

Production and Evaluation of a 2D Animated Short Film for Deaf and Hearing-Impaired Viewers

Felix C. Cabardo¹, Maria Christine O. Deonoso², Ashley C. Ingal³, Karlyn Gabrielle C. Pabustan⁴, Aubrey May A. Parica⁵

¹College of Computing and Information Sciences, Systems Plus College Foundation, Angeles City, Philippines

*Corresponding Author Email: twicgroup00@gmail.com

ABSTRACT

This study addresses the critical gap in accessible narrative media for Deaf and Hearing-Impaired viewers, as conventional 2D animation relies heavily on audio-including dialogue, tone, sound effects, and ambience-to convey narrative and emotional context, which standard captions often fail to communicate fully. While existing research advances captioning practices and sign language animation, most work focuses on live-action or educational content rather than integrated, narrative-driven animation. This project develops and evaluates a 2D animated short film designed with three core accessibility features: enhanced visual captions, visual sound effect cues, and sign language overlays, all integrated from pre-production through post-production. Employing a Descriptive-Developmental research design, the study follows a three-phase animation pipeline, with evaluation centered on caption readability, visual clarity, story comprehension, emotional understanding, and overall accessibility using a 5-point Likert scale and audience feedback. Findings will produce evidence-based design guidelines to support inclusive animation production, advancing SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities) by ensuring equitable access to narrative media.

Keywords: 2D animation, accessibility, Deaf and Hearing Impaired, inclusive design, visual captioning, sign language integration

SECTION I — INTRODUCTION (THE PROBLEM AND ITS SETTING)

1.1 Introduction

Digital animation is now widely used for entertainment, education, communication, advocacy, and storytelling. Animated and video content is increasingly shared across social media, streaming platforms, and educational websites, making accessibility a critical consideration in multimedia production. Accessible media uses various visual methods to convey information typically delivered through audio, including synchronized captions, speaker labels, visual sound effects, sign language interpretation, and visual emotion cues (May et al., 2023). The World Wide Web Consortium emphasizes that captions and visual alternatives to audio are essential for ensuring that Deaf and Hearing-Impaired viewers can fully understand video content (World Wide Web Consortium, 2024a). Yet many animated works treat accessibility as an afterthought, leaving Deaf and Hearing-Impaired audiences excluded. This study explores how integrated visual accessibility features can be designed and evaluated in original 2D narrative animation to support equal access for Deaf and Hearing-Impaired viewers.

1.2 Background of the Study

Digital animation is now a primary medium across entertainment, education, and social media, making accessibility a critical design priority. Recent studies have advanced beyond basic transcription to explore enhanced captioning systems that communicate tone, emotion, and speech style through visual design. Ahn et al. (2025) developed a caption system using color, punctuation, and typographic emphasis to distinguish speech styles, finding that these visual features significantly improved Deaf and Hearing-Impaired viewers' comprehension and enjoyment. Similarly, De Lacerda Pataca et al. (2023) found that captions designed to visualize prosody and emotion helped viewers better interpret speakers' emotional states compared to standard captions.

Sign language animation is also emerging as a powerful accessibility tool; Nayuni Sai Charan Teja and Priyadharsini (2025) demonstrated that AI-driven ASL animation significantly improved comprehension and engagement among hearing-impaired children. However, Denner (2024) notes that sign language is rarely integrated into animated content, limiting full access to narrative media. Li et al. (2022) found that most captioning research focuses on live-action or user-generated content, not narrative animation, while Chen et al. (2024) developed motion design principles for educational video but did not address fictional storytelling or multi-accessibility integration. Wells et al. (2022) and Al Amin et al. (2022) emphasize that caption preferences vary widely-one-size-fits-all approaches do not work, and design decisions directly impact readability and comprehension. This growing body of research demonstrates that accessibility features should be integrated throughout the design and production process, rather than added as an afterthought.

