذا الفيديو التفاعلي، ثم الاستماع إلى رأيكم الكريم من منطلق خبرتكم الأكاديمية، بهدف فهم الفرص والتحديات في تطبيق هذه التقنيات بالتعليم العالي في اليمن.

I have not developed a prototype or MVP yet. However, I will present a sample hypertext video from an existing, lesser-known platform as a demonstration to explain the concept.

ما رأيكم الأولي في الفيديو التفاعلي الذي شاهدتموه؟

كطريقة للتدريس استخدام هذا النوع من الفيديوهات التفاعلية hyperlearnx يعتبر بسيطة وذكية واللغة المستخدمة سهلة

هل تعتقدون أن هذا النوع من الفيديوهات يمكن أن يدعم تعلم الطلاب لمادة مثل التصميم الجرافيكي؟ ولماذا؟
يدعم بشدة لأنه هناك في ظروف معينة نضطر الى التعليم الالكتروني كالأوبئة والحروب وغيرها من الظروف التي تجبر التعلم الرقمي كخيار وحيد

ما المميزات التي لفتت انتباهكم في الفيديو من ناحية دعم الفهم أو التفاعل؟

انه يفهم الطالب اكثر بلغة سهلة من رموز والوان حيث انها مستخدمة بشكل بسيط للطالب ويدعم فهم الطالب, ويمكن للطالب التفاعل مع هذا النوع من الفيديوهات التفاعلية اكثر من المحاضرة المباشرة

كيف يمكن للمحاضر الجامعي أن يوظف مثل هذه الأداة في محاضراته أو أنشطته التعليمية؟

هذه التقنية hyperlearnx جميلة حيث يمكن للمحاضر ان يعرضها ليس كبديل عن المحاضرات ولكن في بعض الظروف الخاصة بالذات الطالب الغائب او فهمه ضعيف فهذا يساعد المدرس بالتواصل مع اكبر عدد من الطلاب

هل ترون أن استخدام النصوص الفائقة والروابط داخل الفيديو يُعزز من التعلم الذاتي لدى الطلبة؟

ليس كل الفيديوهات يمكن ان نعمل لها روابط أسئلة أحيانا يمكن جعلها ملاحظات او أي شي للفت الانتباه وتعزيز الفهم, فمن الممكن استخدام فيديوهات خطية , ويمكن أيضا استخدام فيديوهات بروابط تشعبية للانتقال من مرحلة لمرحلة لدعم الفهم التدريجي للطالب, لضمان ان يمر الطالب على كل الفيديو بتركيز وفهم شامل.

ما التحديات المحتملة التي ترونها أمام استخدام هذا النوع من الفيديوهات في مؤسسات التعليم العالي باليمن؟

الانترنت بشكل اكيد لكنك قد حلت هذه المشكلة بتقنية ال hyperlearnx لانها حلت مشكلة انها تعمل على الانترنت الضعيف او شبه المعدم, وشي اخر الاحتياج لل assistance من الإدارات او من بعض المدرسين او عميد الكلية والإدارات او بعض الطلاب بسبب عدم معرفتهم بالية الاستعمال, فنحتاج الى توعيتهم قليلا, والتوعية تكون للكادر التعليمي والإداري وصولا للطلاب في أهمية التقنية وكيفية الاستفادة منها

هل تعتقدون أن بنية الإنترنت أو مهارات الطلاب قد تعيق فعالية استخدام الفيديو التفاعلي؟ كيف يمكن التغلب على ذلك؟

يجب ان يعرف الناس أولا ان الانترنت هو وسيلة التواصل عن بعد في بعض الظروف او الاختبارات او عمل الأبحاث العلمية وايام كوفيد 19 جربنا التعليم الالكتروني لفصل دراسي واحد وكان هناك تجارب جميلة جدا وكان هناك تفاعل مع الطلاب بسبب الضغط والاضطرار , فاذا كان التفاعل من الإدارات والمحاضرين والطلاب فسيكون رائع لخدمة العملية التعليمية

اذا بنية الانترنت ومهارات الطالب يمكن تجاوزها وذلك بتعليم الطلاب كيفية التعامل مع هذه التقنيات بعمل محاضرات توعوية وورشات عمل لكيفية التعامل مع hyperlearnx , المجتمع اليمني لديه قابلية عالية ورغبة عظيمة بالتعلم , هناك فئة كبية من الطلاب المضطرين لتعلم كل شي وكل الكورسات اونلاين و هم يفعلون ذلك بدون تذمر وبدون عوائق حيث يخترعون لأنفسهم حلول للتعلم بدافع الرغبة الشديدة, وهذا ما يجعل فرصة هائلة للاندماج مع العالم

كيف ترون دور المحاضر في دعم تعلم الطلاب من خلال فيديو تفاعلي مثل HyperLearnX ؟

اغلب محاضراتنا ندعمها بأشياء إضافية من فيديوهات وما الى ذلك وبدونها يقل تقبل الطلاب والأدوات التعليمية تسهل العملية التعليمية فالطلاب لا يستوعبون كثيرا الطرق النظرية فانا اعتقد انها وسيلة مساعدة وتوفر الكثير من الوقت للطلاب.

(الصوت يتقطع كثيرا اثناء اللقاء بسبب ضعف الانترنت) 4g

هل ترون أن هذا النوع من التفاعل يتمشى مع مبادئ مثل الدعم التدريجي (Scaffolding) أو التعلم الاجتماعي؟

يتماشى مع الاحتياجات والدعم الاجتماعي اذا تم استخدامه بطريقة صحيحة
ما التحسينات التي تقترحونها لتطوير هذا الفيديو ليكون أكثر فعالية في تدريس الفنون الرقمية؟
ان تكون المعلومات بالفيديوهات حقيقة من مصادر ومراجع موثوقة وتتماشى مع المناهج المعترف بها عالميا
وواضحة، بحيث ان المدرس يأخذ المسؤولية كاملة
هل لديكم توصيات لتكييف هذه التقنية بما يتناسب مع خصائص الطلبة أو بيئات الجامعات اليمنية؟
لو عملتم نماذج من طلاب وجامعات مختلفة ومدن يمنية مختلفة وملتم مسح ميداني وحللت البيانات ستخرجون
بنتيجة جيدة، مثل عمل prototype وعرضه لفئات طلابية مختلفة وجامعات مختلفة ومدن مختلفة باليمن ونرى
الأراء ونحللها ومجموعة من المدرسين و رؤساء اقسام وعدم اهمال بعض التخصصات مثل قسم العمارة
والجرافكس او التصميم الداخلي
شكرا مرة أخرى على وقتكم ومساهماتكم القيمة في هذه المقابلة.
أراؤكم سئسهم بشكل جوهري في تطوير أدوات تعليمية فعالة وقابلة للتطبيق في السياقات الصعبة، مثل اليمن،
خاصة في مجالات التقنية و الفنون والتصميم.
أؤكد لكم أن جميع المعلومات سئستخدم لأغراض أكاديمية فقط، وتعامل بسرية تامة.
في حال رغبتكم بالحصول على نسخة من نتائج البحث النهائية، يسعدني مشاركتها معكم لاحقاً.

Translation to English:

Dr Mohammed Ismail Ahmed Faya, Dean of the Centre for Quality Assurance,
Lebanese International University

Introduction by the researcher: The video is presented in low-resource environments,
such as the Yemeni context.

I am pleased today to present a sample of this interactive video and then listen to your
esteemed opinion, based on your academic expertise, to understand the opportunities
and challenges in applying such technologies in higher education in Yemen.

I have not yet developed a prototype or MVP. However, I will present a sample
hypertext video from an existing, lesser-known platform as a demonstration to explain
the concept.

1. What is your initial impression of the interactive video you have just watched?

As a teaching method, using this type of interactive video (HyperLearnX) is simple and
smart, and the language used is easy to understand.

2. Do you think this type of video can support students' learning in a subject like graphic
design? Why?

Yes, it strongly supports learning because, under certain circumstances, we are forced
to rely on online education, such as during pandemics, wars, or other crises where digital
learning becomes the only available option.

3. What features caught your attention in terms of supporting comprehension or interaction?

It enhances student understanding using simple language, symbols, and colours. These are presented in a straightforward way that supports student comprehension. Moreover, students can interact with this type of interactive video even more than in face-to-face lectures.

