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A CONCEPT OF ASSISTIVE COURSEWARE FOR HEARING-IMPAIRED LEARNERS

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ABSTRACT

This paper reports on an initiative that develops a concept of teaching and learning material for hearing-impaired learners in higher learning institutions. It describes the needs for the concept. The aim of the paper is to describe about the concept that is developed through User-centered Design approach. It involves observation and interview in three seminars in gathering the components of the concept. In the three seminars, users who are the hearing-impaired learners and their teachers were involved very closely. In the end, the concept has been derived and evaluated. The evaluation further reveal that the concept has been well-accepted by the users.

Keywords: hearing-impaired, assistive, courseware.

INTRODUCTION

There are more than 66 million people in the world suffer hearing-impaired. For this study, they are special people who deserve to acquire knowledge and perform daily tasks similar with normal people. Hence, their limitations need to be cared wisely. Realizing that situation, this study ventures into discovering factors those could assist the hearing-impaired people in their learning process. Part of the initiatives includes determining an appropriate concept for applications for the hearing-impaired people (Ariffin and Faizah, 2010), which could further be the guidelines. The guidelines have been adapted and incorporated into applications for the hearing-impaired people as reported in (Nurulnadwan, Zatul Amilah, Nur Hazwani, Nurul Ulfa, Ariffin, and Mohd Saifullizam, 2011) and (Zatul Amilah, Nurulnadwan, Ariffin, and Mohd Saifullizam, 2011). Later, the guidelines were further refined for hearing-impaired students of higher learning institutions, which shows not big difference (Ariffin, Sharifah Nadia, and Sobihatun, 2012).

Further, this study extends those works, by determining whether hearing-impaired students prefer to learn either with courseware or video. It has to be determined because the nature of courseware and video are different. Conceptually, courseware could be designed with high-level complexity, while video just involves low level (Borsook and Higginbotham-Wheat, 1991). In terms of interaction style, users have to click buttons in courseware to operate and get to the content. This is not required in video, in which the users could watch the contents that move on their own. When necessary, they could use the minimal interaction mechanism to jump to certain content (Dix, Finlay, Abowd, and Beale, 2004). Having experimented that, this study found that the hearing-impaired people prefer video more than courseware, as reported by (Ariffin, Syarifah Nadia, Sobihatun, Mazida, and Massudi, 2014). It was done with

helps of the works reported in (Ariffin, Sharifah Nadia, and Sobihatun, 2012).

In the real world, hearing-impaired people have to perform daily tasks just like normal people. Many studies have been carried out to address their needs. In fact, special education has been designed for them. In Malaysia, there is a special stream for the hearing-impaired people at primary and secondary school levels. Now, special programmes at tertiary level have also been provided for them. When getting closed with them, this study found that they are not quite responsive in themes related to theoretical philosophy. They are slow, and in fact their motivation towards that is low. In contrast, when demonstrating skilled based learning activity, they show deep interest. Besides, they are more interested and more responsive. In short, between the two different learning paradigms (skill-based and theory-based), the hearing-impaired people try as much as possible to get away from having to memorize facts, do calculations, and other cognitive loads. They prefer things that involve their psycho-motor.

This study also discovers (detailed in by Ariffin, syarifah Nadia, Sobihatun, Mazida, and Massudi (2014)) that dealing with hearing-impaired people is very challenging. According to the teachers, they have to be very strong, cool, and passion. The hearing-impaired people really need special attention. They grab contents very slowly, and sometimes similar things need to be repeated many times. Consequently, this study attempts to propose a concept of learning material for hearing-impaired learners. Polytechnique is selected for the testbed because it has a special programme for hearing-impaired learners.

METHOD

Figure-1 illustrates the activities carried out in achieving the objectives. In phase one, which deploys theoretical study, interviews, document study, and observations have been carried out. The outcome is some

