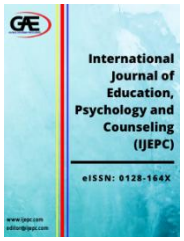
International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 11 Issue 64 (September 2026) PP. 1472-1492



INTERNATIONAL JOURNAL OF EDUCATION, PSYCHOLOGY AND COUNSELLING (IJEPC)
https://gaexcellence.com/ijepc

ACCESSIBLE DIGITAL HAND EMBROIDERY LEARNING FOR DEAF LEARNERS: A VISUAL–MULTIMEDIA INSTRUCTIONAL DESIGN FRAMEWORK

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Article Info:

Article history:
Received date: 24.06.2026
Revised date: 07.07.2026
Accepted date: 30.08.2026
Published date: 28.09.2026

To cite this document:

Ismail, I. N. S. Adnan, N., & Rahim, S. N. A. (2026). Accessible Digital Hand Embroidery Learning for Deaf Learners: A Visual–Multimedia Instructional Design Framework. *International Journal of Education, Psychology and Counselling, 11*(64), 1472-1492.

Abstract:

Digital learning can be challenging for Deaf learners, particularly when content is presented in oral or written language that is complex. As in the case of skill-based learning like hand embroidery, visual methods have become even more important because the visual demonstration is not available; there is no structure with step-by-step instructions; and there is no designing using multimedia to reduce cognitive load. This conceptual paper suggests the visual-multimedia instructional design framework for creating the accessible digital hand embroidery learning environment for Deaf learners. This paper combines four domains: special education for Deaf learners, visual learning principles, multimedia design and cognitive load, and instructional design for skill-based learning in using a conceptual literature synthesis approach. The synthesis results in a structure that connects learner's needs, design principles, kit components and anticipated learning outcomes. The plan will involve visual embroidery guides, sign-language-centred instructional videos, learning modules that are structured, and guided practice activities. It enriches the inclusive education by extending the digital access in learning creative skills as well as providing a design reference for the development of future prototypes and usability assessment.

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 11 Issue 64 (September 2026) PP. 1472-1492
DOI: 10.35631/IJEPC.1164080 **Keyword:**

Deaf Learners, Digital Hand Embroidery, Instructional Design Framework, Learning Accessibility, Multimedia Design

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Introduction

Inclusive education has assumed a key role in modern educational development where it focuses on equal access to learning by different learners. In this context, Deaf learners should have specialised teaching strategies, which can be in tandem with their language preferences and cognitive processing style, especially in a teaching context that entails practical and procedural skills.

In modern day educational technology, digital learning has acquired popularity as a flexible tool to facilitate teaching and learning. However, the effectiveness of digital learning is not solely determined by the availability of technology but by how the instructional content is designed to meet the needs of students. In the case of Deaf learners, visual organisation of materials, obvious sequences of procedures, and properly designed multimedia presentations have a significant impact on understanding and engagement and can be used to facilitate effective processing of information (Polvanov, 2023; Chen et al., 2024).

Hence, this paper will present a visual-multimedia instructional design model to create an accessible online hand embroidery learning platform to Deaf learners. This model combines the visual learning principles, multimedia design strategies, and the structured instructional strategies to facilitate the acquisition of skills. This research, by considering accessibility as an instructional design value, enhances the progress of inclusive education in non-academic areas of creative and skill-based education.

Deaf learners are one such group that demands digital learning methods that are very accommodative of visual communication requirements. Modern learning settings are mostly textually oriented with spoken language, which can be a barrier to understanding among Deaf learners. Even in practice-oriented learning skills like hand embroidery, structured visual teaching, learning speed, and carefully designed multimedia components are crucial in lightening the cognitive load and improving the learning experience.

Even though such educational technological tools as artificial intelligence, virtual reality, and communication support systems have evolved greatly, the literature suggests that the efficacy of digital innovations in Deaf learners continues to depend on content design, digital literacy disparity, and the constraints of accessing devices. It creates the need to use more specialised

International Journal of Education, Psychology and Counseling
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EISSN : 0128-164X
Volume 11 Issue 64 (September 2026) PP. 1472-1492
instructional design strategies to make sure that the technological implementation is efficient regarding the needs of the Deaf learners (Polvanov, 2023; Alit et al., 2025).

Although inclusive education is gaining more popularity in different sectors, Deaf learners still struggle to receive a fair digital education, especially when the learning materials are created using complex textual descriptions. Literature suggests that Deaf learners have a greater dependence on strategies of visual learning, demonstrations, and brief and consistent delivery, yet such requirements are not usually sufficiently applied to digital learning design (Polvanov, 2023; Prasad, 2023).

The bulk of current digital learning resources is made to serve average learners and is likely to be based on elaborate textual explanations without incorporating enough visual aids or sign language. The limitation has the potential to influence self-directed understanding, engagement in learning and the overall learning performance of Deaf learners.

Learning of practical skills like hand embroidery involves accuracy, a sequential series of steps, and practice, which are repetitive to acquire fine motor skills. Misaligned captions and images, excessive speed, or information overload can create complications with information and decrease comprehension among Deaf learners due to the poor design of the multimedia elements (Chen et al., 2024). This emphasises accessibility for Deaf learners goes beyond content availability to instructional design, focusing on visual primacy, micro-step organisation, and usability.

Despite the increasing development of technological solutions (sign language translation systems, motion capture, communication tools, etc.), most of the existing solutions are aimed at general communication support. There is little focus on the design of specialised digital learning kits to train creative skills, like hand embroidery (Nugraha et al., 2024).

Moreover, the accessibility of devices, digital literacy disparities, and the lack of support in the implementation of Deaf learners remain factors that influence the implementation of digital learning, which may be addressed by a more adaptable and pragmatic design framework (Alit et al., 2025).