4. How can a university lecturer integrate such a tool into their lectures or educational activities?

This HyperLearnX technology is excellent. A lecturer can use it not as a replacement for lectures, but in specific cases, such as when a student is absent or struggling to understand. It helps the lecturer connect with a larger number of students.

5. Do you think that using hypertext and embedded links within videos can enhance students' self-learning?

Not every video can be linked to questions. Sometimes they can include notes or other elements to draw attention and reinforce comprehension. It is possible to use linear videos, and it is also possible to use hyperlinked videos that allow the student to progress step by step, ensuring they cover the whole video attentively and comprehensively.

6. What challenges do you foresee in using this type of video in higher education institutions in Yemen?

Internet connectivity, of course. But you have already addressed this problem with the HyperLearnX technology, as it works even under weak or almost non-existent internet conditions. Another challenge is the need for assistance from administrators, some lecturers, deans, and even students, who may not be familiar with how to use it. So, awareness is needed—for the academic and administrative staff, and then for students—about the importance of this technology and how to benefit from it.

7. Do you think that internet infrastructure or students' skills might hinder the effective use of interactive video? How can this be addressed?

First, people need to realise that the internet is a means of distance communication, especially in certain circumstances such as exams or conducting research. During the COVID-19 pandemic, we tried e-learning for one semester. There were very positive experiences, and students interacted well because of necessity and pressure. So, if there is engagement from administrators, lecturers, and students, it will serve the educational process effectively.

Yes, internet infrastructure and student skills could be barriers, but they can be overcome by teaching students how to use these technologies through awareness lectures and workshops on how to use HyperLearnX. Yemeni society has a high willingness and strong desire to learn. A large group of students are already forced to

study entirely online, and they do so without complaints, even creating their own solutions out of eagerness to learn. This represents a great opportunity for integration with the global educational community.

8. How do you see the role of lecturers in supporting student learning through an interactive video such as HyperLearnX?

Most of our lectures are already supported with supplementary resources such as videos, and without them, students' acceptance decreases. Educational tools facilitate the learning process because students do not absorb theoretical methods very well. I believe interactive videos are an important aid that can save students a lot of time.

(Note: The audio was frequently interrupted during the meeting due to a weak 4G internet connection.)

9. Do you think this type of interaction aligns with principles such as scaffolding or social learning?

Yes, it aligns with needs and social support if it is used properly.

10. What improvements would you suggest to make this video more effective in teaching digital arts?

The content of the videos should be factual, based on credible sources and references, aligned with internationally recognised curricula, and presented clearly. This way, the lecturer can take full responsibility for using them.

11. Do you have recommendations for adapting this technology to fit the characteristics of students or university environments in Yemen?

If you could create models involving students from different universities and cities in Yemen, and conduct a field survey with data analysis, you would reach strong conclusions. For example, developing a prototype and presenting it to groups of students across various universities and cities, and also gathering feedback from lecturers, heads of departments, and covering different fields such as architecture, graphics, and interior design would provide comprehensive insights.

Closing by the researcher: Thank you once again for your time and valuable contributions to this interview.

Your insights will make a significant contribution to developing effective and applicable educational tools in challenging contexts such as Yemen, particularly in the fields of technology, arts, and design.

I assure you that all information will be used solely for academic purposes and treated with full confidentiality.

If you wish, I would be pleased to share a copy of the final research results with you later.

Marwa Alhadi, Lecturer at Sana'a University, Head of the Graphics Department, and Head of the Control Unit.

يتم عرض الفيديو في بيئات ذات الإمكانيات المحدودة، كالسياق اليمني.

يسعدني اليوم عرض نموذج من هذا الفيديو التفاعلي، ثم الاستماع إلى رأيكم الكريم من منطلق خبرتكم الأكاديمية، بهدف فهم الفرص والتحديات في تطبيق هذه التقنيات بالتعليم العالي في اليمن.

I have not developed a prototype or MVP yet. However, I will present a sample hypertext video from an existing, lesser-known platform as a demonstration to explain the concept.

ما رأيكم الأولي في الفيديو التفاعلي الذي شاهدتموه؟

من ناحية اختصار زمن الفيديو نحن نهتم بالوقت، بالذات عندما تكون هناك الكثير من الإعادات المرهقة للطلاب، فعادة الطلاب يميلون للبحث عن الفيديوهات الأقل حجما للوصول السريع للمعلومات، فلو تم توظيف hyperlearnx فستزداد نسبة مشاهدة الفيديو وهذا قد يكون مفيد للتحميل اللاحق.

هل تعتقدون أن هذا النوع من الفيديوهات يمكن أن يدعم تعلم الطلاب لمادة مثل التصميم الجرافيكي؟ ولماذا؟

اعتقد ان hyperlearnx عملي جدا لانه يحفظ الكثير من الوقت للطلاب الذين يسعون فقط للحصول على المعلومات فحسب، فاعلم طلابي عند مشاهدة أي فيديو يقوم بعملية التسريع حتى لا يستنزف وقتهم، وهذه التقنية عملت summarise للوقت انهم يشاهدوا اقل ومعلومات اكثر، و أيضا من وجهة نظري بعض المواد الدراسية تحتاج الدراسة وجه لوجه وبعضها يفضل ان تكون بفيديوهات تعليمية، مثلا البرمجة سيكون من الجيد ان يشاهد الطلاب فيديو للتعليم ويحتفظون به كمرجع لاحقا.

ما المميزات التي لفتت انتباهكم في الفيديو من ناحية دعم الفهم أو التفاعل؟

الأسئلة التفاعلية والجودة و الألوان، وأيضا التلخيص وحذف التكرارات

كيف يمكن للمحاضر الجامعي أن يوظف مثل هذه الأداة في محاضراته أو أنشطته التعليمية؟

يمكن ان يوظفها بربطها بدرجات دراسية كاعمال سنة او درجات دراسية للمادة،

هل ترون أن استخدام النصوص الفائقة والروابط داخل الفيديو يُعزز من التعلم الذاتي لدى الطلبة؟

لا ، انا افضل رابط واحد نهاية الفيديو يحتوي الأسئلة لكن كثرة الروابط كمحاضر صعب ان اجعلها للطلاب بعد كل فقرة الا اذا كانت سلسلة تعليمية، لان كثرة الروابط في الفيديو تسبب confuse للطلاب وتمنعه من الاستمرار بسبب الإرهاق، لكن ان تكون كروابط أسئلة فهذا جميل وانا مع الفكرة قلبا وقالبا.

ما التحديات المحتملة التي ترونها أمام استخدام هذا النوع من الفيديوهات في مؤسسات التعليم العالي باليمن؟

اعتمادية ال online غير معتمد بالوقت الراهن ولكن فقط حضوريا الا اذا تم اعتماد التعليم اونلاين فسكون حل رائع وبارز، والتعليم اونلاين غير مقنع به مجتمعا، حيث يرى ان قدرة الطالب لا تعتمد الا بالحضور وجه لوجه حيث اننا لدينا الان بجامعة صنعاء اذا تغيب الطالب ثلاث محاضرات يتم فصله، رغم ان الجامعات الأخرى بالعالم تعتمد online learning وفي خريجين ولديهم ابتكارات علمية وانا مع التعليم عن بعد ولكن الوزارة لم تقنع بهذا المبدأ لانه من جذور التعليم العالي ولا يوجد وقت بسبب الحروب لتغيير سياسات التعليم واستراتيجياته فهذا المجال بقي مجمد ولم يتم تطويره.

