Empowering Hearing-Impaired Learners for Digital Citizenship: A Thai MOOC-Based Design Thinking Approach

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Abstract: In today's technology-driven world, digital citizenship is vital in fostering responsible technology use and essential skills for learning, problem-solving, and community participation. However, a significant focus emerges within digital citizenship—empowering individuals with disabilities. This research addresses this crucial area by spearheading the creation of a specialized Thai Massive Open Online Course (MOOC) meticulously designed for hearing-impaired learners. The core objective is to equip these individuals with indispensable digital citizenship skills for seamless integration and active engagement in digital environments. The study progresses through three key phases. Phase 1 involves crafting the MOOC course to meet the needs of hearing-impaired individuals. Phase 2 develops a course on the Thai MOOC platform, using the MOOC-based Design Thinking Model and universal design learning principles. Phase 3 assesses 20 hearing-impaired learners in the "Utilizing Online Media as Digital Citizenship Course." The research reveals two significant outcomes, highlighting the course's impact. First, an evaluation of digital media quality and learning activities was conducted by five experts with 15 to 30 years of experience in the field, the result was an impressive performance rating of 4.56 on a 5-point Likert scale, indicating the course's high suitability for hearing-impaired learners. Such findings validate the precise alignment of the course with its intended objectives. Second, the outcomes of learning achievement tests on the Thai MOOC platform involving 20 high school hearing-impaired learners revealed that 15 learners scored above 70 (passing), representing 75%. The average post-test score was higher than the pre-test, with an average score of 72.05 points. These results demonstrate the course's effectiveness in improving learning outcomes and meeting predetermined criteria, while also indicating that adopting the MOOC-based Design Thinking model has led to the creation of high-quality media that delivers tangible results for hearing-impaired individuals. This research contributes to the eLearning field by addressing the specific needs of hearing-impaired individuals in digital citizenship education through tailored online learning courses designed to bridge existing gaps.

Keywords: MOOC, Digital citizenship, Online learning, Learning achievement, Universal design for learning, Hearing-impaired learners

1. Introduction

In recent years, there has been a significant uptick in the utilization of online media among individuals grappling with hearing impairments. Maneehaet and Saitong (2023) underscored this trend, highlighting the escalating reliance of the hearing impaired on digital devices across a spectrum of online activities. While this dependence on technology opens up new avenues, it also presents challenges. In the realm of education, the imperative to equip hearing-impaired individuals with essential digital citizenship skills is becoming increasingly pressing, particularly in the context of Thailand. As their digital footprint expands, it becomes essential for them to learn how to responsibly search, evaluate, and disseminate information (Sriwisathiyakun, 2023). Moreover, nurturing their ability to engage in meaningful conversations with diverse groups while upholding ethical and legal standards is equally crucial (Gleason and Von, 2018).

This underscores the necessity for innovative learning approaches. In the era of Education 4.0, marked by rapid technological advancements, the widespread adoption of online education presents a unique challenge for Thailand. This challenge is particularly pronounced for individuals with disabilities, emphasizing the critical need for inclusivity. The goal is to seamlessly integrate them into the digital age and equip them with the requisite knowledge and skills to navigate the digital landscape safely and effectively. Deaf and hearing-impaired individuals have historically had to exert significantly more effort than their hearing counterparts to achieve similar outcomes (Parmisana and Badilla, 2022). Thus, the researcher endeavors to develop fundamental digital citizenship content tailored to the specific needs of hearing-impaired learners, facilitating their learning through digital media on Thai Massive Open Online Courses (MOOC).

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Thai MOOCs epitomize a localized manifestation of online education, with the capacity to reach diverse audiences and offer free services. By integrating digital technologies and thoughtfully crafted learning experiences, learners can actively engage with educational content through various digital mediums, such as exercises, interactive quizzes, collaborative discussions, and practical applications. This collective approach serves to mitigate educational disparities and foster lifelong learning. However, online education for the hearing impaired necessitates a customized approach, including the enhancement of digital infrastructure and the development of pedagogical strategies tailored to their unique learning needs (Sriwisathiyakun and Dhamanitayakul, 2022). Leveraging the human-centered principles of Design Thinking, educators are empowered to innovate empathetic, tailored solutions for varied educational needs. This approach is in harmony with the Universal Design for Learning (UDL), providing a strategic framework to craft inclusive educational content and assessments, including those with special needs. UDL's guidance as well as instructional strategies for hearing-impaired learners support curricula aimed at overcoming learning barriers, increasing teaching flexibility, and securing equitable learning for every student (Meyer, Rose, and Gordon, 2014).