Research Questions

This study addresses the following research questions:

1. What visual and multimedia principles are most suitable to support Deaf learners in hand embroidery skill training?
2. What are the key instructional design features that support accessible digital hand embroidery learning for Deaf learners?
3. How can a digital hand embroidery kit design framework be proposed through the integration of visual and multimedia principles?

Research Objectives

The objectives of this study are:

1. To identify relevant visual and multimedia learning principles for supporting Deaf learners in hand embroidery skill training.

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2. To analyse key instructional design features that support accessibility in digital hand embroidery learning kits.
3. To propose a digital hand embroidery kit design framework that systematically integrates visual and multimedia principles.

This research project builds on the existing literature in the field of special education by introducing an instructional design model to be applied in practical learning skills for Deaf learners. It also adds to the discussion on multimedia design in education through highlighting visual integration, caption-visual alignment, and cognitive load minimisation in the development of digital learning materials. Also, the paper broadens the discourse in the textile arts and cultural heritage domain by positioning hand embroidery as a skill-based learning model, which helps preserve the textile traditions by using innovative and inclusive methods.

This paper aims at projecting a conceptual model on how to create an accessible digital hand embroidery learning kit to Deaf learners. It is not associated with complete prototype development or empirical effectiveness tests. Rather, its main area of interest is literature synthesis and development of conceptual frameworks in accordance with the appropriate visual learning and multimedia concepts.

Literature Review

This section reviews the literature related to digital learning accessibility for Deaf learners and the instructional design considerations required for developing an accessible digital hand embroidery learning kit. The review is organised into three main subtopics: Deaf learners and digital learning accessibility, visual-multimedia learning and cognitive load, and instructional design for skill-based and self-directed learning. These three areas provide the theoretical and conceptual basis for the proposed visual-multimedia instructional design framework.

Deaf Learners and Digital Learning Accessibility

Deaf learners continue to face challenges in accessing digital learning environments, particularly when instructional materials depend heavily on oral explanation, complex written text or abstract language structures. Although digital learning has expanded access to educational content, accessibility for Deaf learners is not achieved merely through the availability of online materials. Rather, it needs instruction that is visually comprehensible, linguistically comprehensible and cognitively manageable. Polvanov (2023) highlights how Deaf learners may have good visual learning skills but need to be provided with well-structured visual content and clear instructional organisation to aid their understanding.

Likewise, Prasad (2023) states that sometimes Deaf learners might struggle with grammar, vocabulary and understanding of abstract concepts making visual approaches, demonstrations and assistive communication devices vital in helping learners. Digital education also has factors of digital literacy, availability of devices and readiness of teachers, and suitability of digital design for accessibility. Alit et al. (2025) state that the lack of technology use equality, technological support, and digital skills influence the effective use of technology by hearing-impaired students. The problems indicated that inclusive digital learning should not only be directed toward technological innovations but also to the development of digital learning materials that are appropriate to the communication needs and learning preferences of Deaf

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EISSN : 0128-164X
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learners. Thus, digital accessibility should be considered as a technological and pedagogical issue.

Skill education is especially dependent on visual communication to observe, imitate and practise procedural steps. Rahim and Ayob (2024) revealed that Deaf learners respond positively to the use of visual technology, particularly augmented reality and virtual reality to improve their understanding and engagement in practical learning activities. But the importance of visual technology is determined by whether or not the instructional design is structured, relevant and easy to follow. Accessible learning materials should minimise reliance on lengthy written explanations and should offer clear visual cues and demonstrations, sequencing and communication support to the Deaf learner. This is particularly pertinent to the learning of hand embroidery, where students must be able to grasp the direction of the stitches, the way the thread is pulled and moved, the positioning of their hands and the repetitive procedural aspects.

Visual-Multimedia Learning and Cognitive Load

The effectiveness of multimedia learning for Deaf learners is related with how the visual, text and visual/video-based elements are organised. Multimedia materials can help learning if they give clear demonstrations and provide concise explanations and even allow students to go over the content of instruction at their own speed. But, when the design of the multimedia is not well, there can be confusion, increase in cognitive load, and decrease in comprehension. The quality of the caption is important in terms of accuracy, synchronisation and readability, as pointed out by Pérez-Arteaga et al. (2025). If captions do not match visual demonstrations, students may be required to pay attention to two or more information sources, and this makes the learning process more challenging.

Cognitive Theory of Multimedia Learning (CTML) is an important theoretical structure to understand the processing of multimedia information by the learner. According to Mayer (2024) learners' information is processed in two channels with limited processing capacities. This theory is significant for Deaf learners since they are highly dependent on visual stimuli in learning. To this end, multimedia materials used in digital hand embroidery teaching should minimize redundant information, emphasize the key points, break down the complex operations into individual parts, and coordinate the appearance of pictures and text.

There are a few CTML principles which directly apply to accessible skill-based learning. The coherence principle says that irrelevant words, images or sounds should be taken out to not impose unnecessary cognitive load. Signalling principle involves underlining, highlighting, using symbols to draw attention to procedures that are important to learn. The segmenting principle is used to break down content into small, manageable learning units. The contiguity principle means that related text, captions and visuals need to appear near each other to help students link information together. In hand embroidery learning, which requires detailed observation and precise movement of the process, these principles can be used to reduce the cognitive load and to make the understanding of the processes clearer.

In this paper, CTML is adapted to explain how Deaf learners process visual and multimedia information in digital hand embroidery learning. The framework emphasises the relationship between multimedia input, cognitive processing and expected learning outcomes. As shown in Figure 1, visual embroidery guides, sign language-supported videos, close-up demonstrations

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Volume 11 Issue 64 (September 2026) PP. 1472-1492

and concise captions function as instructional inputs that support cognitive processing through dual-channel learning, limited capacity management and active processing.