هل تعتقدون أن بنية الإنترنت أو مهارات الطلاب قد تعيق فعالية استخدام الفيديو التفاعلي؟ كيف يمكن التغلب على ذلك؟

لا , الانترنت متاح ومتوفر لا يعيق التعليم بصنعاء بتاتا و وجود الانترنت باليمن يعتبر داعم للتعليم, والملفت للنظر ان الجميع اختلف بالتعليم اونلاين خلال جائحة كوفيد وبعدها لم يتم الموافقة على ذلك , ورجعت الأهمية للتعليم الحضوري, فالطلاب المحتاجين للتعليم عن بعد بسبب أوضاع مثل الحاجة للعمل والدوام لساعات تعيق التوافق مع مواعيد محاضرات الجامعة هذه الفئة تحتاج لرؤية واضحة للتعامل مع التعليم الرقمي و دراسة استراتيجية للتعليم عن بعد

كيف ترون دور المحاضر في دعم تعلم الطلاب من خلال فيديو تفاعلي مثل HyperLearnX ؟

انا مع الفيديو التفاعلي اكثر من الفيديو الخطي الذي يخرجنا على المسار أحيانا ويشتت الطالب ولا يصل للفكرة المطلوبة لقلة التركيز مع زيادة المشتغلات الفكرية بالوقت الراهن لكن الأسئلة اثناء الفيديو ستجعل الطالب اكثر تركيزا وقل تشتتا وذلك يسهل التقاط المعلومة ويفتح مجال للبحث عن نقاط أخرى والشغف بالتعليم اكثر

هل ترون أن هذا النوع من التفاعل يتماشى مع مبادئ مثل الدعم التدريجي (Scaffolding) أو التعلم الاجتماعي؟ اكد لانه كلما كان الفيديو تفاعلي كلما وصل للمجتمع بشكل اكبر وعام, نسبة التفاعلية تجعله اكثر فعالية بالتأكد من مجرد فيديو خطي

ما التحسينات التي تقترحونها لتطوير هذا الفيديو ليكون أكثر فعالية في تدريس الفنون الرقمية؟

إضافة كاركتر , انا احب ان يكون بالفيديوهات شخصيات معروفة, لان الكاركتر يؤثر بالطلاب خصوصا ان كان قدوة بالمجال.

فالطلاب قد يتابع الفيديو فقط من اجل شخصية واحدة تضاف ك كاريكتر بالفيديو , أي شخصية لشخص مؤثر.

هل لديكم توصيات لتكييف هذه التقنية بما يتناسب مع خصائص الطلبة أو بيئات الجامعات اليمنية؟

ليبيئات الجامعة اليمنية اذا كانت جودة الفيديو عالية جدا فمن الصعب ان يفتح بسهولة لان الانترنت عندنا ليس بتلك الجودة الهائلة كما في الدول الأخرى.

شكرا مرة أخرى على وقتكم ومساهمتمكم القيمة في هذه المقابلة.

أراؤكم سنسهم بشكل جوهري في تطوير أدوات تعليمية فعالة وقابلة للتطبيق في السياقات الصعبة، مثل اليمن، خاصة في مجالات التقنية و الفنون والتصميم. أؤكد لكم أن جميع المعلومات سنستخدم لأغراض أكاديمية فقط، وتعامل بسرية تامة. في حال رغبتكم بالحصول على نسخة من نتائج البحث النهائية، يسعدني مشاركتها معكم لاحقاً.

Translation to English:

The video is presented in resource-limited environments, such as the Yemeni context.

Guest: Marwa Alhadi, Lecturer at Sana'a University, Head of the Graphics Department, and Head of the Control Unit.

I am pleased today to present a sample of this interactive video and then listen to your esteemed opinion, from your academic expertise, to understand the opportunities and challenges of applying these technologies in higher education in Yemen.

I have not developed a prototype or MVP yet. However, I will present a sample hypertext video from an existing, lesser-known platform as a demonstration to explain the concept.

1. What is your initial impression of the interactive video you just watched?

From the perspective of reducing video duration, we care a lot about time, especially when there are many exhausting repetitions for students. Students usually prefer shorter videos for quick access to information. If HyperLearnX is employed, the viewership of videos will increase, which could also be beneficial for later downloads.

2. Do you think this type of video could support students' learning in a subject like graphic design? Why?

I believe HyperLearnX is very practical because it saves a lot of time for students who only want to extract the information. Most of my students, when watching any video, tend to fast-forward to avoid wasting time. This technology summarises the time they watch less but gain more information. In my opinion, some subjects need face-to-face teaching, while others are better supported by educational videos. For example, in programming, it would be great for students to watch and keep such videos as a later reference.

3. What features stood out to you in terms of supporting understanding or interaction?

The interactive questions, the quality, the colours, as well as the summarisation and removal of repetitions.

4. How could a university lecturer employ such a tool in lectures or learning activities?

It could be employed by linking it to course grades, such as coursework marks or assessment scores.

5. Do you think that the use of hypertexts and links inside the video enhances students' self-learning?

No. I prefer one link at the end of the video containing the questions. Having too many links is difficult for me as a lecturer to assign after every section unless it is part of a structured learning series. Too many links can confuse students and discourage them from continuing due to fatigue. But if the links are only for questions, that is wonderful, and I fully support the idea.

6. What potential challenges do you foresee in using this type of video in Yemeni higher education institutions?

Online learning is currently not recognised; only face-to-face learning is allowed. If online learning were to be officially adopted, it would be a great and prominent solution. Socially, online learning is not yet accepted. People believe that students' abilities are only verified through face-to-face attendance. At Sana'a University, for example, if a student misses three lectures, they are dismissed. While other universities around the world rely on online learning, producing graduates with scientific innovations, our Ministry has not yet embraced this principle. Due to the ongoing war, there has been no time to change higher education policies and strategies, so this field has remained stagnant and undeveloped.

7. Do you think the Internet infrastructure or students' skills could hinder the effectiveness of interactive video? How can this be overcome?

No. The Internet is available and does not hinder learning in Sana'a at all. In fact, Internet availability in Yemen supports education. What is remarkable is that during the COVID-19 pandemic, everyone accepted online learning, but afterwards, it was not officially approved, and the focus returned to face-to-face learning. Students who need distance learning, for example, those who must work and cannot align their schedules with university classes, require a clear strategy for digital education and a well-studied plan for distance learning.

8. How do you see the role of the lecturer in supporting student learning through an interactive video like HyperLearnX?

I support interactive video more than linear video. Linear video often takes us off track, distracts students, and prevents them from reaching the intended idea due to a lack of focus and multiple mental distractions nowadays. But when there are questions during the video, students become more focused and less distracted. This makes it easier to grasp the information and encourages them to search further, fueling curiosity and passion for learning.

9. Do you think this type of interaction aligns with principles such as scaffolding or social learning?

Certainly. The more interactive a video is, the more it reaches a wider audience. The level of interactivity definitely makes it more effective than just a linear video.

10. What improvements would you suggest to make this video more effective in teaching digital arts?

Adding a character. I personally like having known figures in videos. Characters influence students, especially if they are role models in the field. A student might follow a video just because of one character added as an influencer or figure in the video.

11. Do you have recommendations for adapting this technology to fit the characteristics of students or university environments in Yemen?

For Yemeni university environments, if the video quality is too high, it will be difficult to access smoothly because our Internet is not as strong as in other countries.

Thank you again for your time and valuable contribution to this interview.

Your insights will significantly contribute to the development of effective and applicable educational tools in challenging contexts such as Yemen, particularly in the fields of technology, arts, and design.

I assure you that all information will be used for academic purposes only and will be treated with complete confidentiality.

If you would like to receive a copy of the final research results, I will be happy to share them with you later.

Section 4: University Students (Focus group) more details Error! Reference source not found. illustrates participants descriptions

أسماء الطلاب التي أجريت معهم المقابلة:

أحمد السقاف طالب علوم حاسوب جامعة صنعاء

ليان الشيباني طالبة تصميم جرافيك جامعة تعز

يوسف المقطري طالب هندسة برمجيات جامعة صنعاء

سارة الحيمي طالبة فنون جميلة جامعة إب

رامي غالب طالب هندسة ميكاترونكس جامعة صنعاء

هدى الشرعبي طالبة إدارة أعمال جامعة الحديدة

طارق البريهي طالب إعلام جامعة الرازي

نجلاء المتوكل طالبة تصميم داخلي جامعة صنعاء

محمد الكمالي طالب هندسة كهربائية جامعة عدن

أروى الفقيه طالبة لغة إنجليزية جامعة إب

حسام الهمداني طالب تقنية معلومات جامعة صنعاء

إيناس الذماري طالبة علوم تربية جامعة تعز

علاء الذيفاني طالب هندسة معمارية جامعة صنعاء

ريم الأصبحي طالبة كيمياء جامعة الحديدة

فارس الجلال طالب قانون جامعة عدن

السلام عليكم جميعاً، وشكراً لحضوركم اليوم في هذه الجلسة الجماعية. كما ذكرت سابقاً، أعمل على دراسة بعنوان :
"تطوير التعلم القائم على الفيديو النصي التفاعلي في مجال الفنون والتصميم: حالة تعليم نظرية اللون في اليمن".

