

Pilot Implementation of a Computer-based Training Course on Newborn Hearing Screening and Teleaudiology among Primary Healthcare Providers in Low Resource Settings

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ABSTRACT

Objective. Newborn hearing screening (NHS) in the Philippines has been mandated by law since 2009. However, lack of awareness and knowledge about NHS remains a challenge, especially among healthcare providers. This paper describes the pilot implementation of a computer-based training (CBT) course on NHS and teleaudiology among primary healthcare providers (PHCPs) in rural Philippines.

Methods. A four-module web-based training course on newborn hearing screening and teleaudiology in an online learning management system (LMS) was field-tested among PHCPs from eight rural communities in the Philippines. Participants were given four weeks to complete the course.

Results. Forty-two PHCPs participated in the CBT. Thirty-four (81%) completed the whole course (mean attrition rate of 4.8% per module) at a mean duration of 10.2 days. Baseline data shows that participants had no NHS training, although the majority (83%) had information and communications technology (ICT) training. Comparison of pre- and post-test mean scores showed a 24.0% ($p < 0.001$) significant increase in the post-test in all four modules. Passing rates (i.e., score $\geq 70\%$) from pre- to post-test increased by 54.6% (range: 38-80% increase). Usability of the CBT was rated high with a mean score of 4.32 out of 5 (range: 4.13 to 4.47), covering all eight parameters. Participants expressed general satisfaction and a positive attitude on CBT to improve knowledge on NHS and teleaudiology.

Conclusion. Even in low resource settings where gaps in ICT infrastructure exist, eLearning can be used as an alternative approach to increase awareness and support training of healthcare providers on newborn hearing screening.

Keywords: newborn hearing screening, computer-based training, eLearning



eISSN 2094-9278 (Online)
Published: September 28, 2023
<https://doi.org/10.47895/amp.v57i9.5050>

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INTRODUCTION

Newborn Hearing Screening (NHS) has become a standard of care in many parts of the world.^{1,2} The Joint Commission on Infant Hearing (JCIH) recognizes that the NHS is the first step in identifying childhood hearing loss and recommends a 95% screening rate to implement a universal and national program.³ In the Philippines, the enactment into law of the "Universal Newborn Hearing Screening and Intervention Act" in 2009 established a program for the early diagnosis, intervention, and prevention of hearing loss that mandated all newborns to have access to hearing screening. This is led by the Department of Health (DOH) and its technical arm, the Newborn Hearing Screening Reference Center (NHSRC) of the National Institutes of Health, University of the Philippines Manila (UPM). Implementing the law involves a continuing process of building and instituting basic infrastructures, setting operational and technical standards, and quality assurance programs. The provision also includes certification of personnel and accreditation of newborn hearing centers (NHCs) categorized from A to D. This classification is based on an NHC's ability to provide a range of hearing services for children – from screening, confirmatory diagnostic testing, rehabilitation and/or surgical intervention.⁴

However, despite the law's enactment, less than 10% of newborns are screened for hearing loss.⁵ Challenges include the lack of succeeding confirmatory diagnostic and intervention services,⁶⁻⁸ the complex geography of the Philippine archipelago that render difficult physical access to NHC, and the high proportion of babies born outside hospitals where specialists and equipment are not available.⁹ NHS services can be prohibitive to the poor in this context: the high cost of screening devices means the existing NHC recover investments thru patient service fees. There is a lack of accredited screening facilities and personnel. Many screening NHCs cater to babies but are not clearly organized into an NHS care referral system.¹⁰ These concerns hinder the full implementation of the National Newborn Hearing Screening and Intervention Program.

These challenges reflect the situation in most developing countries characterized by the shortage of healthcare providers and financial resources.^{11,12} The lack of proper training and poor performance of screeners render 80% of hearing screening programs ineffective.¹³⁻¹⁷ The World Health Organization (WHO)¹ highlights working within the framework of primary health care, especially in low resource settings, in addressing the global burden of disabling hearing loss. The WHO emphasized the importance of capacity-building and quality assurance.

The role of health care professionals is crucial in the health care system.¹¹ Their capacities remain inarguably essential to provide healthcare services effectively. Continuing professional development (CPD) must be in place as a mechanism to support the continuous delivery of essential health services.

CPD for professionals serving rural and remote communities poses a challenge. Consequently, eLearning has been applied in health education to increase access to training.¹⁸⁻²⁰ Never has this been more relevant than now, in the setting of a pandemic wherein distance, online, and computer-based learning have become the primary format of education. This is especially true in low resource countries where face-to-face encounters are still limited.^{21,22}

eLearning comprises a new educational paradigm and new learning methods that utilize digital media and tools to promote learning.²³ Alternatively called computer-based training (CBT), this is designed to be remotely accessible and delivered in synchronous (or real-time) or asynchronous mode. The latter affords learners the opportunities for learning at a time and place convenient for them.

There are contradicting findings comparing outcomes of traditional classroom teaching and the use of CBT.²⁴⁻²⁶ Yet, these are but media of instruction. Effectiveness relies on the effort placed throughout the education process: prior to, the actual training, and learner assessment and feedback, as well as the training program evaluation. Schmidt and Brown²⁷ pointed out that the comparison of CBT to face-to-face training does not intend to find significant differences between the two media but rather an affirmation that CBT can be an effective alternative or complement, such as in blended learning.²⁸ When one method is no better than the other in the context of learning outcomes, CBT is justifiable, especially in conditions of distance learning.