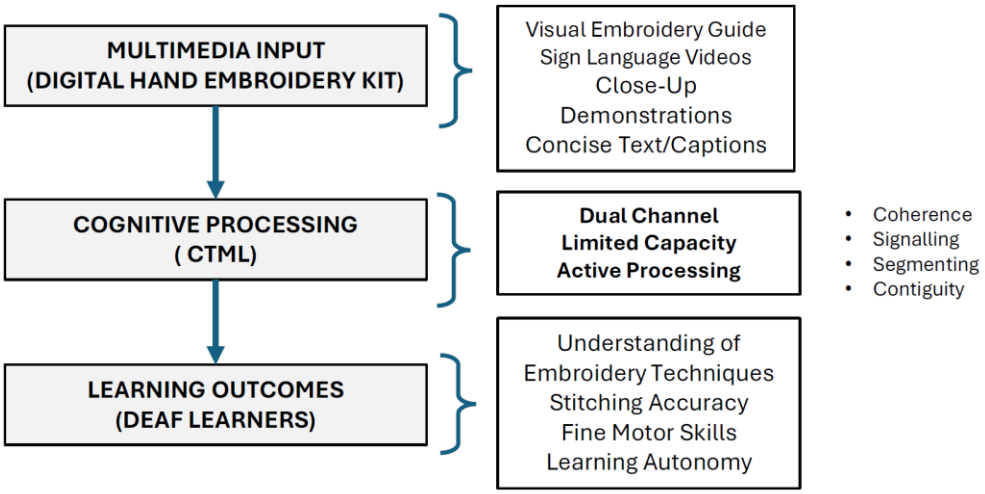


Figure 1: Adaptation of the Cognitive Theory of Multimedia Learning (CTML) in Digital Hand Embroidery Learning for Deaf Learners.
Source: Adapted from Mayer (2024)

Figure 1 illustrates the adaptation of CTML in the context of digital hand embroidery learning for Deaf learners. The figure shows that accessible multimedia input should be organised through clear visual guides, sign language-supported videos, close-up demonstrations and concise captions. These elements are aligned with CTML principles such as coherence, signalling, segmenting and contiguity to reduce cognitive load and support learners' understanding of embroidery techniques, stitching accuracy, fine motor skills and learning autonomy.

Chen et al. (2024) further argue that motion design in video-based learning should consider the cognitive processing capacity of deaf and hard of hearing learners. Fast-paced videos, inconsistent camera angles, excessive text and unclear visual presentation may interfere with learning. In contrast, slow pacing, close-up views, consistent framing and step-by-step demonstrations can improve the accessibility of procedural learning. Liang and Nasir (2026) also emphasise that educational short videos can improve learning efficiency when content is organised through structured segments and aligned visual, audio and textual information. In the context of digital hand embroidery learning, these principles support the use of short instructional videos, caption-visual alignment, controlled pacing, micro-step organisation and consistent visual presentation.

Instructional Design for Skill-Based and Self-Directed Learning

Instructional design provides a systematic foundation for developing learning materials that are structured, purposeful and aligned with learner needs. In skill-based learning, instructional design is important because learners are required not only to understand concepts but also to perform procedures accurately through repeated practice. The ADDIE model, which consists of Analysis, Design, Development, Implementation and Evaluation, is widely used as a flexible and systematic model for instructional development. Abuhassna et al. (2024) explain that

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ADDIE supports the integration of educational technologies into learning design by ensuring that instructional materials are developed through organised and iterative stages.

In the context of embroidery learning, Sunarya et al. (2024) demonstrate that video tutorial-based learning developed through systematic instructional design can improve learners' skill-based learning. This finding is relevant to digital hand embroidery learning because embroidery requires demonstration, repetition, gradual skill development and guided practice. For Deaf learners, these instructional elements must also be supported by visual clarity, accessible communication and multimedia design that reduces cognitive load.

Recent studies in fashion and design education also show the value of visual tools in supporting inclusive skill-based learning. Azhan et al. (2026) found that the EduFIGURE9 Smart Ruler improved drawing accuracy and learning motivation among TVET fashion students, including Deaf learners, through a structured visual workflow. Although the study focused on fashion illustration rather than hand embroidery, its findings are relevant to the present paper because both learning contexts require visual demonstration, procedural sequencing, guided practice and reduced dependence on verbal explanation. This supports the argument that skill focused training for Deaf learners should be taught by utilizing visual, structured and practice-oriented teaching and learning approaches.

Another factor that should be considered when designing digital hand embroidery kits is self-directed learning. Digital modules enable learners to 'revisit' learning content, to set their own learning pace and to practise away from formal learning sessions. But, only a clear, accessible and structured learning material will make self-directed learning effective. This for Deaf learners, translates to digital learning kits that should include visual embroidery guides, sign language supported instructional videos, structured learning modules and guided practice activities. These can aid the learner to comprehend a procedure without relying on the teacher's verbal explanation or constant support.

As a craft activity, hand embroidery is also more than just a visual and procedural learning opportunity. Wolk and Bat Or (2025) talk about embroidery as a medium to show expression and engagement, Ariffin et al. (2023), and Shamsuddin et al. (2024), place embroidery among other textile practice within the realm of cultural heritage preservation. However, in this paper, these aspects are rather secondary implications and not the focus. The main argument remains on the need for an accessible instructional design framework that supports Deaf learners' participation in creative skill-based education through visual-multimedia learning.

Based on the reviewed literature, three main gaps can be identified. First, there is still a lack of digital learning materials specifically designed to meet the needs of Deaf learners. particularly in terms of caption-visual alignment, pacing and cognitive load reduction. Second, limited attention has been given to hand embroidery as a context for accessible digital skill-based learning among Deaf learners. Third, there is an absence of a specific instructional design framework that integrates visual learning, multimedia principles and systematic development approaches for digital hand embroidery learning. These gaps justify the need for a structured visual-multimedia instructional design framework that links Deaf learners' needs, design principles, kit components and expected learning outcomes.

