

Integrating Subtitles for the Deaf and Hard of Hearing (SDH) into Vocabulary Instruction: A Conceptual Framework for Malaysian Deaf Education

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ABSTRACT

Vocabulary knowledge is the gateway to literacy for Deaf and Hard of Hearing (DHH) learners, yet the incidental exposure through which hearing children acquire words is largely closed to them (Convertino et al., 2014). This conceptual paper repositions Subtitles for the Deaf and Hard of Hearing (SDH) from an accessibility service into a deliberately designed instructional resource, a linguistic catalyst for vocabulary learning (Liu, 2025), and advances a testable framework for Malaysian special primary education. The framework assigns each of three cognitive theories a distinct explanatory role: Cognitive Load Theory (CLT) defines the boundary condition imposed by a single visual processing channel (Sweller et al., 2019). The Cognitive Theory of Multimedia Learning (CTML) specifies the selection–organisation–integration sequence that SDH materials must support (Skulmowski & Xu, 2021) and Dual Coding Theory (DCT) supplies the mnemonic mechanism by which a written word form and its visual referent jointly stabilise a lexical representation (Sadoski, 2005). ADDIE provides the instructional-design framework, operationalised through two DHH-specific parameters: caption rate calibrated to learners' reading speed (Szarkowska & Gerber-Morón, 2018) and lexical complexity matched to their reading level (Zárate, 2020). Teacher readiness is hypothesised to moderate the delivery of the intervention (Zirzow, 2019). From these relationships, two falsifiable propositions are derived, providing a basis for empirically examining the proposed relationships through quasi-experimental classroom research.

Keywords: SDH, Deaf learners, vocabulary learning, audiovisual translation, ADDIE framework, multimedia learning

INTRODUCTION

The acquisition of a robust vocabulary is a cornerstone of literacy and academic success for DHH individuals, yet it remains a persistent and formidable challenge (Beal et al., 2024). Its fragility is structural rather than motivational: because deaf children are largely deprived of the incidental exposure through which hearing peers acquire words, vocabulary development is typically delayed (Convertino et al., 2014) and must be pursued through explicit, repeated, and visually supported instruction, as Luckner and Cooke conclude in their synthesis of vocabulary research with deaf and hard-of-hearing students.

Subtitles for the Deaf and Hard of Hearing (SDH) are well placed to provide this kind of engineered input. Unlike conventional subtitles, SDH also render non-dialogue auditory information such as sound effects, speaker identification, and descriptions of music and other relevant audio, so that Deaf viewers receive the full information load of audiovisual content (Zárate, 2020). In educational practice, SDH has been enlisted to a single duty: information access, a reactive accessibility tool rather than a proactive, dynamic didactic resource (Chaume, 2018). The consequence is passive consumption. Deaf students view captioned media without the metalinguistic engagement vocabulary learning requires (Talaván, 2019), and a widening mismatch exists

between the captioned materials already available and their systematic deployment in special education classrooms (Liu, 2025).

Malaysian policy has moved decisively toward inclusive education. The *Program Pendidikan Khas Integrasi (PPKI)* and *Program Pendidikan Inklusif (PPI)*, the Malaysia Education Blueprint 2013–2025, and the Persons with Disabilities Act 2008 commit the system to equitable provision, and the Act recognises *Bahasa Isyarat Malaysia (BIM)* as the official language of the Deaf. Classroom practice has continued to rely on the coded manual system, *Bahasa Melayu Kod Tangan (BMKT)*, and on teachers' own *BIM* proficiency, which, while moderate, shows variation that requires strengthening (Kamaluddin & Rashid, 2024). Instruction remains predominantly text-heavy, rarely leveraging the visual strengths on which Deaf learners depend, and Malaysian DHH students continue to lag behind hearing peers in vocabulary and comprehension (Supermaniam & Muniandy, 2025), with measurable consequences for academic performance and social participation (Nasir et al., 2021).