In the context of this research, the focus lies on outlining the methodology for developing an online course within the Thai MOOC framework, specifically tailored to meet the educational needs of hearing-impaired individuals based on the Design Thinking model, Universal Design for Learning principles and instructional strategies for hearing-impaired learners. The research aims to address the following questions: 1) How is the development of the Thai MOOC course utilizing the MOOC-based Design Thinking Model for learners with hearing impairments? 2) What are the learning achievements of hearing-impaired learners in a Thai MOOC course?

2. Literature Review

2.1 Digital Citizenship for Hearing-Impaired Learners

All learners need digital citizenship skills to participate fully in their communities and make smart choices online and in life. The concept of citizenship has evolved on a global scale, driven in large part by the significant technological revolution and rapid digital transformation (Saputra and Siddiq, 2020). The purpose of delving into digital citizenship is to establish a common and shared understanding, emphasizing the vital connection between humans and technology. Digital citizens are those who recognize the rights, responsibilities, and opportunities that come with living, learning, and working in our interconnected digital world (Ribble, 2021). World Association for Christian Communication - WACC (2017) a digital citizenship education framework comprises nine elements of digital citizenship. These categories encompass, digital access, digital commerce, digital communication and collaboration, digital etiquette, digital fluency, digital health and welfare, digital law, digital rights and responsibility, and digital security and privacy. digital literacy serves as a foundation for developing responsible digital citizenship. Individuals who possess digital literacy skills are better equipped to engage with technology safely, ethically, and responsibly (Ohdigital, 2020). In the meanwhile, digital citizenship reinforces and promotes the development of digital literacy skills, fostering critical thinking, effective communication, and responsible digital behavior. Recognizing and nurturing the interplay between digital literacy and digital citizenship is crucial in empowering individuals to navigate the digital world proficiently while upholding ethical standards and respecting the rights of others (Kritzer and Smith, 2020). The incorporation of digital citizenship and media literacy concepts, along with the analytical and creative aspects, can enhance students' grasp of academic subjects, facilitate their engagement in civic activities, and foster responsible digital citizenship (Gleason and Hutchison, 2022). For individuals who are deaf or hard of hearing, digital media serves as a vital means to access information and facilitate communication. The ability to acquire information through digital media plays a profoundly significant role in their lives (Schäfer and Miles,2023; Rachdito and Hidayat, 2022). By enhancing digital citizenship skills, individuals can engage in responsible online behavior, report inappropriate content or behaviors, and promote online safety within their networks. Digital citizenship skills and comprehensive knowledge of technology use are important for those who use signed language interpreters and who utilize them for functionally equivalent access to society and everyday activities (Napier et al., 2017).

2.2 Massive Online Open Course (MOOC) and MOOC-Based Design Thinking Model for Hearing-Impaired Learners

A Massive Online Open Course (MOOC) is an interactive online learning platform that facilitates the exploration of specific concepts. It can be accessed from anywhere at any time. Over time, MOOCs have expanded globally and have taken on various forms, such as cMOOC, xMOOC, and blended learning approaches (Blum, Stenfors, and Palmgren 2020; Babori, 2020; Mota and Scott, 2014; Zhu, 2021). Recent research has delved into the accessibility of MOOCs, considering both the perspectives of course providers and stakeholders (Iniesta et al.,

2022). An examination of studies conducted on MOOC accessibility since 2014 revealed that these platforms have made significant improvements to their features, rendering them more inclusive and user-friendly for learners with particular needs (Królak and Zając, 2022). MOOCs are widely acknowledged for their substantial potential to provide alternative educational opportunities for individuals with disabilities who encounter difficulties accessing traditional educational institutions. Despite this significant promise and their adaptability for accommodating individuals with disabilities, scholars have contended that the majority of MOOC platforms still fall short of achieving universal accessibility (Akgül, 2018). In the realm of educational accessibility, Hearing-Impaired and deaf Learners encounter profound communication barriers that impede their full integration into broader intellectual communities, thereby limiting their opportunities for success. Deafness, characterized by partial or complete hearing loss, presents linguistic challenges encompassing phonological, morphological, and syntactical aspects (Sundström et al., 2018). Moreover, individuals with hearing impairments, stemming from diverse experiences, may interpret spoken language differently.

