

The Combination Design of Enabling Technologies in Group Learning: New Study Support Service for Visually Impaired University Students

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Abstract

This article aims to show how the process of new service technology-based development improves the current study support service for visually impaired university students. Numerous studies have contributed to improving assisted aid technology such as screen readers, the development and the use of audiobooks, and technology that supports individual learning by the visually impaired. Before conducting research on how the existing technologies could enhance today's study support service, a lead user was identified from among the visually impaired university students that were involved in the new service development process. Telephone interview analysis was used for primary data collection from 49 sampled students while interviews, discussions, and brain storming were used for the primary data collection in the idea generation process and the new service functionality synthesis between the lead user and researcher. The findings from this study make several contributions to the area of service development using the lead user technique. The lead user provided an idea that is claimed to be a useful service solution. It was demonstrated that a group learning technology-based service can work as a new service for visually impaired university students. The findings are also original in that the new service with the capacity for knowledge access and transfer using telephony technology will be the first new service that shifts their individual learning to a group or community that includes instructor participation.

Keywords: group learning enabling technologies, virtual knowledge telephony system, visually impaired student, Ramkhamhaeng University, lead user, new service development, Thailand

1. Introduction

Assistance for visually impaired students by study support services has been provided in various ways for years. For instance, the live reading service, which is the simplest service, does not require technology, but it has many limitations that have been identified in a study by Kaijage Jackton J.L. (J. L., 1993). Live reading efforts will not be setup for only one person. Therefore, a group learning method might need to be considered to enhance the live reading service because it has the potential to generate a transfer of tacit knowledge that contains valuable personal techniques and skills from one member to another member of the group. The effort that was put into the live reading service became self-sustaining, and thus was not limited to only one person. Given that travelling for visually impaired people is difficult in itself, the possibility nowadays of being able to access a live reading service or of obtaining Braille material is important.

Subsequently, many scholars have contributed to the area of individual learning for people with sight disabilities. The provision of digital talking books was implemented as a new library service to improve knowledge access (Cookson John, 2001). Furthermore, the development of digital talking books has been attempted over the types of computer networks that are found in schools (Steve, 2001). This research revealed a broader opportunity to print for disability students in school. The enhancement of computer software which improved the efficiency of the audio book was examined as a consequence (B. T., 2001). Many types of assistive technologies and specialized software were developed and customized to improve internet access quality for people with visual and print disabilities (Jennifer, 2002), (Axtell Robert, 2002), (Byerley & Chambers, 2002), (Loo, Lu, & Bloor,

2003), (Téribi Lobna, 2000). Despite the value of many of these studies, they do not address the group learning aspects. The current research aims to show the value of a new service which enables group learning among visually impaired university students. This research was conducted using the concept of lead user involvement in the steps during the service design and development phases. The primary hypothesis stated that the problems of the current product or service would be improved or partially eliminated by ideas suggested by a lead user (Hippel & Jin, 2009). In this research, the lead user selection criteria were developed by adapting those in earlier studies (Oosterloo, Kratzer, & Achterkamp, 2010). The research expected to demonstrate how the lead user would assist in the new service development since the lead user and end users were all visually impaired university students. One of the objectives of the study was to develop a new service for visually impaired university students which therefore required a literature review of lead user theory. One of the practical limitations was that only 10 concurrent telephone accesses were possible to the telephony virtual knowledge system that was deployed during the system test. However, a system access schedule was generated that assisted in the resource allocation to all testers. The short period of the test was identified as the theoretical implications that aim to study the knowledge access and knowledge transfer behaviors among the group actually that the study would be extended to cover the sustainability of this group learning. The elimination of this issue had significant implications which required additional financial support. Therefore, the sustainability of the learning group will remain an area for further study.

2. Method

This research focuses on the utilization of technology that enhances the capability of the service. The context of service development for visually impaired university students was treated as a specific group since understanding their individual concerns and demands was beyond the scope and resources of this research. The method of this research will push out the design which will be synthesized by a visually impaired student representative who is also the lead user. The process used for lead user selection is detailed in this paper. The lead user and researcher worked on the design based on the data collected from telephone interviews of 49 visually impaired students. The method used in this study contained 6 main steps; the lead user was involved in the 2nd, 3rd, and 5th steps.