In this paper, the missing link is twofold: a theoretical account of *why* SDH can function as a pedagogical instrument, and a design logic that converts that account into classroom practice. Building on the pedagogical turn in Audiovisual Translation (AVT), in which every AVT mode has come to be recognised for its didactic potential (Talaván & Rodríguez, 2023), we develop the *Didactic SDH Model*: subtitles conceived not as a rendering of the soundtrack but as a scaffold for vocabulary learning, constructed through intralingual translation strategies, the rephrasing and simplification of language within the same language (Chaume, 2018). The model integrates three cognitive theories with distinct explanatory roles, a systematic ADDIE design process, and teacher readiness as a hypothesised moderator (Zirzow, 2019). It thereby extends AVT scholarship beyond the European and Western contexts in which the field has concentrated (Liu, 2025) and provides a foundation for intervention research in Malaysian special primary schools, where the present framework is deliberately bounded to the immediate vocabulary learning of DHH upper-primary learners in Standards 4 to 6.

LITERATURE REVIEW

Vocabulary instruction in Deaf education

Vocabulary instruction for DHH students cannot be left to incidental exposure, because incidental exposure is precisely what deafness removes (Convertino et al., 2014). The research literature, above all Luckner and Cooke's synthesis, converges on explicit, repeated, and visually supported teaching (Cannon et al., 2009), yet it does not extend to audiovisual translation or SDH as pedagogical instruments. Where captioned viewing has been studied with deaf school-age viewers, it has demonstrated measurable comprehension gains (Lewis, 2001). Captions more generally have been shown to benefit reading and language skills (Gernsbacher, 2015), an effect line that formal vocabulary instruction has not yet exploited.

SDH in audiovisual translation and language-learning research

Within translation studies, SDH has historically occupied the subfield of media accessibility, with the pedagogical turn emerging only recently (Chaume, 2018). The didactic potential of captions is well documented: captioned media increase exposure to authentic language input, support the noticing of language forms in context, and can improve comprehension and memory of video content (Perez et al., 2014). The evidence converges on the finding that captions function as scaffolding rather than redundancy, particularly for less proficient learners (Lwo & Lin, 2012). Two limitations bound this evidence. First, the empirical base is dominated by hearing second-language learners (Liu, 2025). Second, the design demands are different for Deaf children, whose captions must match their linguistic proficiency, reading ability, and visual-attention constraints (Pavani & Leonetti, 2026). At exactly this intersection, research on SDH designed for Deaf primary learners in school contexts is very limited (Pavani & Leonetti, 2026).

Cognitive processing of captioned input

Subtitle research framed in terms of cognitive load has established that comprehension declines as subtitle speed rises (Tyler et al., 2009). However, the conventional presentation rate of approximately 120 words per minute derives from hearing-viewer practice (Szarkowska & Gerber-Morón, 2018). For deaf and hard-of-hearing students, learning is a visual balancing act. Without access to sound, every piece of information, such as captions, sign language, diagrams, and teacher gestures, competes for the same visual space. This forces students to constantly split their attention, overloading their working memory in ways hearing peers do not experience (Yoon & Kim, 2011). In this high-stakes environment, poorly designed captions aren't just annoying; they directly drain the brainpower students need to learn new vocabulary (Baranowska, 2019).

The gap

The literature's strands- vocabulary pedagogy, SDH accessibility, multimedia learning, and instructional design- are treated largely in isolation, and instructional-design research that specifically addresses deaf students' language difficulties is scarce (Almalhy, 2022). The field also remains geographically concentrated outside the contexts where Deaf education is most in need of it (Liu, 2025). No framework currently integrates intralingual SDH, vocabulary pedagogy, multimedia-learning principles, and systematic lesson design for Deaf primary learners.

