



CHALMERS
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Design principles to facilitate e-learning

And their application to promote social value creation in residential development

Master's thesis in Learning and Leadership

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Abstract

This thesis establishes an evidence-based framework of design principles to optimize asynchronous e-learning. The framework was applied to a digital course raising awareness of social value creation within residential development. A systematic literature review was conducted and supplemented by multimedia learning theories. A manual thematic analysis of this literature resulted in a comprehensive framework of 36 design principles organized into five themes: Navigation, Content Structure, Content Representation, Exercises, and Feedback. Two qualitative interviews were conducted with residential developers to calibrate the illustrations of the course to industry-specific expectations. The empirical results revealed a strong participant preference for watercolor illustration style and photorealism over low-detailed silhouettes. Choosing watercolor illustrations represents a critical compromise between established multimedia learning theory that advocates schematic visuals, emotional design that highlights the importance of color and the professionals' expectations of high-quality visualizations. The synthesized framework and visual strategies were implemented to develop a prototype e-learning course. Evaluation from the client validated the course's instructional clarity, intuitive navigation, and psychological alignment with neuroarchitecture concepts. However, the implementation process exposed technical limitations imposed by developing within Microsoft PowerPoint, which lacks the capacity for assessment data collection and solutions for high-engagement interactivity. Consequently, this study concludes that while slide-based platforms can deliver functional e-learning, future development might require migrating to a dedicated Learning Management System (LMS). The integration of audio narration would support learning further utilizing both visual and auditory channels. This thesis aims to bridge the gap between cognitive multimedia theory and industry-specific cultures, providing a foundation for future empirical research into the boundary conditions of emotional design in professional education.

Keywords: E-LEARNING, DESIGN PRINCIPLES, MULTIMEDIA LEARNING, SOCIAL SUSTAINABILITY, SOCIAL VALUE CREATION

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Denice Ivarsson, Gothenburg, May 2026

Contents

- 1. Introduction 10
 - 1.1. Background 10
 - 1.2. Aim..... 10
 - 1.3. Specification of the issue being investigated 11
 - 1.4. Limitations..... 11
 - 1.5. Additional background information 13
 - 1.6. Societal and ethical aspects 14
 - 1.7. AI disclaimer 14
- 2. Methodology 15
 - 2.1. Literature review of design principles 15
 - 2.2. Interviews 17
 - 2.3. Compiling the e-learning content 18
- 3. Results 19
 - 3.1. Results from the literature review 19
 - 3.2. Results from the interviews 31
 - 3.3. Results from compiling the e-learning content 33
- 4. Design discussion 34
 - 4.1. Implementation of the design principles 34
 - 4.2. Input from the client 41
 - 4.3. Future development 42
 - 4.4. Reflection 43
 - 4.5. Conclusion..... 44
 - 4.6. Implications for future research 44
- 5. References 45

1. Introduction

This chapter establishes the context and motivation of the thesis project. It also outlines the specific research issues, acknowledges the boundaries of the study and addresses relevant societal and ethical dimensions.

1.1. Background

The construction industry is undergoing a significant transition toward sustainable practices. Focus is often disproportionately directed toward economic and ecological dimensions resulting in less consideration to the social aspects of sustainability. This discrepancy frequently arises because social value creation is traditionally associated with ‘soft’ values that lack standardized metrics or direct cost associations, making it difficult to argue for investment in these areas when awareness within the sector remains low.

The idea behind this thesis originates from a previous collaboration with Christina Ingelsten, head of sustainability at a major development and construction company with extensive operational experience in leading social value creation and social innovation in residential development. She has a history of research involvement and is currently, beside her employment, the main team leader of a research partnership called Framework for Enriching Design in urban living environments.

Though it is widely known that the physical environment has a profound impact on our health and wellbeing, awareness regarding specific solutions and how they affect us remains low. Hence, developing residential spaces that actively promote social sustainability requires increased awareness and knowledge among industry stakeholders.

To address this gap, Ingelsten, i.e. the client of this thesis, has identified a need for educational interventions. The underlying premise is that by educating residential developers on social sustainability and social value creation, a broader knowledge platform is established. This, in turn, allows for more informed reasoning and decision-making during the development process.

1.2. Aim

The ambition of this thesis is to investigate how to design digital educational material according to research and to create an online course in line with the findings. This course is intended to support learning among residential developers about social value creation. The scope of the project encompasses both the curation of the educational content and the didactical composition of the learning material.

To be able to create efficient e-learning for the construction sector, general design principles for digital learning, such as segmenting and emotional design, as well as specific design principles related to visual content are mapped out by performing a review of relevant literature. In addition, to further customize the learning material for the target group, different types of illustrations and ways to implement them are looked into further by interviewing actors from the industry.

The learning material intends to function as a foundation of knowledge, to increase awareness about, and broaden the meaning of, social sustainability and social value creation among residential developers, the main target group.

1.3. Specification of the issue being investigated

This thesis mainly addresses the following questions:

1. What general design principles are associated with high quality e-learning according to literature?
2. What design principles can be linked to illustrations in e-learning contexts according to literature?
3. What are the thoughts among residential developers regarding the use of illustrations in e-learning?

Additional questions:

4. What design principles can be implemented using Microsoft PowerPoint as a learning platform?
5. What future improvements can be suggested for the e-learning developed as part of this thesis?

1.4. Limitations

To ensure a transparent evaluation of the research findings, it is necessary to define the constraints encountered during the project. This section covers the practical, technological, and temporal limitations that shaped the scope of the study.

1.4.1 Few respondents

The small sample size of two interview respondents presents a methodological constraint regarding reliability and generalizability, and this limitation needs to be communicated transparently. To conduct more interviews would have been preferable but given the project's temporal constraints, prioritizing a small, focused sample was an intentional choice.

1.4.2. The choice of software

A significant constraint of this study stems from the requirement to develop the e-learning material within the Microsoft Office suite, and PowerPoint was considered to be the most suitable platform. PowerPoint has limitations regarding user interactivity and data tracking. It lacks the capability to execute interactions of higher complexity, such as drag-and-drop mechanisms or sorting tasks, which are important for generative learning to take place.

Furthermore, PowerPoint's slide-based framework does not support the collection of assessment data or user tracking. Because it cannot track which specific assets or modules have been processed by the learner, it is also unable to adapt progress indicators if a learner chooses to diverge from the course's intended linear path. These structural limitations restrict the tool to a rigid format, preventing the implementation of formative assessment strategies, passive course evaluations and adaptive, self-regulated learning pathways.

1.4.3. Level of difficulty

The learning material has been presented to the client, and it was very well received. However, it has not yet been reviewed or tested within the target group, hence there is no empirical data to determine whether the difficulty and depth of the content accurately align with the prior knowledge and professional expertise of the learners.

1.4.4. No audio narration

Accessibility is a key ethical component of instructional design. Because temporal constraints prevented the inclusion of audio narration, the current iteration of the course relies heavily on visual text. Acknowledging this as a current limitation is essential, and future developments should consider incorporating audio options to ensure the learning material is inclusive and accessible to individuals with varying learning preferences or visual impairments.

1.4.5. Excluded design principles

Several design principles and aspects such as cognitive effects identified during the review of literature were intentionally excluded from the framework presented in the results chapter. This was mainly due to the scope, technological and temporal constraints of the thesis project. Collaborative and social strategies, such as peer-to-peer learning, virtual networks and synchronous discussion elements, were excluded because of the course's asynchronous environment.

Furthermore, practical limitations within the project timeline and the chosen software prevented the realization of technically demanding features such as gamification, on-screen pedagogical agents, upfront preparatory needs assessments, and dedicated learning support infrastructures.

Finally, a subset of specific Cognitive Load Theory concepts, including the goal-free, imagination, expertise reversal, and element interactivity effects were deemed outside the immediate scope of this thesis. The complete list of excluded aspects is presented below.

1. Preparatory activity to determine learners' needs.
2. Grant access to learning support.
3. The goal-free effect.
4. The imagination effect.
5. The expertise reversal effect.
6. The element interactivity effect.
7. The use of synchronous interactions for discussion and deepening of the content.
8. Peer-to-peer learning.
9. Virtual networks.
10. On-screen agents that serve a relevant instructional purpose such as directing attention or providing feedback.
11. Gamification.

1.5. Additional background information

This section provides context and defines the core concepts of social sustainability and social value creation. Additionally, it highlights the unique role of visual communication within the construction sector and explains the choice of format for the learning material.

1.5.1. Defining social sustainability and social value creation

An initial task has involved defining social sustainability and social value creation within residential development. The definitions used in the context of this thesis are presented below and they are based on definitions from the following sources (FN, 2008; Folkhälsomyndigheten, 2026; Skanska, 2026; FN, 2022; Brundtland, 1987):

Residential development contributes to social sustainability through social value creation. This involves designing living environments where every individual is granted the same right to feel included, free, and secure, as well as a sense of belonging.

These environments should be designed to promote health, well-being, and personal development. To achieve this, spaces and places for community, rest, and cultural experiences are essential.

If social sustainability is our goal, encompassing aspects like equality and good health, then social value creation represents the concrete solutions that lead us there, such as green courtyards and meeting places.

1.5.2. The importance of visual material in the construction sector

Within the construction sector, drawings, renderings, and other forms of visual information are fundamental to communication (Ferguson, 1977). Illustrations are critical when communicating complex concepts that are difficult to articulate through text alone. They serve as the primary tool when translating a project from an abstract idea to a finished project.