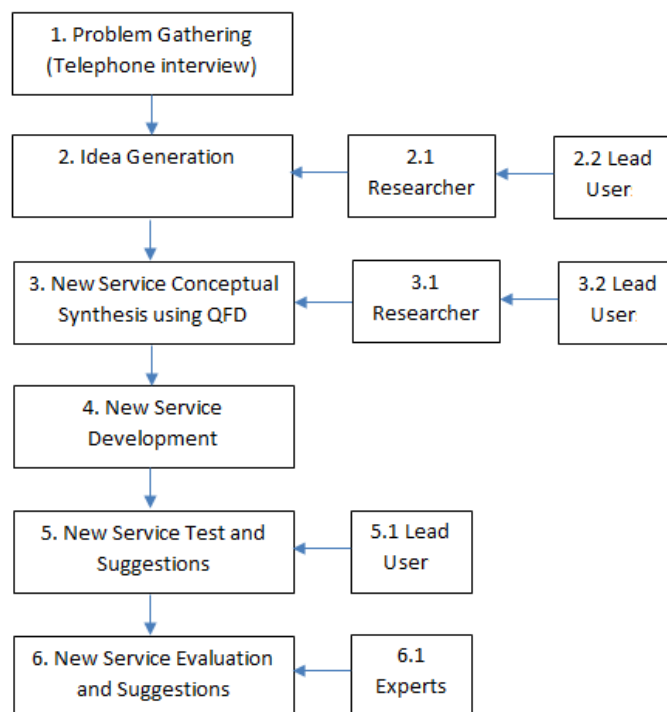


Figure 1. Research method adopted from Service Innovation Process

2.1 Problem Gathering

Telephone interviews of 49 randomly selected people were conducted between 12th-20th January 2012 to obtain data on the problems being experienced. After the researcher gave a short introduction to this project, interviewees introduced themselves and explained the issues they had been encountering. The interview results were collated and interpreted between 21st-25th January 2012. The interview results revealed that the most important issue for the sample group was the current study support service because it was deemed inadequate. In addition, the late response of the reading service from the Disability Support Service Unit caused problems. Most of the responses indicated a preference for audio files as the sample group did not possess Braille skills. At that time, they paid for the live reading service out of their own budget, but they needed to plan for this approximately 2-3 months in advance. Unfortunately, they still had to deal with the delayed response which has led to failure to graduate or, in some cases, withdrawal from courses. The second issue concerned the difficulty of travelling due to the lack of a universal design for transportation. The third issue concerned difficulties in accessing the DSS website where recordings of previous classes are uploaded. A lack of internet access, not having a personal computer, and not having the current teaching class recordings available were cited as possible reasons for these difficulties.

Table 1. Summary of the current study support service at Ramkhanhaeng University

Current DSS issues	Frequency
Inconvenience of travelling to get access to the service at the DSS center	25
Inadequate service officers to prepare Braille materials	7
Inadequate knowledge of the subjects that are recorded in audio format, i.e., English subjects	19
Difficulty in accessing information on the DSS university website because it was not regularly updated	24
Poor sound quality (voice)	18
Inadequate/ late response from the live reading service	40
Students relying on the people around them for reading	21

2.2 Idea Generation

In the next step of idea generation, the researcher constructed a conceptual idea that could become a solution to these issues. The information that was collected from the telephone interviews led to the generation of two possible solutions which are illustrated in Table 2. However, a requirement was added that stipulated the need to have a form of two-way communication to share and transfer knowledge among the students that were identified as beneficiaries of this research. Each issue was given a priority and was assigned a percentage based on the advice of the current study support service at Ramkhanhaeng University and discussions between the researcher and lead user.

The most important part in this step was to combine the expectations relating to the new functions into groups for conceptual new services. Furthermore, the feasibility of each new function that was suggested during the interview process needed to be evaluated in order to feed into the development stage. Once everything had been considered, the researcher and lead user used the opportunity to finalize the solution that would be selected to advance to the new service development step.

Table 2 shows that the telephony system concept gained the highest score at 4.8, while the second concept, which planned to improve the current DSS website, scored 4.2 points. In contrast, the audio book solution was found to be the least suitable for development within the context of group learning.

Table 2. Individual solution comparison

Current DSS issues	Expected main functions	Weighting	Audiobook		Virtual knowledge telephony system		Virtual knowledge website system	
			A1	Score	A2	Score	A3	score
Inconvenience of traveling to get service from the DSS center	Ease of accessing information and knowledge anywhere anytime	10%	4	0.4	5	0.5	4	0.4
Inadequate service officers to prepare Braille materials	Appropriate technology would be considered	10%	5	0.5	4	0.4	5	0.5
Difficulty in accessing the DSS university knowledge source (website) / Limited access due to not having a personal computer	Appropriate technology would be considered	10%	3	0.3	5	0.5	3	0.3
Today's equipment that assists visually impaired students focuses on individuals. There is a lack of equipment or systems that promote the exchange of learning in groups.	A system that permits two-way communication	20%	0	0	5	1	4	0.8
Poor knowledge quality (voice)	Acceptable knowledge quality; clarity of voice	10%	5	0.5	4	0.4	4	0.4
Inadequate live reading service	System without the constraints of time which students can access 24/7 with no limits on the use of technology.	20%	5	1	5	1	4	0.8
Students rely on the people around them for reading	A system that allows students to use self-service knowledge access and thus minimize their dependence on others / self-service.	20%	5	1	5	1	5	1
Inconvenience of traveling to obtain service from the DSS center	Ease of accessing information and knowledge anywhere anytime	10%	4	0.4	5	0.5	4	0.4
Inadequate service officers to prepare Braille materials	Appropriate technology would be considered	10%	5	0.5	4	0.4	5	0.5
Total scores		100%	3.7		4.8		4.2	