The design and development phases facilitate and contribute to better learning outcomes.²⁹⁻³¹ Additionally, Sinclair and colleagues³² refocus the debate on learning that promotes behavioral change and improvements in patient outcomes, emphasizing the importance of standardized assessment beyond the knowledge gained and satisfaction with instruction. Similarly, the measure (of CBT) should eventually include organizational impact.³³

The Hearing for Life Project

Increasing the Rates of Newborn Hearing Screening with Novel Technologies and Telehealth, or the *Hearing for Life (HeLe)* research program is led by the University of the Philippines (UP), in collaboration with the University of California, under the Commission on Higher Education (CHED) - Philippine California Advanced Research Institute (PCARI). The HeLe is proposed to increase hearing screening rates through several convergent components. The HeLe is a strategic approach towards democratizing access to hearing screening for all Filipino newborns. This is through building capacities of primary care government Rural Health Units (RHUs) to become Category A NHC, more accessible to communities. Primary healthcare providers (PHCPs) serving these RHUs, will be equipped with competencies in the NHS. The HeLe research program also includes the development and eventual deployment to these Category A NHCs of low-cost, accurate, and clinically validated hearing

screening devices with telehealth capabilities.³⁴ That is, NHS data will automatically be relayed to the HeLe NHS Registry; and in the case of newborns screened to warrant confirmatory testing to ascertain hearing loss, these patients will be tele-referred through the HeLe telehealth system. These Category A NHCs will be linked with Category B to D NHCs, organized as the NHS and intervention service delivery network (SDN) for infants with hearing impairment within the locale. These are steps towards a more sustainable National Newborn Hearing Screening Program.

The capacity building component of the HeLe capitalizes on the use of information and communications technology (ICT) to train clinicians to facilitate NHS service delivery, and ethically and securely manage health information of patients. It builds on the existing training programs and experience of the Newborn Hearing Screening Reference Center (NHSRC) and the National Telehealth Center (NTHC), of the National Institutes of Health, UP Manila. The HeLe Capacity Building Program for the PHCPs was designed and developed using a blended-learning approach combining: (1) computer-based training, (2) face-to-face training, and (3) on-site coaching. It aims to build the abilities of PHCPs, to value, practice NHS by integrating the use of novel technologies, and appropriately refer patients identified to have potential congenital hearing problems to the closest Category B NHC for confirmatory diagnosis, and eventual intervention. The design of the HeLe Capacity Building Program is discussed in another paper.

Aside from the known benefits of CBT, this was also a means to minimize the number of days PHCPs need to be pulled-out from their clinics to attend and learn the HeLe, its innovations in support of the Universal NHS and Intervention Program. This is the first known computer-based training, embedded in a blending learning strategy in the Philippines intended for PHCPs serving government rural health units.

The HeLe Computer-Based Training Course

The Hearing for Life CBT Course, a three-day face-to-face training and on-site coaching comprise the blended learning strategy of the HeLe Capacity Building.

The Hearing for Life CBT Course aims to provide the learners with theoretical and procedural knowledge on NHS and teleaudiology. It was developed as a web-based, learner-paced (asynchronous) course delivered via Learning Management System (LMS). It was made accessible to targeted learners using common web browsers. The CBT is composed of a pre-test, and four Modules that target specific learning objectives, described in Table 1. Each Module contains learning units that embody didactics, learning exercises, and an assessment section that the learners must complete before moving to the next Unit or Module. For the learner, the post-test serves as a summative assessment for the HeLe CBT. The study participants were given four weeks to complete the course.

The HeLe Computer-Based Training Course was deployed in two batches, as prerequisite to the face-to-face training (FTF) learning event, which, in turn, was held four weeks after the start of the CBT implementation period.

The CBT course administrator provided instructions via email, as well as technical support in accessing the course. During the period of implementation, for Batch 1, Modules 1 to 3 were made available altogether. On the other hand, Module 4 was released three weeks after the start of the course. This was due to the delays in HeLe device development affecting the original timeline. The participants were advised of the schedule of release. For Batch 2, Modules 1 to 4 were released altogether.

A forum in the HeLe social media platform was created for announcements, i.e., additional resources. Questions from participants were also addressed through this; the HeLe social media page was designed to encourage group interactions/discussions.

This paper presents the results of the pilot implementation of the developed CBT among primary healthcare providers (PHCPs) serving in selected rural health units.

METHODS

Research Design, Setting, and Recruitment of Participants

This is a descriptive study utilizing mixed methods to describe the experience of primary healthcare providers (PHCPs) from rural health units (RHUs) and assess the learning outcomes resulting from the use of the developed HeLe CBT Modules.

The PHCPs were recruited from eight RHUs: four from the Western Visayas Region, three from the Romblon islands, and one from the province of Bulacan. Each RHU covers an average of 31 barangays ($SD = 16.6$; ranges from 12 to 52 barangays per RHU), caters to a mean population of 47,732 ($SD = 28,287$) individuals, and has an average of 316 livebirths per year ($SD = 235.9$). Four out of the eight RHUs provide services to geographically isolated and disadvantaged areas (GIDAs).

Purposive sampling

Pilot sites were identified in line with the overall objectives of the HeLe research program. The selection was based on the following criteria:

1. A previous eHealth project implementation site, considered as a successful pilot site;
2. With an Electronic Medical Record (EMR);
3. With internet connectivity; and
4. Proximal to certified NHS confirmatory and intervention centers, which are part of the (HeLe) NHS Service Delivery Network (SDN).