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understandings on the elements of the AC4HI. The observation and interview activities involved lecturers and HI learners at Politeknik Tuanku Syed Shirajudin (PTSS), Perlis. This study decides to select PTSS because it enrols HI learners into their academic programme. Understanding that HI learners are homogeneous, results of this study could further be generalized to the other polytechniques. The philosophy of the HI education, syllabus, and books are among documents being studied. Besides, this study also observed how teaching and learning take place in the natural setting to identify instructional and multiple intelligences elements utilized by lecturers so that they can be incorporated into the AC4HI.
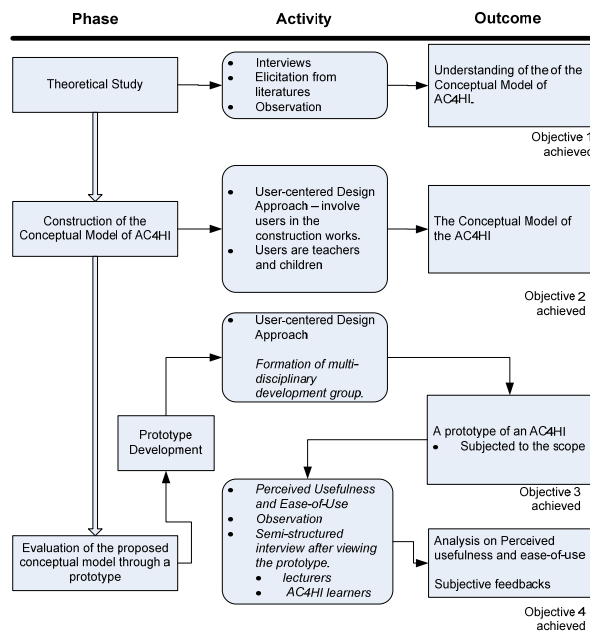

Figure-1. The methods in achieving the objectives.

In constructing the conceptual model, real users involved (20 real users), in which this method is called User-Centered Design Approach. This study refers the real users to lecturers (3 lecturers) and HI learners (17 learners) in PTSS. The gathered elements for the concept of the learning material were transformed into principles that can make the AC4HI usable. Users determined whether their tasks in teaching and learning are assisted by the proposed conceptual model. This was iterated in formulating the conceptual model. There were three one-day workshops organized, on three different dates, with the following aims:

- Workshop 1 - is aimed at gathering the instructional elements for the AC4HI.
- Workshop 2 - is aimed at gathering the elements of multiple intelligences for incorporation in the AC4HI.
- Workshop 3 - is aimed at gathering ideas in the interaction design of the AC4HI.

Each workshop was started with a briefing session, introducing the aim of the workshop respectively. Also, the findings from previous workshop were addressed and discussed. It was followed with brainstorming and prompting and chunking activities, in which they contain the actual activities in gathering the intended information. Nevertheless, the luncheons were provided for the participants, together with an hour break. The workshops ended with a debriefing session, in which the gathered information was discussed in the group and the expected next workshop. In addition, after each workshop, the findings were analyzed and any possible questions were prepared for discussion and confirmation with the workshop participants. They were well-documented for future reference. On top of that, in Workshop 3, an example of existing application was brought to the workshop. Users experienced the applications and fed back their experiences. Generally they addressed the good and bad elements they experienced while using the application.

The scenario in the workshops was very lively and under control. Everyone was sincere in addressing their ideas and opinions, making the UCD workshops very reliable in gathering data. Additionally, it was very lucky for this study, because the users (teachers) who participated in the workshop were very co-operative.

Outcome of workshop 1

Workshop 1 for developing the model was aimed at gathering the instructional elements for the AC4HI. In the early observations and interviews (Seminar 1) with HI learners and their teachers, the objective was to identify the dimensions of instructional and Multiple Intelligences suitable for AC4HI. Hence, the observation and interviews were focused only for that. As a result, it was found that (1) contents, (2) media elements (specifically text, audio, and visual), (3) navigation, and (4) instructional are important aspects that support for instructional purposes to be emphasized in the AC4HI. Meanwhile, the methods of addressing contents support the various competencies for supporting the Multiple Intelligences. Hence, this study deduced that they (contents, media elements, navigation, instructional, and methods) should be specially considered for the users, particularly the hearing-impaired.

Outcome of workshop 2

Having finished the first workshop, and gathered the elements to be incorporated in the AC4HI, workshop 2 was carried out. It involved similar users as the subjects, with a specific objective to gather the elements of multiple intelligences for incorporation in the AC4HI. This required this study to observe the hearing-impaired students' interaction among themselves, the way they interact with their learning materials, and the way their teachers interact with them.

Accordingly, during the seminar, the subjects were given a few tasks to do. It includes learning through the various applications developed for hearing-impaired people available on the Internet. They were allowed to

select the applications themselves. Hence, many applications were retrieved and utilized (this study has no intention to discuss about the retrieved applications). This allows this study to observe the way they interact with the digital interactive products. Besides, they were also asked appropriate questions when necessary for this study to understand certain actions, for clarification and confirmation. On top of that, this study also referred to their teachers for further confirmation.