Appraisal level (refers to A1, A2, and A3)

5 = highest suitability 4 = high suitability 3 = medium suitability 2 = low suitability 1 = least suitability

2.3 New Service Conceptual Synthesis - QFD

In reference to the previous step, a decision was made on the selection of a virtual knowledge system using telephony technology which will be discussed in the detailed design. A quality function development (QFD) tool was utilized in this step. QFD is a tool to transfer customers' demands to the product or service design quality. The correlation technique used by this tool allows the designer to be aware of new functions that might impact on other function so any new additional functions would need to check against the correlation results which are identified by the following levels; strong positive, positive, strong negative, and negative. The main benefit of this tool was to provide an in-depth analysis of the new functions that were suitable for development. This tool was originally developed by Yoji Akao in 1966 (Akao, 1993). The main areas consist of 2 parts:

What – individual aspects of customers demand

How – current aspects of the product or service delivery and a new approach to servicing customers' demands

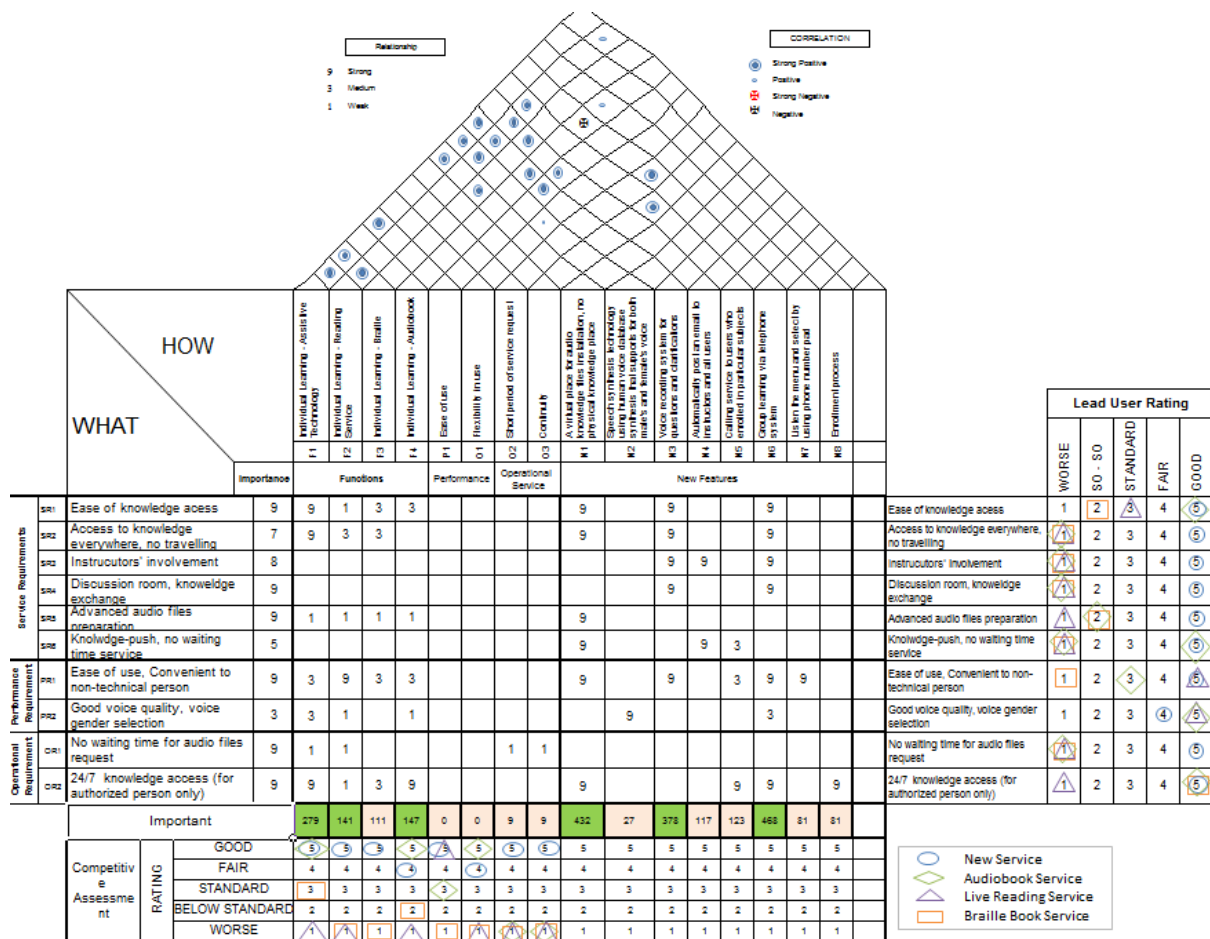


Figure 2. QFD tool with functional analysis results

Once the customers' demands were collected by the telephone interview process, all concerns and demands were classified into 3 main categories: Service Requirements (SR), Performance Requirements (PR), and Operational Requirements (OR). Each issue was evaluated and given a priority level in the range 1 to 9 with Level 9 as the most important and Level 1 as the least important. In this step, aspects of the demands were discussed with the lead user and a new approach created which might be useful in answering the customers' demands.