THEORETICAL AND CONCEPTUAL FRAMEWORK

These three theories don't just sit side by side; each does a specific job in explaining the full picture. Cognitive Load Theory defines the boundary condition, the capacity of working memory, and, for DHH learners, its confinement to a single visual channel (Sweller et al., 2019). The Cognitive Theory of Multimedia Learning specifies the processing sequence- selection, organisation, integration- that any SDH material must support; and Dual Coding Theory supplies the mnemonic mechanism by which dual-coded words are retrieved more reliably (Sadoski, 2005).

The mnemonic mechanism

A word encoded with both a verbal trace and an imagery trace is retrieved more reliably than a word encoded with only one code (Sadoski, 2005). SDH is designed as a dual-coding tool. The caption provides the verbal code, while the video scene offers the non-verbal code. The educational value comes from intentionally combining these, so the target word connects to its context without needing to hear it. This is also why intralingually subtitled content is used. For learners who cannot access spoken language, only the written form of the target language can act as the verbal code. Importantly, the difference between verbal and non-verbal here is about how information is represented, not how it is perceived. Both types of input may come through the eyes, but they trigger different mental codes. Captioned video is not just repeating information visually; it activates two separate systems at the same time within one sense.

The processing constraint

DHH learners rely on captions, images, sign language, and teacher explanations, all delivered visually. This places greater strain on their working memory than on hearing viewers (Yoon & Kim, 2011). CTML therefore requires that SDH materials minimise extraneous processing so that selection, organisation, and integration can occur (Skulmowski & Xu, 2021). Two key design parameters are set during the analysis and design phases of ADDIE. The first is setting the caption rate to match learners' reading speed. If subtitles move too quickly, comprehension drops (Tyler et al., 2009). Standard subtitle rates, about 120 words per minute, are based on hearing viewers (Szarkowska & Gerber-Morón, 2018). The framework also monitors characters per second and translates this into production practice. The second parameter is matching language complexity to learners' reading levels. Captions should be easy to read, especially for children, so both length and word choice must fit their reading speed (Zárate, 2020). For Deaf audiences, using verbatim SDH is preferred, so designers focus on complexity and pacing rather than shortening the text (Szarkowska et al., 2016). These parameters are not just

style choices. They decide whether learners can use their mental resources to connect new words with their meanings, or if they get stuck on text they cannot read (Paas et al., 2010).

The instructional framework

ADDIE converts these principles into a deliverable intervention (Shakeel et al., 2022): the analysis phase identifies the vocabulary needs and reading levels of the learners; the design and development phase results in captioned materials in which both of these factors are enforced, with the target words highlighted in a typographical way to prompt recognition of them (Perez et al., 2017); implementation involves an intervention that spans 5-6 weeks, featuring 30-40 minute sessions that introduce 4-6 target words through a structured three-phase protocol. First, a 5- to 10-minute pre-viewing phase introduces new words by pairing written text with corresponding signs and images. Next, a 15- to 20-minute while-viewing phase engages students with an SDH-subtitled video played twice; the teacher pauses at key moments to point out target vocabulary on-screen and reinforce sign-word pairs with a supporting vocabulary chart; and the evaluation phase measures vocabulary gains (Alodwan & Almosa, 2018).

The moderator

The framework further suggests that the teachers' level of readiness influences the impact of the intervention: it is the teacher's pedagogical competence, their confidence in using technology, and their knowledge of strategies specific to the deaf and hard of hearing that decide whether the cognitive resources preserved by well-designed captions are actually channelled into the learning of instructed vocabulary (Zirzow, 2019). This is no mere formality since teachers of deaf and hard of hearing students name a lack of time for training (74%), the absence or outdated state of software (68%), insufficient funding (67%), and missing or outdated hardware (65%) as the main obstacles to integrating technology (Fernández-Batanero et al., 2022; Zirzow, 2019). Therefore, the same materials can be delivered either well or badly. In this case, readiness is presented as a claim that empirical investigation can test rather than as an assumption.