Based on the observation and interviews, it was found that the hearing-impaired students read slowly, and rely strongly on their sight. Briefly, this study revealed that:

- Applications that incorporate sign language will be preferred more than those do not - linguistic.
- Colour matters for their motivation, in which they prefer plain green or blue - intrapersonal.
- Screen display can distort their cognitive if it is too messy - spatial.
- Use of graphics supports their learning significantly - spatial
- Mouse click distorts their interaction - logical.
- They like to interact with their peers while interacting with learning materials - interpersonal.

Outcome of workshop 3

The inputs in workshop 2 were used in further strengthening the gathered information on the requirements for the AC4HI. Hence, the third workshop was aimed at gathering ideas in the interaction design of the AC4HI. Workshop 2 found something interesting, that the hearing-impaired were not happy with mouse-clicking during interacting with learning contents. It made this study confused. Hence, it was further studied in workshop 3.

Accordingly, a digital interactive learning material (Figures 2 through 5) was developed and utilized for determining their interaction with interactive learning materials. This enabled this study to obtain rich information regarding the needs and preferences in the interactive learning materials. The learning material is called Koswer Pendidikan Islam Tunakerna (KOSPIT). It contains contents about solat. In KOSPIT, all gathered requirements in workshops 1 and 2 are incorporated. Particularly, notes in text are provided with graphical representations, using colors that enhance the hearing-impaired students' sighting. The display is ensured very minimal, avoiding any unnecessary element. Particularly, only contents are displayed to the users. Some parts of the contents are in video form. Most importantly, some parts are coupled with sign language in video form. The titles are made available at all time to avoid users lost in their interaction.

In the workshop, the subjects were distributed with KOSPIT so that this study could observe them while interacting. It was planned so in an effort to understand the interaction style that they prefer most. Hence, when they

interact with KOSPIT, this study not only observes their behaviour, but also interview them as well as their teachers.

Figure-2. Front page of KOSPIT.

Figure-3. video in KOSPIT.

Figure-4. Graphics in KOSPIT.

Figure-5. Sign language in KOSPIT.

In the end, it was found that the hearing-impaired students prefer to interact with learning materials with minimal mouse-click. It is understood that the approach for learning material should not be similar with the approach for other applications such as games and online shopping. In regards to that, having been prompted closely, it was clearly understood that the hearing-impaired students prefer to learn in a video form rather

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than any form that requires them to engage themselves through continuous mouse-click.

As a consequence of the little work on the specific objectives of Workshop 3, this study took the advantage to decide on the model for the AC4HI. Hence, users were engaged in forming the model for AC4HI. It was an easy task, because they were very participative and excited. Hence, it was very successful, and the model is explained in the next section. Besides, Workshop 3 has also been utilized to decide on the layout of the prototype, in which storyboarding was used. This study has no intention to emphasis on the storyboard because it is only utilized to guide this study; however, a sample of the storyboard is illustrated in Figure-7.

THE CONCEPT OF AC4HI

Having carried out all the three workshops, as elaborated in the previous sections, this study has successfully gathered significant findings regarding the elements for AC4HI, as preferred by the users. Consequently, the elements found in Workshop 1 have been further detailed with the findings in Workshops 2 and 3. Eventually, the detailed elements are specified as visualized in Figure-6. Having composed the elements (in Figure-6), this study forwarded it to the teachers for confirmation. When seeing this, the teachers were very happy because the model fits the needs of the hearing-impaired students.
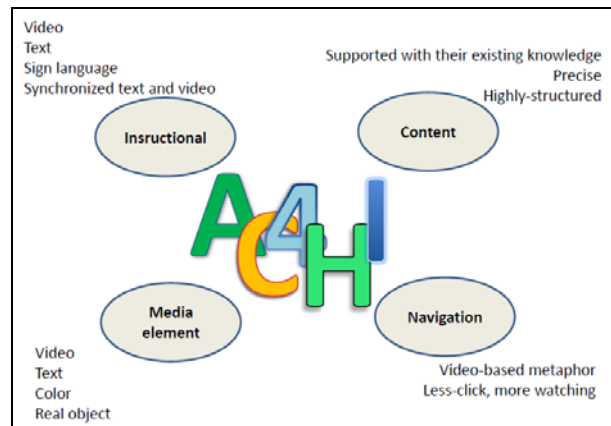

Figure-6. The model for AC4HI.