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Methodology

This part describes the methodology that was followed to come up with an instructional design framework of an accessible digital hand embroidery learning kit among Deaf learners. Since the research will be conceptual, there will be no empirical data gathering or experiment. Rather, the framework is constructed by conducting a conceptual literature synthesis and thematic analysis to reflect on the identification of applicable design principles and visualising the connections between user needs, design constructs, instructional elements, and anticipated learning outcomes. The process of synthesis was repeated, and the themes and constructs could be refined continuously to achieve a conceptual coherence.

Research Design

This paper involves a conceptual research design that is based on systematic literature synthesis to come up with an instructional design framework. Conceptual research is especially suitable when the aim is to develop theoretical models or frameworks in areas where the literature is disjointed or disintegrated.

This choice of the design can be explained by the research gap that was determined, i.e., the lack of an instructional design framework that would be comprehensive and adjusted to the available digital hand embroidery teaching to Deaf learners. Instead of producing new empirical data, the present study is aimed at synthesising the current theoretical and empirical knowledge to create a logical and practical framework.

This methodology is consistent with the known principles of conceptual research, according to which the focus is on the integration of the theory, clarity of the concepts, and logicality (Ahmed, 2024). The paper, therefore, incorporates the multidisciplinary approaches to ascertain that the proposed framework is not only theoretically based but also practical.

Literature Sources and Scope of Analysis and Conceptual Synthesis Procedure

The literature synthesis was conducted across four primary domains that are directly aligned with the objectives of the study:

1. Digital learning accessibility and special education for Deaf learners, particularly issues related to communication barriers, digital literacy, and equitable access.
2. Visual learning principles and accessible communication strategies, focusing on demonstration-based instruction, visual structuring, and reduced reliance on complex textual information.
3. Multimedia design and cognitive demand reduction, with specific attention to caption-visual alignment, pacing, segmentation and consistency of presentation.
4. Instructional design models and skill-based learning development, including the application of the ADDIE model as a systematic approach for designing structured learning materials.

Three criteria were used as a guide in selecting literature. The first criteria were that the sources needed to relate to Deaf learners and accessibility in digital learning environments. Secondly, the literature should correspond to skill-based or procedural learning situations. Thirdly, preference was given to peer-reviewed and indexed academic sources to ensure scholarly rigour. The foci of analysis focused on the principles that have implications for skill acquisition

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and accessibility in digital hand embroidery learning. A three-stage conceptual synthesis process was used to develop the proposed framework, as follows:

Stage 1: Extraction of Design Principles

Relevant studies were systematically analysed to identify recurring design principles associated with:

- Visual dominance in instruction
- Instructional structuring and sequencing
- Sign language integration
- Cognitive load reduction strategies

This stage focused on isolating transferable design constructs that are consistently supported across multiple studies.

Stage 2: Thematic Grouping

Extracted principles were categorised into coherent thematic clusters. The key themes identified include the following:

- Visual-centred instruction
- Caption–visual alignment
- Controlled pacing and micro-step structuring
- Integration of sign language as communication support
- Usability and flexible accessibility

This thematic grouping enabled the consolidation of fragmented insights into structured conceptual categories.

Stage 3: Framework Modelling

The results of the identified themes were then mapped to a hierarchical framework structure that forms relationships between:
User Needs → Design Principles → Kit Components → Learning Outcomes

This process converts theoretical constructs to practical design aspects, making it possible to use the framework as a conceptual model and a design guide for future development. The mapping process includes a specific mapping of each design construct to the literature domain and practical implementation in the proposed kit components to enhance rigour and traceability. This systematic mapping helps to keep the knowledge-based framework running.

Table 1: Mapping of Literature Synthesis to Framework Constructs and Kit Components

Literature Domain	Key Focus	Extracted Design Principles	Framework Construct	Kit Components
Special Education & Digital Learning Accessibility	Communication gaps; digital literacy; device access	Visually oriented content; concise and consistent delivery	Accessibility & Usability	Structured modules; visual guides; guided practice

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Visual Learning & Accessible Communication	Demonstration is more effective than complex text.	Step-by-step visuals; close-up views; clear sequencing	Visual-Centred Instruction	Visual embroidery guide; structured modules
Sign Language in Learning	Sign language as a primary communication medium	Sign language as concise explanatory support	Sign Language Integration	Sign language-supported videos
Multimedia & Cognitive Load	Misalignment of captions and visuals; excessive text	Caption–visual alignment; controlled pacing; micro-step structure	Structured Sequencing & Cognitive Load Reduction	Structured modules; short instructional videos; visual guides
Instructional Design Models (ADDIE) & Skill-Based Learning Kits	Systematic and testable development	Analysis → Design → Development → Evaluation	Systematic Development	Phased module structure; guided practice activities
Hand Embroidery Learning	Repetitive practice; precision; fine motor skills	Guided practice, mini projects, and demonstration-based learning	Skill-Based Learning	Guided practice activities; visual guides

Note: This mapping illustrates that each kit component is grounded in consistent and well-established design principles across multiple literature domains.

The fact that the literature synthesis has been conducted in a variety of different areas in Table 1 and that a systematic compatibility of extracted design principles and framework constructs with the proposed kit components is present, in turn, reinforces the theoretical basis of the framework. This mapping confirms as well that the suggested components are based on the uniform and evidence-based design principles that provide an opportunity to develop accessible hand embroidery skills among Deaf learners.

Conceptual Validity and Rigour

To strengthen the conceptual rigour of the study, several strategies were employed:

- Thematic consistency across domains: Ensuring that identified principles are supported across multiple literature sources rather than isolated findings.
- Explicit construct mapping: Clearly linking theoretical principles to framework components and expected outcomes.
- Logical coherence: Maintaining consistency in the relationships between user needs, instructional strategies, and learning outcomes.