1.3 Objectives of the Study

- **General Objective:** To produce and evaluate an accessible 2D animated short film designed for Deaf and Hearing-Impaired viewers.
- **Specific Objectives:**
 1. To identify the accessibility needs of Deaf and Hearing-Impaired viewers when watching animated videos;
 2. To design and develop a 2D animated short film with integrated accessibility features;
 3. To evaluate the animation in terms of caption readability, visual clarity, story comprehension, emotional understanding, engagement, and overall accessibility;
 4. To determine the experiences and preferences of Deaf and Hearing Impaired viewers regarding the accessibility features used;
 5. To formulate design recommendations for creating more accessible digital animations.

1.4 Scope and Limitation of the Study

- **Scope:** This study covers the production and evaluation of a single 2D animated short film designed with integrated accessibility features for Deaf and Hearing Impaired (D/HI) viewers. The film, approximately eight to ten minutes in length, will incorporate synchronized captions, speaker identification labels, visual representations of sound effects and music, visual cues for emotional tone and prosody, and sign language interpretation integrated as an animated character or overlay, with sign language content limited to American Sign Language (ASL) and translated for key dialogue and narration rather than a word-for-word interpretation of every sound cue. These accessibility features will be designed and integrated from the pre-production stage through production and post-production. The finished film will be evaluated by D/HI participants on caption readability, sign language clarity and accuracy, visual clarity, story comprehension, emotional understanding, engagement, and overall accessibility, with data gathered through surveys, questionnaires, or post-viewing interviews, including feedback from sign-language-fluent participants and professionals specifically on interpretation quality. The study will culminate in design recommendations for integrating captions, sign language, and visual cues cohesively in 2D animation.

• **Delimitations:** However, the study has several delimitations. It is confined to one short film in a single language pairing and does not extend to multilingual sign systems or regional sign language variation. Professional feedback will be limited by the number of experts the researchers can consult within the study's timeline and resources, and their review does not constitute full linguistic certification of the signed content. The signing character's design, animation style, and role within the story will follow a single fixed approach, meaning the study does not test alternative ways of representing sign language on screen, such as a separate interpreter overlay versus an in-story signing character, against one another, though this comparison could be flagged as a direction for future research. The evaluation sample may include both signing and non-signing D/HI participants, but the study does not claim generalizability across all D/HI subgroups, such as late-deafened adults unfamiliar with sign language versus Deaf-community members fluent in sign. Technical and timeline constraints may also limit the complexity or naturalism of the animated signing, such as reduced facial expression or handshape fidelity compared to professional motion-capture ASL animation. Finally, the study does not cover real-time or live sign language interpretation systems, being scoped only to pre-rendered narrative animation.

1.5 Significance of the Study

Deaf and Hearing Impaired (D/HI) Viewers. This study directly benefits D/HI audiences by providing an animated short film that integrates synchronized captions, visual sound effects, emotional visual cues, and an in-story Deaf character who communicates through American Sign Language (ASL), ensuring fuller access to narrative content that is conventionally delivered through audio alone. By centering D/HI viewers' feedback in the evaluation process, this study also ensures that the accessibility features reflect real user needs and preferences rather than assumptions made on their behalf.

Animators, Designers, and Content Creators. The findings and design recommendations produced by this study offer actionable guidelines for professionals in digital animation and multimedia production, demonstrating how accessibility features can be embedded into the creative process from the earliest production stages rather than treated as a post-production afterthought. This equips animators with practical, evaluated strategies for producing more inclusive content without compromising storytelling quality.

Deaf Representation in Media. By portraying a Deaf character who communicates in ASL as an active participant in the story, rather than relying solely on an external interpreter overlay, this study contributes to more authentic and meaningful Deaf representation in animated media, supporting broader industry efforts toward inclusive and diverse storytelling.

Future Researchers. This study provides an evaluated design framework and empirical data on integrating multiple accessibility features, captions, sign language, and visual cues, within a single narrative animation. This serves as a reference point for future studies exploring accessible media design, sign language animation, or multimodal accessibility research.

Academic Institutions and the BSEMC-Digital Animation Program. This study showcases the practical application of digital animation skills toward socially relevant, inclusive design problems, reflecting the program's capacity to produce graduates capable of addressing real-world accessibility challenges through creative and technical expertise.