Consequently, learners with hearing impairments may encounter difficulties in comprehending lectures that rely heavily on language comprehension, potentially impacting their academic performance (Meinzen-Derr et al., 2017). Research has shown that creating multimedia content tailored for the hearing impaired is effective in enhancing content comprehension when combining text and images, compared to content consisting solely of text or text accompanied by sign language, and using videos can have a powerful effect on learning (Deaf Unity, 2019; Mingsiritham and Chanyawudhiwan, 2020). Therefore, digital media accessibility for individuals who are deaf or hard of hearing encompasses not only the use of technological accommodations such as captioning and sign language videos but also the broader spectrum of opportunities it provides. These opportunities include fostering increased interaction, enhancing language proficiency, enriching learning experiences, and bolstering motivation when engaging with digital media (Toofaninejad et al., 2017).

Nevertheless, strategies for MOOC-based media creation must adopt a more comprehensive approach, as proposed by Dhamanitayakul et al. (2023). Dhamanitayakul et al. (2023) developed a MOOC-based Design Thinking Model specifically for hearing-impaired learners to improve educational outcomes and satisfaction. This Model underlines the importance of MOOCs for these students, emphasizing stakeholder engagement, strategic instructional methods, and adherence to UDL principles for better accessibility and learning quality. It also involves learners in creating digital media, providing social interaction, and ensuring the content meets their specific needs. The model comprises integral components, as delineated in Figure 1, which can be described as follows:

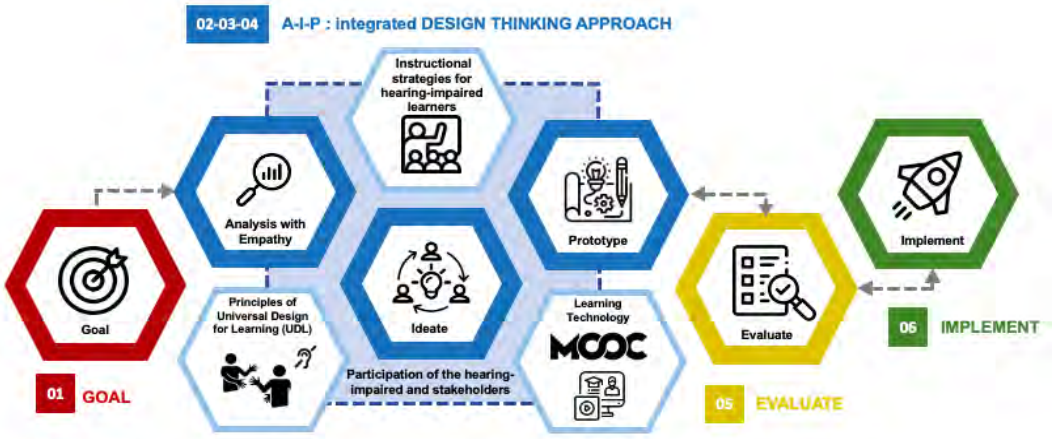

Figure 1: MOOC-based Design Thinking Model for hearing-impaired learners (Dhamanitayakul et al., 2023)

Six stages of MOOC-based Design Thinking Model for hearing-impaired learners.

- Goal (Learning objectives and target audience definition): Set clear learning objectives and identify the target audience for the MOOC. Outline the course prerequisites, craft a comprehensive syllabus, and delineate the essential particulars. Establish the specific learning outcomes aligned with the target learner group.
- Empathetic analysis: Thoroughly analyze and synthesize information with empathy to comprehend the rationale, emotions, perceptions, and motivations underlying the actions of hearing-impaired

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learners. Construct a learner empathy map employing research methods such as observations, interviews, surveys, and involving stakeholders.

- Idea generation: Generate innovative concepts to address challenges and formulate appropriate media solutions for learner issues. Engage in brainstorming sessions to identify unmet requirements of hearing-impaired learners.
- Prototyping: Initiate the creation of pioneering digital media solutions, focusing initially on rapid development rather than aesthetics. Utilize prototypes to validate the effectiveness of proposed concepts in addressing the identified learner challenges. Continuously revisit the empathetic analysis and idea generation stages, modifying and enhancing the media iteratively until the defined objectives are met.
- Evaluation: Conduct thorough testing before implementation, ensuring compliance with relevant standards and compatibility with interconnected systems.
- Implementation: Execute the finalized media solutions on the MOOC platform. Incorporate them into instructional modules and maintain vigilant oversight to monitor and assess learner progress and outcomes.