Table 1. HeLe CBT Modules' Learning Objectives and Units

Modules	Learning Objectives	Units	Duration (in minutes)
1	Newborn Hearing Screening Course		
	1. Describe RA 9709, theoretical basis, purpose, and its history	1. Introduction to the Universal Newborn Hearing Screening and Intervention Act of 2009	16
	2. Define the different hearing screening and diagnostic modalities in determining hearing loss in infants	2. Hearing Screening and Diagnostic Modalities in Determining Hearing Loss in Infants	25
	3. List the available interventions for hearing loss in infants in the Philippines	3. Available Interventions for Hearing Loss in the Philippines	10
	4. Define the Newborn Hearing Screening Registry and reporting methods	4. Reporting and Registry	18
	5. Describe the Newborn Hearing Screening Program including the significance of early identification and intervention of hearing loss		
2	How to Do Newborn Hearing Screening		
	1. Enumerate and describe the steps in conducting the newborn hearing screening test using OAE or AABR	1. Screening (NHS) Using Otoacoustic Emissions (OAE)	18
	2. Describe the preparation prior to conducting the test, and	2. Newborn Hearing Screening (NHS) Using Automated Auditory Brainstem Response Test (AABR)	17
	3. Recall scripts in communicating a Pass or a Refer result		
3	eHealth and ICT Tools for NHS Implementation		
	1. Describe eHealth and the ethical and legal guidelines governing its practice	1. The Ethico-Legal Aspects of eHealth	29
	2. Describe the Community Health Information Tracking System (CHITS) and its benefits.	2. An Introduction to the Community Health Information Tracking System (CHITS)	18
	3. Define telemedicine and its different types and uses	3. Getting Started with CHITS	15
	4. Demonstrate how to use CHITS to find or register patients, put them on queue, and manage their folders	4. Telemedicine and the National Telehealth System (NTS)	15
4	Newborn Hearing Screening Using the HeLe Device and Teleaudiology		
	1. Describe the Hearing for Life Project	1. The Hearing for Life Project	6
	2. Explain the steps on how to do newborn hearing screening using the HeLe device	2. Using the HeLe AABR Device	5
	3. Demonstrate how to use the CHITS Newborn Hearing Screening Module, and	3. Using the CHITS Newborn Hearing Screening Module	9
	4. Demonstrate how to refer a patient through the NTS Teleaudiology Module	4. Using the National Telehealth System (NTS) Teleaudiology Module	7
Total:			208 minutes (3 hrs., 28 mins.)

These inclusion criteria resulted from discussions by the research proponents, who are experts in the field of NHS, public health, eHealth and medical device research implementation, and health professions education in the Philippines. Likewise, these sites were selected based on a review of relevant studies on the implementation of telehealth projects, and analysis of the existing healthcare system, and the potential for an SDN for hearing screening and audiology. A final list of HeLe sites was prepared. The HeLe research proponents engaged the RHU physicians as the facility HeLe program managers, who, in turn, assigned their PHCPs as the designated hearing screeners of these selected RHU pilot sites. Each RHU was initially asked to identify three to five PHCPs to undergo training on NHS and teleaudiology. The minimum number of trainees per RHU was set to include at least one physician (usually the Municipal Health Officer), and one to two public health nurses and/or midwives. An average of four PHCPs was recommended for training by their respective MHOs per RHU. We calculated the minimum sample size at 30 PHCPs from eight RHUs, assuming a 5% margin of error. Training is

acknowledged as a preparatory step to implement the NHS service. All study participants consented to participation.

Data Collection

A pre-test and post-test were administered for each HeLe Course Module to assess learners' progress in their knowledge of the basic concepts of NHS and eHealth.

A Usability questionnaire was adapted from Zaharias' Usability Questionnaire.^{35,36} The questionnaire was used to characterize and qualify the user's perceived usability of the CBT. That is, the degree to which the PHCPs can use the HeLe eLearning software to achieve the learning objectives with effectiveness, efficiency, and satisfaction.³⁷ The questionnaire contains 36 items grouped into eight parameters: (a) *content (of the CBT)*, (b) *learning and support*, (c) *visual design*, (d) *navigation*, (e) *accessibility*, (f) *interactivity*, (g) *self-assessment & learnability*, and (h) *motivation to learn*. Parameters *b* to *g* relate to the web design and instructional aspects of the CBT; these are the technology-related components of the CBT. Parameter *h* relates to the affective dimension of learning.³⁶ The learners were asked to rate their agreement

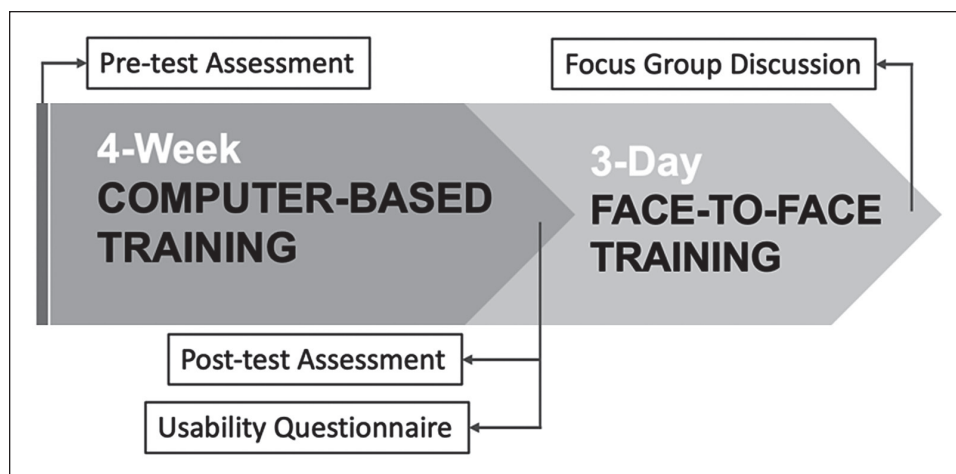


Figure 1. Data collection process.

to statements using a 5-point Likert rating scale, where 1 corresponds to *strongly disagree* and 5 for *strongly agree*.

A focus group discussion (FGD) was conducted to elicit other qualitative feedback from the learners. The FGD was conducted at the end of the face-to-face training of the HeLe Capacity Building Program; the latter was implemented four weeks after the start of the CBT course. The FGD facilitator was guided by a semi-structured questionnaire developed by the research team. Figure 1 shows the data collection process relative to the training implementation period.