The demands from the sample of 49 visually impaired university students, which mostly related to their current problems and concerns, were allocated the following numbers: SR1, SR2, SR5, PR1, PR2, OR1, and OR2 after discussion with Thitikarn, a lead user who was a visually impaired university student at Thammasart University. Thitikarn has not only won many Braille reading and writing competitions, but she is also skilled with assistive technology for blind people. Her interests included social media applications such as Skype. Furthermore, she previously worked at the Association for the Blind and, in particular, for the Thai Blind People Project which is still providing information to the blind community, for example, on career opportunities and news. Thitikarn thought that the new service to support the studies of visually impaired university students would help students who had greater access knowledge to communicate and share that knowledge with others who had fewer opportunities. Thitikarn had many friends who were studying at Ramkhamhaeng University so she understood that this Open University had various kinds of students. Her idea was to have a group learning service that provided not only knowledge access functions but also knowledge transfer among users. Moreover, students who had the ability to access this knowledge might not want to be limited to an online group discussion. They might want to extend it to an offline discussion with a different community which would add to the benefits of the process. Finally, this was allocated the demand number SR4. At this stage, the researcher suggested that bringing an instructor into the discussion group would help to ensure that conversations amongst students were monitored and verified. The demand number SR6 utilized repeatedly in a few days later when the researcher read the interview results.

After identifying new features using the QFD tool, it was necessary to verify that the correlations between the existing features and the new features were valid. The new service should lead to either a strong positive or a positive correlation while the occurrence of a strong negative or a negative correlation would indicate that the features were incompatible. In this research, most of the new features were linked to the demands and concerns that were mentioned during the interview process. Use of the QFD tool led to 8 new features being proposed for the new design.

In the last process, the researchers and lead user evaluated these new features along with the existing services. The results showed that all the new features were given good ratings which were higher on average than all the existing services.

The first three features with the highest scores are as follows:

- (1) A virtual place for audio knowledge files installation without a physical knowledge place: 432 points
- (2) Group learning via a telephone system: 408 points
- (3) A voice recording system for questions and clarifications: 378 points

There were 2 types of technology that supported all of the new features above: text to speech technology and telephony technology that allow the contents to be stored and accessed via a telephone. The remainder of the new features will be discussed later in the new service development selection.

2.4 New Service Development

In this stage, the selected functions that were synthesized from the problem and requirements steps will be installed during the service development. This stage consists of 3 main parts: service plan review, content management and transformation, and system review by experts.

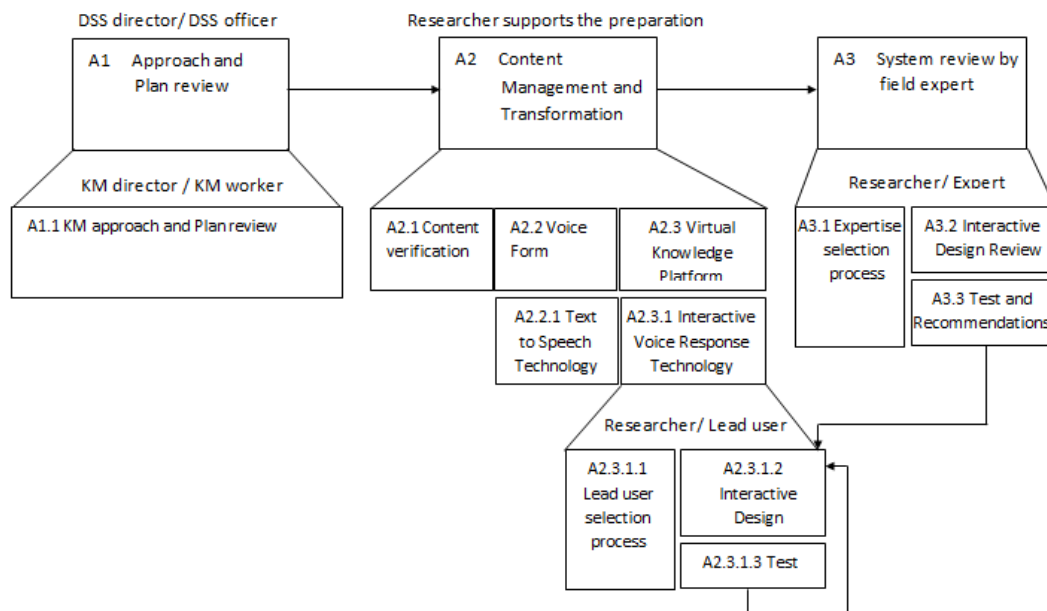


Figure 3. New Service Development Process

Step A1: The researcher was involved in the service plan review at the Disability Student Support Office at RamkhamHaeng University. The Office Director determined the short-term and long-term aims for the delivery service and indicated a number of constraints that were being eliminated such as inadequate resources, and a limited budget for service improvements. The researcher also felt that visually impaired students were not satisfied with the service.