In addition, established learning theories such as the Dual Coding Theory and the Cognitive Theory of Multimedia Learning suggest that the strategic use of illustrations in educational materials significantly enhances learning (Clark & Mayer, 2023; Clark & Paivio, 1971). Reflecting the industry's dependence on visual communication, this thesis explores the selection and implementation of illustrations in learning material.

1.5.3. The format of the learning material

The main format chosen for the educational material is asynchronous e-learning, accompanied by lecture slides to make blended learning possible. E-learning refers to the delivery of education and through digital technologies, typically utilizing the internet to enable remote and flexible learning (Clark & Mayer, 2023). Asynchronous e-learning is defined as self-paced instruction delivered via digital devices to support work-relevant knowledge and skills (Clark & Mayer, 2023).

This choice of format was driven by the flexibility and scalability of e-learning. In the context of the construction industry, where professionals often manage demanding schedules, e-learning offers a consistent and convenient environment that can be tailored to individual

needs. Furthermore, research indicates that online learning environments can be as effective as traditional classrooms, given the instruction is well-designed (Clark & Mayer, 2023).

Despite the potential of this format, evidence suggests a gap between qualitative instruction described in literature and the instruction given in many online courses (Margaryan et al., 2015). E-learning frequently scores poorly on core instructional design principles. Studies have shown that critical elements such as the use of authentic material, work-related exercises and feedback are rarely applied (Oh et al., 2020).

This thesis seeks to avoid the common pitfall where digital learning materials function well, technology-wise, but are pedagogically hollow. The efficacy of e-learning depends less on the delivery medium itself and more on the strategic integration of multimedia elements and instructional methods (Clark & Mayer, 2023). By anchoring the development of the learning material in evidence-based design principles, this thesis aims to ensure that the instruction is not merely accessible but utilizes learning theories to support increased professional knowledge regarding social value creation.

1.6. Societal and ethical aspects

Because the instructional material developed in this project addresses social value creation, social dimensions are woven into the entire research process. The ambition of this work is to educate residential developers, encouraging them to prioritize aspects like physical activity, community, and urban greenery in future housing projects. By increasing awareness of social value creation and social sustainability, the indoor and outdoor spaces shaped by new residential developments can more effectively contribute to long-term safety, wellbeing, and health of the residents. To support this objective, the core content and its visual delivery were designed using an evidence-based approach, ensuring that the educational tool relies on validated learning theory.

Ethical considerations were maintained throughout the empirical phase of this study, during the planning and execution of the qualitative interviews. Prior to engaging in the study, all respondents were provided with an overview of the project's purpose and nature of the data collected. Empirical data was only gathered from participants who provided their consent. All personal data was handled in accordance with GDPR to guarantee participant anonymity.

The creation of the e-learning material also involved ethical considerations. While generative AI imagery served as an efficient placeholder for this initial iteration, future versions of the course would benefit from replacing these elements with illustrations from professional artists. This transition eliminates the copyright and ownership uncertainties inherent to generative AI.

1.7. AI disclaimer

As part of this thesis, AI has been used to:

- Generate illustrations used in the e-learning course.
- Translate interviews.
- Check for grammatical errors and elevate texts.

2. Methodology

This chapter outlines the research design and empirical methods utilized to establish the e-learning framework and develop the resulting educational material. A dual-method approach was employed to ensure both theoretical robustness and industry relevance. The process consists of three main phases: a systematic literature review to identify core multimedia design principles, qualitative semi-structured interviews with industry professionals to guide visual adaptation, and compilation of the e-learning course content.

2.1. Literature review of design principles

To build an evidence-based foundation for the e-learning design principles, a systematic literature review was conducted. This approach was applied to identify, evaluate and synthesize existing research regarding instructional design and learning theories in digital environments.

2.1.1. Search strategy

The primary search was conducted using Scopus, selected for its intuitive search tool that helps users to build their search strings. The search strategy was divided into two distinct phases to cover broad pedagogical frameworks as well as specific principles regarding visual media and cognitive load.

While no specific date filters were applied during the search phase, the resulting literature reviewed for this study spans from 2002 to 2024, representing two decades of digital instruction.

2.1.2. Search 1 – general design principles

The first search targeted foundational pedagogical structures for e-learning. To ensure the results focused on general instructional design rather than media-specific elements, the term "multimedia" was explicitly excluded, as it was the primary focus of the second search. Immersive technologies (VR/AR) were also excluded to maintain focus on standard digital devices such as computers or tablets. This search gave 622 results using the following Boolean string:

“design principl” OR “pedagogical principl*”* AND e-learning OR “computer-based learning” OR “computer-based instruction” AND NOT VR OR “virtual reality” OR “augmented reality” AND NOT multimedia

2.1.3. Search 2 – media and visual representation

The second search was designed to identify principles specifically linked to the use of illustrations, dual coding, and cognitive processing. By separating this from the first search, the results provided a deeper look into the cognitive science of visual learning without overlapping with general pedagogical hits. This search gave 301 results:

“multimedia learning” OR “dual coding” AND e-learning OR digital* OR electronic OR computer* OR online* AND graphic OR pictur* OR illustrat* OR image* OR visual* AND cogniti* AND NOT VR OR “virtual reality” OR “augmented reality” AND NOT child*

2.1.4. Screening

Due to the high volume of initial results, a citation-weighted screening process was utilized to ensure the inclusion of scientifically validated and influential studies. The results from both searches were sorted by the number of citations, and the top 50 publications from each (100 total) were selected for further screening. It is important to be aware that sorting by the number of citations involves some risks:

- Recently published, high-quality research that has not yet accumulated citations are excluded automatically.
- Heavily cited papers gain more visibility and thus more citations, regardless of their ongoing accuracy or relevance
- This metric cannot distinguish a publication cited for its groundbreaking methodology from one cited frequently to be critiqued or controversial.

The following inclusion and exclusion criteria were then applied:

Inclusion: Peer-reviewed articles or book chapters written in English; studies focusing on adult learners or generalizable instructional frameworks.

Exclusion: Literature focusing on highly specialized niches, e.g., medical procedures, primary school mathematics, or tools specifically for dyslexia, was filtered out to ensure the principles remained applicable to the broader professional context of residential development.

2.1.5. Supplemental literature

During the review, it became evident that Richard E. Mayer made substantial and recurring contributions to the identified literature. To obtain a comprehensive picture of his research on the cognitive theory of multimedia learning, the 5th edition of *e-Learning and the Science of Instruction* (Clark & Mayer, 2023) was included as a primary supplemental source.

2.1.6. Data extraction and analysis

The analysis of the selected literature was conducted through a manual extraction process. Each publication was reviewed in detail, with relevant instructional principles and experimental findings highlighted and extracted.

This data was then synthesized using a thematic analysis approach. Individual principles, such as segmenting and personalization, were identified and grouped based on their instructional function. This process resulted in the formulation of five themes: navigation, content structure, content representation, exercises, and feedback. These themes and their related design principles then functioned as a structural framework for the design of the social sustainability e-learning course.

2.2. Interviews

While the systematic literature review established a generalized framework for effective e-learning design, instruction should also be calibrated to the specific cultural and professional context of the target audience. In the building sector, professionals are accustomed to high visual communication standards.

To try and bridge the gap between general cognitive principles and the unique expectations of this industry, complementary qualitative data collection was conducted. This phase focused specifically on adapting the illustration styles of the visual elements in the course, to ensure they aligned with the preferences of the target group.

To achieve this, semi-structured interviews were conducted with two residential developers. The interviews were recorded and transcribed using Microsoft Word. The sessions were centered around the pre-defined discussion guide below, consisting of comparative visual stimuli categorized as options A–D for content layout and E–H for illustration technique.

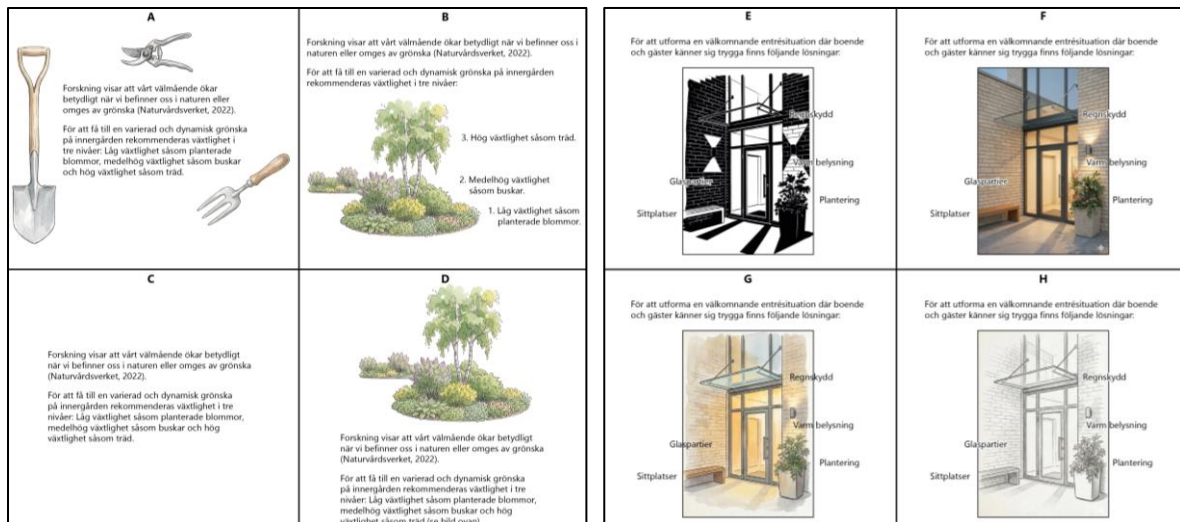


Figure 1. Discussion guide

Interview questions:

1. Which option A-D makes it easiest for you to take in the content?
2. Why do you think that is?
3. Which type of illustration E-H do you find most appealing?
4. Why?
5. Which type of illustration E-H feels most appropriate for educational purposes?
6. Why?