Technical implementation of the development phase

In the development phase of the ADDIE cycle, two main goals emerge: creating captioned materials with clearly marked keywords and setting caption speed to match how fast learners read, measured in characters per second. The next step is finding a way for teachers to create these materials. Research shows that highlighting is effective: DHH viewers prefer bold, word-level highlighting in captioned educational videos (Kafle et al., 2021), and highlighted keywords or keyword-only captions help understanding more than unhighlighted full captions (Perez et al., 2014). Systems for keyword-highlighted and timed captions have already been built and tested (Draxler et al., 2023). The challenge is figuring out how teachers in regular schools can make these files at scale. The suggestions are three methods, each with different levels of difficulty, and choosing one based on a readiness check during the analysis phase.

The simplest method uses automatically created drafts instead of timing captions by hand. YouTube Studio and Otter.ai both make captions that users say work "surprisingly well," but they still need a lot of editing (Dillon et al., 2021). Since these captions come as editable text files, you can focus your corrections on the most important parts. For example, captions from YouTube can be downloaded in subviewer (.sbv) format and opened in a basic text editor (McCarron, 2021). Cloud recordings from Zoom and Microsoft Teams also create editable WebVTT transcripts that teachers can download, edit, and upload again (McCarron, 2021). This automation has been shown to lighten teachers' workloads during busy semesters. In one remote-teaching system using free platforms, students only needed to correct about 6% of words on average, and the process was manageable because editing and finishing steps were automated (Hofstätter et al., 2022). Still, treat this method as a draft, not a finished product, because automatic captions often contain errors, and incorrect captions can make understanding harder even for well-educated adults (Smith et al., 2017).

If you need to create materials from scratch or redesign them, you can use special editing tools. Subtitle Workshop is a popular free tool with timing and insertion features that are easy for beginners to learn (Talaván,

2006), and it is still a common free choice for making caption files (Parton, 2016). MAGpie was the first free caption-making tool and is powerful, but it is harder to learn (Parton, 2016). Aegisub, an open-source editor, supports SSA/ASS subtitle formats, which let you style text and add karaoke-style animation, making it helpful for highlighting words (Talaván, 2019; Zárate, 2020). If you need to show who is speaking using colour, an important SDH rule, yellow, cyan, and green are the suggested colours (Fox, 2018). WebVTT supports colour for each caption and works well in browsers, YouTube, and Vimeo (Zárate, 2020). Researchers have also released a free, open-source Rich Caption Editor for creating captions with extra display options, showing that flexible, customizable caption creation is now easy and not just for experts (May et al., 2024).

The third method uses workflow automation to solve the two main time-consuming tasks. You do not need to highlight keywords one caption at a time. Since each lesson usually has only four to six target words, you can use a single find-and-replace step to add formatting, like bold or colour, to each target word throughout the whole caption file. By using a template made once for the lesson series, you can finish this task in just a few minutes. This kind of automated batch process is the same as the ones used in the lecture and language-learning systems mentioned earlier (Draxler et al., 2023; Hofstätter et al., 2022). You can also automate caption speed adjustments. The system tracks characters per second by calculating caption length and display time, so you can check and adjust the whole file at once. For example, you can make captions longer if the speed is too fast for your class's reading ability, instead of changing each caption one by one.

Two practical warnings are worth keeping in mind, and both suggest that teachers should use the easiest method their situation allows. Many teachers say that subtitle-editing software is hard to use and that hardware can be limited, especially in rural schools (Fernández-Costales, 2020). Professional captioning services are accurate but are often too expensive and slow for the many short videos needed in a five-to-six-week program (Parton, 2016). Still, schools have a long history of making their own captions. For example, teachers of the deaf tested early captioning systems decades ago using equipment already in schools (Baker & Damper, 1986). The development phase should end with a clear audit result, a chosen method (auto-draft, dedicated editor, or batch workflow), the tools to use, and reusable template files. This way, you can plan resources ahead of time instead of searching for them during the process.