Co-components of MOOC-based Design Thinking Model for hearing-impaired learners.

- Engagement of hearing-impaired individuals and stakeholders: Incorporate the active participation of individuals with hearing impairments, and experts in hearing and deafness, along with relevant stakeholders.
- Pedagogical approaches tailored for hearing-impaired learners: Employ instructional media strategically to cater to the unique needs of hearing-impaired learners. This encompasses delivering comprehensive content to participants before the course commencement, featuring distinct, clear, and audible sounds or speech.
- Integration of universal design for learning principles: Apply established design principles, such as Universal Design for Learning (UDL), to the creation of digital media that is well-suited for individuals with hearing impairments.
- Incorporation of MOOC (Learning Technology): Incorporate meticulous technical specifications, parameters, constraints, and standards as guiding principles for the meticulous development and design of instructional media.

This research employs the MOOC-based design thinking model for hearing-impaired learners to conceptualize and create a course within the Thai MOOC platform. The aim is to translate the theoretical framework of the model into a practical, tangible course that addresses the specific needs and learning requirements of hearing-impaired individuals.

3. Methodology

3.1 Course Development by Utilizing the MOOC-Based Design Thinking Model

The researcher developed the “Utilizing Online Media as a Digital Citizenship” course using the MOOC-Based Design Thinking Model, for hearing-impaired learners, as elaborated in Table 1.

Table 1: The implementation of course development using the six stages of the MOOC-based design thinking model

Stages	Implementation
01 Goal	This course, titled "Utilizing online media as digital citizenship," focuses on online media proficiency, covering key aspects like online safety, digital presence management, and fostering digital citizenship. The course is 3 hours long, and the assessment includes chapter quizzes (60%) and a final test (40%) combined to be post-test (100%), with certification requiring a minimum score of 70%. Successful students receive an official certificate.

Stages	Implementation
02 Analysis with Empathy	This study involves a thorough analysis of the experiences of individuals with hearing impairments, achieved through interviews with 3 experts who work with hard-of-hearing and deaf learners. The findings can be categorized as follows: Education and communication: Focuses on hard-of-hearing and deaf individuals, emphasizing sign language and real-time captions for effective communication. Digital citizenship for deaf adolescents: Addresses the knowledge gap in understanding online content among deaf teenagers. Tailored interventions emphasize digital rights, security, and privacy in the online context. Creating accessible digital media: Highlights the development of inclusive digital content, featuring simulation-style presentations, sign language, and real-time captions. Encourages active participation of hearing-impaired individuals in media production. Disseminating disability-related content: Stresses the importance of a respectful approach in sharing content related to disabilities. Compliance with the Thailand Personal Data Protection Act (PDPA) and obtaining consent are crucial.
03 Ideate	A collaborative meeting with the production team is scheduled. This team includes instructors, sign language interpreters, deaf performers, directors, and other stakeholders. The goal is to create guidelines for online course development, specifically tailored to meet the needs of hearing-impaired learners. The meeting will address: Guideline creation: Developing guidelines that reflect the unique requirements of hearing-impaired learners, guiding the content development process for the course titled "Utilizing Online Media as digital citizenship." Roles and collaboration: Defining roles for team members and promoting collaboration to ensure a comprehensive approach. Filming schedule and coordination: Planning media filming in coordination with the Thai MOOC team to align with platform dynamics. Activity design adaptation: Tailoring activity designs to meet the needs of hearing-impaired learners, including the use of True/False tests and shorter digital media content.
04 Prototype	The prototype was tested within the assessment framework of the Thai MOOC system, using the testing system (Sandbox studio). The course design adheres to the established Thai MOOC standards. Furthermore, the digital media content produced for this course was uploaded to a dedicated YouTube channel and then integrated into the Thai MOOC platform to enhance the learning experience, as illustrated in Figure 2.  **Figure 2: Screenshot of online media as a digital citizenship course**
05 Evaluate	Assessing digital media quality and formulating online instructional approaches for hearing impaired learners, conduct an evaluation of the caliber of digital media content and the formulation of online pedagogical strategies designed specifically for hearing-impaired individuals. The evaluation process involves the input of five subject matter experts. This panel comprises two experts in hearing-impaired education, two specialists in educational technology, and one authority in curriculum development and teaching methodologies. To assess the suitability of digital media and online learning activities, the outcomes of the suitability assessment were evaluated by calculating their mean ($\bar{x}$) and standard deviation (SD). The means were interpreted using a five-point Likert scale, which ranged from 'Most suitable' (average 4.50 – 5.00) to 'Not suitable / Needs improvement' (average 1.00 – 1.49). A suitability acceptance threshold was set, requiring a minimum average score of 3.50 in each dimension to meet the standard. This benchmark ensures that every aspect of the media and activities achieves a commendable level of suitability.
06 Implementation	This phase involves the seamless inclusion of the course within the operational Thai MOOC platform, ensuring accessibility for hearing-impaired learners. The online scheduling of the course emphasizes educating participants about online media as a facet of digital citizenship. Moreover, a thorough assessment of learning outcomes was conducted with a sample group of 20 learners to measure their