The concept in Figure-6 explains that the *instructional* strategy for the hearing-impaired people should incorporate text and video. The text should be minimized, so that they can focus on the visual element, which is also complemented with sign language. In fact, the sign language is a must for the hearing-impaired people. Also, the text should be synchronized with the video and sign language. In terms of *content*, it has to be highly structured. As the hearing-impaired people are slow in grasping contents, the content must be precise, and supported with their existing knowledge.

Meanwhile, the *contents* must be presented with supports of various media elements, such as text and video. In case real objects could be incorporated easily, they should be incorporated together. However, less variety of colors is more preferred by the hearing-impaired people. Among all, green should dominate the space because the color could harmonize their attention and cognition. To support user task, *navigation* should be designed efficiently. For hearing-impaired people, they prefer to click less and watch more. Hence, the video metaphor is utilized. All these elements are described in Table-1.

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Table-1. Elements for AC4HI.

Element	Description
Instructional	
Text	Text should be minimized. Short sentences. Easy language. Should be synchronized with the video and sign language.
Video	Must be incorporated with sign language.
Sign language	Must be located at the easiest point to see, together with the video.
Synchronization of text and video	Video and text should appear together. Good for the text to appear word by word parallel with the video and sign language.
Content	
Support of existing knowledge	The content should be provided based on the knowledge the users already have. It has no problem to extend the knowledge up to a limit the users could absorb. The use of terminologies must be considered for users' understanding.
Precise	The content must be precise, straight to the point. The users tend to confuse between the content and non-content easily. This applies to the whole display, including the background, the text, the video, and the sign language.
Highly structured	Besides precise, the contents have to be highly structured. The flow of the content must be made easy, straight-forward, and standardized.
Navigation	
Video-based	The hearing-impaired users work slowly on clicking mouse, hence they prefer to click less. Accordingly, video-base metaphor, in which they do not have to engage with the mouse is preferred.
Less click, more watching	That does not mean that they do not want to click the mouse at all, but they prefer to minimize their physical and cognitive efforts while watching the contents.
Media element	
Video	The video in delivering the contents should be clear.
Text	Obvious between background and foreground.
Color	Color determines hearing-impaired users' motivation. Use plain green or blue as the background. Avoid too colors on one display. Standardize the use of colors.
Real objects	Hearing-impaired learn better with visual, especially through real objects. The video should demonstrate real objects.

THE AC4HI

Having gathered the concept for the AC4HI, as outlined in the previous section, this study developed a prototype. It is important to convey the concept to the users. First, it was storyboarded (as illustrated in Figure-7). The storyboard expresses the idea regarding the layout. It was decided together with the users in Workshop 3.
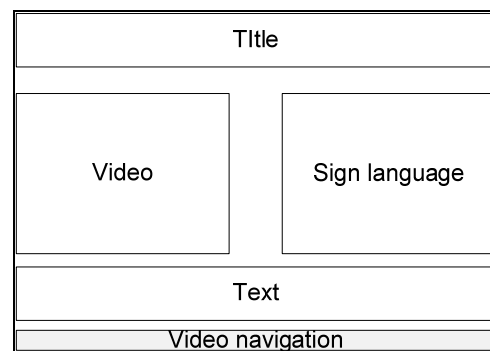
Figure-7. A sample of the storyboard.

Having decided on the layout (based on the storyboard), the prototype was developed. This paragraph and the following describe about the prototype with the elements in the model. The shooting was done in PTSS, with help of their teachers, technicians, and administrative staff. The contents were on Malaysian recipe, from a

course the students take in their study programme. It was decided so that the students and their teachers could get some benefits out of the project. Figure-8 visualizes the title part in the AC4HI.
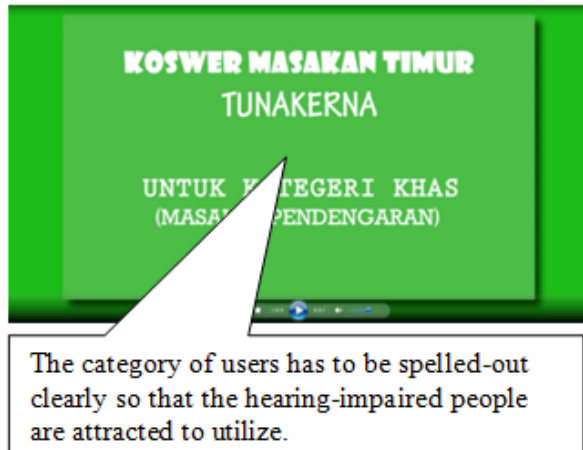
Figure-8. Title part of the AC4HI.