Learner-level covariates and potential secondary moderation

Caption processing efficiency may vary across DHH learners according to individual learner characteristics. The framework therefore recognises learner-level conditions, including baseline reading proficiency, primary communication mode, and degree of hearing loss, as potential sources of variation in SDH processing and vocabulary learning. The framework incorporates three learner-level covariates: baseline reading proficiency, primary communication mode (*BIM/BMKT*), and degree of hearing loss. These characteristics are identified during the ADDIE Analysis phase, which considers learners' vocabulary needs and existing reading abilities.

In the primary empirical analysis, these learner characteristics may be treated as covariates to account for pre-existing differences among learners when estimating the effect of the SDH-based intervention. In subsequent or secondary analyses, they may also be examined as potential moderators. In this role, the analysis would test whether the magnitude of the intervention effect differs by learners' reading proficiency, communication mode, or degree of hearing loss. Thus, the same learner characteristic may function as a control variable in the primary analysis and as a moderator in a secondary analysis, depending on the analytical question being addressed.

The first covariate is baseline reading proficiency. It is particularly relevant because caption comprehension closely aligns with reading ability, and DHH students' caption comprehension consistently remains below that of hearing peers (Lewis, 2001). Reading level correlates with caption success and appears to be the dominant factor. Previous research suggests that reading level is associated with caption comprehension and that the effects of caption rate and text-reduction modifications may vary according to learners' reading abilities (Burnham et al., 2008). Accordingly, the framework calibrates caption rate to reading speed and lexical complexity to reading level. Baseline reading proficiency therefore serves as both a design consideration during the ADDIE Analysis phase and a potential covariate in the empirical evaluation.

The second covariate is primary communication mode, specifically *Bahasa Isyarat Malaysia (BIM)* versus *Bahasa Melayu Kod Tangan (BMKT)*. The Persons with Disabilities Act 2008 recognises *BIM* as the official language of the Deaf (Tahir et al., 2021). However, classroom practice often relies on *BMKT*, and teachers' proficiency in *BIM* is moderate but varies and requires further development. (Kamarudin et al., n.d.) Learners' primary communication mode influences how they process visual information. (Marschark et al., 2005). When captions and sign language are presented simultaneously, the two visual channels compete for attentional resources, and no single arrangement has sufficient evidence to support it (Pavani & Leonetti, 2026). Therefore, primary communication mode is recorded as a learner-level characteristic and may be treated as a covariate in the primary analysis and examined as a potential moderator in future research.

Degree of hearing loss represents another potential source of heterogeneity. The World Health Organisation says 'hard of hearing' means mild to severe loss, often with spoken language use, and that people benefit from devices and captions. 'Deaf' usually means profound loss, sometimes with sign language use. Classrooms show this range, with participants' hearing loss going from mild to profound, and groups are similar at the start. How much hearing a learner has left affects how much of the audio they can use as an extra cue (Moradi et al., 2017). Learners with more hearing may follow spoken audio and use captions as support, while those who rely only on captions and visuals experience the material differently (Si et al., 2024). Research shows that caption rate and text reduction affect people differently depending on hearing status (Burnham et al., 2008). Learners who are hard of hearing and have some usable hearing may find captioned materials less visually demanding than those who are profoundly deaf and rely only on visual information (Burnham et al., 2008). Consequently, degree of hearing loss may be included as a covariate when accounting for learner differences and may subsequently be examined as a potential moderator of the intervention effect.

Accordingly, the conceptual framework distinguishes between the primary role of learner characteristics as covariates and their potential secondary role as moderators. In the primary analysis (P1), learner characteristics are statistically controlled when examining the SDH-based intervention's effect on vocabulary acquisition. In the secondary moderation analysis (P2), we examine interaction terms between the intervention and individual learner characteristics to determine whether intervention effects vary across learner profiles. Figure 1 should therefore distinguish the learner-characteristic pathway from the teacher-readiness pathway rather than treating them as a single moderator construct.

