Issues in Conducting Expert Validation and Review and User Evaluation of the Technology Enhanced Interaction Framework and Method

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***Abstract*—A Technology Enhanced Interaction Framework has been developed to support designers and developers design and develop technology enhanced interactions for complex scenarios involving disabled people. Issues of motivation, time, and understanding when validating and evaluating the Technology Enhanced Interaction Framework were identified through a literature review and questionnaires and interviews with experts. Changes to content, system, and approach were made in order to address the identified issues. Future work will involve detailed analysis of the expert review and validation findings and the implementation of a motivating approach to user evaluation.**

Keywords - validation; expert review; user evaluation; framework; interaction

I. INTRODUCTION

This paper focuses on the issues involved with expert validation and review and user evaluation of the Technology Enhanced Interaction Framework (TEIF) and Method. The TEIF has been adapted from and extends the work of Dix [1] and Gaines [2] to support developers and designers design and develop technology enhanced interactions for complex scenarios involving disabled people. A review of interaction frameworks showed that many frameworks focus on people to people communication in the same time and at the same place but not using technology to enhance communication. Some frameworks address many interactions between humans and computers and Dix's framework for Computer Supported Cooperative Work [1] seems to address some of the possible interactions but it misses out some important interactions in the same time and at the same place situations such as people using technology to interact with real objects. In Dix's framework, the participants communicate with other participants in what is called "direct communication". Furthermore, the participants also interact with artefacts (man-made technology tools) by "controlling" or "acting". Sometimes an artefact is shared between the participants; in this case, the artefact is not only the subject of communication but can become a medium of communication, called "feedthrough". In communication about work and the artefacts of work, various means are used to refer to particular artefacts, and Dix terms this "deixis", as shown in Figure 1. However, no current framework addresses all of the interactions covered by the Technology Enhanced Interaction Framework explained in the next section. As information and communication technology has become more important in society, many researchers have been concerned with how to use technology to support communication between people and improve interactions between people, technology and objects [3] - [9]. A comprehensive review of existing frameworks [10] confirmed that there has, however, until now been no framework that has helped technology designers and developers consider all of the possible interactions that occur at the same time and in the same place. Section II briefly explains the Technology Enhanced Interaction Framework and Method. Section III describes the research methods used. Section IV presents the pilot study findings. Section V summarises conclusions and future work.

II. TECHNOLOGY ENHANCED INTERACTION FRAMEWORK AND METHOD

The Technology Enhanced Interaction Framework supports developers and designers design and develop technology enhanced interactions involving people, technology and objects and has seven main components as shown in Table I and an architecture shown in Figure 1.

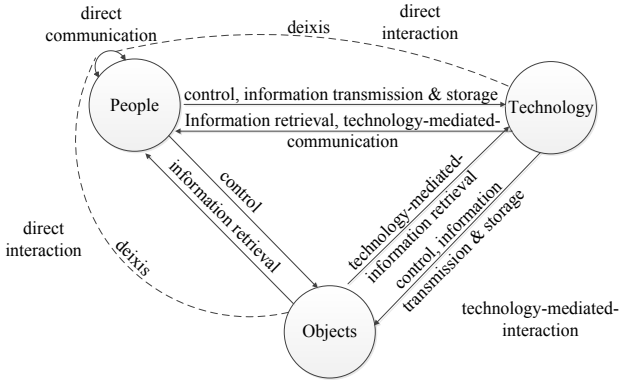

Figure 1. The Technology Enhanced Interaction Framework

The following scenario describes some problems faced by hearing impaired visitors at a museum and it is used as an example to help explain the TEIF Method by providing experts and users with requirements for an example technology solution developed using the framework. The TEIF method which has been explained in detail elsewhere [11], [12], involves 19 requirement questions based on the framework's components and a wide range of technology suggestions based on the answers to these questions.