Figure-9. Introduction page.

Then, the introduction part is visualized in Figure-9. The text appears word by word, synchronized with the sign language and audio. There must not be any decorative element, because hearing-impaired people grab the content through visual. So, messy appearance with non-content elements make them feel tired.

When there are video and sign language, the layout is adapted into that in Figure-10 through Figure-13. They are side-by-side, with text at the bottom. It has to always be side-by-side, because it helps the hearing-impaired people to see easily. In this form, the text must be minimalized, to avoid them feel confused and tired. This is because they rely very strongly on visual elements.

Figure-10. Picture and text - ingredients.

Figure-11. Video and sign language - ingredients.

Figure-12. video and text.

Figure-13. Video and sign language - cooking steps.

Throughout the video, the contents are precise, straight to the point, and highly structured. The video and the sign language are ensured synchronized. It is very important, so that the hearing-impaired users could connect the sign language and the contents.

EVALUATION

Having formulated the guidelines in Phase 2, they were evaluated. It is very hard to evaluate guidelines without translating them into a working prototype. So this requires this study to develop a prototype that incorporates the elements gathered in Phases 1 and 2. Developing the prototype was also utilizing the UCD approach, as in constructing the guidelines. This is important because this study serves for the needs of the end users, who are not experts. When the prototype had been developed, it was utilized for testing the guidelines.

Empirical study involving studying the usability of the developed prototype. On top of that, qualitative techniques i.e. interview and observations were also carried out. They enrich the data on top of the empirical study. The evaluation was carried out involving similar subjects (the 17 learners) in the guideline construction.

First, the interface was evaluated. It is very important in making sure that users are happy to use the teaching/learning material. When they are happy with the material, than they could have good responses on whether they feel the teaching material is appropriate in assisting classroom teaching. If the interface is not supporting their task, they may reject the teaching material, in which the rejection may be caused by the unfriendliness of the interface but not the teaching material itself. The results of data collection and testing activities support the achievement of Objectives 3.

This study employs Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) to gather data from users. (Kendall and Kendall, 2002) claim that questionnaire is a technique for data collection purpose that uses a specific form to gain feedback from respondents. On top of that, questionnaire is cheap and it enables administrators to complete it in less time, and

specific information can be gathered from many respondents at one time (Hoffer et al., 2002). In this study, the PU and PEOU are utilized to measure users' satisfaction on usability aspects of the teaching material.

Analyzing the experience

The hearing-impaired users were distributed with the developed AC4HI. They were allowed to experience the prototype on their own laptop. Also, the prototype was made running on a big screen. They were observed, in which this study noted all their reactions, expressions, and interactions.

It was found that they enjoyed the prototype very much. Everyone was seen relaxing on the chair back while watching the content. Most of them communicated with their learning contents. Although this is not possible to be observed through think-aloud protocol, their hand sign explains that they communicate with the contents. No one was seen leaving the AC4HI during the process, and everyone was seen confident with the video-base interaction. Particularly, everyone was able to use the slider to move from one point to another when necessary. While watching the content, they also chat with their peers, perhaps confirming something.

Having finished the session, they were interviewed to gather their feedback on the AC4HI. This study was able to interview individually (Figure-14) as well as in group (Figure-15). All interviews were assisted with a sign language expert. Also, this study confirmed the findings with their teachers (Figure-16).

Figure-14. Interviewing individually.

Figure-15. Interviewing in a group.

Figure-16. Interviewing the teacher.

The interviews were very lively, in which the hearing-impaired students were very excited. This study was very lucky because the sign language expert who assisted the sessions was very supportive. He was entertaining the hearing-impaired at his best. In the interview, the details in Table-2 have been found.

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Table-2. Findings from the observation and interview.