This interview guide is an attempt to balance theoretical validation with industry-specific exploration. The first two questions are designed to investigate whether the empirical preferences of professionals within the building sector correspond with established cognitive learning frameworks, such as the Dual Coding Theory and the Cognitive Theory of Multimedia Learning (Clark & Mayer, 2023; Clark & Paivio, 1971).

Conversely, the four following questions are exploratory, aimed at contributing new insights to the intersection of instructional design and industry-specific aesthetics. Four distinct visualization techniques are evaluated; black and white silhouettes, greyscale sketches, watercolor paintings and photorealistic visualizations.

2.3. Compiling the e-learning content

The content of the learning material was mapped out by compiling and analyzing three recent research projects about social sustainability and social value creation. An inductive thematic

analysis of the project reports was conducted by identifying all indicators linked to social sustainability that occur in the material, and by labeling these indicators based on their prevalence.

A latent approach was used when labeling the indicators, considering the underlying meaning of the concepts rather than searching for key words. The labels used for this purpose were ‘occurs in 3/3’, ‘occurs in 2/3’ or ‘occurs in 1/3’ of the three project reports analyzed. This distinction offers valuable information that indicates how prominent the different indicators should be in the learning material.

The following sections provide brief descriptions of the three research projects that the learning material is based on. Together, they form a solid knowledge base to define and practice social value creation within residential development.

2.3.1. Sociala värden hela vägen

The research project ‘Sociala värden hela vägen’ (Social Values All the Way) was carried out between 2021 and 2024 through a collaboration between Tyréns, Lund Municipality, and Skanska, with funding from Vinnova. The primary purpose of the project was to create a systematic and common framework for understanding, analyzing, and following up on social sustainability in the physical environment throughout the planning and building process (Vinnova, 2024). This initiative addressed a significant industry need for clarity regarding how the physical environment contributes to social value and which interventions should be prioritized.

The project resulted in a framework that categorizes social values into three core areas to facilitate a more nuanced analysis of how design affects wellbeing:

1. The physical environment should be healthy, functional, and stimulating.
2. People.
3. Interaction.

For this thesis, the project is highly relevant as it provides a structured methodology to categorize and organize the learning content, ensuring that the educational material is anchored in a systematic approach to social sustainability.

2.3.2. Framework for Enriching Design of Living Environments (FED)

The ‘Framework for Enriching Design of Living Environments’ (FED) project was a multidisciplinary collaboration involving Chalmers University of Technology, the Swedish University of Agricultural Sciences (SLU), Sahlgremska Academy, and local partners like Härryda Municipality (Swecris, 2023). The project aims to explore design qualities in living environments that contribute to health and wellbeing, specifically the theory of ‘enriched environments’. This theory suggests that physical, social, and cognitive stimulation from the surrounding environment can positively influence brain function and overall health.

The goal of the FED project is to develop guidelines, principles, and indicators across various scales, from individual residences to neighborhoods, for design that promotes health. This project is useful in the context of this thesis because it provides a theoretical link between

architectural design and our wellbeing. By integrating FED's principles, the learning material can move beyond abstract 'soft' values to concrete, evidence-based indicators for how specific design choices enrich the lives of residents.

2.3.3. Uppföljning av Brf Viva

'Uppföljning av Brf Viva' (Follow-up of Brf Viva) consists of a series of studies conducted by the Center for Housing Architecture (CBA) at Chalmers University of Technology in collaboration with Riksbyggen (Braide et al., 2024). These studies, presented in reports from 2021 and 2024, investigate how the physical environment of the Brf Viva housing project in Gothenburg contributes to social sustainability and a sustainable lifestyle. Brf Viva serves as a 'knowledge laboratory' where innovative design solutions such as shared social spaces, flexible apartment floor plans, and integrated mobility services, are tested and evaluated by the residents themselves.

The findings from these follow-ups provide empirical evidence regarding which design elements successfully foster social interaction, safety, and resident wellbeing. For the educational material developed in this thesis, these reports provide authentic examples and 'lessons learned' from a large development project. They offer both theoretical frameworks and practical applications, by illustrating the effects of specific social sustainability concepts in a finished residential environment.

3. Results

This chapter presents the empirical outcomes generated throughout the research process. The findings are structured to mirror the chronological phases of the methodology. First, it introduces the comprehensive framework of design principles synthesized from the literature review. Second, it delivers the insights gathered from the qualitative interviews regarding industry visual preferences. Finally, it provides a representative excerpt from the compiled course content.

3.1. Results from the literature review

Based on the literature review, a framework of 36 design principles was established and organized into five core categories; Navigation (table 1), Content Structure (table 2), Content Representation (table 3), Exercises (table 4) and Feedback (table 5).

By systematically applying these evidence-based design principles to digital learning environments, a wide range of positive outcomes can be achieved. The framework establishes instructional structure that makes digital material intuitive to use, thereby reducing uncertainty for the learner. This foundation enhances accessibility and offers instructional clarity, allowing for a rich variation of learning elements while preventing cognitive overload.

It also facilitates interactivity and grants the learner autonomy over their instructional path. A learner-centered environment elicits positive emotions, sustains motivation and engagement. By working with these principles, the overall effectiveness of the e-learning experience can be improved. The framework is presented as five tables in the following pages.

3.1.1. Navigation

Table 1. Design principles related to navigation

Navigation			
Introduction			References
<p>Navigation in e-learning is more than a functional utility for moving between screens, it is a critical instructional component that has a direct impact on the learner's cognitive and emotional journey. Effective navigation is designed to minimize extraneous cognitive load and provides the scaffolding required for learners to manage their own progress.</p> <p>When the navigational structure is intuitive and reliable, it prevents negative emotional states such as frustration and uncertainty, and provides a sense of security necessary for engagement. Beyond usability, navigation serves as a vital pedagogical roadmap that helps learners construct a mental model of the course structure.</p>			<p>(Clark & Mayer, 2023; Kim & Frick, 2011; Moon et al., 2005; Mulqueeny et al., 2015; Plass & Kaplan, 2015; Reilly & Reeves, 2024; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)</p>
Number	Design Principle	Short Description	References
1	Start page	<p>The start page serves as the initial gateway to the learning experience, providing an obvious and intuitive entry point. Beyond mere access, it establishes the necessary context for the learner by presenting a clear course overview, defined learning objectives, and the underlying purpose of the instruction.</p> <p>This initial orientation is critical for reducing uncertainty. By clearly outlining what is to be achieved and why the content is relevant, the start page helps prime the learner's motivation and sets the stage for the structural sequence of the course.</p>	(Stiwinter, 2013)
2	Topic menus	<p>Effective navigation relies on navigational roadmaps, such as topic menus, that graphically represent the relationship between different modules. These elements act as a digital syllabus, providing 'landmarks' that orient the learner by clarifying where they have been, where they currently are, and what remains to be covered.</p> <p>Milestones further ensure a seamless transition between modules. By indicating the next steps at the conclusion of each segment, the design prevents the disorientation that often occurs when a learner reaches the end of a module and is unsure how to proceed.</p>	(Clark & Mayer, 2023; Stiwinter, 2013; Theelan & van Breukelen, 2022)
3	Movement buttons	<p>Standard movement buttons, including forward, backward, link to course overview, play, pause, and exit options, are fundamental tools for interactivity and engagement. Providing consistent controls, particularly for revisiting previous material, allows learners to manage their interaction with the content without technical frustration.</p> <p>To maintain high usability, these elements should be easily accessible throughout the course. In courses utilizing scrolling pages, placing navigation at both the top and bottom of the screen prevents unnecessary scrolling, thereby reducing extraneous cognitive processing that is unrelated to the actual learning goal.</p>	(Clark & Mayer, 2023; Mulqueeny et al., 2015; Stiwinter, 2013)

Number	Design Principle	Short Description	References
4	Headers	<p>Headers, headings and introductory statements function as structural cues to the organization of the content and highlights the hierarchy of information.</p> <p>These textual signals improve comprehension by directing attention to the most important elements of a screen. This reduction in the effort required to decipher the content's structure frees up working memory capacity for the deeper processing required to assimilate the material.</p>	(Clark & Mayer, 2023)
5	Self-explanatory in nature	<p>Asynchronous e-learning environments require a design that is intuitive and self-explanatory, as learners typically lack immediate access to an instructor. This is achieved by a clear interface design and consistent logic so that the navigation feels like an integrated part of the learning rather than a separate hurdle.</p> <p>Scaffolding the interface in this way allows the learner to direct their focus on the content. When the navigation is intuitive, the learner's self-efficacy and satisfaction increase.</p>	(Moon et al., 2005; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)
6	Progress indicator	<p>A progress indicator, such as a visual bar or a numerical 'Page X/Y' counter, provides essential feedback regarding the learner's journey. By clearly showing how much of the lesson has been completed and how far the learner has to go, these indicators help learners manage their time and mental effort.</p> <p>This transparency reduces uncertainty in digital environments. Seeing tangible evidence of progress acts as a motivational booster, reinforcing the learner's sense of accomplishment as they move toward completion.</p>	(Clark & Mayer, 2023; Mulqueeny et al., 2015; Stiwinter, 2013)
7	Learner controlled pace	<p>Pacing control allows learners to progress through instructional segments at their own rate, which is particularly vital when dealing with complex material. By providing the ability to pause, replay audio or video, and spend more time on specific screens, the design accommodates individual processing speeds and prevents information from disappearing before it can be fully processed.</p> <p>This autonomy ensures that the flow of information matches the learner's cognitive capacity, leading to better comprehension and a more positive emotional experience.</p>	(Clark & Mayer, 2023; Stiwinter, 2013; Theelan & van Breukelen, 2022)
8	Set vs free order of content	<p>The decision between a set (linear) or free (flexible) order of content depends largely on the learner's prior knowledge. For novices, linear sequencing is often superior because it prevents the cognitive load of making sequencing decisions and ensures prerequisite information is handled first. Research suggests that when beginners are given too much control over the order, they may skip critical instructional events.</p> <p>In contrast, experienced learners benefit from greater control and autonomy. For these users, the ability to select and sequence topics based on their existing needs increases motivation and engagement.</p> <p>A balanced design often makes the primary instructional path the default while providing flexible routes or optional enrichment materials for more advanced learners.</p>	(Clark & Mayer, 2023; Plass & Kaplan, 2015; Reilly & Reeves, 2024; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)