Step A1.1: The service plan for the Disability Student Support Office at RamkhamHaeng University is a timely response to a request from students. There were 96 visually impaired students enrolled in second semester in 2012; however, the workload was challenging because there were only 2 officers to provide assistance. In

addition, collaboration was regularly conducted with some external institutions which, for instance, led to improvements in the audiobook project as a result of new techniques. However, the area of internal communications for all instructors needed to be developed as most of the teaching class was allowed to be recorded and distributed to visually impaired students while distribution of the teaching materials was still prohibited due to intellectual property rights.

Step A2: Content Management and Transformation. This step consists of 3 parts:

Step A2.1: Content Selection: the researcher analyzed the group of visually impaired students that were enrolled in semester 1 in 2012. The breakdown analysis by faculty is shown below:

Table 3. Summary of visually impaired students that were enrolled in the 1st semester of the 2012 academic year

Faculty	Number of students
Faculty of Humanities	46
Faculty of Political Sciences	21
Faculty of Laws	13
Faculty of Education	8
Faculty of Business and Administration	4
Faculty of Fine and Applied Arts	2
Faculty of Sciences	1
Faculty of Human Resource Development	1
Total students	96

The data are sorted by faculty in descending order

The content selection process included the number of enrolled students under consideration. The three faculties with the highest enrolments were as follows: Faculty of Humanities, Faculty of Political Sciences, and Faculty of Laws. Another conditions fall into the content format that this stage really needs the content that has been already transformed as digital files. In this case, the researcher had to put a greater emphasis on content format transformation after the Disability Study Support officers indicated that the foundation subjects were mandatory for all students. The foundation subjects included Thai and English.

The conditions mentioned above were carefully considered. The decision of content selection results to the Law subject and Thai language subject that are selected.

Table 4. Summary of content classification in a law subject

Law	Transformation Method
Chapter 1: What is the law?	Text to Voice
Chapter 1: The nature of law	Text to Voice
Chapter 1: An assortment of laws	Picture to Text, Text to Voice
Chapter 1: Law enforcement	Text to Voice
Chapter 2: Ancient laws	Picture to Text, Text to Voice
Chapter 2: The Evolution of Roman Law	Picture to Text, Text to Voice
Chapter 3: The use and interpretation of the law	Text to Voice
Chapter 4: The principles of common law	Text to Voice
Chapter 5: Civil and commercial law	Text to Voice
Chapter 5: Getting a life	Picture to Text, Text to Voice
Chapter 5: The end of life	Text to Voice

Chapter 5: Reaching majority by age	Picture to Text, Text to Voice
Chapter 5: Reaching majority by marriage	Text to Voice
Chapter 6: Legal transactions	Picture to Text, Text to Voice
Chapter 7: The domicile of a person	Text to Voice
Chapter 7: The domicile that is required by law	Text to Voice
Chapter 8: Disappearance	Text to Voice
Chapter 9: Legal entity	Text to Voice

Table 5. Summary of content classification in a Thai language subject

Thai language	Transformation Method
Chapter 1: Content preparation	Text to Voice
Chapter 1: Source of the subject	Picture to Text, Text to Voice
Chapter 1: The aim of the subject	Text to Voice
Chapter 1: Organizing the ideas	Text to Voice
Chapter 2: What is the storyline?	Picture to Text, Text to Voice
Chapter 3: What is a paragraph?	Picture to Text, Text to Voice
Chapter 3: Components and layout of paragraphs	Picture to Text, Text to Voice
Chapter 4: What is the word?	Text to Voice
Chapter 4: The meaning of the word	Picture to Text, Text to Voice
Chapter 5: Sentences and the use of sentences	Picture to Text, Text to Voice
Chapter 6: History of the dictionary	Text to Voice
Chapter 6: Types of dictionaries	Text to Voice
Chapter 6: Sorting in dictionaries	Picture to Text, Text to Voice
Chapter 7: Speech	Text to Voice
Chapter 7: The aim of speech	Text to Voice
Chapter 7: Advantages and limitations of communication by speech	Text to Voice
Chapter 7: Listening	Text to Voice
Chapter 8: Personality of the speaker	Text to Voice
Chapter 8: Voice tone in speech	Text to Voice
Chapter 9: Persuasive Speech	Text to Voice
Chapter 10: The relationship between the speaker and the listener	Text to Voice
Chapter 10: Manner of speech	Picture to Text, Text to Voice

Step A2.2: Voice files synthesis

Step A2.2.1: Text to speech synthesis program which is formally supported by the Faculty of Computer Engineering at Chulalongkorn University.