Data Analysis

Data from all participants of Batch 1 (28 learners) and Batch 2 (14 learners) were combined for analysis. The data on the pre- and post-test scores and the duration of access to the CBT were extracted from the LMS utilizing descriptive statistics to present data. Item analysis was done to identify knowledge gaps. Participants' ratings on the Usability questionnaire were summarized and were presented using mean scores. User Satisfaction was described using a qualitative content analysis^{38,39} of the recordings and transcripts of the FGD. Identified themes were categorized as Enablers and Obstacles/Barriers to CBT use. The participants' statements were quoted, enclosed in quotation marks, and italicized. These have been translated from Filipino to English. Words or phrases in brackets were insertions to complete the intent of the speaker, and ellipses signified deletions.

Ethical Considerations

This study was approved by the University of the Philippines Manila Review Ethics Board prior to implementation. A Research Agreement for the HeLe Research Program was formally entered into by the pilot sites and the PNEI, and individual informed consents from participating PHCPs were obtained.

RESULTS

Characteristics of Participants

The participants include 42 PHCPs from eight identified RHUs; ages of the learners range from 22 to 64 years (M=41.3, SD=12.4) and majority are female. Among them are physicians, midwives, nurses, medical technologists, and other support staff (e.g., IT designate, nurse aide, and staff). The majority (83%) reported previous training in ICT for health, while none had any experience with NHS training (Table 2).

Completion of the HeLe CBT Modules

Out of the 42 participants, the majority or 34 (81%) learners completed the whole CBT course within the prescribed four-week period. A total of eight participants were unable to complete the course, with mean attrition rate of 4.76% per module. Overall, the mean duration to complete the CBT was 10.2 days (range: 3-21 days) or 245.3

Table 2. Demographics of the Primary Healthcare Providers

Demographics	n (%)
Age (years)	22-64
Mean	41.3
SD	12.4
Sex	
Male	11 (26%)
Female	31 (74%)
Occupation	
Physician	9 (21.4%)
Nurse	11 (26.2%)
Midwife	15 (35.7%)
Medical Technologist	2 (4.8%)
Others	7 (16.7%)
Previous training	
Newborn Hearing Screening (NHS)	0 (0%)
Information Communication Technology (ICT)	35 (83%)

Table 3. Comparison of Average Pre-Test and Post-Test Score per Module

	Mean Pre-test Score (%)	Mean Post-test Score (%)	Mean % Change (Pre- to Post-test)	p value
Module 1	61.7	77.6	16.1	<0.001
Module 2	64.7	93.4	28.7	<0.001
Module 3	73.7	93.6	20.0	<0.001
Module 4	59.8	75.4	31.2	<0.001
Total	65.0	85.0	24.0	<0.001

hours for all participants. The duration of access extracted from the LMS was computed from when the learner first started the course to the day it was completed and does not exclusively account for the login hours.

Extracting the data for the two separate schedules of CBT release, Batch 1 (28 learners) completed the course for the mean duration of 13.6 days (range: 3-21 days) or 327.9 hours, where 10 (45%) participants started the course on week 1 but had to wait for the delayed modules resulting to the increased in the duration of access. Despite accessing the course early, the recorded time of completion for Batch 1 significantly increased. Batch 2 had a mean duration of 3.9 days (range: 1-7 days) or 94 hours; 2 (20%) participants accomplished the course within 24 hours. Apart from the availability of all modules at the time of release for Batch 2, other reasons for shorter time completion were not explored.

Pre-Test and Post-Test Results

Participants undertook the HeLe pre-test prior to the CBT and the post-test upon completing the four modules. Passing rate of participants (i.e., those who had a score ≥70%) from pre- to post-test increased overall by 54.6% (range: 38-80% increase for the four modules). Table 3 compares

pre- to post-test results showing a 24.0% (p<0.001) mean significant increase in the post-test in all four modules.

Figure 2 shows the proportion of participants who met the 70% passing mark in the pre-and post-test. Mean pre-test scores revealed failure in three of the four modules, with an average of 65% across all modules. The range of mean scores is 59.8% (Module 4) to 73.7% (Module 3). More than half of the participants failed the pre-test on modules 1, 2, and 4. The learners only passed Module 3, in which the majority of the content is already familiar to them and for which they received prior training (eHealth and ICT tools). Results are not unexpected, given that the participants had no prior training on the NHS.

Pre-test item analysis showed knowledge gaps in the following areas: (a) *scope of the universal NHS law*, (b) *categories of NHCs*, (c) *stop criteria for NHS*, (d) *early hearing diagnostic and intervention services*, (e) referral protocol for newborns with 'refer' NHS results (for Module 1), and (f) *testing procedures* (for Module 2). Low scores were also noted in items regarding (g) *basic bioethical principles*, (h) *components of Data Privacy Act*, and (i) *practice of telemedicine* (for Module 3). Module 4 introduces a novel technology – the HeLe system – which was developed for the project; the learners scored least in this module in the pre-test (mean score of 59.8%).

After taking the CBT course, a significant increase is shown in the post-test for all four modules – as was expected. The least improvement is observed for Module 1, at 16.1%. Given the 71.05% passers for the post-test, the remainder of about 29% of learners were still unable to meet the passing score. Post-item analysis revealed knowledge gaps remain for *categories of NHCs*, with only 50% of the participants answered the related question correctly and 13.6% for *stop criteria* and *referral protocol*.

Overall mean post-test score was 85%; thus, the mean post-test score is considered as passing the HeLe CBT.