Such tactics are consistent with the idea of credibility in qualitative and conceptual studies that prioritises clarity, rigour, and theoretical support (Ahmed, 2024; Muid et al., 2025). Also, the incorporation of the Cognitive Theory of Multimedia Learning (CTML) as an analytical framework provides better theoretical support to the framework, making sure that the postulated design principles are backed by the known cognitive learning theory.

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Methodological Flow of Framework Development

Figure 2 shows the flow of methodology that would be used in the current research, describing the way in which the problem would be identified, and the framework would be developed. The methodological procedure of this research is in a systematic flow, starting with problem identification to the construction of the framework. It starts with the definition of the research focus, literature collection and content analysis.

The Cognitive Theory of Multimedia Learning (CTML) is then used to apply a theoretical perspective to interpretation and synthesis. The themes as extracted in the case of visual learning, multimedia design and accessibility are then combined and mapped into a hierarchical framework that will tie together user needs, design principles and kit features, and anticipated learning outcomes. The process leads to a consistent conceptual framework that has an explanatory and useful design role.

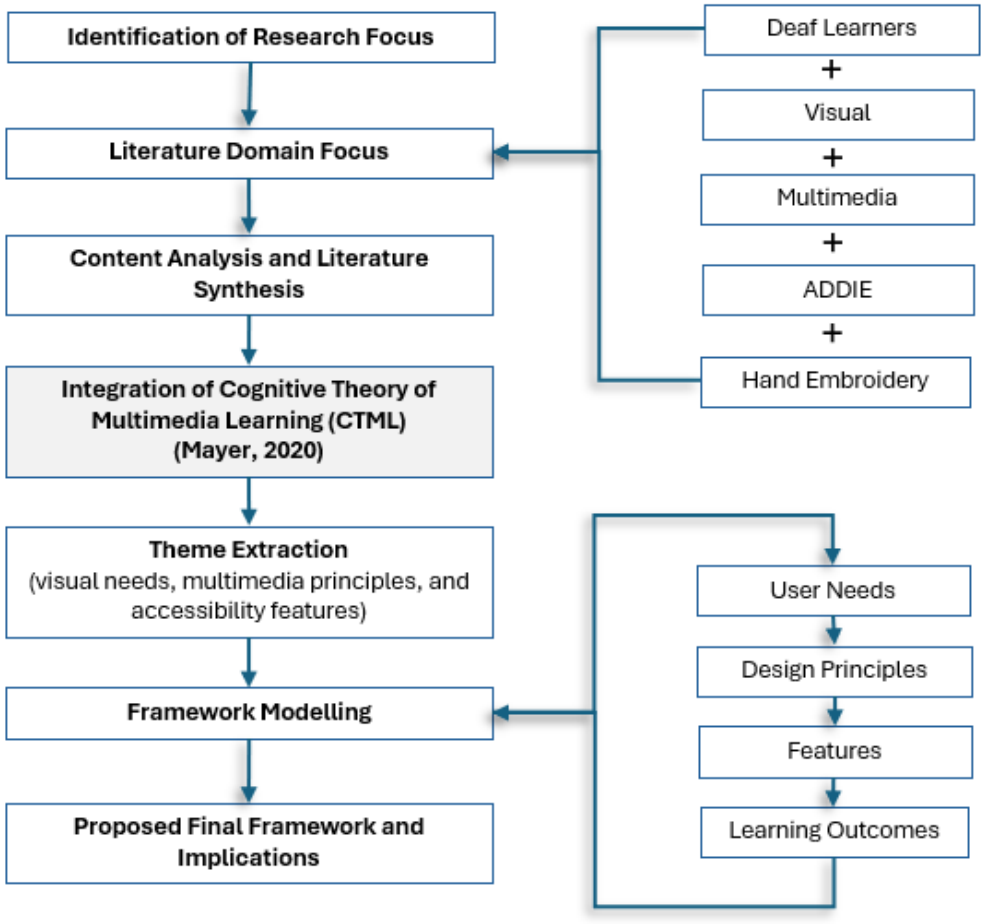


Figure 2: Flow of Methodology for Developing the Digital Hand Embroidery Kit Design Framework.

The final framework represents a synthesis of multidisciplinary knowledge and provides a structured reference for the development of accessible digital hand embroidery learning kits for Deaf learners.

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Results: Proposed Visual-Multimedia Instructional Design Framework

The result of the conceptual literature synthesis is a visual-multimedia instructional design framework for developing an accessible digital hand embroidery learning kit for Deaf learners. The framework was generated by mapping learners' needs, theoretical foundations, instructional design principles, kit components and expected learning outcomes. Rather than functioning as an evaluated product, the framework serves as a theoretically grounded design reference for future prototype development and usability evaluation (Figure 3).