A testable model

The framework yields two falsifiable propositions: (1) SDH-based vocabulary instruction produces greater vocabulary gains than conventional instruction matched for target words and lesson hours; and (2) the size of this effect increases with teacher readiness. Central to the model is the concept of the *linguistic catalyst*: SDH accelerates vocabulary acquisition by providing multimodal input that learners would not receive from unimodal written text alone (Sadoski, 2005). It facilitates word learning in context, activates multiple codes simultaneously, and complements rather than replaces direct instruction. Vocabulary acquisition is correspondingly operationalised as gain in written receptive knowledge of the target curriculum words; 15 items assessed through a word–picture matching format and quantified through normalised gain scores (Nissen et al., 2018). As stated, the framework is a testable model rather than an illustration.

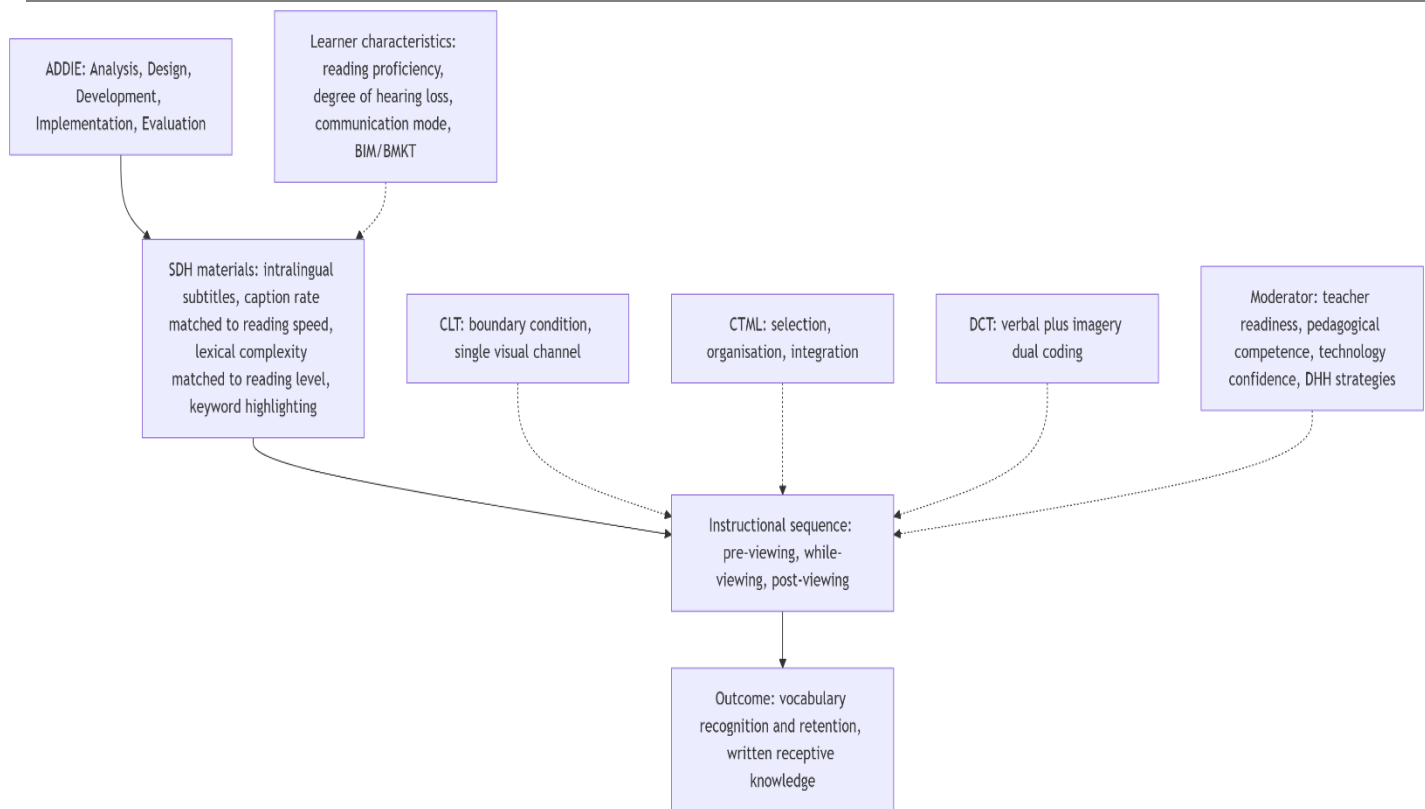


Figure 1 Conceptual Framework for SDH-Based Vocabulary Instruction

The model predicts that ADDIE-designed SDH lessons, grounded in dual-coding and multimedia-learning principles, improve vocabulary recognition and retention by pairing written word forms with contextual visual meaning; teacher readiness is hypothesised to moderate the strength of this effect.

FUTURE WORK AND CONCLUSION

Limitations

The framework is conceptual and awaits empirical validation. Its central assumption is that Deaf learners can benefit from written captions, but this is complicated by the wide variance in reading proficiency within this population (Holt, 1993). They may require supplementary support through sign language, pictures, repetition, or teacher mediation (Cannon et al., 2009). The SDH design itself carries risk: captions that are too fast, too long, visually cluttered, or poorly synchronised can increase cognitive load rather than reduce it (Szarkowska et al., 2016). Finally, implementation depends on teachers' digital skills, access to video-editing tools, institutional support, and knowledge of SDH principles (ÜNLÜER, 2011) dependencies the model makes explicit rather than disguises (Cranmer, 2019).

Future research