Element	Description
Instructional	
Text	Text in AC4HI is minimal, and sentences are short, precise. The users were happy with the text, with no sign of distraction. When that happens, their motivation has not been negatively affected.
Video	Videos in AC4HI were specifically designed for the hearing-impaired. Thus, users were found enjoyed watching the video. While watching the video, users nod their head, chat with their friend (seen through their hand sign), stayed focus (not leaving the video), and sometimes repeated certain parts, rewind, and pause. All these are signs of active participation, which explain that the cognition is in the flow.
Sign language	The sign language in AC4HI is acted by the sign language expert they have been familiar with, i.e. the sign language expert who have been assisting their teachers. During the observation, they were found enjoying the contents (through video and text) because they understand completely through the sign language.
Synchroniza tion of text and video	When the text appear word by word, parallel with the video and the sign language, the users were found able to grasp the meaning completely. They say "oo…that is interesting"… This supports their cognitive strongly; especially the text is not too lengthy.
Content	
Support of existing knowledge	The content in the AC4HI is about traditional recipe. All subjects have heard of the recipe, hence they could connect the content in the video with the knowledge they have in mind. This enables them to understand quickly while being explained.
Precise	The background, the text, the video, and the sign language in AC4HI are blended together, in straight-forward contents. All parts are precise. This enables the users to be confident, and not confused. Always, they are in the flow, and never get lost.
Highly structured	The contents in AC4HI are also structured well. There are six recipes, in which all recipes are presented in similar format. They start with a brief explanation on the recipe, the ingredient, and cooking steps, finally serving. With this, especially the technique for explaining the ingredients and the cooking steps are standardized, users are not confused. They are always able to anticipate the flow.
Navigation	
Video-based	With video-based interaction style, users were found enjoying the content in their preferred relaxed posture. When necessary, they slide the content to any part they want to. They are very confident in that.
Less click, more watching	This philosophy makes the users engaged deeply with the flow and the content. They enjoyed watching the content, while relaxing in their preferred posture.
Media element	
Video	Video really helps the users in grasping the content.
Text	When used appropriately, text makes learning very meaningful to the hearing-impaired users.
Color	In AC4HI, green is used as the dominant colors. It was found that the color harmonizes users' cognition. It makes them able to watch the content without any cognition disruption, because it was described that green makes their cognition rests.
Real objects	In AC4HI, everything used in the video are real objects. It helps a lot.

Gathering perceptions

Having finished, the users were issued with a set of questionnaire (available in Appendix A), to gather their feedback on how useful the AC4HI is, and how easy it is to use. This study analyzes the usefulness aspect first, followed with the ease of use.

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A. Perceived usefulness

The questions in the list below have been answered well by the subjects. Having collected the questionnaire, the data as seen in Table-3 have been obtained (between 1-strongly disagree and 4-strongly agree).

- PU1: AC4HI helps me be more effective.
- PU2: AC4HI helps me be more productive.
- PU3: AC4HI is useful.
- PU4: AC4HI gives me more control over my learning activities.

- PU5: AC4HI makes the things I want to learn easier to get done.
- PU6: AC4HI saves my time when I learn with it.
- PU7: AC4HI meets my needs.
- PU8: AC4HI does everything I would expect it to do.

It is seen in Table-3 that most subjects strongly agree with all statements, which convey positive values of the AC4HI. Further, the mean (shown in Table-4) for all questions are very high. Particularly only questions PU1, PU2, and PU6 do not get perfect score (4 - strongly agree), while the rest were strongly agree by all subjects.

Table-3. Perceived usefulness.

		S1	S2	S3	S4	S5	S6	S7	S8	S9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	S 17
PU	1	4	4	4	4	4	4	4	4	4	4	4	4	3	4	3	4	4
	2	3	3	4	4	4	4	4	4	4	4	4	3	3	4	3	4	4
	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	6	3	3	4	3	3	4	3	4	3	3	3	4	3	4	4	4	4
	7	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Note: S1 - subject 1

Table-4. Means for perceived usefulness.

	PU1	PU2	PU3	PU4	PU5	PU6	PU7	PU8
Mean	3.88	3.7	4	4	4	3.47	4	4

The results in Tables 3 and 4 indicate that the AC4HI is highly useful. Although questions 1, 2, and 6 have not been strongly agreed by all subjects, they still agree with the statements. Hence, the means greater than 3 also show agreement upon the questions.

A. Perceived ease of use

For perceived ease of use, the questions in the following list were asked. Having the subjects answered the questionnaires; the data as exhibited in Table-5 were gathered.

- EOU1   AC4HI is easy to use.
- EOU2   AC4HI is simple to use.