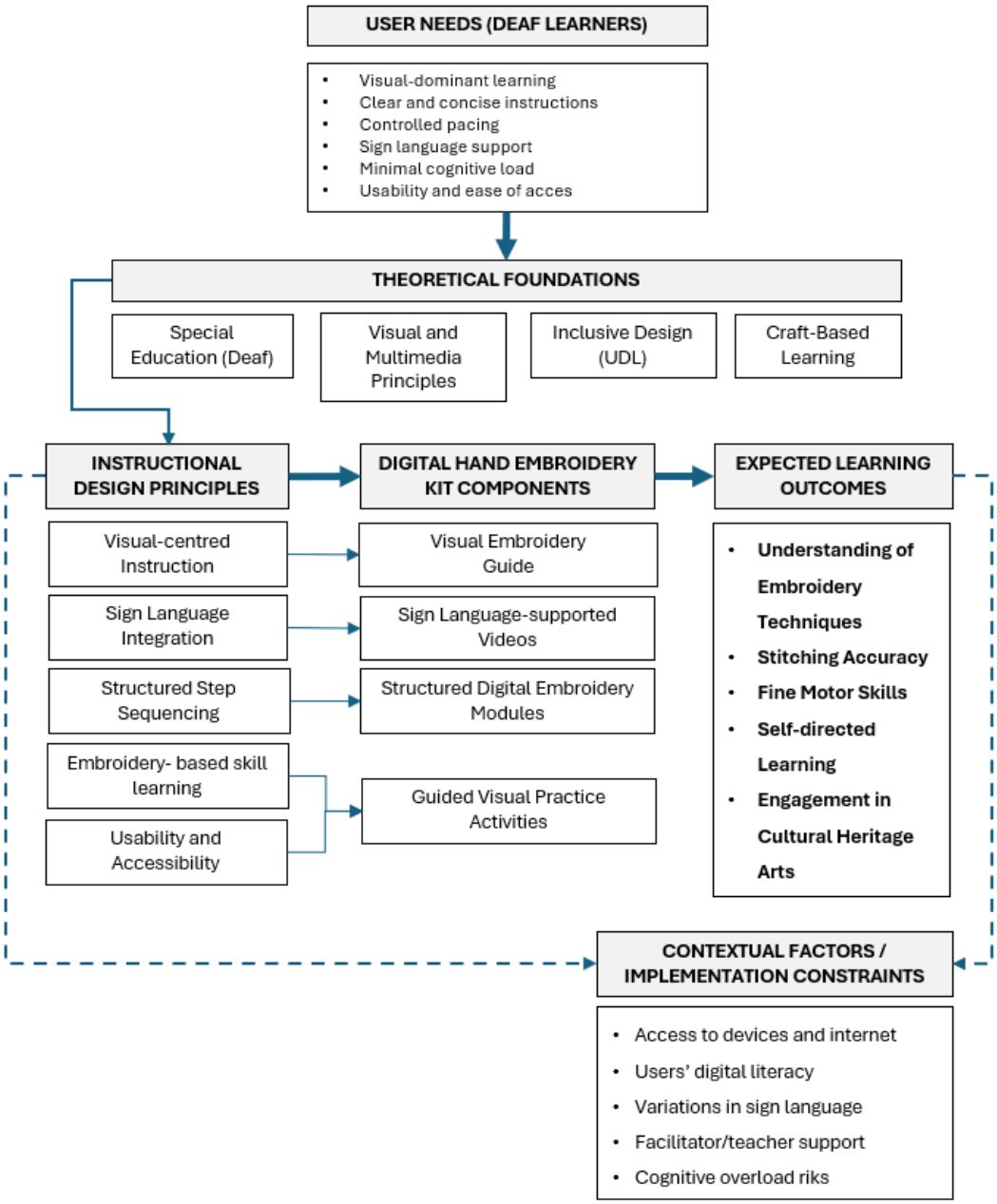


Figure 3: Instructional Design Framework for Developing an Accessible Digital Hand Embroidery Kit for Deaf Learners.

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Core Constructs of the Instructional Design Framework

It is supported by several major instructional constructs, which are all fundamental in supporting accessible learning among Deaf learners in digital skill-based environments. The basic construct of the suggested framework is visual-centred instruction as a manifestation of a very visual character of information processing of Deaf learners. The instructional media should focus on demonstrations, images, and procedural visuals that are guided clearly and thus should come first in the list of priority issues. The visual strengths of Deaf learners must be tapped with the help of dominant visual instructional design and reduced use of complex textual explanations.

In the framework of hand embroidery, it requires a teaching method that displays techniques in close-up demonstrations, sequentially arranged steps and continuous visual cues, so that Deaf learners can observe and follow the procedure accurately without having to process it through too much cognitive load.

Sign language in instructional design as a support, not a dominant component in supporting communication. Although visual demonstrations are still the main element, the concept of adding sign language to visuals makes the idea clearer and improves the idea in communication. According to Prasad (2023), language barriers often occur with Deaf learners; therefore, additional explanations are very helpful in improving understanding without causing repetition or cognitive load.

The model further highlights the rapid instructional direction by organising it into micro-steps, pacing and maintaining consistency in presentation. These factors coincide with the Cognitive Theory of Multimedia Learning (CTML), which emphasises the need to address working memory by dividing it into Fragments and Coherence (Mayer, 2024). In practice, this consists of completing the embroidery method in small steps, ensuring that the easy, then the more complex, and the difficult are learnt while the flow of instruction. This type of organisation minimises the complexity of information and enhances learning.

In addition to instructional design, usability and accessibility also make learning kits viable and usable in a variety of settings. Alit et al. (2025) stated that access to technology by Deaf learners is often limited by device, digital, and infrastructure availability. In this regard, the framework promotes straightforward and easy navigation, uniformity in layout and icon use, and cross-platform compatibility, including mobile platforms. This guarantees that accessibility is not only confined to content design but also the learning process that interacts with the user.

Lastly, the framework sees hand embroidery as a process of procedural and experiential learning with repetition, precision and fine motor skills. Practice based learning, guided tasks, development of skills should be supported by instructional design. In addition, Wolk and Bat (2025) highlight the expressive and therapeutic qualities of embroidery, making it an inclusive learning tool. Embroidered in this context, it is not only a technical detail, but an important way of interaction, expression and learning.

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EISSN : 0128-164X
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Instructional Components of the Digital Hand Embroidery Kit

The four interrelated teaching elements that translate design constructs and principles into practical learning materials make up the proposed framework. The methods are presented in the form of diagrams, stitch patterns, sequences of steps, and results and are introduced through the main teaching element, the visual embroidery guide. This element emphasizes clarity of vision and the accuracy of the procedure, so that the student can interpret and repeat the procedures without relying on long texts and explanations.