Society and Digital Inclusion Advocacy. More broadly, this study supports the growing movement toward digital inclusion by demonstrating that accessible design benefits all viewers, not only D/HI audiences, while affirming that Deaf and Hearing Impaired individuals are essential stakeholders in media creation and consumption, not merely an afterthought in accessibility compliance.

1.6 Definition of Terms

Accessibility Features. Refers to design elements added to media content to make it usable by people with disabilities. Operationally, in this study, it refers to the combination of synchronized captions, speaker identification labels, visual sound effects, emotional visual cues, and an American Sign Language (ASL)-signing character integrated into the animated short film.

American Sign Language (ASL). A complete, natural language expressed through handshapes, movement, facial expression, and body posture, used primarily by Deaf communities in the United States. Operationally, in this study, it refers to the sign language used by the animated Deaf character to communicate their own dialogue within the film's narrative.

Caption Readability. Refers to how easily viewers can read and understand on-screen text within the time it is displayed. Operationally, in this study, it refers to D/HI participants' rated ease of reading and comprehending the film's captions, as measured through post-viewing surveys.

Character Development. The process of creating and defining a character's design, personality, behavior, and role within a story, ensuring they are believable and consistent throughout the narrative. Operationally, in this study, it refers to the process of designing the animated Deaf character, including their appearance, personality, and signing mannerisms, as well as defining their role and relationships within the film's plot during the pre-production stage.

Deaf and Hearing Impaired. Refers to individuals with varying degrees of hearing loss, ranging from partial to total, who may or may not use sign language as a primary mode of communication. Operationally, in this study, it refers to the target evaluators of the animated short film, whose accessibility needs, comprehension, and preferences are assessed to determine the film's effectiveness.

Diegetic (In-Story) Element. Refers to any character, sound, or visual element that exists within the story world itself and can be seen or heard by the characters in it. Operationally, in this study, it refers to the ASL-signing Deaf character, who exists as a participant within the film's narrative rather than as an external translation feature layered on top of it.

Emotional Visual Cues. Refers to non-verbal visual signals used to convey a character's emotional state or tone. Operationally, in this study, it refers to design elements such as color, motion, and composition used within the animation to represent emotional tone and prosody that would otherwise be conveyed through vocal inflection.

Speaker Identification Labels. These are visual indicators used to identify which character is speaking, particularly useful when the speaker is off-screen or unclear. Operationally, in this study, it refers to text or visual markers paired with captions to indicate which character's dialogue is being displayed.

Story Comprehension. Refers to a viewer's ability to understand and follow a narrative's plot, characters, and events. Operationally, in this study, it refers to D/HI participants' measured understanding of the film's plot and characters after viewing, as assessed through survey or interview responses.

Visual Sound Effects. Graphic representations used to convey non-speech audio information, such as music, background noise, or sound effects. Operationally, in this study, it refers to animated visual elements (e.g., motion lines, icons, or text effects) used within the film to represent sound events that D/HI viewers would not otherwise perceive.

SECTION II — LITERATURE REVIEW

2.1 Introduction to the Review

Digital animation is now a primary medium across entertainment, education, and social media, making accessibility a critical design priority. Recent studies have advanced beyond basic transcription to explore enhanced captioning systems that communicate tone, emotion, and speech style through visual design. Ahn et al. (2025) developed a caption system using color, punctuation, and typographic emphasis to distinguish speech styles, finding that these visual features significantly improved Deaf and Hearing-Impaired viewers' comprehension and enjoyment. Similarly, De Lacerda Patata et al. (2023) found that captions designed to visualize prosody and emotion helped viewers better interpret speakers' emotional states compared to standard captions.

Sign language animation is also emerging as a powerful accessibility tool; Nayuni Sai Charan Teja and Priyadharsini (2025) demonstrated that AI-driven ASL animation significantly improved comprehension and engagement among hearing-impaired children. However, Denner (2024) notes that sign language is rarely integrated into animated content, limiting full access to narrative media. Li et al. (2022) found that most captioning research focuses on live-action or user-generated content, not narrative animation, while Chen et al. (2024) developed motion design principles for educational video but did not address fictional storytelling or multi-accessibility integration. Wells et al. (2022) and Al Amin et al. (2022) emphasize that caption preferences vary widely-one-size-fits-all approaches do not work, and design decisions directly impact readability and comprehension. This growing body of research demonstrates that accessibility features should be integrated throughout the design and production process, rather than added as an afterthought.