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Stages	Implementation
	achievements. This evaluation adheres to the standards and requirements set by the Thai MOOC framework.

The harmonious blend of key elements within the MOOC-based design thinking model. These components include involving hearing-impaired individuals and stakeholders, using Instructional strategies customized for their needs, applying universal design for learning principles, and integrating MOOC as a sophisticated learning tool. This combination results in a unified and comprehensive model as illustrated in table 2 below.

Table 2: The implementation of four Co-Components of the MOOC-Based Design Thinking Model

Co-Components	Implementation
Participation of the hearing-impaired and Stakeholders	The course development for Thai MOOC has enlisted a dedicated team, encompassing renowned deaf actors, skilled sign language interpreters, and proficient educators. Additionally, a production team with extensive expertise in crafting television content tailored for the hearing impaired has been assembled. This collaborative approach aims to ensure the creation of highly relevant and effective course materials that cater to the diverse needs of the student audience.
Instructional Strategies for hearing-impaired learners	Designing effective content and online learning activities for the hearing-impaired learners by emphasis on sign language Integration with real-time closed captioning and streamlined content development for enhanced comprehension. In the context of online assessment creation, the approach entails crafting questions in a True/False format, supplemented by embedded video clips featuring sign language accompanied by real-time closed captioning for all queries. Moreover, the involvement of hearing-impaired actors is leveraged to foster a sense of trust and authenticity in communication.
UDL for hearing-impaired learners	The guiding principles for designing courses and digital media for hearing-impaired learners, aligned with Thai MOOC standards, and integrated with the MOOC-based design thinking model: Use captions and subtitles for audio. Include visuals to support text and audio. Offer transcripts and text versions of videos. Provide sign language interpretation in videos. Incorporate interactive elements for engagement. These principles serve as a blueprint for creating tailored courses using UDL exclusively for this group of learners.
MOOC (Learning Technology)	According to the course development framework on Thai MOOC platform, the researchers examined the procedural intricacies involved in curricular development within the Thai MOOC system, specifically addressing the needs of hearing-impaired learners. The sequence of activities encompassed the following key steps: Seeking authorization within Thai MOOC: Initially, permission was sought from Rangsit University to create a course in the Thai MOOC system, following the standard "Create a new course" procedure. Crafting MOOC course components: Adhering to instructional material design standards, a thorough approach was taken. This included compiling ten key components: course code, content structure, expert content review, learning media integration, learning activity design, assessment and evaluation methods, course information provision, examination strategy, assessment instruments, and certification documentation. Ensuring copyright compliance: To meet copyright regulations, a systematic investigation was conducted to secure multimedia licenses under Creative Commons licenses, primarily (CC BY NC SA), addressing copyright issues. Assessing learning media development: High-quality video content with clear captions was a priority, promoting autonomous student learning. Reviewing learning activity guidelines: Detailed guidelines for effective learning activities were explored, including content comprehension, interactive learning, and discussion forums for student engagement. Examining learning outcome evaluation: Methods for assessing learning outcomes were studied, involving pre-test, chapter quizzes, and post-test with a defined passing score.

3.2 Evaluating Learners on the Thai MOOC Platform

3.2.1 Research instruments and data analysis

Assessment of learning achievement test consistency: The evaluation of the learning achievement test was conducted by comparing the learning achievement test with the learning content and activity plan, utilizing a panel of five experts, and applying the Index of Congruence (IOC). Each question in the test used had a congruence value meeting the criterion (with the IOC value ranging between 0.50 -1.00).