1) Open the program: double click on the file "SynthesisTool1.exe" and then the small window below will be displayed.

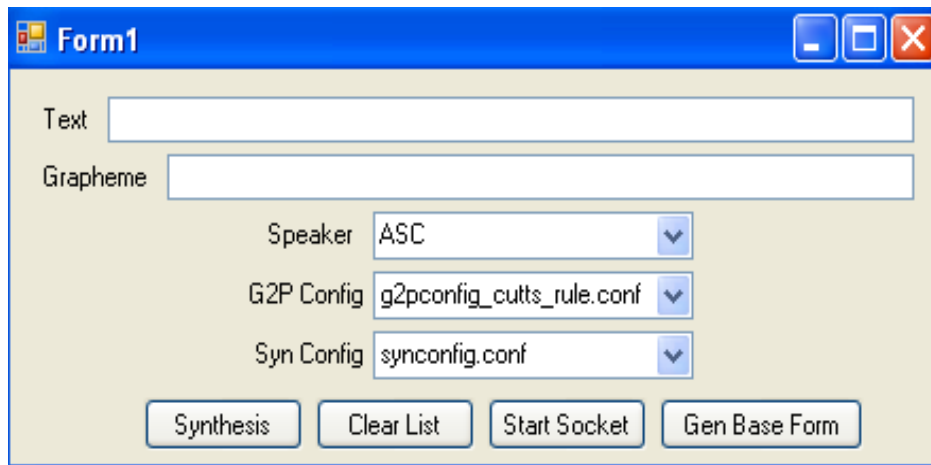


Figure 4. Chula Text to Speech Program

- 2) Paste the selected content into the “Text” field
- 3) Press the button labeled “Synthesis”. Then the Thai pronunciation will be heard at the same time as the voice file which will be placed in the temp folder of the system.
- 4) The program produces a file with a WAV extension. If the file format is not compatible with the telephony system, an additional process of file conversion might be required.

Step A2.3: Virtual Knowledge Platform design. This step focuses on the voice audio files installation design over the telephone system, where the researcher split one audio file into many small files and each small file was separated by the main headers. Users will be able to select their preferences and choose the section most relevant to them. For the questions and clarifications using tacit knowledge, the researcher defined this part to be stored separately from the main contents. The menu design for the Virtual Knowledge Platforms will be described next.

Table 6. Virtual Knowledge Platforms Design

Platforms	Key functions	Actions in knowledge management context
Text to speech system	Transform the text format to voice format	Knowledge acquisition and knowledge form preparation
Telephony system	Provide knowledge access via a voice menu interactive design	Knowledge access
	Provide clarification access via a voice menu interactive design	Knowledge sharing
Voice recording system	Record voice as questions or clarifications	Knowledge capturing Knowledge sharing
Email system	Send a notification to expedite the knowledge cycle for all participants	Knowledge cycle catalyst

There are 4 main integrated platforms that support this new service. The telephony system, which is the main platform, provides a place to store knowledge, and also works with the voice recording system when the associated voice files are recorded. An email will be sent out automatically to notify the disability support officers and instructors.