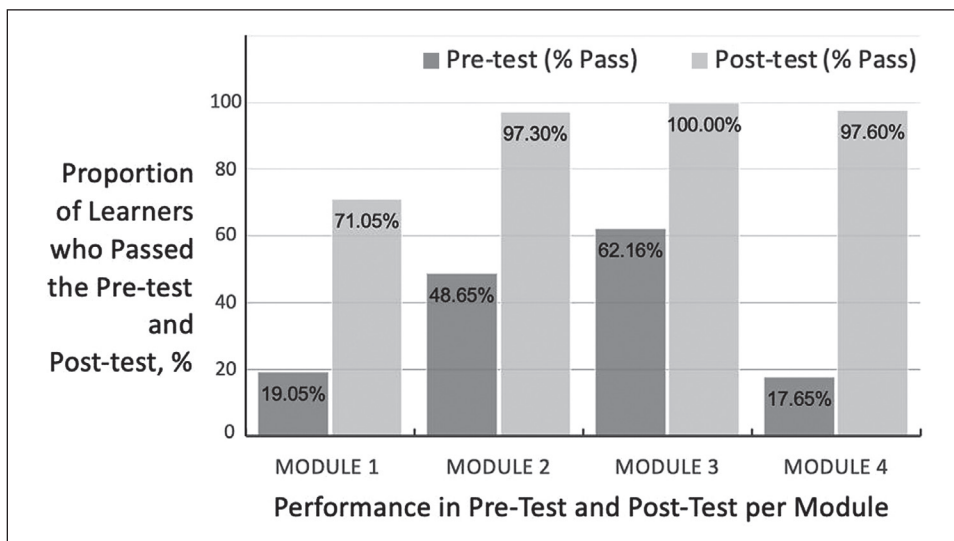


Figure 2. Proportion of learners with passing scores for pre-test and post-test.

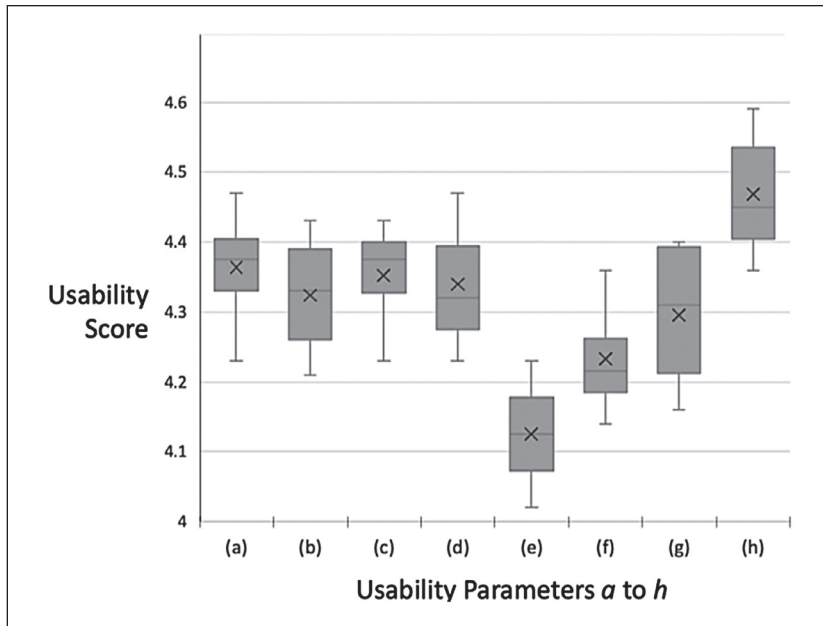


Figure 3. HeLe CBT usability: average scores per parameter.

(a) content, (b) learning and support, (c) visual design, (d) navigation, (e) accessibility, (f) interactivity, (g) self-assessment and learnability, and (h) motivation to learn; x = mean score

The range of mean scores for the four modules is 75.4% (in Module 4) to 93.6% (in Module 3), again considered as passing for each module. The trend is preserved as that of the pre-test module mean scores. That is, performance is lowest to highest in Modules 4, 1, 2, and 3, respectively, in both pre-test and post-test.

Usability of CBT Course

The participant's overall perceived usability of the CBT was rated high (mean score of 4.32 out of 5), covering all eight parameters. The range of scores was from 4.13 to 4.47 out of 5. Figure 3 presents the average scores per parameter rated by the learners.

Motivation to learn was the CBT Usability parameter rated highest (4.47 out of 5). Participants agreed that the CBT met the (learners') needs, and the frequent presentations of activities increased their success. The CBT is also perceived to provide opportunities to use new skills, giving learners positive feelings about their accomplishments. *Content* also received high ratings (4.4 out of 5). Participant ratings show favorable agreement with clear learning objectives, appropriate alignment and sequencing of course materials, and consistent vocabulary and terminologies suitable for the learners.

Accessibility received the lowest rating (4.13 out of 5). Related questions include, "The pages and other components of the course download quickly / open quickly," and "The course is free from technical problems (i.e., hyperlink errors, programming errors, etc.)." *Interactivity* was also rated relatively low (4.23 out of 5), which relates to the lack of (additional) resources and variety of engaging or immersive and animated learning exercises.

FGD: User Satisfaction

Of the 42 PHCPs-learners, 26 (62%) participated in a series of FGD that sought qualitative feedback on the CBT and the learners' satisfaction (or non-satisfaction) with its use. During the FGD, the participants were asked to rate how satisfied they were with the CBT to improve their knowledge. Using a scale of 1 to 10, the respondents gave scores of 9, 8, and 7, rated by 19% (5 learners), 62% (16), and 7% (4), respectively. This reflects the learners' general satisfaction and positive attitude towards the CBT use.

Content analysis of the responses revealed several themes, categorized as Enablers and Obstacles/Barriers to CBT use. The themes and the responses of the learners are presented in Table 4.

Enablers of CBT Use

Use of interactive learning components

The inclusion of interactive learning approaches in the CBT encourages further use and translates to a better learning experience.

"One good thing about the modules is that they include the demonstration part. [Such as] how to insert [the ear probe] and type [or enter data into the EMR]. So maybe maintain that. I learn much better when I see how [it is done]. Because if it's only instructions, like, do this and that, [it will be hard]... it is better [when there is a video] demonstration, [like,] where to type in CHITS (Community Health Information and Tracking System EMR)" – Participant 5

Flexible nature of the CBT that fits the users' environment

The flexible nature of the CBT allowed the learners to set their own time and pace to complete the course.