2.2 Review of Related Literature and Studies

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2.3 Conceptual Framework

The conceptual framework of this study proposes that an accessible 2D animated short film for Deaf and Hearing-Impairment (D/HI) viewers should be developed through an inclusive, multimodal design approach that considers both communication accessibility and visual information processing.

Figure 1

Conceptual Framework

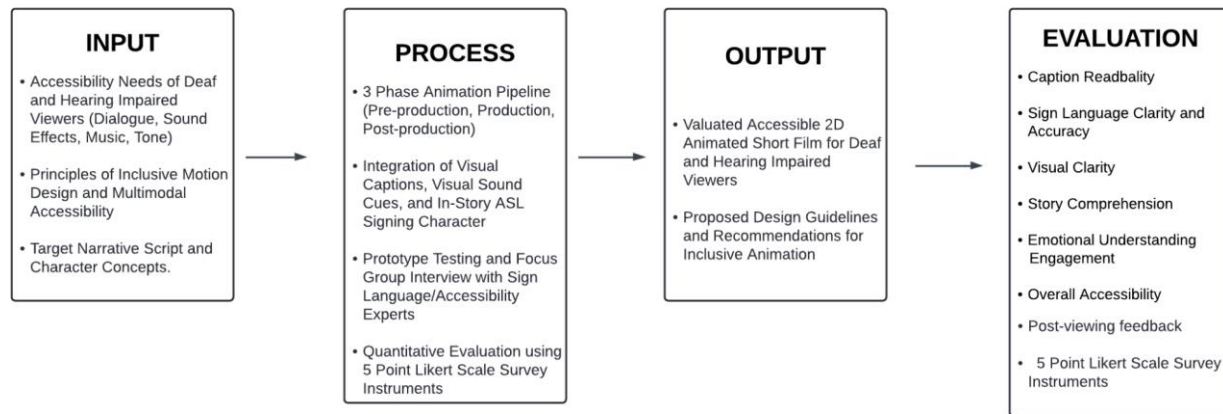


Figure 1 shows the conceptual framework highlighting the input, process, and output of the proposed study. The input consists of the foundational knowledge required to design an accessible animated short film. This includes the accessibility needs of Deaf and hearing-impaired viewers with respect to dialogue, sound effects, music, and tone, as well as the principles of inclusive motion design and multimodal accessibility. These inputs also encompass the development of the target narrative script and character concepts, which together provide the conceptual basis necessary for the animation to be produced.

The process begins with a three-phase animation pipeline consisting of pre-production, production, and post-production. Within this pipeline, visual captions, visual sound cues, and an in-story ASL-signing character are integrated into the film to address the identified accessibility needs. Once a working version of the film is produced, prototype testing is conducted through focus group interviews with sign language and accessibility experts to gather qualitative feedback on the film's clarity, inclusivity, and overall design. This is complemented by quantitative evaluation using 5-point Likert scale survey instruments to measure viewer comprehension, engagement, and satisfaction with the accessibility features.

After the testing and evaluation of the film's effects, the output consists of the finalized, evaluated 2D animated short film designed for Deaf and hearing-impaired viewers, along with a set of proposed design guidelines and recommendations for inclusive animation. The resulting film and guidelines can support future animators and content creators in developing more accessible multimodal media, as well as inform further research on inclusive design practices within the animation industry.

2.4 Synthesis

Digital animation is now a primary medium across entertainment, education, and social media, making accessibility a critical design priority. Recent studies have advanced beyond basic transcription to explore enhanced captioning systems that communicate tone, emotion, and speech style through visual design. Ahn et al. (2025) developed a caption system using color, punctuation, and typographic emphasis to distinguish speech styles, finding that these visual features significantly improved Deaf and Hearing-Impaired viewers' comprehension and enjoyment. Similarly, De Lacerda Patata et al. (2023) found that captions designed to visualize prosody and emotion helped viewers better interpret speakers' emotional states compared to standard captions.

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SECTION III — RESEARCH DESIGN

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