3.1.2. Content structure

Table 2. Design principles related to content structure

Content Structure			
Introduction			References
<p>This theme focuses on the deliberate arrangement of instructional elements to facilitate learning. The structure of e-learning content serves as the invisible architecture of the learning experience, determining how effectively a learner can absorb, process, and retain new information.</p> <p>Rooted in Cognitive Load Theory, a well-designed structure recognizes the limitations of our working memory, which can only hold a few pieces of information for a short duration. By strategically organizing material into logical segments ensuring a coherent flow, the design shifts the learner's effort away from navigating a chaotic layout and toward the learning process. Ultimately, a disciplined approach to structure ensures that every element on the screen serves a specific instructional purpose.</p>			<p>(Chen et al., 2017; Clark & Mayer, 2023; Gellevij et al., 2002; Hussin et al., 2009; Lin et al., 2016; Moon et al., 2005; Mulqueeny et al., 2015; Plass & Kaplan, 2015; Reilly & Reeves, 2024; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)</p>
Number	Design Principle	Short Description	References
9	User interface	<p>The user interface (UI) bridges the gap between instructional content and the learner's perception. Beyond usability, a sophisticated interface utilizes creative design to weave course material into a cohesive narrative structure. By organizing content around a storyline, the UI provides a consistent logic that guides the learner through the intended sequence. This structural clarity ensures that the visual presentation supports, rather than distracts from, the achievement of learning objectives.</p> <p>The effectiveness of a UI is deeply tied to the Emotional Design Principle, which suggests that 'what is beautiful is good'. Aesthetically pleasing layouts induce positive affect, which in turn facilitates comprehension and the transfer of knowledge. Consequently, an interface that is both visually attractive and intuitively structured primes the learner's cognitive system.</p>	<p>(Hussin et al., 2009; Plass & Kaplan, 2015; Reilly & Reeves, 2024; Stiwinter, 2013)</p>
10	Introductions	<p>Introductions to courses, modules, and chapters function as the foundation for the Pretraining Principle. By presenting key concepts, names, and characteristics before the main lesson tasks begin, the design allows learners and particularly novices to do some of the mental processing in advance. This ensures that when the learner reaches more complex material, their cognitive system is not overwhelmed by trying to learn both the basic components and the broader process simultaneously.</p> <p>Furthermore, introductions serve a motivational purpose by activating prior knowledge. Providing a clear course overview and learning objectives helps the learner understand the big picture.</p>	<p>(Chen et al., 2017; Clark & Mayer, 2023; Reilly & Reeves, 2024)</p>

Number	Design Principle	Short Description	References
11	Segment	<p>Segmenting, also known as chunking, involves breaking down complex instruction into smaller bits or segments. This principle addresses the limited capacity of human working memory by ensuring that learners are not forced to process too much information at once.</p> <p>In practice, this may involve using slide overlays to progressively add content or breaking a long video into shorter modules. By dividing the content into manageable units, the design allows learners to process one idea before moving to the next.</p>	(Clark & Mayer, 2023; Moon et al., 2005; Mulqueeny et al., 2015; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)
12	Even distribution	<p>Effective course structure requires an even distribution of various content types, such as instructional text, visuals, and exercises, throughout the learning event. Practice should be scheduled periodically rather than concentrated at the end of a lesson. This approach encourages learners to continuously reorganize and integrate new information into their existing knowledge base.</p> <p>By alternating between information delivery and engagement activities, the design maintains a high level of engagement. Grouping related items together in a way that makes sense regarding space, time, and concept ensures that the transitions between learning and doing are smooth, which helps to maintain the learner's focus.</p>	(Clark & Mayer, 2023; Stiwinter, 2013)
13	Screen disposition	<p>Screen disposition refers to the strategic arrangement of elements to ensure that all information necessary for a specific learning task fits on the screen without the need for scrolling. This is closely related to the Contiguity Principle, which states that learning is more effective when corresponding words and graphics are placed near each other. If a learner must scroll or flip between screens to match a text description with a graphic, they are forced to engage in split attention, which wastes valuable cognitive capacity.</p> <p>Proper disposition also ensures that interactive content is not presented as audio alone. By maintaining critical information, like exercise directions, as on-screen text, the design allows learners to refer back to it as needed, ensuring they have all the tools visible to complete the task at hand.</p>	(Chen et al., 2017; Clark & Mayer, 2023)
14	External links	<p>In a well-structured e-learning course, links that take the learner off the main teaching screen are avoided or used with caution. Links signal to the user that the information is adjunct or peripheral to the main content. Navigating away from the primary instructional environment can disrupt the learning flow by breaking the narrative structure of the lesson.</p> <p>When links are necessary, they should be clearly annotated to provide a preview of their content. This allows learners to make an informed decision about whether the external information is relevant to their learning goals.</p>	(Clark & Mayer, 2023; Theelan & van Breukelen, 2022)

3.1.3. Content representation

Table 3. Design principles related to content representation

Content Representation			
Introduction			References
<p>This theme is rooted in the theory of dual coding, which recognizes that the human mind processes information through two separate channels, one for auditory/verbal material and another for visual/pictorial material. By combining these channels through the Multimedia Principle, using both words and graphics together, designers can help learners build more robust mental models than they could from text alone.</p> <p>The goal here is to balance instructional clarity with psychological engagement. This involves eliminating extraneous noise to preserve cognitive resources for essential learning. Through the use of signaling, spatial contiguity, and emotional design, the presentation of content is transformed from plain to dynamic. Whether utilizing static illustrations, conversational text, or video demonstrations, every representational choice is designed to direct the learner's attention toward relevant information.</p>			<p>(Brünken et al., 2002; Chen & Sun, 2012; Chen et al., 2017; Clark & Mayer, 2023; Gellevij et al., 2002; Hussin et al., 2009; Kartal, 2010; Kim & Frick, 2011; Lin et al., 2016; Mayer, 2017; Mulqueeny et al., 2015; Narciss, 2008; Noh et al., 2014; Oh et al., 2020; Plass & Kaplan, 2015; Sinclair et al., 2017; Sorden, 2005; Stiwinter, 2013; Sung & Mayer, 2012; Theelan & van Breukelen, 2022)</p>
Number	Design Principle	Short Description	References
15	Relevance	<p>The principle of relevance is grounded in the Coherence Principle, which suggests that less is often more in instructional design. A simple summary often outperforms a longer, more cluttered version of the same instruction.</p> <p>Learning is significantly hindered when extraneous information, such as 'seductive details' (interesting but irrelevant stories or graphics), decorative images, or lengthy, redundant text, is included. These additions distract the learner and disrupt the mental organization of relevant material. By minimizing content to only what is essential for the instructional goal, the design reduces the cognitive cost associated with processing noise.</p>	<p>(Chen et al., 2017; Clark & Mayer, 2023; Hussin et al., 2009; Kim & Frick, 2011; Mulqueeny et al., 2015; Stiwinter, 2013; Theelan & van Breukelen, 2022)</p>
16	Authenticity	<p>Authenticity refers to the alignment between e-learning content and real-world application. According to the Authentic Learning Continuum, instruction is most effective when it incorporates information from actual projects, workplace problems, and relatable situations.</p> <p>By simulating real-world scenarios, the design helps learners recognize the immediate utility of the information, which increases motivation and facilitates the transfer of knowledge to professional practice.</p>	<p>(Kim & Frick, 2011; Stiwinter, 2013; Theelan & van Breukelen, 2022)</p>