"[I could] do it faster, [taking each module and units of the course] should be continuous. As a health officer, we have constraints [while in the RHU], so we do it [the CBT] at home. Then sometimes patients still come to our house to consult... so I have to [stop the course and attend to the patient]. Then, the continuity of your thought and your interest is lost... [For instance,] I started with Module 1, Unit 1, then [proceeded to] Unit 2, [and] 3. Then I had to stop because of a patient. [Then it was only] after three days [that I had time to work on the CBT]. I had to restart again from Module 1, Unit 1 [and so on]. Then I decided to stay up until 11:00 PM and finish [the modules] ... It doesn't matter, as long as I pass, [and] take [the unit exams] ... then I passed [the exam] – Participant 8

The availability on-demand of the CBT also allowed the participants to access the course at their preferred location. Of the 26 FGD participants, 38% (10 learners) reported accessing the modules at home, 42% (11) in the workplace or RHU, and 12% (3) in commercial establishments.

Learner engagement, sense of accomplishment

The HeLe CBT was able to engage the learners and elicit a sense of accomplishment.

"In the CBT, the topic becomes more exciting because when you finish one page, you can proceed to the next, then you can take the [unit] exam... It's more exciting because you will know, I'm already done. I can proceed to the next. It's like (comment from another participant: "accomplishment"), yes, ... [a sense of] accomplishment, I am done with module 1, yehey (or hooray)." – Participant 7

Table 4. FGD Themes and Learners' Responses

Enablers of CBT Use
<p>Use of Interactive Learning Components</p> <p>"One good thing about the modules is that they include the demonstration part. [Such as] how to insert [the ear probe] and type [or enter data into the EMR]. So maybe maintain that. I learn much better when I see how [it is done]. Because if it's only instructions, like, do this and that, [it will be hard], it is better [when there is a video] demonstration, [like,] where to type in CHITS (Community Health Information and Tracking System EMR)" – Participant 5</p>
<p>Flexible Nature of the CBT that Fits the Users' Environment</p> <p>"[I could] do it faster, [taking each module and units of the course] should be continuous. As a health officer, we have constraints [while in the RHU], so we do it [the CBT] at home. Then sometimes patients still come to our house to consult... so I have to [stop the course and attend to the patient]. Then, the continuity of your thought and your interest is lost. For my experience, for module 1, since it's long, right? (Facilitator 2: it's more than 1 hour, yes) [For instance,] I started with Module 1, Unit 1, then [proceeded to] Unit 2, [and] 3. Then I had to stop because of a patient. [Then it was only] after three days [that I had time to work on the CBT]. I had to restart again from Module 1, Unit 1 [and so on]. Then I decided to stay up until 11:00 PM and finish everything, [from] module 1 unit 3, [and then] unit 4, up to module 4. More than that, I almost slept at 12 midnight. I was already sleepy, It doesn't matter, as long as I pass, [and] take [the unit exams] ...then I passed [the exam] – Participant 8</p>
<p>Learner Engagement, Sense of Accomplishment</p> <p>"In the CBT, the topic becomes more exciting because when you finish one page, you can proceed to the next, then you can take the [unit] exam. That's the most exciting part. Because when your answers are wrong, you have to take it again, [thus,] you cannot proceed to the next page. We won't [be able to] finish [the module] unless we do not pass the [unit] exams (or exercises). It's more exciting because you will know, I'm already done. I can proceed to the next. It's like (comment from another participant: "accomplishment"), yes, ... [a sense of] accomplishment, I am done with module 1, yehey (or hooray)." – Participant 7</p>
Obstacles and Barriers to CBT Use
<p>Competing Core Work of Healthcare Provision vs. Continuing Professional Development In Situ and User Interface Issues</p> <p>"... [Module 1] takes more than an hour to finish...it becomes dragging because the audio is a bit slow. It really takes up your time. [Module 1] is like more than an hour or even two hours to finish the course. Module 2 was good [because of the better pacing of the audio] ...Because when you're at home, of course, you are tired... And since [the pacing of the audio is] slow so it becomes dragging, you really get tired halfway through [taking the modules]. But your goal is to try to finish at least one module per day." – Participant 1</p>
<p>Unavailability, Delayed Release of Modules</p> <p>"The concept of the CBT is great. However, in terms of the availability of all modules, I hoped the pre-test, post-test, and everything [were] uploaded timely so that there won't be any gaps [when we take the course]." – Respondent 2</p>
<p>Poor Internet Connectivity</p> <p>"... if your internet [connectivity is not good], ... you'll think your answers were incorrect [for the Unit exercises] ... but it was just because of [the unstable] internet." – Participant 3</p> <p>"For us, one limitation is that the CBT is highly internet-based... in remote areas like ours, a little fluctuation [in the internet connection], sometimes [cause] you have to reset from the start." – Participant 5</p>

Obstacles and Barriers to CBT Use

Competing core work of healthcare provision vs. continuing professional development in situ

Learners cite that the "overwhelming workload of the PHCPs" is the biggest barrier to the HeLe CBT use and completion. This is so, such that more than half of the FGD participants completed the CBT outside the workplace and completed this outside of office hours.

User interface issues

Participants emphasized that appropriate configuration of the "audio and visual" elements is essential. When there are some "glitches" - specifically typographical errors, overlapping slides and poor audio or voiceover, pacing, and unresponsive "next" buttons) – these detract from the smooth use of the CBT. Slow pacing also renders the CBT "dragging."

"... [Module 1] takes more than an hour to finish... it becomes dragging because the audio is a bit slow... Module 2 was good [because of the better pacing of the audio]... Because when you're at home, of course, you are tired... so it becomes dragging... But your goal is to try to finish at least one module per day." – Participant 1

Some participants experienced problems with the Unit exercises where answers were incorrectly scored. Participants promptly raised these concerns via email, and the course administrator applied corrective measures.

Unavailability, delayed release of Modules

The delays in uploading and loading content or getting off-track the schedule disrupt the continuity of learning.

Poor internet connectivity

Furthermore, problems in internet connectivity affect the quality of the eLearning experience.