The learning outcome was assessed through true/false questions in both chapter quizzes and the final test assessments, which were conducted within three hours of studying on the Thai MOOC platform. Initially, learners completed a pre-test consisting of 20 questions (with scores not counted). Subsequently, they completed five chapters, each followed by a test comprising five questions, totaling 25 questions with scores recorded. After completing the lessons, learners undertook a final test with 20 questions. To qualify for a certificate from the Thai MOOC, learners needed to achieve a cumulative score of over 70 points from both the chapter quizzes and the final test.

To study learning achievement, the learning outcome—comprising the combined score of the chapter quizzes and the final test—serves as a reference value for the post-test score. This score is then compared to the pre-test score, with both scores normalized to a scale of 100 points for comparison.

3.2.2 Participants

This phase of the study involved the selection of a targeted sample group using a purposive sampling method. The participants comprised students with hearing impairments enrolled at Sethsathien School, an institution located in Bangkok that caters to deaf and hearing-impaired learners. The sample was specifically drawn from students in grade 8-10 levels, a total of 20 individuals.

4. Results

4.1 Expert's Evaluation

Results from experts' analysis of the quality of digital media and design of learning activities for Thai MOOC participants in Table 3

Table 3: Finding of analysis on digital media quality and learning strategy formulation

n=5

Items	Assessment		
	Mean	S.D.	Level of Suitability
Suitability of digital media development within the framework of Thai MOOC			
The suitability of digital media content	4.78	0.16	Most suitable
The suitability of design and development techniques, including teaching methods used in digital media for hearing-impaired learners	4.22	0.31	Suitable
The suitability of utilizing digital media for hearing-impaired learners	4.56	0.29	Most suitable
Average	4.52		Most suitable
Assessing the instructional strategy alignment of designed online learning activities for individuals with hearing impairments			
The suitability of the learning activities aligns with the requirements of Thai MOOC	5.00	0.00	Most suitable
The suitability of the learning activities ensures adequate support for the lesson	4.33	0.31	Suitable
The suitability of the learning activities for learners	4.56	0.31	Most suitable
The suitability of the methodology for evaluating learner outcomes	4.56	0.29	Most suitable
Average	4.61		Most suitable
Total Average	**4.56**		Most suitable

The outcomes of a comprehensive assessment, undertaken by a panel of five experts during the evaluation phase of the model, which included specialists in educational contexts for hearing-impaired learners,

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educational technology, and digital literacy, offer insights into the suitability of digital media utilized by the "Utilizing Online Media as Digital Citizenship" course. These findings, outlined in Table 3, highlight the effectiveness of media content, with a notable mean score of 4.78 and a standard deviation of 0.16. Similarly, the evaluation of techniques employed in digital media garnered a mean score of 4.22, along with a standard deviation of 0.31, indicating a satisfactory level of proficiency. Furthermore, the assessment of media suitability for the intended audience revealed a significant mean score of 4.56, accompanied by a standard deviation of 0.29, thus confirming the highest quality of content alignment.

Shifting the focus to the instructional strategies employed for developing online learning experiences tailored to individuals with hearing impairments, the evaluation results affirm the model's validity. The assessment of the alignment of instructional strategies with designed online learning activities for hearing-impaired learners showcased outstanding performance levels. Specifically, the mean score for the suitability of the learning activities in line with the requirements of Thai MOOC reached the highest level at 5.00. Similarly, the evaluation results for the adequacy of support provided by the learning activities for the lesson were robust, with a mean score of 4.33 and a standard deviation of 0.31. The effectiveness of the learning activities for hearing-impaired learners also demonstrated high proficiency, with a mean score of 4.56 and a standard deviation of 0.31. Notably, the suitability of the methodology for evaluating learner outcomes achieved a mean score of 4.56, supported by a standard deviation of 0.29, indicating a high level of accomplishment.

4.2 Learning Outcomes of Hearing-Impaired Learners

The learning achievement of 20 high school students with hearing impairment, who comprised the experimental group in the "Utilizing Online Media as Digital Citizenship" course, was examined. Research findings revealed that when converted to a scale of 100 points, the average score on the pre-test was 68.55 points. The average score on the post-test (chapter quizzes and final test) was 72.05 points. Out of these students, 15 individuals passed the test, accounting for 75 %, while 5 students did not pass (scoring below 70 points according to the Thai MOOC criteria), representing 25 %. The results indicated that the average post-test scores were higher than the pre-test. The scores of each learner were arranged in ascending order based on their pre-test scores, with the post-test scores also included, as illustrated in Figure 3.