A2.3.1.2 Interactive Design

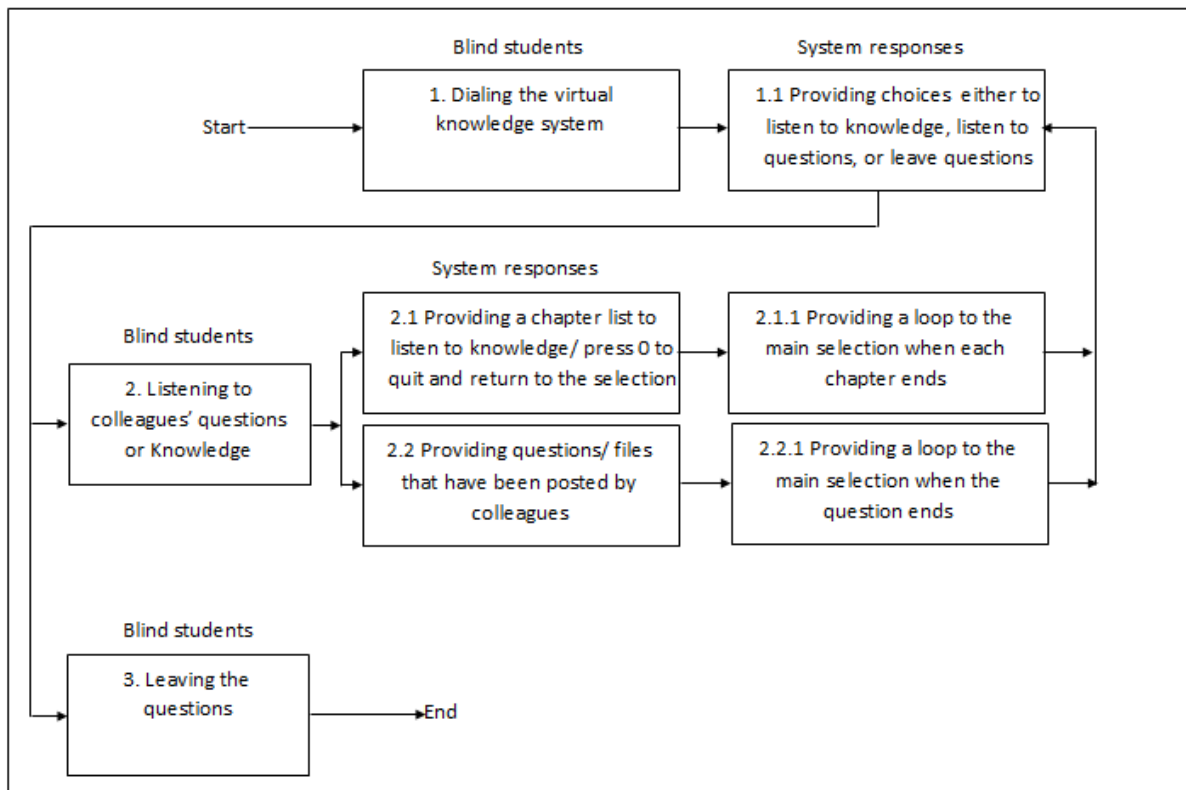


Figure 5. Telephony System: the User Interactive Design

Step A2.3.1: User interface design between the system and users. This process consists of 3 parts: lead user selection, user interface design, and system test. Initially, the lead user was selected as a template for the other students. Unfortunately, there was no entrance exam which meant that there was no information as to whether the students met the minimum requirements. This was due to the fact that the Head of the Disability Study Support Office has stated that as Ramkhamhaeng University is an Open University, they do not need to do an exam. All disability students are encouraged to study as their academic costs are covered by the government. In the meantime, the researcher was working with the Association of the Blind to recruit a visually impaired educational expert to improve the knowledge system. The researcher was introduced to Thitikarn who was one of the part-time employees at the association. Thitikarn was studying at Thammasart University. She is familiar with many of the technologies that relate to visually impaired students. Finally, Thitikarn was selected to be a lead user and was invited to take part in this research (Thitikarn's profile is listed at end of this paper). The user interface design process starts when the system is connected to a call from a user. Then the system provides options either to access knowledge or to leave questions/request clarifications with the support of voice recording. If the knowledge access option is selected, the system will provide further options to access knowledge in various subjects. If the user prefers to leave the questions/clarifications module, the system will then give instructions before the voice recording process is started. In all of these processes, it is possible to return to the main menu by pressing the zero button. The user interface design is formed according to the process flow described here.



Figure 6. Telephony System: Email Interface Design

The user interface design also includes integrated email between the system and instructors to ensure that all questions and clarifications are monitored. Registered instructors are allowed to be involved in the discussion as part of the community. All the voice files on the voicemail list screen (Figure 6) of the telephony system can be downloaded. The information is referenced with the date and time when the voice file was recorded. CallerID indicates to which student the voice belongs while the duration refers to the length of the file.

2.5 New Service Test and Suggestions

To complete the new service test, the researcher ran his own initial test with the lead user and five visually impaired students. The test followed the system design and took one week to complete. A few unexpected practical and technical errors needed to be solved after the test. The problems were detected when visually impaired students made use of the telephone number. They were not registered upfront so their identification was not immediate when using the telephone number. This problem was fixed by adding a self-introduction process before the start of questions or clarifications. The self-introduction required the caller's name, surname, nickname, and faculty. Initially, the voice speed was set too fast so the configuration needed to be adjusted.

Table 7. Summary of new service test and suggestions

New Functions	Feedback from the lead user	Feedback from students
A virtual place for audio knowledge files installation; no physical knowledge place		
Speech synthesis technology using human voice database synthesis that supports both male and female voices		Suggestions
Voice recording system for questions and clarifications	Suggestions	
Automatically post an email to instructors and all users		
Calling service for users who are enrolled in particular subjects	Suggestions	
Group learning via the telephone system	Suggestions	Suggestions
Listen to the menu choices and make a selection using the phone number pad		
Enrollment process		Suggestions

The suggestions are listed below.

- 1) There were no suggestions from either the lead user or students for the new function 1.
- 2) For the new function 2, students indicated that they would like to hear the voice of their favorite news reporters. Therefore, future enhancements might be planned for this function.
- 3) The lead user suggested that recording questions or clarifications should be possible with only one call but that a special sign be used to separate them. More efficient ability will improve its information classifications.
- 4) There were no suggestions from either the lead user or students for the new function 4.
- 5) The lead user suggested that the calling service should be managed automatically by the system instead of being managed manually by the officer. Further enhancements will be planned for this function.
- 6) The lead user indicated that group learning should be undertaken using synchronous learning that allowed users to share knowledge in real-time; the current asynchronous mode might result in a long knowledge transfer cycle between the sender and the receiver.
- 7) There were no suggestions from either the lead user or students for the new function 7. They were all satisfied with the provided functions.
- 8) For enrollment, the students requested multiple telephone numbers be allowed for the registration process.