Instructional videos in sign language are used for this purpose to provide short explanations to support the conceptual learning and understanding of instructions. These videos are not meant to be demonstration tools, but rather communication supports, centred around key terms, procedural intent, and learning objectives. The design focuses on a shorter period, consistency with the module material, and little overlap with the visual illustrations to prevent cognitive overload.

The learning modules in terms of basic to advanced embroidery techniques are further structured to create instructional material. These modules facilitate self-paced learning based on the controlled progression, repetition and constant sequencing which are fundamental in controlling cognitive load (Chen et al., 2024). The use of the ADDIE model also makes sure that the content development is a systematic and cyclic process, which improves the quality and coherence of the instruction (Abuhassna et al., 2024).

The supported activities include guided practice activities, which play a central role in the kit to facilitate the acquisition of skills. These activities give guided practice to learners in using learned skills by pattern-based stitching, repetitive execution of techniques and small-scale projects. This type of practice is essential to the acquisition of fine motor control and procedural knowledge, which will eventually result in the ability to transfer skills (Sunarya et al., 2024).

All these elements are integrated into the proposed framework for a structured instructional system, which facilitates visual learning, progressive organisation, and accessibility. Table 2 outlines the operational design principles, which transform the conceptual framework into actual development policies, focusing on visual clarity, logical presentation and optimisation of cognitive load. These guidelines provide an instructional design framework for educators to create accessible and inclusive skills-based learning materials.

Table 2: Operational Design Guidelines for Accessible Skill-Based Learning Kits

Learning Kit Component	Design Principles and Guidelines	Accessibility Rationale	Non-Recommended Design Practices
Visual Embroidery Guide	Close-up visuals; directional arrows for thread movement; numbered steps; final output examples	Enables comprehension without reliance on extensive text	Small visuals; mixed or unclear steps; excessive text

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Demonstration Videos	Focus on one technique at a time, slow pacing, and consistent camera angles.	Supports observation and fine motor skill development	Fast-paced videos; multiple techniques at once; inconsistent angles
Sign Language Videos	Concise explanations; key terminology; clear instructions	Supports communication and conceptual understanding	Overly long videos; not aligned with module content
Captions/Text	Short sentences; consistent terminology; positioned near visuals	Reduces cognitive load	Long captions; inconsistent terminology; excessive text
Module Structure	Basic → intermediate → application; micro-step organisation; summaries	Supports progressive and self-paced learning	Overloaded modules; too many subtopics
Guided Practice Activities	Repetition of techniques; simple patterns; mini projects	Reinforces skill acquisition	No practice activities; overly complex tasks
Navigation & Usability	Clear icons; consistent layout; mobile-friendly design	Ensures accessibility across different levels of digital literacy	Complex menus; inconsistent layout

Note: These guidelines operationalise the conceptual framework into practical design recommendations for prototype development and usability evaluation.

Overall, these formulated guidelines emphasise that learning accessibility for Deaf learners should be understood as a design of learning experiences that is visually dominant, structured, and reduces cognitive load. Therefore, this table complements the proposed framework by providing design recommendations that can be directly used in the prototype development phase as well as usability evaluation in further studies.

Expected Learning Outcomes

The implementation of the proposed framework is expected to result in several important learning outcomes, such as better understanding of embroidery techniques based on the structured visual teaching and well-structured sequence of steps. It also encourages fine motor control and accuracy in stitching by practising with guidance and by undertaking repetitive learning tasks, and it encourages a greater level of learner autonomy by providing access to online modules that allow students to independently study and learn. Also, the framework can increase the involvement of the Deaf learners in textile arts and inclusivity in the knowledge transfer of cultural heritage (Ariffin et al., 2023; Shamsuddin et al., 2024).

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EISSN : 0128-164X
Volume 11 Issue 64 (September 2026) PP. 1472-1492

Design Guidelines for Implementation

To translate the conceptual framework into practical use, a series of design principles is suggested to make sure there is coherence between instructional design, multimedia components and user experience. Visual design should pay more attention to close-up pictures, direction signs, and steps in procedures that are clearly numbered, to make the design more precise and clearer. In the cognitive aspect of the multimedia design, caption-visual alignment and pacing control are very important to help with cognitive processing and prevent cognitive overload. The use of text must be clear, regular and devoid of redundancy that is not necessary to avoid losing instructional focus.

Furthermore, systematic skill acquisition must be included in the structure of the modules, which must be characterised by gradual sequencing and micro-step organisation. The design should be easy to navigate, have a consistent layout and be device friendly to cater for the various user scenarios. All these together indicate that accessibility should be considered as part of the general learning design and not as an extra.

Conceptual Contribution of the Framework

The proposed framework contributes to the literature in three keyways:

1. Extending accessibility discourse beyond academic learning into creative skill-based domains.
2. Operationalising CTML principles within a visual-procedural learning context, specifically hand embroidery.
3. Integrating multidisciplinary perspectives, including special education, multimedia design, and craft-based learning, into a unified instructional design framework.

By explicitly linking user needs, cognitive principles, and instructional components, the framework provides both theoretical and practical value for future research and development.

Discussion

This paper argues that digital accessibility for Deaf learners should be viewed as an instructional design issue, rather than merely a technological feature. Conceptual synthesis shows that accessible Digital Learning should not only be a means of providing online content, captions or assistive tools. Rather, accessibility needs to be incorporated into the design, order and delivery of instructional content. It is especially crucial in skill training like hand embroidery, where learners have to watch each other's hand movement, and understand the procedures and repeatedly practise the techniques.

The proposed visual-multimedia instructional design framework responds to this need by integrating three major areas: special education for Deaf learners, multimedia learning principles and skill-based instructional design. The framework highlights the need for visual-based learning, short sentences and avoiding the need for lengthy written or spoken explanations for Deaf learners. This is in line with the belief that Deaf learners learn best through visual demonstration and structured presentation and communication support that meets their learning needs (Polvanov, 2023; Prasad, 2023). Meanwhile, the framework

International Journal of Education, Psychology and Counseling
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EISSN : 0128-164X
Volume 11 Issue 64 (September 2026) PP. 1472-1492
acknowledges the impact of digital device access, digital literacy, and the provision of suitable learning support on digital accessibility (Alit et al., 2025).