Number	Design Principle	Short Description	References
17	Proper level	<p>To be effective, content must be presented at a proper difficulty level, matching their current expertise. Complex material should initially be broken down into isolated components before presenting detailed information.</p> <p>Conversely, designers must be wary of the reversed effect where instructional supports that help beginners (such as worked examples) become redundant and actually hinder the performance of more advanced learners.</p>	(Clark & Mayer, 2023; Kim & Frick, 2011; Narciss, 2008)
18	Guide attention by signaling	<p>The Signaling Principle states that learning is enhanced when cues direct attention to important content, thereby reducing the mental effort required to identify relevant information. Signaling can be achieved through several methods:</p> <p>Textual Cues: Using outlines, headings, bolding, italics, and paragraph headers to signal the structural hierarchy.</p> <p>Visual Cues: Employing arrows, pointers, spotlighting, outlines or coordinated colors to link text to specific portions of a graphic.</p> <p>Verbal Cues: Adding explicit on-screen text or audio directions telling learners exactly where to look.</p> <p>Audio Cues: Using changes in intonation or emphasis in narration to highlight key terms.</p>	(Clark & Mayer, 2023; Gellevij et al., 2002; Lin et al., 2016; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)
19	Text	<p>Text is a fundamental medium for instruction to give directions and communicate goals, but its effectiveness depends on how it is written and where it is placed.</p> <p>Minimize text where possible, especially when used alongside graphics. For complex situations, directions for exercises should remain on-screen as text to allow learners to refer back to them over time without relying on their memory.</p> <p>Text should be placed in close physical proximity to the graphic it describes. Place labels near the relevant parts of a diagram, rather than using a legend or caption at the bottom of the screen. This ensures the learner does not waste cognitive resources searching for the connection between words and images.</p> <p>According to the Personalization Principle, people learn better when the language is conversational, polite, and friendly rather than formal. Using first- and second-person language (I, you, we) creates a sense of social presence. This feeling of being in a conversation improves engagement and primes the learner to work harder to understand.</p>	(Clark & Mayer, 2023; Kartal, 2010; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)

Number	Design Principle	Short Description	References
20	Static illustrations	<p>Static graphics, such as drawings, diagrams, and photos, are essential for the Multimedia Principle, which posits that people learn better from words and graphics than from words alone.</p> <p>Graphics should never be an afterthought, they must be relevant to the goal to avoid the problem where decorative graphics improve satisfaction but fail to improve learning. The design of a graphic should match the instructional goal. Simple visuals, such as two-dimensional line drawings, are often more effective than photographs or 3D animations for explaining processes because they contain fewer distracting details.</p>	(Clark & Mayer, 2023; Gellevij et al., 2002; Mayer, 2017; Sorden, 2005; Sung & Mayer, 2012)
21	Emotional design	<p>Emotional Design involves incorporating features that induce positive emotions to facilitate learning. Research suggests that using warm colors (like orange and yellow) and adding human-like features (such as eyes or facial expressions) to essential on-screen objects can improve comprehension. Rounder shapes are often perceived as more safe and less threatening than sharp-edged graphics, helping to reduce learner anxiety and increase hope and enjoyment.</p> <p>Ultimately, these design choices help regulate the learner's emotional experience throughout the course, ensuring that mental resources are directed toward sense-making rather than managing psychological discomfort.</p>	(Clark & Mayer, 2023; Mayer, 2017; Noh et al., 2014; Plass & Kaplan, 2015; Sung & Mayer, 2012)
22	Narration	<p>Rather than forcing a learner's eyes to constantly split attention between a graphic and explanatory on-screen text, multimedia instruction is optimized when text is shifted to the auditory channel as spoken narration. This balance takes full advantage of both processing streams without overtaxing either one. Highly interactive, complex, or long-lasting concepts should not be presented in spoken form alone. Because audio is fleeting, learners struggle to retrieve spoken data once it disappears, meaning critical content like task instructions must remain as on-screen text.</p> <p>Furthermore, the narration should incorporate an instructor with a positive voice, tone, and attitude to align with the Personalization Principle.</p>	(Brünken et al., 2002; Chen & Sun, 2012; Clark & Mayer, 2023; Mayer, 2017; Noh et al., 2014; Oh et al., 2020; Sorden, 2005; Sinclair et al., 2017; Sung & Mayer, 2012)
23	Video	<p>Video-based multimedia is often highly effective because it can positively impact both 'visualizers' and 'verbalizers'. For demonstrations of complex tasks, a first-person perspective is recommended to help the learner mentally simulate the actions.</p> <p>To maximize effectiveness, videos should be brief (ideally 60–90 seconds) to capture and maintain attention. Incorporating an on-screen instructor who uses positive gestures and attitudes further enhances social presence and directs the learner's attention to key visual elements.</p>	(Chen & Sun, 2012; Clark & Mayer, 2023; Mayer, 2017; Noh et al., 2014; Sinclair et al., 2017; Sorden, 2005)

3.1.4. Exercises

Table 4. Design principles related to exercises

Exercises			
Introduction			References
<p>The design of exercises in e-learning transitions the learner from a recipient of information to an active participant in the construction of knowledge. Below are the design principles for creating effective practice interactions, based on cognitive and generative learning theories.</p>			<p>(Chen et al., 2017; Clark & Mayer, 2023; Hussin et al., 2009; Kim & Frick, 2011; Moon et al., 2005; Reilly & Reeves, 2024; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022;)</p>
Number	Design Principle	Short Description	References
24	Active learning	<p>Active learning is defined by meaningful psychological interaction rather than mere behavioral activity, such as clicking 'next'. It occurs when learners engage in generative processing by selecting relevant information, organizing it, and integrating it with prior knowledge.</p> <p>By requiring the learner to apply and refine their knowledge, active learning fosters deeper comprehension and increases motivation. Whether through reflection, articulation, or problem-solving, these activities provide the necessary opportunities for learners to construct their own mental representations of the content.</p>	<p>(Clark & Mayer, 2023; Reilly & Reeves, 2024; Stiwinter, 2013; Theelan & van Breukelen, 2022)</p>
25	Increase the number of exercises with time	<p>When determining the volume of exercises, designers should start with a relatively low amount of practice and scale based on the criticality of the learning goal; highly critical tasks, such as those with safety consequences, warrant more extensive, deliberate practice.</p>	<p>(Clark & Mayer, 2023)</p>
26	Increase complexity	<p>As a learner's expertise builds, the instructional design should transition from high levels of support to more complex, autonomous tasks, a process known as the Guidance Fading Effect.</p> <p>For novices, it is often beneficial to initially present isolated elements of a task before introducing the full complexity. As the learner becomes more proficient, support is gradually removed, replacing completion assignments with more challenging activities follow.</p>	<p>(Chen et al., 2017; Clark & Mayer, 2023; Theelan & van Breukelen, 2022)</p>
27	Pre-training	<p>Pre-training involves presenting key concepts and facts, such as the names and characteristics of components, prior to the main lesson tasks. By using micro-assignments or short sections to familiarize learners with the vocabulare of a topic, designers can reduce the amount of processing required during the main lesson.</p> <p>This technique is particularly critical for beginners who might otherwise be overwhelmed by the complexity of simultaneous new information and task application.</p>	<p>(Clark & Mayer, 2023)</p>
28	Authenticity	<p>Authentic exercises are designed to simulate real-world situations and job-relevant problems, facilitating the transfer of knowledge from the course content to the workplace. By centering practice on authentic cases, learners can recognize the relevance and utility of the instruction. This ensures that the skills practiced are directly applicable to the learner's professional context, which increases both motivation and self-efficacy.</p>	<p>(Clark & Mayer, 2023; Kim & Frick, 2011; Moon et al., 2005; Reilly & Reeves, 2024; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)</p>

Number	Design Principle	Short Description	References
29	Worked examples	<p>Worked examples provide a step-by-step demonstration of how to solve a problem or perform a task. By allowing the learner to 'borrow' the knowledge of others, worked examples reduce the cognitive load that would normally be used for trial-and-error problem-solving.</p> <p>Relying on worked examples early in instruction is more efficient than assigning problems immediately, as it allows working memory to focus on building the necessary knowledge structures before they are automated through later practice.</p>	(Chen et al., 2017; Clark & Mayer, 2023; Moon et al., 2005; Reilly & Reeves, 2024; Sinclair et al., 2017)
30	Other types of exercises	<p>Effective e-learning utilizes a wide variety of interaction formats to stimulate different cognitive processes. Behavioral interactions may include clicking, drag-and-drop, and typing, while more complex cognitive exercises involve self-explanation prompts, concept mapping, and reflective thinking.</p> <p>By varying the format from traditional multiple-choice to interactive simulations, designers can maintain engagement and ensure that learners process content in multiple ways to achieve different learning outcomes.</p> <p>Some examples of exercises suitable for e-learning are multiple-choice questions, sorting activities, flip-cards, drag and drop activities, true or false statements and writing down reflections.</p>	(Clark & Mayer, 2023; Kim & Frick, 2011; Moon et al., 2005; Reilly & Reeves, 2024; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)

3.1.5. Feedback

Table 5. Design principles related to feedback

Feedback			References
Number	Design Principle	Short Description	References
Introduction			
<p>Feedback is one of the most powerful influences on learning, serving to bridge the gap between a learner's current performance and the desired instructional goal. Below are design principles for creating effective feedback loops in e-learning.</p>			(Bokhove & Drijvers; Clark & Mayer, 2023; Guo, 2022; Hussin et al., 2009; Kim & Frick, 2011; Narciss, 2008; Reilly & Reeves, 2024; Saplacan et al., 2018; Sinclair et al., 2017; Stiwinter, 2013; Theelan & van Breukelen, 2022)
31	Clarity	<p>To be effective, feedback must be delivered in manageable chunks that are clear, specific, and simple. This clarity ensures that the learner is not overwhelmed at the moment of correction. By keeping the message focused and intuitive, the learner can quickly understand their errors and adjust their mental models accordingly.</p>	(Clark & Mayer, 2023)