"... if your internet [connectivity is not good], ... you'll think your answers were incorrect [for the Unit exercises] ... but it was just because of [the unstable] internet." – Participant 3

"For us, one limitation is that the CBT is highly internet-based... in remote areas like ours, a little fluctuation [in the internet connection], sometimes [cause] you have to reset from the start." – Participant 5

Similarly, the usability parameter *accessibility* was rated lowest, which relates to the problems in loading of content and technological glitches (i.e., delays in moving to the next page of the Unit) which are often due to poor internet connectivity.

DISCUSSION

The primary care health professionals from the Rural Health Units selected for HeLe typifies that of the majority serving about 2500 local government-supported primary care centers in the Philippines. The workforce reflects the national picture: it is feminized (majority are females), and represents the range of young graduates to near-retirees. The learners are health providers, mainly general care physicians, nurses, and midwives, who are adept with the delivery of an array of health promotion services (such as maternal antenatal care, immunization, family planning) to primary care wellness services (birthing and postpartum care, breastfeeding, and nutrition promotion) and disease management (such as care for acute respiratory infections, tuberculosis, non-communicable diseases, and injuries). These eight RHUs provide periodic reports to the Department of Health (DOH) on rendered services of public health import. Democratizing access to NHS means necessarily expanding from the current hospital-based NHS and targeting these community RHUs and primary care facilities where newborns are delivered, and their families live.

Population screening should be ethically done in an environment where intervention is available and accessible to the community. This is the spirit of the law defining the Universal Newborn Hearing and Intervention Program.

Purposive sampling was implemented in this study to meet the overall objectives of the HeLe research program. The 42 participants were selected based on the recommendation of each MHOs, allowing for the participation of more screeners per RHU but not exceeding to the point of disrupting the usual clinical work when required to attend trainings. Also, accommodating a certain number allowed by the resources of the project. Notwithstanding social problems besetting rural communities, the HeLe innovations depend on having an IT infrastructure in place. Specifically, internet access is a requirement in order to field test the web-based tele-referral system and the electronic submission of NHS results to the HeLe NHS Registry. These primary care centers would have the necessary IT equipment (for telehealth and the CHITS-EMR), systems of which would also be used for the HeLe.

These sites were also selected because they have had good/successful eHealth implementations for telemedicine and EMR. As such, the HeLe learners are already familiar with, and the majority (if not all) use IT for health. Furthermore, these RHUs have demonstrated leadership in eHealth, and commitment to innovation testing – critical elements for successful pilot project implementations.⁴⁰

Arrangements have been made for these RHUs – envisioned as future Category A NHC – to be formally linked to a diagnostic hearing center (Category B NHC). Research studies on screening are compelled to provide, at the minimum, confirmatory testing to those who will be found positive.⁴¹ For the HeLe, it was necessary to properly

organize the SDN for the NHS Program in the locale of participating RHU.

The HeLe CBT is designed to be available on-demand to support the learner's pace amidst their circumstances.^{19,42} The majority (34 out of 42, or 81%) completed the course within the allotted four-week period. With the release of the course on two separate schedules and the availability of all modules, the learners from Batch 2 were able to complete the course in less than four days; a difference of about ten days compared to Batch 1, where there was a delay in the release of the last module. Overall, this is instructive and affirms that this simple structure (of allotting a specific duration) in computer-based education is practicable also for PHCP serving RHU. That is, setting the time to access the course highlights flexibility and relies on the learners' self-directed learning to manage one's time and accomplish the task.⁴³ Completion of the HeLe CBT qualified participation in the subsequent in-person training program that centered on skills building on the NHS.

The simple majority of the learners accomplished the CBT at home or in an internet cafe. This preference to focus solely on either clinical work or continuing professional development (CPD) is not unexpected. Yet while patient care naturally takes precedence, many (11 of the 26) completed the CBT in the workplace. This is encouraging: the IT infrastructure was in place (even if the internet was intermittent), and the health workers were able to maximize office hours (conducting clinical work and continuing professional education side-by-side).

These 11 PHCPs epitomize "success" and what is possible for the future regarding CBT not only for the NHS but for continuing professional development, in general. Perhaps what can be considered is that specific schedules for each PHCP, within official clinic hours, can be reserved for CBT-based CPD.

It is encouraging that passing rates from pre-test to post-test increased overall by 54.6% and that the mean scores for all four Modules were above passing. Post-test item analysis showed knowledge gaps remain for specific areas. Imbibing knowledge on the *Categories of NHCs* appears to be a challenge to the learners, with only half of the participants correctly identifying these despite the lower-order cognitive processing required for this concept (Remember and Understand). On item analysis, however, this may be due to the choice of test format, i.e., the use of a multiple-true-false (MTF) question. According to Brassil and Couch,⁴⁴ this type of question format is often confusing and leads learners to random guessing rather than informed reasoning.

Similarly, the *stop criteria* and *referral protocol* were still confusing to some learners, missing to answer the related question correctly. These require mid-level cognitive processing (application and analysis).^{45,46} Rozul, Yarza, and Ombao^{22,47} emphasized the importance of the mastery of these key concepts as a competency of screeners, adding weight on assigned points for these items in the online

adaptation of the NHS certification course. In practical applications, it is best measured as a procedural skill.⁴⁸ For the CBT course, remediation can be done by including more interactive learning exercises. Gaupp, Körner, and Fabry⁴⁹ recommend including case-based simulations to encourage analysis and decision-making. Therefore, in light of the HeLe blended learning approach, the CBT will promote better knowledge transfer as it transitions to face-to-face training.⁵⁰⁻⁵²

Therefore, further review and analysis of the HeLe CBT course content and assessment tools are warranted for these future enhancements. It is worthwhile to process with the learners the course content, including the assessment and test questions, primarily where the lowest scores were garnered. Specific learners' perspectives can be obtained to improve the succeeding course offerings.