Three directions follow. First, the main path of the framework (P1) needs to be tested by quasi-experimental classroom designs comparing the normalised vocabulary gains of learners taught with SDH with those taught with conventional instruction using the same target words and lesson hours (Alqraini & Paul, 2020). This comparison isolates the intervention's contribution from mere time on task. Second, the moderation path (P2) requires an investigation of teachers' perceptions, barriers, and training needs as the principal implementers of SDH-based lessons (Fernández-Batanero et al., 2022), and the ADDIE model should be refined based on teacher feedback and classroom observations (Baldwin et al., 2018). Third, the effects of discrete SDH features- keyword highlighting, subtitle speed, font size, labels for sound effects, and caption placement- on attention and comprehension require systematic study (LEE & Révész, 2018; Perez et al., 2015). The effectiveness of multimedia is ultimately determined by the design of verbal and visual elements that manage cognitive load

(Skulmowski & Xu, 2021). Learner-level conditions, including reading proficiency, sign language background, age, and degree of hearing loss, should be considered in all three programmes of work (Luft, 2017).

Conclusion

This paper contributes a theoretically grounded and pedagogically usable framework that links accessibility and instruction (Liu, 2025) demonstrating how SDH can be deliberately designed and systematically implemented to support vocabulary learning in Malaysian Deaf education. It repositions SDH not as an accessibility afterthought but as an instructional instrument; one that converts passive viewing into active decoding (Talaván, 2019). It supplies the testable propositions on which that repositioning can be empirically secured. For a population whose literacy futures depend on explicit, visual, context-rich vocabulary instruction, that reorientation is not a refinement of practice; it is the practice itself.

Author Note

This study forms part of the main author's ongoing doctoral research at Universiti Sains Malaysia (USM), which examines the use of Audiovisual Translation (AVT) in language learning. The research focuses on the potential of AVT to enhance language acquisition and communicative competence across diverse learning contexts, including both deaf and hearing learners. The author is currently a lecturer at Universiti Teknologi MARA (UiTM) Perak Branch, Tapah Campus.

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