Number	Design Principle	Short Description	References
32	Physical proximity	<p>The placement of feedback is governed by the Contiguity Principle, which dictates that feedback should be positioned in close physical proximity to both the original question and the learner's response.</p> <p>This layout minimizes split attention, a state where the learner's limited cognitive resources are wasted by scanning back and forth between different areas of the screen to coordinate related information. By keeping these elements visible in a single cohesive view, the learner can hold the question, their answer, and the explanation in working memory simultaneously.</p>	(Clark & Mayer, 2023)
33	Encouragement	<p>Feedback plays a critical role in maintaining motivation and self-confidence. Phrases such as 'well done' or other forms of positive reinforcement can arouse positive emotions, improve the learner's internal state and encourage persistence.</p> <p>By highlighting advancement and providing encouragement, the feedback loop transforms potentially frustrating errors into constructive milestones in the learning journey.</p>	(Clark & Mayer, 2023; Kim & Frick, 2011; Theelan & van Breukelen, 2022)
34	No grades	<p>Avoid normative feedback, such as grades or rankings that encourage learners to compare themselves with their peers. Such comparisons can trigger negative emotions like anxiety or a sense of neglect. When the focus shifts to external competition, the internal motivation to master the content often declines.</p> <p>Instead of ranking performance, the feedback should remain centered on the individual's mastery of the learning outcomes. By removing the pressure of grades during the formative stages of a course, the environment becomes a safe space for exploration and engagement.</p>	(Clark & Mayer, 2023)
35	Task specific	<p>Effective feedback is task-specific. This is achieved through explanatory feedback, which provides an explanation to why a response was correct or incorrect. For complex tasks or novice learners, these explanations are essential to stimulate reflective thinking.</p> <p>If a learner receives no explanation for an incorrect answer, their motivation typically declines. Providing a standardized set of feedback that addresses common errors ensures that the learner is not just told they are wrong, but is given the specific information needed to understand the underlying principles and adjust their actions for future tasks.</p>	(Bokhove & Drijvers, 2012; Clark & Mayer, 2023; Guo, 2022; Narciss, 2008; Sinclair et al., 2017)
36	Multiple attempts	<p>Allowing learners multiple opportunities to reattempt questions encourages persistence without the fear of failure. Instead of simply revealing the correct answer after a mistake, the design should prompt the learner to retry the problem, perhaps by providing a hint or an analogous example. This ensures the learner re-engages with the material rather than passively moving forward.</p> <p>This iterative process embeds learning at the time of delivery and prevents the frustration associated with being stuck. By treating errors as a natural part of the learning process, multiple attempts help learners build the self-efficacy required for long-term success.</p>	(Narciss, 2008; Sinclair et al., 2017)

3.2. Results from the interviews

This section presents the qualitative findings gathered from the semi-structured interviews conducted with two practicing residential developers. The dialogue focused on isolating visual preferences and evaluating layout formats to optimize the course's aesthetic delivery. The results are followed by a synthesis of key takeaways that directly informed the visual and emotional design choices of the final course material.

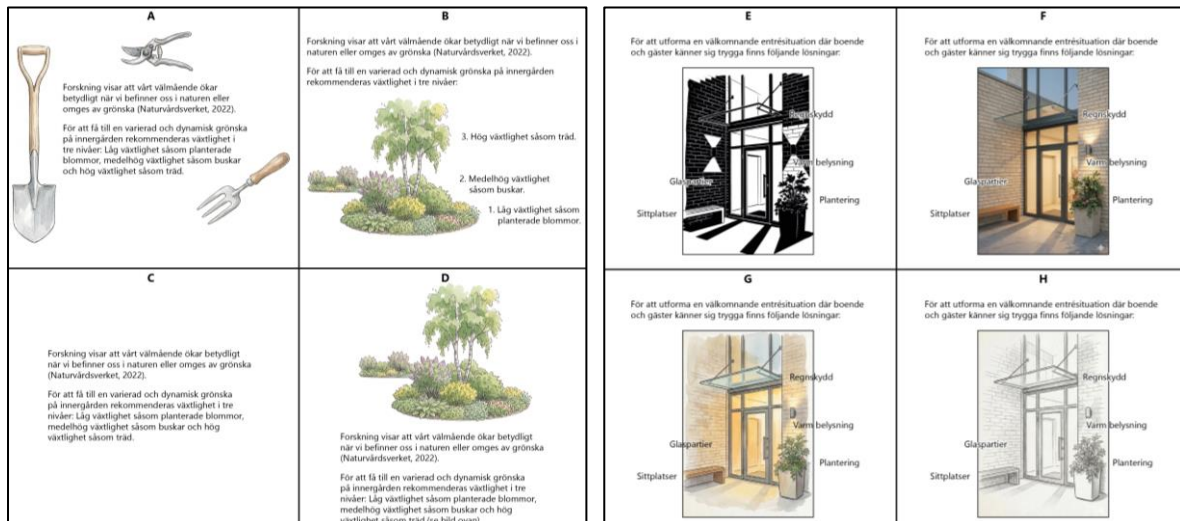


Figure 1. Discussion guide

3.2.1. Interview 1

1. Which option A-D makes it easiest for you to take in the content?

"I actually think the one that is B, but I would have put 1, 2, 3 and not 3, 2, 1."

2. Why do you think that is?

"It's very quick to take in and easy to get an overview of, I think."

"Good to have an image that visualizes it."

"Beautiful picture that matches the content of the text."

3. Which type of illustration E-H do you find most appealing?

"Well, it's the one that is photorealistic, B, I can answer that one quickly."

4. Why?

"It's clear to the eye, so to speak. Yes, that's what I think."

5. Which type of illustration E-H feels most appropriate for educational purposes?

"I think photorealistic is good, so B. But otherwise, there's always C, but I'll probably say B anyway."

6. Why?

"Well, I think colors are something that is pleasing to the eye."

"And you do talk about warm lighting in the text, you see a warm light."

"Quite logical."

"That can't really come through in those black-and-white images."

"I'm a marketing person, maybe I just like color and shape."

3.2.2. Interview 2

1. Which option A-D makes it easiest for you to take in the content?

"Off the top of my head, I would say B."

2. Why do you think that is?

"Partly because you clearly get the introduction at the top, and then it's visualized in a broader way, I think, when you have points 1, 2, 3, like. And that it aligns with low, medium, and higher. So, to me, it feels like that visualization covers a broader target audience, that a wider spectrum of people can easily absorb it."

Extra question: Which of them feels most difficult to take in?

"I probably think that, well, C feels more like pure facts and could certainly appeal to one target audience while not to another. Personally, I find it a bit too dull. And A feels a bit too cluttered and messy."

3. Which type of illustration E-H do you find most appealing?

"Personally, I find G most appealing."

4. Why?

"Well, I like that it feels like a visualization, and it feels like an ambition, like you're painting a picture of what your idea is. It feels very soft."

"And spontaneously, if you were to go with the one that is a photo, F, I think I would rather have seen them work more with it, yes, adding a softer light on G, the one with daylight. It looks a bit like twilight now, giving it a bit of an evening vibe."

Extra question: The black-and-white one and the sketched one, what was your impression of them?

"No, it felt a bit menacing, I think, with the black. There is too much heavy darkness/blackness."

"H is also nice, but G had more life to it."

5. Which type of illustration E-H feels most appropriate for educational purposes?

"Well, it's probably a bit of a toss-up between F and G, I think."

6. Why?

"I'm thinking that this educational material will be largely aimed at engineers, and they usually focus more on clarity, direction, and structure anyway, so maybe F fits better for that target audience after all, if you were to work a bit more on that daylight feeling."

3.2.3. Takeaways from the interviews

Two interviews are too few to draw any reliable conclusions, hence these results should be interpreted with caution. However, based on the interviews conducted, the main takeaway is that visual clarity and the use of color are important for effective content comprehension and engagement among residential developers.

For the layout options, both respondents strongly favored option B because of its structured presentation, such as clear introductory placement and numbering, and the direct illustration made the content quick to absorb and appealing to a broader audience. Conversely, the text-heavy option was perceived as too dull, and overly busy designs felt cluttered.

When evaluating the illustrations for aesthetic and educational purposes, the presence of color and lighting was considered crucial. The photorealistic and watercolor illustrations F and G were preferred for their warmth and ability to bring the text to life. In contrast, black-and-white or sketched styles were rejected for being too stark, dull, or even menacing.

3.3. Results from compiling the e-learning content

The findings derived from the thematic analysis are presented below as a list of nine indicators linked to the design of residential spaces that affect the wellbeing of people occupying them. The indicators have been grouped into three superior themes.

Due to confidentiality agreements with the client, the complete curriculum of the developed learning material cannot be disclosed. A representative part about physical activity, approximately one-seventh of the total instructional content, is provided here to illustrate its nature. The sample is presented in its original Swedish language.

1. Gestaltning för vardagsrörelse

- Trappans placering (1/3)
- Rymlighet och ljus (3/3)
- Nyttänkande parkering (2/3)
- Aktivitetsvänliga miljöer (3/3)
- Gröna rekreativa ytor (3/3)

2. Dedikerade ytor för träning och sport

- Integrerade gym (2/3)
- Anläggningar för spontanidrott (3/3)

3. Närhet och lokalisering

- Nära vardag (2/3)
- Blandad miljö (3/3)

4. Design discussion

This chapter provides a critical perspective on the theoretical frameworks, empirical findings, and practical execution of the e-learning course. It evaluates how effectively the synthesized design principles were implemented within practical constraints and integrates qualitative feedback received from the client. Furthermore, this section outlines suggestions for future course development, offers a reflection on the project's successes and shortcomings, and concludes with broader implications for future instructional design research.