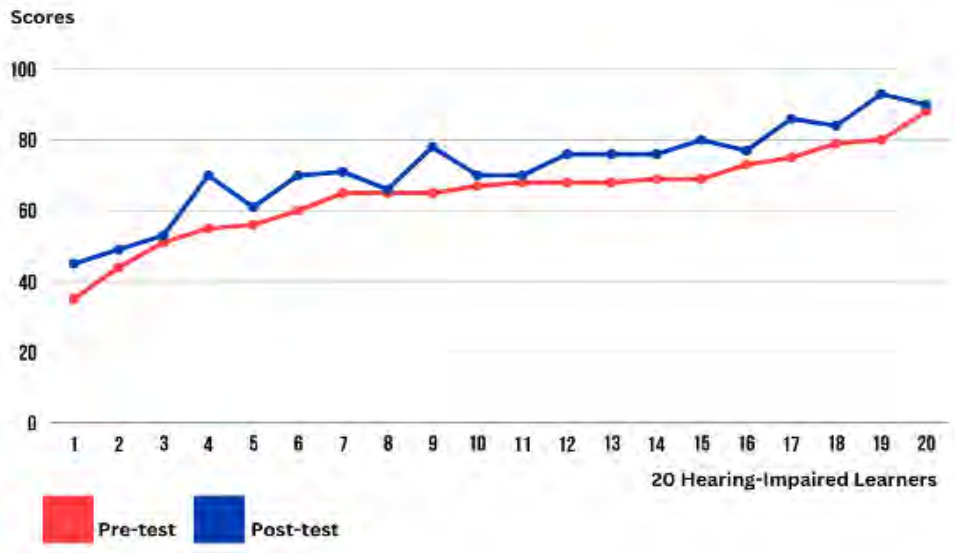

Figure 3: Illustration of the learning achievement of the hearing-impaired learners

5. Discussion

This study has embarked upon the development of a curriculum segment within the MOOC framework, with a primary focus on catering to the educational requirements of hearing-impaired learners. This particular module, titled "Utilizing Online Media as Digital Citizenship Course," has been meticulously crafted utilizing the MOOC-Based Design Thinking Model (Dhamanitayakul et al., 2023). The application of this model in developing digital media has been smooth, encountering no issues. Furthermore, there has been no prior development of learning media specifically for the hearing impaired on Thai MOOC, and adopting this model as a roadmap for development has resulted in high-quality media that yield tangible results for hearing-impaired individuals. The

standout feature of this model lies in its utilization of Thai MOOC, which offers benefits such as accessible, flexible, and cost-effective online education across a wide range of subjects, promoting lifelong learning and skill development for learners worldwide. Additionally, integrating the design thinking model has further enhanced the effectiveness of the curriculum, particularly in catering to the needs of hearing-impaired learners. The research findings indicate that learners achieved higher post-study scores than pre-study scores and passed the Thai MOOC criteria with a success rate of up to 75%, thus confirming the model's efficacy. This aligns with the research of Mingsiritham and Chanyawudhiwan (2020), who experimented with online learning resources on MOOCs to develop life skills for hearing-impaired students and found significant improvements in academic achievement scores and high overall student satisfaction. Moreover, it resonates with de Sá Escudeiro and Campos (2023), who studied the use of MOOCs paired with automatic sign language translation technology and found positive impacts on the learning outcomes of deaf students. Additionally, the digital media developed within this model framework is highly suitable for hearing-impaired learners, a benefit derived from integrating design thinking principles. This is consistent with the research of Suzianti and Atthousi (2019), which employed a design thinking approach to design learning support tools tailored to the needs and desires of deaf elementary students. The testing phase demonstrated significant improvements in visual receptive and expressive language comprehension, indicating the effectiveness of the teaching aids designed using the design thinking approach in enhancing the learning quality for hearing-impaired elementary school students by their needs and desires, as validated by stakeholders.

Additionally, the results of evaluating the suitability of techniques employed in digital media, including the assessment of instructional strategic alignment in the design of online learning activities targeting individuals with hearing impairments, have been deemed highly appropriate, aligning closely with the findings of Ahmed et al. (2022). This alignment underscores the platform's inherent capability to facilitate distance learning, particularly through the provision of educational content complemented by sign language translation videos. Consistent with the research of Mingsiritham and Chanyawudhiwan (2017), it has been established that purely text-based media tends to result in limited comprehension. Multimedia formats, comprising text, images, and sign language, prove to be more effective in enhancing content understanding compared to media containing only text or text combined with sign language, thus meeting the remote learning needs of deaf or hearing-impaired learners. This perspective is supported by the observations of Almalhy (2022), where the effectiveness of video tutorials featuring declarative content and captions was notably evident.