سأعرض لكم الآن نموذجاً قصيراً من فيديو تعليمي تفاعلي مطور باسم HyperLearnX، وبعدها نناقش معاً
تجربتكم وآرائكم.

يتم عرض الفيديو القصير للطلاب

القسم الأول: الانطباع الأول

إلهام :كيف كانت تجربتكم في مشاهدة الفيديو التفاعلي؟

أحمد السقاف (علوم حاسوب): بصراحة كان ممتع جداً. عادة الفيديوهات طويلة ومملة، لكن هذا جذبني أكثر.

ليان الشيباني (تصميم جرافيك): أنا كمان حسيت بالفرق. وجود الأسئلة خلاني أركز، مش زي الفيديو العادي اللي الواحد يتفرج ويمشي.

رامي غالب (هندسة ميكاترونكس): (مبتسم) بس أحس الفيديو قصير زيادة، يعني لو كان فيه تفاصيل أكثر بيكون أوضح.

سارة الحيمي (فنون جميلة): لا بالعكس يا رامي، القصر ميزة، يخلي المعلومة مركزة وما يضيع وقتنا.

طارق البريهي (إعلام): أتفق مع سارة. الطالب ما يحب فيديوهات طويلة، خصوصًا إذا كنت ضعيف.
إيناس الذماري (علوم تربوية): (تضحك) صح! أنا عادة أفقد التركيز بعد 5 دقائق، بس هنا تفاعلت طول الوقت.

القسم الثاني: الفهم والتفاعل

إلهام: هل شعرتُم أنكم فهمتم المعلومة بشكل أفضل مقارنة بالفديوهات العادية؟
يوسف المقطري (هندسة برمجيات): أكيد. لأن التفاعل يجبرك إنك تفكر مش بس تشاهد.
هدى الشرعي (إدارة أعمال): بالنسبة لي فهمت بشكل أسرع. حسبت أن الفيديو شرحني خطوة بخطوة.
محمد الكمالي (هندسة كهربائية): وأنا لاحظت أن التفاعل يمنع السرحان، يعني لازم تجاوب.
أروى الفقيه (لغة إنجليزية): (مقاطعة) بالضبط، وأنا كنت أراجع إجابتي فورًا، هذا خلاني أركز أكثر.
حسام الهمداني (تقنية معلومات): أنا بصراحة تعلمت أحسن من الفيديو العادي وحتى أحسن من بعض المحاضرات المباشرة.

القسم الثالث: الروابط والنصوص والدعم

إلهام: هل وجدتم الروابط والنصوص داخل الفيديو مفيدة؟ ولماذا؟
نجلاء المتوكل (تصميم داخلي): مفيدة جدًا، ساعدتني أربط المعلومات بشكل أوضح.
ريم الأصبحي (كيمياء): وأنا شفتها كمرجع فوري، بدل ما أفتح كتب أو جوجل.
فارس الجلال (قانون): (يتدخل) بالنسبة لي، الروابط عطتني شعور إن عندي مكتبة صغيرة داخل الفيديو.
إلهام: وهل شعرتُم أنكم بحاجة إلى دعم إضافي مثل وجود معلم أثناء المشاهدة؟
ليان: لا، الاستخدام سهل جدًا، أي شخص يقدر يتعامل معه.
علاء الذيفاني (هندسة معمارية): بس في بعض المواد الصعبة ممكن نحتاج شرح إضافي من معلم.
سارة: أنا مع علاء، الفيديو ممتاز كبداية لكن يظل دور المدرس مهم.

القسم الرابع: سهولة الاستخدام والتقنية

إلهام: هل واجهتم أي صعوبة تقنية أثناء مشاهدة الفيديو؟
رامي: أنا شغلته على G3 واشتغل كويس.
محمد الكمالي: (يضحك) بس عندنا في عدن النت يقطع فجأة، هنا بتكون مشكلة.
أحمد: لو في خيار تغيير الجودة حسب سرعة النت بيكون أفضل.
ريم: صحيح، أنا واجهت تأخير بسيط بالتحميل لكن مش مشكلة كبيرة.
إلهام: هل تعتقدون أن هذا النوع من الفيديو مناسب لبيئتكم التعليمية وظروف الإنترنت؟
طارق: أكيد مناسب، خاصة للطلاب اللي يدرسون من الريف.
هدى: هو حل عملي جدًا للوضع اللي نعيشه باليمن.

القسم الخامس: الرأي العام والاقتراحات

إلهام: هل تحبون أن تتعلموا موادكم بهذه الطريقة التفاعلية؟ ولماذا؟

أروى: طبعًا، لأنه يوفر وقت ويكسر الملل.

إيناس: وأنا شفت أنه يشجع على التعلم الذاتي.

يوسف: وأفضل شيء أنه يجعل الطالب مشارك، مش مجرد مستمع.

إلهام: طيب، ما الاقتراحات التي تقدمونها لتحسين الفيديو؟

حسام: إضافة خيار للطالب يسأل سؤال والفيديو يوجهه للمقطع المناسب.

علاء: تقليل عدد الإطارات (frame rate) حتى يشتغل أسرع مع النت الضعيف.

نجلاء: اقتراح إدخال التجربة رسميًا بالجامعات اليمنية، حتى لو كداية بمقرر تجريبي.

فارس: وكمان لو تضيفوا عناصر تحفيزية مثل نقاط أو شارات (badges).

سارة: (بحماس) وأتمنى يكون في تطبيق للهاتف عشان يسهل علينا الوصول.

رسالة الختام

إلهام: شكرًا جزيلاً لكم جميعاً على مشاركتكم القيمة. ملاحظاتكم ستساعدني في تطوير أدوات تعليمية مناسبة لكم ولزملانكم، خصوصاً في البيانات التي يصعب فيها الوصول للتعليم الجيد.

أؤكد أن مشاركتكم ستستخدم فقط لأغراض أكاديمية وبسرية تامة.

أتمنى لكم كل التوفيق في دراستكم.

Translation to English:

Participants:

Ahmed Al-Saqqaf, Computer Science student, Sana'a University

Lian Al-Shaibani, Graphic Design student, Taiz University

Yousef Al-Muqtri, Software Engineering student, Sana'a University

Sarah Al-Haimi, Fine Arts student, Ibb University

Rami Ghalib, Mechatronics Engineering student, Sana'a University

Huda Al-Shuraibi, Business Administration student, Hodeidah University

Tareq Al-Buraihi, Media student, Al-Razi University

Najla Al-Mutawakkil, Interior Design student, Sana'a University

Mohammed Al-Kamali, Electrical Engineering student, Aden University

Arwa Al-Faqih, English Language student, Ibb University

Hossam Al-Hamdani, Information Technology student, Sana'a University

Enas Al-Dhamari, Education Sciences student, Taiz University

Alaa Al-Dhaifani, Architecture student, Sana'a University

Reem Al-Asbahi, Chemistry student, Hodeidah University

Fares Al-Jalal, Law student, Aden University

Elham (Moderator):

Peace be upon you all, and thank you for joining today's group session. As I mentioned earlier, I am working on a study titled:

" Advancing Hypertext Video-Based Learning in Art and Design Education: An Interpretive Case Study of Colour Theory Learning Among Art Students in Yemen"

I will now show you a short sample of an educational hypertext video developed under the name HyperLearnX, and afterwards, we will discuss your experiences and feedback together.

(A short video is shown to the students)

Section 1: First Impressions

Elham: How was your experience watching the interactive video?

Ahmed Al-Saqqaf (Computer Science):

Honestly, it was very engaging. Usually, videos are long and boring, but this one kept my attention.

Lian Al-Shaibani (Graphic Design):

I felt the difference too. Having questions inside the video made me focus, unlike regular videos, where you just watch passively.

Rami Ghalib (Mechatronics Engineering):

(Smiling) But I feel the video was too short. If it had more details, it would have been clearer.

Sarah Al-Haimi (Fine Arts):

On the contrary, Rami. The shortness is a strength; it makes the information concise and saves our time.

Tareq Al-Buraihi (Media):

I agree with Sarah. Students don't like long videos, especially when the internet is weak.

Enas Al-Dhamari (Education Sciences):

(Laughs) True! I usually lose focus after 5 minutes, but here I stayed engaged the whole time.

Section 2: Understanding and Interaction

Elham: Did you feel you understood the material better compared to regular videos?