The framework is from the multimedia learning perspective, which is based on the Cognitive Theory of Multimedia Learning (CTML) in a visual-procedural learning context. CTML principles such as coherence, signalling, segmenting and contiguity are relevant because hand embroidery requires learners to process visual information carefully and sequence (Mayer, 2024). When video demonstrations, captions, close-up visuals and sign language-supported explanations are not properly aligned, Deaf learners may experience unnecessary cognitive load. Therefore, the proposed framework highlights caption-visual alignment, controlled pacing, short instructional videos and micro-step organisation as essential design principles. This is supported by Chen et al. (2024), who argue that motion design in video-based learning should be aligned with the cognitive processing needs of Deaf and hard-of-hearing learners. Similarly, Liang and Nasir (2026) emphasise that educational short videos become more effective when visual, audio and textual information are structured into meaningful segments.

In terms of skill-based learning, the framework supports the development of procedural understanding through structured modules and guided practice, gradual progression and visual demonstration, making systematic instructional design necessary. The ADDIE model provides a suitable development structure because it allows learning materials to be planned, designed, developed and evaluated in a systematic manner (Abuhassna et al., 2024). Sunarya et al. (2024) also demonstrate the value of video-based tutorial models in supporting vocational embroidery learning. Although their work does not focus specifically on Deaf learners, it supports the importance of structured video-based instruction in skill acquisition.

The inclusion of Azhan et al. (2026) further strengthens the argument that visual instructional tools are valuable in fashion and design education, particularly for learners who require low-verbal and visually guided instruction. Their research about the use of their own product named "EduFIGURE9 Smart Ruler" revealed that the visual support provided in the system does improve drawing accuracy and the motivation of the TVET fashion learners including Deaf learners. This is applicable to the current framework since digital hand embroidery learning also involves visual aids, sequencing and guided practice to enable independence.

Self-directed learning is done through the proposed framework as well. Deaf learners can possibly control the speed of their learning, re-visit materials, practise beyond the class environment and use sign language supported instructional videos, with visual embroidery guides, and structured modules and guided activities. This is important because self-directed learning can reduce overdependence on direct teacher explanation or continuous interpreter support. However, such independence is only possible when digital learning materials are accessible, logically structured and easy to navigate.

Although embroidery also carries expressive, therapeutic and cultural heritage value, these aspects are treated as secondary implications in this paper. The main contribution of the framework lies in its instructional design value. Nevertheless, recognising embroidery as part of creative and textile-based learning may broaden opportunities for Deaf learners to participate in inclusive art and design education. In this sense, the framework contributes not only to digital accessibility but also to the wider discussion on inclusive creative skill learning.

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 11 Issue 64 (September 2026) PP. 1472-1492

Conclusion

This conceptual paper proposed a visual-multimedia instructional design framework for developing an accessible digital hand embroidery learning kit for Deaf learners. Through a conceptual literature synthesis, the paper integrated literature from special education, visual learning, multimedia design, cognitive load theory and instructional design for skill-based learning. The synthesis resulted in a framework that connects Deaf learners' needs, theoretical foundations, instructional design principles, kit components and expected learning outcomes.

The framework highlights four main instructional components: visual embroidery guides, sign language-supported instructional videos, structured digital embroidery modules and guided visual practice activities. These components are designed to support visual clarity, caption-visual alignment, controlled pacing, micro-step sequencing, usability and self-directed learning. The paper therefore suggests that accessibility should be part of the process of designing instruction instead of as an afterthought when the learning materials are created.

The unique value added by this paper is the shift in digital accessibility discussion to creative and skill education with hand embroidery learning for Deaf (students/learners). The framework serves as a design reference for educators, instructional designers and future researchers for the design of inclusive digital learning materials for practical skills in art and design, with theoretical grounding.

But the framework is still a conceptual one and hasn't been tested empirically. To complete the research, expert validation, prototype development, a usability test and intervention-based evaluation with Deaf learners is needed. Such studies would be helpful in finding out the effectiveness of the proposed framework in enhancing the understanding of the embroidery technique, accuracy in stitching, autonomy and engagement in learning of the learners in creative skill-based education.

Acknowledgements: The authors would like to thank the Ministry of Higher Education and Politeknik Ibrahim Sultan for their academic support and environment which helps to develop the conceptual paper. Special thanks also go to those colleagues and peers who gave constructive feedback and scholarly insights that helped to clarify and improve the quality of this manuscript.

Funding Statement: No funding was received for the preparation of this manuscript.

Conflict of Interest Statement: The authors declare that there is no conflict of interest concerning the publication of this paper. Each of the authors has participated in the work and agrees to the final version of the manuscript submitted to the International Journal of Education, Psychology and Counselling (IJEPC).

Ethics Statement: This study did not include any human subjects or sensitive information that needs ethical clearance. The authors confirm that the research was conducted without academic dishonesty or conflict of interest.

Author Contribution Statement: The first author conceptualized the study, did the literature synthesis, prepared the proposed framework and wrote the initial manuscript. The second author gave academic guidance, checked the conceptual and methodological coherence and made critical revision of the manuscript. Before submission, the third author reviewed the instructional design components, gave comments on the framework structure and helped to improve the manuscript.

Declaration of AI-Generated Content AI language refinement, idea organization and clarity enhancement tools were used by the authors in the preparation of the manuscript. The ideas, theories and interpretation of the literature and the final scholarly decision are the responsibility of the authors. The manuscript was reviewed, revised and approved by all authors before submission.

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 11 Issue 64 (September 2026) PP. 1472-1492

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