Monitoring the attainment of educational objectives through computer-based instruction of these crucial competencies must be done diligently in the subsequent offerings of this training module. If these competencies, despite revisions in the curriculum, consistently cannot be satisfactorily obtained by the learners through this CBT, these competencies will have to be met through a different training course format.

Learners rate the HeLe CBT to be highly usable, with a range of scores for all eight parameters between 4.13 to 4.47 out of 5, the highest score. That is, in terms of content, the technology components of the CBT, and the ability of the CBT to encourage continuing learning (or at least, the completion of the HeLe CBT course).³⁶ The latter (*motivation to learn*) is seen to be a consequence of positive user experience and satisfaction with the CBT.^{53,54}

The intermittent internet connectivity in the locale remains a challenge beyond the control of the HeLe research proponents; this continuing social development issue is raised to the national government. The course may be improved with regard to accessibility through more reliable internet providers for the participants and the various new applications in systems and designs that have developed since the initial formulation of the course. An offline version of the CBT can be made available, yet maintain the web-based mode for learner assessment.

Technical components such as web design and instructional parameters are seen to facilitate better learning experiences and increase one's motivation to learn. Corollary, issues with the user interface, availability of modules, and internet access become barriers in completing the course.

Internet connectivity must be addressed by national government investment. This is elevated by the HeLe proponents to the CHED as part of the overall campaign of the UP for the social development of the country's rural communities.

However, the HeLe research team can and should improve *user interface* concerns raised by the learners: typographical errors, overlapping slides and poor audio or voiceover, pacing, and unresponsive "next" buttons. The user

interface (UI) is the point at which the PHCPs "interact with a computer, website or application" such as the HeLe CBT. The UI intends to "appeal to the human senses (sight, touch, auditory and more). An effective UI is to make the user's experience easy and intuitive, requiring minimum effort on the user's part to receive the maximum desired outcome."⁵⁵ The HeLe UI should encourage, rather than discourage, users to complete the CBT.

Other operational and pedagogical concerns were with Unit exercises where answers were incorrectly scored, and the delayed upload of subsequent Modules. These must be corrected immediately. In general, a better and more stringent preparation stage for CBT development must be invested in to ensure that these 'glitches' that the PHCP identified during this pilot run must not even be encountered by future PHCP-learners.

In general, user satisfaction describes how the course is perceived by the learners. Learner satisfaction stems from the comparison between the learner's expectations before taking the course, and his/her perceptions upon completion of the course. Though expectations were not explored during the pre-course period, the post-course FGD generated relevant information.

It is important to note the high *motivation to learn* of the participants was gleaned from the Usability Survey. This was also qualified during the FGD with their expressions of a sense of accomplishment, eagerness to finish the course, and recognizing that the CBT provides them opportunities to use new skills in new situations.^{53,54}

The participants' feedback highlights the importance of a sound instructional design and well-thought-out operations in implementing eLearning programs.^{26,29-31,45} This relates to the high rating for the *content* parameter in the Usability Survey, where alignment and sequencing of course materials were highly appreciated. The progression of content has contributed to the 'excitement' in moving through the pages of the CBT.

User satisfaction is one of the most important factors that affect the success of the course and should be monitored regularly. Ideally, pre-course learner expectations must be solicited to be able to compare with post-course perceptions. The timing and schedule of the sessions for learner satisfaction should be set and made known to generate a greater percentage of responders. It may be a component of the course that is considered a requirement for completion of the course.

Limitations

The pilot implementation of the CBT is one component of the HeLe Capacity Building Program that combines blended learning strategies in training the PHCPs on NHS and teleaudiology. The CBT is designed to target factual and conceptual knowledge as a preparatory course to face-to-face training. It would be interesting to show how learning is integrated into the work setting. But for the present study, measures of behavioral outcomes will not be solely due to

the CBT but rather the result of blending various teaching strategies utilized in the HeLe training program. This is described in a separate paper.

Furthermore, feedback from subject matter experts and usability experts using standardized evaluation tools would have provided a more comprehensive description of the usability of the HeLe CBT. And exploring relationships by quantifying associations among the technical aspects of the usability components and *motivation to learn* as an intrinsic construct.

CONCLUSION AND RECOMMENDATIONS

The current study demonstrated the feasibility of using CBT to train health care providers in NHS and teleaudiology in rural communities. This mode of education is seen to fast-track training and accreditation of NHS Category A screeners and their Rural Health Units as Category A NHC. The current ICT infrastructure in the Philippines remains a challenge that limited the online version of the CBT in reaching more remote areas, especially the GIDAs. An offline version of the CBT can be made available, yet maintain the web-based mode for learner assessment. This may be explored in future iterations of the study or for similar technology-based health projects.

Utilizing eLearning requires intentional planning of the instructional design and teaching strategies to facilitate meaningful learning experiences. Its application has expanded from the initial goal of reaching remote areas, but now also to provide for remote learning for all in the setting of a pandemic where face-to-face education is limited. Thus, the results of the review and analysis of CBT usability and user satisfaction can be a basis for future revisions and improvement in the instructional design of similar endeavors. Furthermore, this investigation showed the CBT as an effective teaching strategy for distance learning and, more so, a viable option in low resource settings where gaps in ICT infrastructure exist competing with demands of clinical and public health work.

Finally, eLearning can be used as an alternative approach to increasing awareness and support training of healthcare providers on newborn hearing screening. This is one step closer to ensuring a better and more equitable future for children with hearing loss.

Acknowledgments

The implementation of the HeLe Project was endorsed by the Department of Health. The HeLe CBT Program was hosted in the UPM Virtual Learning Environment with support from the NTTCP-HP & UPM-IMS. Finally, our sincerest gratitude to all the healthcare providers from the participating RHUs.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

All authors declared no conflicts of interest.

Funding Source

This study is an output of the Hearing for Life Project and funded by the Commission on Higher Education – Philippine California Advanced Research Institutes (CHED-PCARI).

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