Yousef Al-Muqtri (Software Engineering): Definitely. The interactivity forces you to think, not just watch.

Huda Al-Shuraibi (Business Administration): For me, I understood faster. It felt like the video guided me step by step.

Mohammed Al-Kamali (Electrical Engineering): I noticed that interaction prevents distraction; you have to respond.

Arwa Al-Faqih (English Language): (Interrupting) Exactly! And I was able to check my answers immediately, which kept me focused.

Hossam Al-Hamdani (Information Technology): Honestly, I learned better than from a regular video, and even better than some live lectures.

Section 3: Links, Texts, and Support

Elham: Did you find the links and texts inside the video useful? Why?

Najla Al-Mutawakkil (Interior Design): Very useful, they helped me connect the information more clearly.

Reem Al-Asbahi (Chemistry): I saw them as an instant reference, instead of searching books or Google.

Fares Al-Jalal (Law): (Joining in) For me, the links felt like having a mini library inside the video.

Elham: Did you feel you needed additional support, like having a teacher present during viewing?

Lian: No, it was very easy to use. Anyone can handle it.

Alaa Al-Dhaifani (Architecture): But for some difficult subjects, we might still need extra explanation from a teacher.

Sarah: I agree with Alaa. The video is excellent as a foundation, but the teacher's role remains important.

Section 4: Ease of Use and Technology

Elham: Did you face any technical difficulties while watching the video?

Rami: I played it on 3G, and it worked fine.

Mohammed Al-Kamali: (Laughs) But in Aden, the internet cuts suddenly, that's where problems happen.

Ahmed: If there were an option to change the video quality depending on internet speed, it would be better.

Reem: True, I experienced a small delay in loading, but it wasn't a big issue.

Elham: Do you think this type of video suits your educational environment and internet conditions?

Tareq: Definitely, especially for students studying in rural areas.

Huda: It's a very practical solution for the situation we live in here in Yemen.

Section 5: General Opinions and Suggestions

Elham: Would you like to learn your courses through this interactive method? Why?

Arwa: Of course, it saves time and breaks boredom.

Enas: And I found it encourages self-learning.

Yousef: The best part is that it makes the student participate, not just listen.

Elham: Alright, what suggestions would you give to improve the video?

Hossam: Add an option where students can ask a question, and the video directs them to the relevant part.

Alaa: Reduce the frame rate so it works faster with weak internet.

Najla: I suggest introducing this experience officially in Yemeni universities, even starting with a sample hypertext video from an existing, less-known platform as a demonstration to explain the concept.

Fares: And if you add motivational elements like points or badges, it would be great.

Sarah: (Excitedly) I also hope there will be a mobile app version, so it's easier to access.

Closing Message

Elham: Thank you all very much for your valuable participation. Your feedback will help me develop educational tools suitable for you and your peers, especially in environments where access to quality education is difficult.

I assure you that your contributions will be used only for academic purposes, with complete confidentiality.

I wish you all the best in your studies.

Elyas Almajedi Master's Degree in Information Technology with a Specialization in Artificial Intelligence, Al-Razi University

السلام عليكم ورحمة الله وبركاته،

شكراً جزيلاً لك/لك على موافقتك للمشاركة في هذه المقابلة البحثية.

تم تطوير نموذج تعليمي تفاعلي باسم HyperLearnX، يهدف إلى تقديم محتوى فيديو تعليمي يمكن التفاعل معه من خلال روابط ونصوص داخلية، حتى في ظل ضعف الإنترنت.

سأعرض لك/لك الآن نموذج فيديو تعليمي قصير، وأود بعده أن أستمع إلى رأيك وتجربتك كمُتعلم، بما يُساعد في فهم مدى فاعلية هذا الأسلوب الجديد في التعليم عن بُعد.

كيف كانت تجربتك في مشاهدة الفيديو التفاعلي؟

بالنسبة للفيديو رائع وهناك تقنيات للفيديو مثل الفيديوهات التي تترجم النصوص داخل الفيديو ولكنها ليست شائعة كثيرا، لكن فكرتك hyperlearnx محتوية على أسئلة تفاعلية يجيب عليها الطالب شي جديد ومساعد جد بمجال التعليم لجهات التعليم التي تراكب التكنولوجيا ويمكن ان يتم تقديمها كمحتوى إضافي للطلاب لمشاهدتها لاحقا كمرجع فتكون هذه التقنية مناسبة للغاية ونقلة نوعية وجميلة جدا.

هل شعرت بأنك فهمت المعلومة بشكل أفضل مقارنة بالفيديوهات العادية؟

نعم بالتأكيد. مؤخرا بدأت بعض الجامعات والمعاهد بعمل دورات تدريبية للتحويل الرقمي خصوصا للطلاب الذين لديهم اعمال بدوام جزئي او الأشخاص المحرومين من التعليم فسوف تساعد بشكل كبير للغاية بالذات للانترنت الضعيف، ومن الصعوبات الواقعية هي الاحتياج لدورات تأهيلية لمعرفة كيفية التعامل مع هذه النوع من الفيديوهات ومن جانب تقني حتى الانترنت ال 4g ليس حقيقي بتلك السرعة وانما فقط مصطلح تجاري، والجهات المعنية مثل وزارة الاتصالات لها صلاحيات حظر او إعطاء صلاحيات لمنصات مثل منصة تعليمية، ومن وجهة نظري لا يوجد أي تحديات لتطبيقه على ارض الواقع، بالنسبة للذكاء الصناعي كان هناك صعوبات للحاضرين بعمل أسئلة للطلاب ومع وجود الذكاء الصناعي ومجموعة من المحاضرات صارت اسهل، فمن الرائع استغلال تقنية hyperlearnx لاستغلال الوقت باختصار الفيديو الخطي الملل.

القسم 2: التفاعل والدعم

هل وجدت الروابط والنصوص داخل الفيديو مفيدة؟ لماذا؟

بالتأكيد. حيث انها تعزز الفهم وتوفر الوقت. والميزة التي نالت اعجابي انه يتم عمل سؤال وتصحيحه بنفس الوقت. تحديد وقت وزمن ويمكن إضافة للفيديو يجب رؤية اراء اشخاص متعددين أيضا،

هل شعرت أنك بحاجة إلى دعم إضافي (مثل وجود معلم) أثناء المشاهدة؟

لا. لانه الفيديو سهل الاستخدام

هل واجهت أي صعوبة تقنية أثناء مشاهدة الفيديو (تحميل، تشغيل، فهم التفاعل)؟

أي شخص يمكن استخدامه سهل للغاية لأي شخص

هل تعتقد أن هذا النوع من الفيديو مناسب لبيئتك التعليمية وظروف الإنترنت لديك؟

نعم بالتأكيد، لانه اثناء الوباء كوفيد 19 الفيديوهات التعليمية لم تكن واضحة جيدا ولم تكن نفهم الغزى بشكل أوضح بعكس الفيديو التفاعلي التي انتي عرضتيه hyperlearnx

هل تحب أن تتعلم موادك بهذه الطريقة التفاعلية؟ ولماذا؟

افضل بطريقة تفاعلية، لانه وجه لوجه ننسى المعلومات ولكن الفيديو رائع لاسترجاع المعلومات بالمستقبل حتى بعد التخرج

ما الاقتراحات التي تقدمها لتحسين الفيديو أو جعله أكثر فائدة لك كطالب/ة؟

الفيديو يفي بالغرض ولي هناك أي اقتراحات اخرى

شكراً جزيلاً لك/لك على مشاركتك في هذه المقابلة.

لقد كانت ملاحظاتك مهمة جدًا وستساعد في تطوير أدوات تعليمية مناسبة لك ولزملائك، خصوصًا في البيئات التي يصعب فيها الوصول للتعليم الجيد.

Translation to English:

Guest: Elyas Almajedi, Master's Degree in Information Technology with a Specialisation in Artificial Intelligence, Al-Razi University

Interviewer: Peace be upon you,

Thank you very much for agreeing to participate in this research interview.

A new interactive educational model called HyperLearnX has been developed. It aims to deliver educational video content that allows interaction through internal links and embedded texts, even under low-bandwidth internet conditions.

I will now show you a short sample of this educational video, and afterwards, I would like to hear your opinion and experience as a learner. Your feedback will help us understand the effectiveness of this new approach in distance learning.