- EOU3   AC4HI is user friendly.
- EOU4   AC4HI requires the fewest steps possible to accomplish what I want to do with it.
- EOU5   AC4HI is flexible.
- EOU6   Using AC4HI is effortless.
- EOU7   I can use AC4HI without written instructions.
- EOU8   I do not notice any inconsistencies as I use AC4HI.
- EOU9   Both occasional and regular users would like AC4HI.
- EOU10 I can recover from mistakes quickly and easily.
- EOU11 I can use AC4HI successfully every time.

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Table-5. Data on perceived ease of use.

		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17
PEOU	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4
	3	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4
	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	5	4	4	4	4	4	4	4	4	4	4	4	4	3	4	3	4	4
	6	3	4	4	3	4	3	4	4	4	4	4	4	3	4	3	4	4
	7	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	9	4	3	3	4	4	4	4	4	4	3	4	4	4	4	3	4	4
	10	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	11	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Note: S1 - subject 1

It is seen in Table-5 that all subjects agree with the statements. Particularly majority of them strongly agree. While all statements convey positive values of the AC4HI, the results indicate that the AC4HI is very easy to use. This is further strengthened by referring to the means exhibited in Table-6.

Table-6. Means for perceived ease of use.

	PEOU										
	1	2	3	4	5	6	7	8	9	10	11
Mean	4	3.94	3.94	4	3.88	3.7	4	4	3.76	4	4

DISCUSSIONS

Having developed the prototype of the AC4HI, this study gathered feedback from the users, which have been carried out through observation, interview, and questionnaire. In this chapter, the outcomes of the observation and the interview are combined, and addressed together. Meanwhile, the results of the questionnaire are addressed separately.

Having analyzed the gathered data, this section discusses the results with relation to the context. It has to be noted that the subjects involved in this study are hearing-impaired students, the real users the AC4HI is designed for. Having experienced the AC4HI, the results reveal that the users perceived it is useful and easy to use. This is similar with the findings by (Ariffin, 2009) who proposed Reality Learning Media (RLM), a video-based learning material. With the video-based navigation style, they do not have to engage their hands on the mouse to click for next content. In contrast, in this environment, they watch the contexts while relaxing at their preferred posture (Karat, Pinhanez, Karat, Arora, and Vergo, 2001).

Besides that, the approach in the AC4HI itself, which combines various media elements including text, video, and sign language makes them able to understand the contents well. This reduces their cognitive load (Sweller, 1988). The video in the AC4HI was recorded in a kitchen, bringing a metaphor they are very used to. It was selected because the contents in the AC4HI is recipes. This is a significant element in ensuring they are clear with the objective of the AC4HI. The use of sign language is a added value in this learning content. IT supports the hearing-impaired students to grasp the contents quickly through the sign language and the visual representation (the video).

When they continue watching, it explains that they are not bored. This has been underlined by many authors such as (Preece, Rogers, and Sharp, 2007), (Mayhew, 1999), (Schneidermen, 1998), (Nielsen, Clemmensen, and Yssing, 2002), and (Jesse, 2000). Additionally, they communicate with their teachers that they prefer to have the multi-sensory recipe in addition to their books.

Although hearing-impaired people are slow at reading and memorizing (than the normal people), they have good talents at physical tasks. So, cooking interests them, and the contents in the video developed in this study engages their attention. Not only the contents, but the instructional and navigation styles really take part in engaging their cognition.

When discussed about hearing-impaired, their characteristics are homogeneous. Hence, their requirements are also homogeneous. So, the requirements gathered in this paper could be used in other works.

On the other hand, this multi-sensory recipe makes use of Asian Sign Language. It is universal in the Asian region. Hence, the multi-sensory recipe could be used in Asian region. Besides the hearing-impaired people, normal people could also use the multi-sensory recipe because they can get into the contents through the video, audio, and text, which are in normal form. For parents who

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have hearing-impaired children, they can gradually learn sign language through the multi-sensory recipe.

The population of hearing-impaired in Malaysia is more than 60, 000 (registered with the welfare department only, but a big percentage are not registered). Additionally, it is estimated that the population in Asia is beyond 6 millons.

CONCLUSIONS

This paper describes about a concept of learning material for hearing-impaired learners at higher learning institutions. The techniques were explained in detail. Having gone through the techniques, the concept has been tranaformed into a working prototype, which has been experienced by the users. Through the evaluation, it has been found that the users are happy with the concept.

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