The study sheds light on the complex interactions between deaf or hearing-impaired learners and online technology, emphasizing the inherent challenges of online distance learning, which necessitates the establishment of additional communication channels. Moreover, it acknowledges the cultivation of technological proficiency and adaptability skills among hearing-impaired learners. The academic achievements of hearing-impaired learners emphasize their strong understanding of online media concepts, particularly when media utilize a combination of images and text to enhance engagement and align with learning objectives. These accomplishments reflect an improved ability to effectively utilize online media while also developing a heightened awareness of associated risks. Enhancing online media literacy and digital citizenship is crucial for distinguishing between reality and the digital representation of the world, especially for deaf and hard-of-hearing students. Aligning with the research of Potter, M., Vivienne, S. and Thomas, P. (2014) and Ohler (2011), emphasizing the importance of framing digital education to assist the digitally native generation with disabilities in balancing personal empowerment through digital technology usage and fostering a sense of responsibility towards themselves, their communities, and the world.

6. Conclusions

In conclusion, this research marks a significant stride towards fostering inclusive education and cultivating digital citizenship among hearing-impaired learners through the development of a customized Thai MOOC course. The methodical, three-phase approach ensured the creation of a top-tier course tailored to the unique needs of this demographic. The success of this endeavor underscores the critical importance of providing accessible and inclusive educational opportunities for individuals with hearing impairments. By seamlessly integrating digital citizenship principles into an online learning format, the developed MOOC course equips learners with indispensable knowledge and skills essential for thriving in the digital landscape.

This study's favorable outcomes offer a beacon of inspiration for educators, policymakers, and researchers alike, encouraging them to explore and adopt similar strategies in crafting bespoke courses for other marginalized groups. Throughout the experimental phase, involving 20 hearing-impaired learners, the course's efficacy was meticulously evaluated, yielding impressive results. Notably, the course received exceptional ratings for digital

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media quality and learning activity design, reaffirming the effectiveness of the course development process. Additionally, the learner's exam scores surpassed the pass threshold, reflecting a commendable 75% pass rate and affirming the course's capacity to elevate learning outcomes for hearing-impaired individuals.

Nevertheless, the success of the Thai MOOC course for hearing-impaired learners underscores the transformative potential of integrating digital citizenship education into online learning frameworks. It stands as a testament to the power of inclusive pedagogy and educational technology in creating a more equitable, empowering, and digitally literate society.

Future research should delve into the efficacy of similar tailored MOOC courses, developed using the model employed in this study, for other groups with hearing impairments. This exploration could yield valuable insights into promoting inclusive education on digital platforms. Moreover, investigating the scalability and sustainability of such courses across diverse educational contexts and regions could enhance understanding and implementation strategies. Efforts to mitigate limitations should include expanding sample sizes, integrating qualitative data collection methods, and exploring alternative statistical approaches.

7. Limitations of the Study

The current study encompasses limitations that warrant acknowledgment 1) limited sample size, The study's sample size was constrained due to the specific demographic of hearing-impaired students within audio-visual educational schools. These institutions typically maintain a class size cap of limit at 10 students per class, comprising a heterogeneous group that may include individuals with autism and dual auditory challenges. This unique composition posed challenges in managing the sample for experimental purposes; 2) simplistic statistical approaches, the research opted for straightforward statistical methods to gauge academic attainment. This choice arose from aligning with established requisites, guidelines, and performance standards pertinent to authentic online instructional delivery and management evaluations on the Thai MOOC platform. Evaluation centered on achievement benchmarks derived from chapter quizzes and final tests combined to be 100 assessment points. Successful completion, entailing the attainment of scores exceeding 70 points, was a prerequisite for certification.

8. Protection of Participants' Rights

The researchers ensured the protection of participants' rights by receiving authorization from the chair of the human research ethics committee at Rangsit University to gather research data. The research received official approval with certification number COA. No. RSUERB2022-099, effective as of September 22, 2022. Adhering to the principles stated in the Declaration of Helsinki, the Belmont Report, the CIOMS Guidelines, and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP), the researcher communicated the study's objectives and data collection procedures to the participants before collecting research data. Furthermore, participants were informed that their identities would remain confidential, and the research outcomes would be treated with confidentiality, exclusively for academic purposes.

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