Section 1: Experience with the Interactive Video

1. How was your experience watching the interactive video?

The video was excellent. There are existing technologies, such as videos that translate texts within the video, but they are not widely used. However, your idea of HyperLearnX includes interactive questions that students can answer, which is something new and very helpful for the education sector that keeps pace with technology. It can also be offered as additional content for students to view later as a reference. This makes the technique extremely suitable, a significant step forward, and a very impressive innovation.

2. Did you feel you understood the information better compared to ordinary videos?

Yes, definitely. Recently, some universities and institutes have started offering digital transformation training courses, especially for students with part-time jobs or those deprived of access to education. This will help them tremendously, particularly under weak internet conditions.

One real challenge, however, is the need for preparatory training courses to teach people how to deal with this type of interactive video. From the technical side, even 4G internet is not truly as fast as advertised—it is more of a commercial term. Also, authorities such as the Ministry of Communications have the power to block or grant access to platforms, including educational ones.

From my perspective, there are no major challenges to applying this in practice. With artificial intelligence, it has become easier to generate student questions from lectures, whereas before it was a challenge. So, it would be excellent to use HyperLearnX to save time and shorten long, linear, and boring videos.

Section 2: Interaction and Support

3. Did you find the links and texts inside the video useful? Why?

Absolutely. They enhance understanding and save time. What impressed me most was the feature of answering a question and getting immediate feedback. Setting time limits is also possible. I would suggest adding viewpoints from multiple people as well.

4. Did you feel you needed additional support (such as a teacher) while watching?

No, because the video is easy to use.

5. Did you face any technical difficulties while watching the video (loading, playing, or interacting)?

Not at all. It is extremely easy for anyone to use.

6. Do you think this type of video is suitable for your educational environment and internet conditions?

Yes, definitely. During the COVID-19 pandemic, educational videos were not clear enough, and we could not fully understand the main points. In contrast, the interactive video you presented, HyperLearnX, was much clearer.

7. Would you like to learn your courses using this interactive method? Why?

Yes, I prefer the interactive method. In face-to-face classes, we often forget the information. But with interactive videos, it is excellent for recalling information in the future, even after graduation.

8. What suggestions would you offer to improve the video or make it more useful for you as a student?

The video serves its purpose well, and I do not have any additional suggestions.

Interviewer:

Thank you very much for your participation in this interview.

Your feedback is very valuable and will help in developing suitable educational tools for you and your colleagues, especially in environments where access to quality education is limited.

Eman Alaqeel, graphic design, Lebanese International University (LIU Yemen), Sanaa

السلام عليكم ورحمة الله وبركاته،

شكراً جزيلاً لك/لك على موافقتك للمشاركة في هذه المقابلة البحثي

تم تطوير نموذج تعليمي تفاعلي باسم HyperLearnX، يهدف إلى تقديم محتوى فيديو تعليمي يمكن التفاعل معه من خلال روابط ونصوص داخلية، حتى في ظل ضعف الإنترنت.

سأعرض لك/لك الآن نموذج فيديو تعليمي قصير ، وأود بعده أن أستمع إلى رأيك وتجربتك كمُتعلم/ة، بما يُساعد في فهم مدى فاعلية هذا الأسلوب الجديد في التعليم عن بُعد.

كيف كانت تجربتك في مشاهدة الفيديو التفاعلي؟

بمجال الألوان لابد ان يكون هناك دمج وشيء عملي , لكن من خلال مشاهدتي للفيديو انه جذاب ويعتبر عملي ونظري بنفس الوقت.

بالتأكيد أي معلومة مختصرة تكون اكثر استيعابا وفهما وتحاكي العقل , فحببت بالفيديو الاختصار للوقت والجهد وجودة الوصول للمعلومة

هل شعرت بأنك فهمت المعلومة بشكل أفضل مقارنة بالفيديوهات العادية؟

بالتأكيد , لم اكن لافهم من الفيديو العادي الخطي

هل وجدت الروابط والنصوص داخل الفيديو مفيدة؟ لماذا؟

الروابط مهمة جدا بتخصص الجرافكس اذا اضطررنا للدراسة اونلاين من المستحيل او الصعوبة الشديدة الدراسة بمجرد فيديو خطي , لان الألوان تحتاج لشيء عملي واقعي , ففي اخر سنة دراسية درست بالجرافكس الرسم على القماش ولم يكن هناك الية للتدريس بشكل عملي فباليت توافرت تقنية مثل HyperLearnX في تلك المادة , لان الشرح كان مطول ومتعب للغاية فما اجمل هذه التقنية التي سهلت الفهم للغاية , ولو انه من وجهة نظري ان الدراسة وجه لوجه هو الأفضل بل منازع ولكن التعليم الرقمي ان اصبح الزامي فهذه هي الطريقة الأفضل, فانا كأمر عندي طفل رضيع أحيانا كنت اجد صعوبة بالذهاب للتعلم وجه لوجه فهذه التقنية HyperLearnX خيار رائع وضروري للغاية

هل شعرت أنك بحاجة إلى دعم إضافي (مثل وجود معلم) أثناء المشاهدة؟

قبل ما تقطع الشاشة بسؤال رابط لابد من وجود تعليمات انه سيكون هناك أسئلة بدل من المفاجأة بسال لانه قد يعتقد الطالب انه انتهى الفيديو .

هل واجهت أي صعوبة تقنية أثناء مشاهدة الفيديو (تحميل، تشغيل، فهم التفاعل)؟

حببت الفكرة ولكن عندي اقتراح ان يكون ببداية الفيديو شرح مبسط عن الية الفيديو انه يحتوي أسئلة اثناء الفيديو حتى يكون التركيز مركز اكثر لتوقع سؤال , بينما ان لم يتوقع الطال أسئلة سوف يتفاجأ الطالب ولن يستطيع الرد وسيرتبك ولن يحله

هل تعتقد أن هذا النوع من الفيديو مناسب لبيئتك التعليمية وظروف الإنترنت لديك؟

جدا مناسب لبيئتي التعليمية لانه بسيط والانترنت يشغل عندي بدون انقطاع.

هل تحب أن تتعلم موادك بهذه الطريقة التفاعلية؟ ولماذا؟

حببت جدا الأسئلة التفاعلية لانها بها الكثير من الاهتمام ولفت نظر الطالب للاستيعاب اكثر

ما الاقتراحات التي تقدمها لتحسين الفيديو أو جعله أكثر فائدة لك كطالب؟

احب جدا انه يتم تنبيهي قبل مشاهدة الفيديو بلفته بسيطة عن الية الفيديو وانه يحتوي على أسئلة متعلقة

شكراً جزيلاً لك/لك على مشاركتك في هذه المقابلة.

لقد كانت ملاحظتك مهمة جداً وسُساعد في تطوير أدوات تعليمية مناسبة لك ولزملائك، خصوصاً في البيئات التي يصعب فيها الوصول للتعليم الجيد.

Translation to English:

Interview with: Eman Alaqeel, Graphic Design, Lebanese International University (LIU Yemen), Sana'a

Interviewer: Peace be upon you. Thank you very much for agreeing to participate in this research interview.

A new interactive educational model called HyperLearnX has been developed. It aims to deliver educational video content that learners can interact with through hyperlinks and embedded texts, even under low-bandwidth internet conditions.

I will now show you a short sample of this interactive video. Afterwards, I would like to hear your opinion and experience as a learner, in order to better understand the effectiveness of this new approach in distance education.

How was your experience watching the interactive video?

In the field of colours, there must be both practical and theoretical aspects combined. From my experience, I found the video engaging, offering both practical and theoretical perspectives at the same time.

Certainly, any concise information is easier to comprehend and stimulates the mind. What I appreciated in the video was the way it saved time and effort while ensuring high-quality delivery of the information.

2. Did you feel that you understood the information better compared to regular videos?

Absolutely, I would not have understood as much from a regular linear video.

3. Did you find the hyperlinks and texts within the video useful? Why?

The links are very important, especially in the field of graphics. If we are forced to study online, it is almost impossible or at least very difficult to rely solely on a linear video, because colours require practical, hands-on learning.

For example, in my final year of studying graphics, we had a course on painting on fabric. Unfortunately, there was no practical mechanism for teaching it. I wish a technology like HyperLearnX had been available for that course, because the explanations were long and exhausting. This new approach makes learning much easier to understand.