4.1. Implementation of the design principles

The development of the e-learning course has focused on implementing the established design principles to the greatest extent possible, utilizing Microsoft PowerPoint as the development platform. The following sections offer individual explanations of how the design of the course corresponds to each design principle.

4.1.1. Navigation



Figure 2. Start page 1



Figure 3. Start page 2

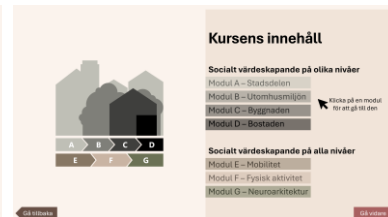


Figure 4. Start page 3

1. Start page: Instead of designing one start page, the course is introduced by three start pages that include a statement of the course's purpose, learning objectives, key definitions and a course overview.



Figure 5. Topic menu

2. Topic menus: Topic menus occur between modules to break down the content of every individual module.



Figure 6. Movement buttons

3. Movement buttons: The movement buttons used in the material include forward and backward navigation, play and pause functions for videos, and a button that takes the learner back to the course overview.



Figure 7. Header and introduction

4. Headers: The material consistently utilizes headers, headings and introductions to organize the content.

5. Self-explanatory in nature: The course is designed for intuitive use through a consistent design language and explanatory hints.

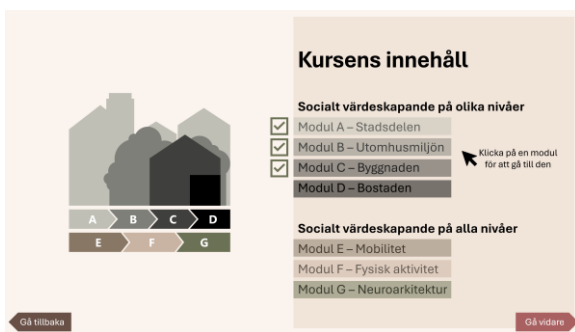


Figure 8. Progress indicator between modules



Figure 9. Progress indicator within a module

6. Progress indicator: After a module is finished, the course overview reappears with a tick mark for all completed modules, clearly illustrating the progress made so far. The progress within a module is shown in a similar way.

7. Learner controlled pace: The pace of the instruction is entirely controlled by the learner, who navigates freely through the material by manual clicking. When watching a video, the learner has the ability to pause, fast forward, and rewind.

8. Set vs free order of content: The content is sequenced linearly, and the progress indicators illustrate the progression correctly when following the planned order. This design choice was made because the level of knowledge among the learners might vary from novice to advanced. While the course is intended to be taken chronologically, there is nothing stopping a learner from choosing their own learning path. It is easy to navigate freely using the course overview button and skipping through selected parts.

Future improvements to consider regarding navigation:

There is currently nothing in the course interface to help the learner exit. This design choice depends on the assumption that most learners know how to click the escape button to exit a PowerPoint slide show.

While progress is illustrated clearly after each module and by slide overlays within the modules, the progress could be made even clearer by adding visual indicator bars in every module or by numbering the slides.

A clear downside of the current learning material is that it only displays the progress correctly when the learner navigates through the material as intended. It would be preferable to match the progress indicators with completed modules regardless of the learning path chosen by the learner. At present, the progress indicators are not based on what content has been processed by the learner but simply follow the chronological order. Greater control of this feature would be beneficial to ensure that progress is tracked correctly regardless of the chosen path.

4.1.2. Content structure

9. User interface: The interface is designed with the ambition to look minimalistic yet warm and welcoming, following the principles related to emotional design. The background color is warm, bright beige, and excessive content is avoided. For consistency, the layout of the different parts and dominant design features, such as menus, fonts, and buttons, reoccur throughout the entire course.

10. Introductions: All modules and lower-hierarchy content are properly introduced by shorter text segments presenting what is to come.



Figure 10. Text segmenting

11. Segment: Information is presented in shorter chunks of text, written with clear and concise language and generally matched with an icon or illustration.

12. Even distribution: The course contains different elements, such as texts, icons, illustrations, videos, and exercises, which are distributed as evenly as possible to achieve variation and minimize cognitive overload.



Figure 11. Screen disposition

13. Screen disposition: Since the course is designed as PowerPoint slides rather than vertical material that requires scrolling, the format allowed for designing each slide with careful consideration of this principle. Extra effort was made when designing exercises and feedback so that the learner can always see the question, their response, and the customized feedback simultaneously.

14. External links: The course does not contain any external links, as PowerPoint supports all the media that has been utilized.

Future improvements to consider regarding content structure:

More consideration could be given to the design of the user interface for improved aesthetics and graphics. While some illustrations were created by artists, the majority are AI-generated. It would be ideal to eventually replace all AI-generated elements with illustrations made by artists.

4.1.3. Content representation

15. Relevance: The instructional texts have been written to present the content in a clear and efficient way. Elements of a seductive or decorative character have been consciously avoided to maintain focus on the elements that directly support the learning process.

16. Authenticity: The course content is based on three studies, and videos from realized projects have been added to strengthen the presence of authenticity.

17. Proper level: Consideration was taken regarding this aspect by limiting the target group to residential developers rather than other professions, such as builders or municipality employees, who are also actors involved in planning and building residential projects. This design principle has been significantly overlooked due to time constraints. The material has not been properly tested or reviewed, making it impossible to determine how the level of difficulty matches the previous knowledge of the target group.

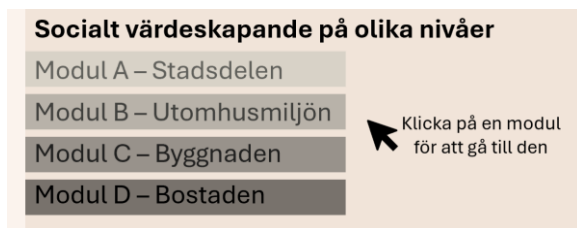


Figure 12. Signaling

18. Guide attention by signaling: Examples of cues used in the material include varied text sizes, bold text, arrows and highlighting different parts of illustrations with attention-guiding texts. In many cases, the content presented on the screen is limited and does not require additional signaling.

19. Text: The text in the learning material is written to be clear, concise and relevant, yet maintains a friendly tone using first and second-person language. The text is placed to make sense and is often closely accompanied by or interwoven with illustrations matching the content at hand.



Figure 13. Watercolor illustration 1



Figure 14. Watercolor illustration 2

20. Static illustrations: This has been a challenging design principle to implement because while ‘less is more’ is an established phrase in this context, people working in the construction sector are accustomed to highly detailed drawings and visualizations. Schematic illustrations with a low level of detail are appropriate for describing chemical processes or machine parts, but selecting illustrations to describe a welcoming entrance situation is more complex.

Emotional design states that warm colors and round shapes can be used to elicit positive emotions and enhance learning. The two interviews with residential developers indicated that they appreciate color and that atmosphere is highly important. Although the literature review advises against photographs, the residential developers agreed that colored or photorealistic images were more appreciated than grey-scale analogies.

Taking all these factors into consideration, the style of the illustrations used in this material is a compromise in watercolor, intended to set an atmosphere, trigger emotions, and represent the design guide with a sufficient level of detail. Even though photorealism was discussed enthusiastically by interviewees, it lacks scientific support and was not considered for this material.

Simple icons are also used frequently in the material, representing the text in an efficient way.

21. Emotional design: Significant effort has been made to add emotional design features to the course. The background color, overall aesthetics, and illustrations have all been chosen to trigger positive feelings, a choice that aligns naturally with social sustainability and designing for improved wellbeing.

22. Narration: Due to time constraints, this course has not been voice narrated.



Figure 15. Video content

23. Video: Short videos demonstrating different aspects of realized residential projects are included in the course.

Future improvements to consider regarding content representation:

More authentic elements could be added, such as worked examples involving media publications from residential projects and exercises where the learner has the opportunity to reflect on real-life scenarios.

4.1.4. Exercises

24. Active learning: Information is accompanied by exercises where the learner is required to reflect on the content, which allows for active learning to take place.

25. Increase number of exercises with time: In its present state, the course has a low number of exercises. This decision aligns with the design principle of starting with few exercises, testing the material, and increasing the number over time. However, the absence of exercises is also related to the choice of software, PowerPoint, and project time constraints. PowerPoint lacks many functions, such as drag-and-drop or sorting activities. Creating well-thought-out exercises and customized feedback is time-consuming and had to be limited.

26. Increase complexity: This design principle has been difficult to implement because this particular learning material covers a wide range of aspects rather than going into depth. Consequently, there is no clear progression from simpler exercises at the beginning to more advanced ones toward the end.

27. Pre-training: Pre-training is activated by presenting all modules at the beginning and providing an introduction to each module, sometimes via a short video. Micro-assignments are currently lacking.

28. Authenticity: The principle of authenticity within the exercises is not yet fulfilled.

29. Worked examples: Videos showing solutions from realized residential projects are utilized as worked examples.



Figure 16. Exercise of reflective character

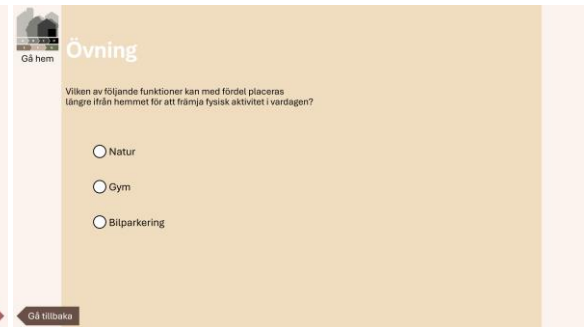


Figure 17. Multiple choice exercise

30. Other types of exercises: Figure 16 illustrates an exercise that encourages the learner to reflect on their own professional experience by ranking different solutions. Figure 17 is an example of a multiple-choice exercise.