2.6 New Service Evaluation and Suggestions

When working with the Association of the Blind, the researcher invited three visually impaired educational experts to conduct an evaluation of the new service. The objective was to gain some valuable suggestions prior to the ending of the new service development process. One of the experts was from the Association of the Blind with the other two being from Ratchasuda College which has a focus on disability students. It was suggested that the technique was quite similar to that of audiobooks which have the capacity for rewinding and fast forwarding as well as pause and play functions. Another valuable suggestion was that for the live group discussion, the current design was created to have an asynchronous mode. The expert explained that knowledge speed flow from sender to receiver is via put and pick so the put and pick period might take a half-day or more. However, this issue might be held back for a later development plan. The knowledge system is already helping visually impaired students. The three main benefits are as follows: an increase in the graduation success rate, less reliance on peers, and pride from being self-reliant.

3. Findings

Based on the data collected by sampling 49 visually impaired university students from Ramkhamhaeng University, numerous issues were identified and grouped. The researcher created the first draft of the idea generation and then the lead user provided input into the process. Each interview was conducted by telephone for 50 minutes. First, the researcher described the service improvement process that had been used as one of the research methods in order to get a clear understanding for further feedback. Each problem was discussed in turn during the interview. (1) The new study support service for visually impaired students was put in place and its quality was tested by the lead user as well as visually impaired educational experts. Hence, the actual implementation for universities that enrol visually impaired students has been planned and will not be limited to only one university but will be available for all universities in Thailand where visually impaired students are studying. The new service utilizes two technologies, namely text to speech technology and telephony technology, which together provide three main functions. Firstly, it stores knowledge audio files that have been converted from text-based formats. An option for selecting a male or female voice is available during this step. Secondly, the voice recording functions that capture both questions and clarifications from the users were designed to increase students' level of understanding to help with self-learning and to permit support by their peers. Third, email integration was designed to function when questions were posted by students. The system sends an email notification to instructors. Consequently, questions that are not solved by peers will be copied to the instructor to ensure the knowledge cycle from sender to receiver is completed. This new service solves the current problems which students are encountering and has led to a better service that has an impact collectively instead of individually. The Disability Study Support Service has enjoyed other benefits since less exertion is required while user satisfaction is higher. The most important impact is the paradigm shift from individual learning to group learning, which is achieved by matching up senders and receivers who are interested in the same area and who possess the same objectives. (2) The new service development used the lead user involvement technique for new service idea generation and new service synthesis and design. This paper shows that bringing a lead user that had a sight deficiency into the new service development was a success. It produced results that had never

been seen previously in disability study support services in Thailand. The ideas that were presented by the lead user not only solved the current issues but also created a new service that changed the way of providing a service to visually impaired students. Valuable suggestions from lead users were derived from personal experiences, skills, and what they needed to study effectively. The conclusion is that the successful integration and application of a new service synthesis was born not only because of a need to combine the technologies as a design which worked harmoniously but also because of the need to consider the users' limitations as well as the user interface. Most of the contributions that were made by the lead user provided the basis for the functional design of this new service and resulted in an efficient design that is aligned to previous studies on lead user involvement.

4. Conclusion

During the discussion with the lead user, it became clear that her personal experiences and characteristics were in sync with the initial idea that became a solution to the problem. The solutions were determined using various methods depending on how many lead users were engaged in new service development. The solution confirmation process using visually impaired academic experts assisted in the process of service evaluation before the launch of a real implementation of that new service. New features that were suggested by the lead user in this context, such as the knowledge calling service by the system, were not implemented in the initial research stage, but it would be technically possible to implement them at a later date. Furthermore, the researcher utilized a manual process for the calling service which was carried out by an officer instead of the system during the system test. Another new feature that was suggested by the experts, an online forum for knowledge sharing, also remains under development. Instead, the researcher utilized a manual process with the forum being looked after by an officer at the university.

All participants that were involved in the new service development fully believe that this new service implementation will dramatically help in increasing graduation success rate if the program can be continuously promoted throughout each academic year to students and if attempts are made to provide various types of content. The new services that support both knowledge access and knowledge transfer will not only result in less reliance on peers but will also increase their pride due to their self-reliance.

Further research is needed to test the virtual knowledge telephony system. Conversations between the knowledge transferor and the knowledge transferee should be captured and analyzed using a variety of knowledge management tools. The test results might help form a group learning model for visually impaired university students. The results should be presented to the policy planner and all the management who are responsible for the work of the Disability Study Support Office.

“The voice of customers who cannot see is the best source of new solutions.”

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