From my perspective, face-to-face learning is still the best without a doubt. However, if digital learning becomes mandatory, this would be the most effective method. As a mother with an infant, I sometimes struggled to attend face-to-face classes, so this technology (HyperLearnX) is an excellent and highly necessary option.

4. Did you feel the need for additional support (such as a teacher) while watching?

Before the video pauses to show a question or a link, there should be clear instructions that questions will appear, instead of surprising the learner. Otherwise, students might assume the video has ended.

5. Did you face any technical difficulties while watching (loading, playing, understanding the interaction)?

I liked the idea, but I suggest adding a brief explanation at the beginning of the video about how it works, such as the fact that questions will appear during playback. This would help students focus and anticipate questions. Otherwise, unexpected questions may cause confusion or hesitation, making it difficult to respond properly.

6. Do you think this type of video is suitable for your educational environment and internet conditions?

Yes, it is very suitable for my educational environment. It is simple, and the internet works fine without interruptions.

7. Would you like to learn your subjects using this interactive method? Why?

Yes, I really liked the interactive questions because they engage the learner and capture the student's attention, leading to better understanding.

8. What suggestions would you give to improve the video or make it more useful for you as a student?

I would very much appreciate receiving a simple note or notification before watching the video, explaining its mechanism and that it will contain related questions.

Interviewer: Thank you very much for your participation in this interview. Your feedback is extremely valuable and will help in developing educational tools tailored for you and your peers, especially in environments where access to quality education is challenging.

Mohanad Khalid Zayed, Second-year Mechatronics Engineering student, more details Error! Reference source not found. illustrates participants' description.

السلام عليكم ورحمة الله وبركاته،

شكراً جزيلاً لك/لكِ على موافقتك للمشاركة في هذه المقابلة البحثي

تم تطوير نموذج تعليمي تفاعلي باسم HyperLearnX، يهدف إلى تقديم محتوى فيديو تعليمي يمكن التفاعل معه من خلال روابط ونصوص داخلية، حتى في ظل ضعف الإنترنت.

سأعرض لك/لكِ الآن نموذج فيديو تعليمي قصير، وأود بعده أن أستمع إلى رأيك وتجربتك كمُتعلم/ة، بما يُساعد في فهم مدى فاعلية هذا الأسلوب الجديد في التعليم عن بُعد.

كيف كانت تجربتك في مشاهدة الفيديو التفاعلي؟

أوقات يكون في أشياء طويلة تحتاج لاختصار أكثر ولا يوجد وقت للمتابعة و هذه التقنية رائعة.

هل شعرت بأنك فهمت المعلومة بشكل أفضل مقارنة بالفيديوهات العادية؟

العرض أحياناً يكون رائع كفيديو تفاعلي خصوصاً انه مختصر واسئلة ولكنه ليس مثل وجه لوجه
أوقات يكون الكتابة بالكمبيوتر افضل , اقصد الأشياء المكتوبة بالفيديو افضل من مجرد سرد سماعي
هل وجدت الروابط والنصوص داخل الفيديو مفيدة؟ لماذا؟

مفيدة للغاية , وترى مستوى الفهم للطالب

هل شعرت أنك بحاجة إلى دعم إضافي (مثل وجود معلم) أثناء المشاهدة؟

سهل للمستخدم ولا تحتاج أي توجيه إضافي وهو شيء سهل ورائع لمستخدم

هل واجهت أي صعوبة تقنية أثناء مشاهدة الفيديو (تحميل، تشغيل، فهم التفاعل)؟

لا كان سلس للغاية

هل تعتقد أن هذا النوع من الفيديو مناسب لبيئتك التعليمية وظروف الإنترنت لديك؟

نعم جداً . كمان صغر الفيديو صفة ممتازة للغاية

هل تحب أن تتعلم موادك بهذه الطريقة التفاعلية؟ ولماذا؟

نعم أتمنى ان اتعلم لغات جديدة او مهارات جديدة بتقنية HyperLearnX لاني مؤخرأ أوقفت التعليم والان اريد
التعلم لاكتساب مهارات بسوق العمل فياليت لو تعمم مثل هذه التقنية ليس للتعليم الجامعي فحسب ولكن كتقنية تعليمية
لكل المجالات , خصوصاً اننا لا نملك الوقت لمشاهدة الفيديوهات الخطية الطويلة المملة, انا افضل هذه الطريقة
لاختصار الوقت ولدعمها باسئلة ترسخ الفهم

ما الاقتراحات التي تقدمها لتحسين الفيديو أو جعله أكثر فائدة لك كطالب ؟

لا يوجد أي اقتراحات غير تطبيقها على ارض الواقع, وأتمنى تطوره اكثر بالمستقبل والزمن دائماً يجلب لنا المزيد
من التطور .

شكراً جزيلاً لك/لك على مشاركتك في هذه المقابلة.

لقد كانت ملاحظاتك مهمة جداً وسأساعد في تطوير أدوات تعليمية مناسبة لك ولزملائك، خصوصاً في البيئات التي
يصعب فيها الوصول للتعليم الجيد.

Translation to English:

Interview with: Mohanad Khalid Zayed, Second-year Mechatronics Engineering Student

Interviewer: Peace be upon you. Thank you very much for agreeing to participate in this research interview.

A new interactive educational model called HyperLearnX has been developed. It aims to deliver educational video content that learners can interact with through hyperlinks and embedded texts, even under low-bandwidth internet conditions.

I will now show you a short sample of this interactive video. Afterwards, I would like to hear your opinion and experience as a learner, in order to better understand the effectiveness of this new approach in distance education.

How was your experience watching the interactive video?

Sometimes there are long topics that need to be summarised further, and there is not always enough time to follow them. This technology is excellent for that purpose.

2. Did you feel that you understood the information better compared to regular videos?

The presentation can be very effective as an interactive video, especially because it is concise and includes questions. However, it is still not the same as face-to-face learning.

At times, written text on the screen is more effective than just listening to spoken narration.

3. Did you find the hyperlinks and texts within the video useful? Why?

Yes, they are extremely useful. They also help measure the student's level of understanding.

4. Did you feel the need for additional support (such as a teacher) while watching?

It is very user-friendly and does not require any extra guidance. It is simple and great for the learner.

5. Did you face any technical difficulties while watching (loading, playing, understanding the interaction)?

No, it was very smooth.

6. Do you think this type of video is suitable for your educational environment and internet conditions?

Yes, very much so. The small file size of the video is also an excellent feature.

7. Would you like to learn your subjects using this interactive method? Why?

Yes, I would love to learn new languages or skills through HyperLearnX. Recently, I had to stop my formal studies, but now I want to continue learning to gain skills relevant to the job market.

I hope this technology is generalised not only for university education but also across various fields, since we often do not have the time to watch long and boring linear videos. Personally, I prefer this method because it saves time and reinforces understanding through embedded questions.

8. What suggestions would you give to improve the video or make it more useful for you as a student?

I have no specific suggestions except to apply it in practice. I hope it develops further in the future, as time always brings more progress.

Interviewer: Thank you very much for your participation in this interview.

Your feedback is extremely valuable and will help in developing educational tools tailored for you and your peers, especially in environments where access to quality education is challenging.