Future improvements to consider regarding exercises:

Future developments should focus on increasing the number of exercises, adding exercises based on authentic cases, and incorporating micro-assignments. Additionally, it could be a good idea to migrate the course to another learning platform that supports more exercise types and offers more integrated possibilities for interactivity.

4.1.5. Feedback



Figure 18. Feedback

31. Clarity: The feedback given is consistently concise and brief, focusing on what was correct or incorrect and providing short clues when appropriate.

32. Physical proximity: The screen is consistently dispositioned so that the exercise, the response, and the associated feedback are all shown at the same time.

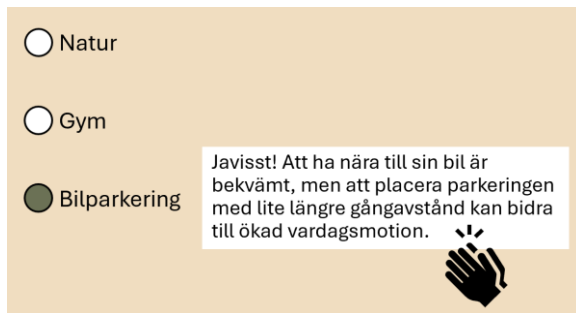


Figure 19. Encouraging icon

33. Encouragement: The feedback primarily focuses on the task at hand, but also includes encouraging icons or phrases such as ‘well done’.

34. No grades: The course is not graded; the learner can make as many new attempts as they need for every exercise, and their progress is not documented.

35. Task specific: The feedback is customized to every question, providing correct or incorrect markers plus clues. This is a very time-consuming activity for the course designer, and due to time constraints, exercises and their associated packages of feedback have been kept to a minimum.

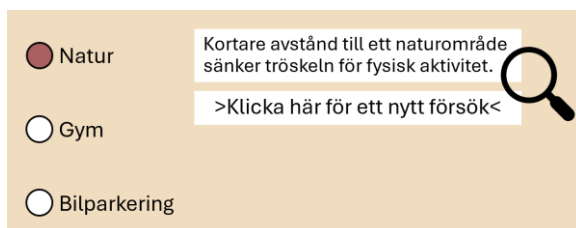


Figure 20. Click to make a new attempt

36. Multiple attempts: Learners are permitted to make as many attempts as they need to complete an exercise.

Future improvements to consider regarding feedback:

To support the further development of the course it might be a good idea to collect assessment data that can give valuable insight of what parts are considered more difficult than others among learners.

4.2. Input from the client

When the learning material was presented to the client, Christina Ingelsten, it was very well received. Ingelsten thought the course created a highly professional and pedagogical first impression. She was particularly impressed by the overall graphics and aesthetics, including the use of warm colors and illustrations. She expressed great appreciation for the decision to utilize a watercolor style for the illustrations.

She experienced a sense of calm when navigating the course and pointed out that the design aligns perfectly with the section of the learning content focusing on neuroarchitecture. She also appreciated the simplicity of the course navigation, making the content accessible to individuals with lower computer proficiency.

She agreed that the learning material would benefit from the addition of more exercises and feedback loops, to offer more of an active learning process. Additionally, she expressed an interest in translating the course into English, thereby expanding the target group. After this, the conversation moved toward potential distribution models discussing whether to deploy the course as a standalone resource for remote learning or to combine it with her in-person lectures.

4.3. Future development

This section presents suggestions on how the course can be developed to better support learning. The proposed advancements focus on technological migration to increase interactivity, pedagogical refinements to enhance authenticity, the replacement of illustrations, and the implementation of data-driven evaluation methods.

4.3.1. Technological migration and increased interactivity

A primary objective for future iterations is to consider the migration of the course from a slide-based PowerPoint format to a dedicated Learning Management System (LMS) or a robust e-learning tool. This shift is essential to overcome current software constraints that limit interactivity.

A more advanced platform would allow for the integration of diverse exercise types, such as drag-and-drop activities and sorting tasks, which are currently lacking. Furthermore, a platform transition would enable the implementation of a more sophisticated progress-tracking system. This would ensure that progress indicators and tick marks accurately reflect the specific content processed by the learner, even when they choose to depart from a linear path and explore the material more freely.

4.3.2. Pedagogical refinement and authenticity

To further bridge the gap between theory and practice, future development should focus on enriching the course with more authentic instructional elements. This includes the addition of worked examples drawn from media publications of realized residential projects, providing learners with concrete, real-world examples.

Additionally, the inclusion of audio narration would enable the course to better balance the cognitive load between the visual and auditory channels, moving away from the current text-dominated representation.

4.3.3. Illustrations

Based on aesthetic, but primarily ethical considerations, while AI-generated imagery served as an efficient placeholder for this iteration, future versions would benefit from replacing these with bespoke illustrations created by artists. This transition would eliminate potential copyright and ownership uncertainties inherent to generative AI and ensure an even stronger visual narrative, further strengthening the emotional design of the course and its appeal to professional residential developers.

4.3.4. Evaluation and data-driven improvement

The next phase of development should include learner testing and data collection. Because the current material was developed under significant time constraints, it has not yet been subjected to a formal peer review or pilot study within the target group.

Future iterations should utilize the data-tracking capabilities of a Learning Management System (LMS) to monitor learner performance and satisfaction. Collecting this data will allow for a more precise calibration of the proper level of the content, ensuring the difficulty effectively matches the prior knowledge of the target group and allowing for evidence-based refinements of the material.

4.4. Reflection

This section offers a retrospective, critical evaluation of the design and development process, balancing theoretical intentions against execution. It identifies the operational successes achieved in course navigation and structure, while also examining the challenges faced during content representation. Additionally, it highlights the gaps identified in exercise integration and feedback loops, providing a transparent assessment of the current prototype.

4.4.1. Successes in navigation and structure

The most successful implementation of theory lies in the navigation and content structure of the course. The material makes use of the signaling and segmenting principles, prioritizing the reduction of extraneous cognitive load. The use of a clear start page and periodic topic menus effectively provide familiar landmarks for the learner. These elements, combined with a minimalist and consistent user interface, ensure that the learner's focus is directed toward the complex topic of social sustainability, rather than the design of the interface.

Furthermore, the emotional design principle is a primary strength. The decision to use a warm, bright beige palette and a watercolor aesthetic represents a successful bridge between theories on positive affect and the specific aesthetic expectations of the residential development industry. This approach gives the course an inviting atmosphere that aligns with the course's core message of wellbeing and social sustainability.

4.4.2. Challenges in content representation

In terms of content representation, the material represents a strategic compromise between empirical evidence and professional culture. While literature suggests that simple, schematic illustrations are superior for learning, the target audience, residential developers, is accustomed to highly detailed, photorealistic visualizations. The resulting watercolor compromise successfully avoided the 'seductive details' by keeping graphics relevant and static, yet aesthetically rich enough to maintain professional interest.

However, a notable weakness is the absence of audio narration. While learning theory suggests that words presented as narration are often more effective than on-screen text only, time constraints lead to a text-heavier approach. The lack of an auditory channel may increase the risk of cognitive overload for some learners, but the placement of text in close proximity to relevant icons and illustrations has been a way to adapt the material to both visualizers and verbalizers.

4.4.3. The gap in exercises and feedback

The greatest discrepancy between theory and practice occurs within the exercises and interactivity themes. Theoretical models advocate for a high volume of diverse, interactive tasks and a clear progression in complexity. In practice, the choice of PowerPoint as a development tool created a limitation in interactivity. The software lacks the capacity for the drag-and-drop or sorting activities that characterize high-engagement e-learning.

Consequently, while the feedback provided is clear, task-specific, and honors the principle of physical proximity, the low number of exercises means these feedback loops are underutilized. The current version of the course succeeds more as an informative guide than a stimulating practice environment. To move closer to the theoretical ideal, further development might require migrating the content to a more robust Learning Management System (LMS) or tool that has a wider range of opportunities when it comes to designing exercises and more advanced simulations.

4.5. Conclusion

When comparing the created e-learning (practice) to the formulated design principles (theory), there is a high level of adherence regarding how information is presented but a lower level regarding how learners interact with it. The course successfully implements the more passive side of multimedia learning, ensuring that the content is accessible and well-organized.

The more active side of the theory, specifically active learning, represents the primary area for growth. The lack of an adaptive progress indicator that tracks non-linear learning paths and the absence of micro-assignments highlight the challenge of creating a fully self-regulated environment within a linear slide-show format. Ultimately, this project demonstrates that while theory provides a desirable standard, one must often prioritize impactful principles such as navigation and clarity when working within the boundaries of time and software.

4.6. Implications for future research

While this thesis opened an entry point into exploring different illustration techniques in a context of learning, no reliable conclusions can be drawn from the limited sample size of two qualitative interviews. Future research should expand upon this work by quantitatively evaluating the actual learning effects of various visual styles. Moving beyond self-reported user preferences is essential, future investigations need to measure whether the visual techniques preferred by industry professionals genuinely facilitate cognitive processes during learning.

This research would offer a natural extension of the Emotional Design theory, particularly when designing for specialized fields with distinct visual cultures. Future studies should systematically isolate and test the impacts of specific visualization styles on adult learners. Addressing the conflict between cognitive multimedia theory, which advocates for schematic simplicity and industry expectations which demand an atmosphere, will add nuance to the boundary conditions of instructional design.

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