Rola Alhadjj, Graphic design bachelor's degree, see Table D.1 for participant details

السلام عليكم ورحمة الله وبركاته،

شكراً جزيلاً لك/لك على موافقتك للمشاركة في هذه المقابلة البحثي

تم تطوير نموذج تعليمي تفاعلي باسم HyperLearnX، يهدف إلى تقديم محتوى فيديو تعليمي يمكن التفاعل معه من خلال روابط ونصوص داخلية، حتى في ظل ضعف الإنترنت. سأعرض لك/لك الآن نموذج فيديو تعليمي قصير، وأود بعده أن أستمع إلى رأيك وتجربتك كمُتعلم/ة، بما يُساعد في فهم مدى فاعلية هذا الأسلوب الجديد في التعليم عن بُعد. كيف كانت تجربتك في مشاهدة الفيديو التفاعلي؟

شيء رائع للغاية للطلاب وغير الطلاب بجعل الفيديو تفاعلي ومختصر و يحتوي على أسئلة لدعم الفهم , يصلح ان يتم تعميمه لكل فئات المجتمع من طلاب و دكاترة وحتى لربات البيوت

هل شعرت بأنك فهمت المعلومة بشكل أفضل مقارنة بالفيديوهات العادية؟

نعم انا افضل التعليم بتقنية HyperLearnX اكثر من التعليم وجه لوجه واكثر من التعليم بالفيديو الخطي أيضا للفائدة الشديدة المتعلقة بالاسئلة

هل وجدت الروابط والنصوص داخل الفيديو مفيدة؟ لماذا؟

مفيدة جدا , لانه يرسخ المعلومة , بعض الأحيان الدراسة كمجموعة لا تتيح لنا فرصة لسؤال المحاضر لانه نريد إعطاء فرصة لزملائنا الآخرين وهذا يفقد التفاعل بالمحاضرات و تكون فرصة تشتت الانتباه اكبر ونفس الشي للفيديو الخطي بينما الفيديو التفاعلي يجعل التفاعل الزامي ويسهل العملية التعليمية

هل شعرت أنك بحاجة إلى دعم إضافي (مثل وجود معلم) أثناء المشاهدة؟

سهلة جدا واي شخص يمكن استخدامه فهذا تسهيل للطلاب و الاستخدام سهل لكل واحد لأننا بعصر التكنولوجيا

هل واجهت أي صعوبة تقنية أثناء مشاهدة الفيديو (تحميل، تشغيل، فهم التفاعل)؟

الانترنت باليمن ضعيف ولكن انا رغم ان الانترنت ضعيف عندي يمكنني مشاهدة هذا الفيديو وليست هناك مشكلة للتحميل وانا استخدم الان 3G وانا احداثك بشكل طبيعي بالمكالمة الفيديو بجوجل ميت رغم انه هناك تكسرات بال pixels للفيديو

هل تعتقد أن هذا النوع من الفيديو مناسب لبيئتك التعليمية وظروف الإنترنت لديك؟

نعم مناسب , نحن حتى ولو بالمنزل لدينا على الأقل الانترنت العادي ADSL

هل تحب أن تتعلم موادك بهذه الطريقة التفاعلية؟ ولماذا؟

نعم اريد التعليم بهذه الطريقة لوجود الحركات التفاعلية حيث كثير نقاط تتكرر بشكل ملل وهذا يساعد الطلاب بشدة لتوفير الوقت

ما الاقتراحات التي تقدمها لتحسين الفيديو أو جعله أكثر فائدة لك كطالبة؟

تحسين الQuality وتقليل frame per second , اقترح إضافة خاصية للمستخدم بتعديل الدقة كم الأرقام التي تكون بها دقة الشاشة للفيديو ليتناسب مع الانترنت عندي و اقترح إدخاله بشكل واقعي للتعليم حتى لو كانت الجودة

ليست جيدة و تقليل اليكسلات او إيجاد أي حل لعرض الفيديو مع انترنت الجيل الثالث وأيضا ان يكون هناك ادخال من الطالب كاستعلام لطرح سؤال من قبل الطالب للفيديو وعرض المقطع المتعلق بالمعلومة المبحوث عنها شكراً جزيلاً لك/لك على مشاركتك في هذه المقابلة.

لقد كانت ملاحظتك مهمة جداً وسأساعد في تطوير أدوات تعليمية مناسبة لك ولزملائك، خصوصاً في البيئات التي يصعب فيها الوصول للتعليم الجيد.

Translation to English:

Interview with: Rola Alhajj, Bachelor's Degree in Graphic Design

Interviewer: Peace be upon you, and thank you very much for agreeing to participate in this research interview.

A new interactive educational model called HyperLearnX has been developed. It aims to provide educational video content that can be interacted with through embedded links and texts, even in conditions of weak internet connectivity.

I will now show you a short sample of an interactive educational video, and afterwards, I would like to hear your opinion and experience as a learner. This will help in understanding the effectiveness of this new approach to distance learning.

How was your experience watching the interactive video?

It was extremely impressive for both students and non-students. Making the video interactive and concise, while including questions to support understanding, is excellent. It can be generalised to all segments of society, students, lecturers, and even housewives.

2. Did you feel that you understood the information better compared to regular videos?

Yes. I prefer learning through HyperLearnX more than face-to-face learning and even more than linear video learning, because of the great benefit related to the embedded questions.

3. Did you find the links and texts within the video useful? Why?

Very useful, because they reinforce the information. Sometimes, in group study, we do not get the chance to ask the lecturer questions since we want to give opportunities to our colleagues. This reduces interaction in lectures and increases distraction. The same applies to linear videos. In contrast, interactive videos make interaction mandatory and facilitate the learning process.

4. Did you feel you needed additional support (such as a teacher) while watching?

It was very easy, and anyone can use it. This simplifies things for students, and the usability is straightforward for everyone since we live in a technological era.

5. Did you face any technical difficulties while watching the video (loading, playing, understanding the interaction)?

The internet in Yemen is weak, but despite that, I was able to watch this video without any problem loading it. I am currently using 3G, and I am speaking with you normally via Google Meet video call, although there are some pixel breakages in the video.

6. Do you think this type of video is suitable for your educational environment and internet conditions?

Yes, it is suitable. Even at home, we at least have regular ADSL internet.

7. Would you like to learn your courses in this interactive way? Why?

Yes, I would like to learn this way because of the interactive elements. Many points in traditional learning are repetitive and become boring. This method helps students greatly in saving time.

8. What suggestions would you make to improve the video or make it more useful for you as a student?

Improving the quality and reducing the frame per second. I suggest adding a feature that allows the user to adjust the resolution (by numbers that define the video screen resolution) to match their internet speed. I also suggest implementing it in actual education, even if the quality is not perfect, by reducing pixels or finding any solution to make the video viewable with 3G internet. Another suggestion is to allow student input, such as the option to submit a query, so that the video can display the segment related to the requested information.

Interviewer: Thank you very much for participating in this interview.

Your feedback has been extremely valuable and will contribute to developing educational tools that are more suitable for you and your colleagues, especially in environments where access to quality education is limited.

Participant verification was documented and retained by the researcher as part of the study's audit trail.

AUTHOR'S PROFILE



Elham Mohammed Kaid Alshabi is a Yemeni educator and digital artist with a Bachelor's degree in Network Engineering and Information Security from the University of Sana'a. She has professional teaching experience in multimedia, Adobe After Effects, Photoshop, digital circuits, and computer skills at several higher education institutions, including the British University in Yemen and the Jordanian University. Her interdisciplinary background combines technical expertise with a lifelong passion for drawing, visual storytelling, and 3D graphics, which is reflected in both her teaching practice and professional design work, including advertising banners and visual communication materials.

Her research interests lie in the intersection of Art and Design education, interactive media, and educational accessibility, with a particular focus on Hypertext video learning environments. This research culminated in the development of HyperLearnX, an AI-supported interactive learning platform designed to enhance visual studies education in low-bandwidth and marginalised learning contexts. The platform has been officially registered with the Intellectual Property Corporation of Malaysia (MyIPO).

In addition to scholarly publications, the author has actively participated in academic conferences, international competitions, online seminars, and university-based workshops related to education, innovation, research skills, and academic writing. She has also contributed to various volunteer and community-oriented academic events, reflecting sustained engagement with both academic and social impact initiatives within the university environment.

LIST OF PUBLICATIONS

A. Published Journal Articles

- Alshabi, E. M. K. A. (2025). Enhancing visual studies education through hypertext-based interactive video: Insights from developing regions. *Malaysian Journal of Social Sciences and Humanities*, 10(12). <https://doi.org/10.47405/mjssh.v10i12.3709>
- Alshabi, E. M. K. A. (2025). Hypertext video for visual studies in developing contexts. *Journal of Creative Arts*, 2(2). <https://doi.org/10.24191/jca.v2i2.9122>

B. Manuscript Under Review

- Alshabi, E. M. K. A. (2026). Aesthetic and accessible: Designing hypertext video for inclusive art and design education. Manuscript under review at *International Journal of Art & Design*.

C. Other Research Outputs

- HyperLearnX: Adaptive Hypertext Video for Low-Bandwidth Education. Copyright Registration No. CRLY2025W07058. Intellectual Property Corporation of Malaysia (MyIPO), 8 August 2025.
- HyperLearnX: Adaptive Hypertext Video for Inclusive Visual Learning. **Silver Award**, BAHTERA 2025 Innovation Competition, Universiti Teknologi MARA, Shah Alam, Malaysia, 15 October 2025.