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TABLE I. THE TECHNOLOGY ENHANCED INTERACTION FRAMEWORK

Main Component	**Main Component of Technology Enhanced Interaction Framework**	
	Sub-component	***Example***
People	Role	A person has a role when communicating with others (e.g., presenter, audience, peer). Roles normally come in pairs such as speaker and audience (e.g., teacher and student or owner and visitor) and peer to peer (e.g., student and student or visitor and visitor).
	Ability/ Disability	People have abilities and disabilities which can affect their use of technology or understanding of language and which can lead to communication breakdown (e.g., physical, sensory, language, culture, communication, Information Technology (IT)).
Objects	Dimension	Objects have 2 dimensions (2D) or 3 dimensions (3D), and a 3D object may have a 2D representation.
	Property	Objects have colour, shape and size.
	Content	Objects have content which is human readable (text, pictures, audio, video) and machine readable (QR code, AR tag, barcode, RFID tag, NFC).
Technology	Electronic	Electronic technology has stored information, is online (e.g., internet, phone network) or offline (e.g., not connected to the internet or phone network), and is mobile (e.g., smartphone) or non-mobile (e.g., desktop computer).
	Non-electronic	Non-electronic technology is used to store information in objects (e.g., writing with a pen on paper) and is mobile (e.g., pen) or non-mobile (e.g., full-size desktop typewriter).
	User Interface	People interact with technology through its user interface (e.g., touch screen, keyboard).
	Application or Service	Electronic technology is an application (e.g., dictionary) or a service (e.g., weather forecast).
	Cost	Technology has cost (e.g., of hardware, software, maintenance).
Interactions and Communication	People-People (P-P)	People communicate verbally (speak, listen, ask, answer) and non-verbally (lip-read, smile, touch, sign, gesture, nod). When communicating, people may refer (speak or point) to particular objects or technology – this is known as deixis.
	People-Objects (P-O)	People interact with objects for two main purposes: controlling (e.g., touch, hold or move), and retrieving information (e.g., look, listen, read, in order to get information or construct personal understanding and knowledge).
	People-Technology (P-T)	People control technology (e.g., hold, move, use, type, scan, make image, press, swipe) and transmit and store information (e.g., send, save, store, search, retrieve)**.**
	People-Technology -People (P-T-P)	People use technology to transmit information to assist communication with (e.g., send sms, mms, email, chat, instant message) other people.
	People-Technology -Objects (P-T-O)	People use technology (e.g., point, move, hold, scan QR codes, scan AR tag, use camera, use compass) to transmit, store, and retrieve information (send, save, store, search, retrieve) to, in, and from objects.
Time/Place	Place	Same and different time and place yield four categories: same time (ST) and same place (SP), different time (DT) and same place (SP), different time (DT) and different place (DP), same time (ST) but different place (DP).
	Time	
Context	Location	Location affects the use of technology (e.g., indoors, outdoors). For example GPS does not work well indoors.
	Weather Condition	Weather condition may affect the use of technology (e.g., rainy, cloudy, sunny, windy, hot, cold, dry, wet). For example, the mobile phone screen doesn't work well in sunshine.
	Signal Type and Quality	Signal type can affect the quality of electronic technology (e.g., broadband, GPS, 3G, 4G).
	Background Noise	Background noise can affect the communication particularly for hearing impaired people (e.g., background music, crowded situation).
	Lighting	Light can affect the interaction (e.g., Inadequate light, too bright).
Interaction Layer	Culture	Cultural layer includes countries, traditional, language and gesture (e.g., "hello" is a normal greeting used in the culture).
	Intentionality	Intention layer involves understanding, purpose and benefit (e.g., the intent is a greeting).
	Knowledge	Knowledge layer involves facts, concepts, procedures, and principles (e.g., how to spell the word "hello").
	Action	Action layer involves actions and behaviours (e.g., pressing the correct key and not hitting neighbouring keys).
	Expression	Expression layer describes how actions are carried out (e.g., whether action is correct, accurate, prompt).
	Physical	Physical layer is the lowest layer at which people interact with the physical world (e.g., the button is depressed and so sends the electronic code for the letter to the application).

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TABLE II. EXAMPLES OF TECHNOLOGY SUGGESTIONS

Technology suggestions	Explanation	Which requirements the technology meets																
		1a.improve communication	2a.same time/ same place	3a.presenter-audience	6b. speaker speaks Thai	7b. presenter speaks Thai	9a. hearing impaired	11a. people – people	11b. people - objects	12a.online technology	13a.mobile devices	14a.pre-prepared speech	16a. indoor	17a. noise	17e.inadequate lighting	18a. low cost solution	19a. work with smart phones	Total Score
1. Mobile web site	A Mobile Web refers to access to the world wide web, i.e. the use of browser-based Internet services, from a handheld mobile device, such as a smartphone, a feature phone or a tablet computer, connected to a mobile network or other wireless network.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	16
2. Pre-prepared caption	Captions are text versions of the spoken word. Captions allow the content of web audio and video to be accessible to those who do not have access to audio. More information about captions see: http://webaim.org/techniques/captions/	✓	✓	✓	×	×	✓	×	✓	✓	✓	✓	✓	×	✓	✓	✓	12

Table II shows two of the technology suggestions with explanations. Although the TEIF can be applied to any disability, only one disability is mentioned in the scenario to help keep the example short and easy to understand. "Suchat Trapsin allocated some parts of his house to become the Museum of Folk Art and Shadow Puppets, in Thailand. There are exhibits of shadow puppets inside the museum, but there is no information provided in text format because Suchat normally explains the history and tradition in Thai by talking to visitors. He presents the same information in the same order every time. Chuty (who has been hearing impaired since birth) and her parents (who have some hearing loss due to their age) are local people who visit the museum. Suchat starts the talk by explaining about the exhibits. During the talk, Chuty and her parents find it very difficult to hear Suchat clearly. Chuty asks Suchat some questions about the exhibits. Suchat answers the questions, but Chuty misses some of the words. While Chuty and her parents are watching the shadow puppet show, they cannot hear the conversation clearly because of the background music, which is part of the show. It is also fairly dark which makes lip-reading very difficult for them. Suchat would like to have a technology solution that makes it easier for Chuty and her parents to understand him. There is good Wi-Fi at the museum so he would like to use Chuty's and her parents' smartphones to keep his costs low."

III. RESEARCH METHEDOLOGY

A. Pilot Study

Validation and review of the framework by experts was undertaken using an online system before engaging with the users (designers). In this study, the combination of online questionnaire on the system and interviewing were chosen. The online questionnaire gave experts time to complete the questionnaire as they could choose their preferred time and place and also could stop and return to the questionnaire whenever they wanted. Using the online questionnaire helps experts to see a prototype of the system so they can give more suggestions or comments about how to design the layout of the system. However, it might result in confusion between validating or reviewing the questionnaire and the system. Therefore, in the analysis of the results it was important to note whether the comments were about the system or the framework. For example, in the pilot test respondents gave comments about the slow response of the online system, which is not an issue about the content. The online questionnaire makes it easy to analyse the data and read the comments compared to the paper based system but doesn't help when the expert requires clarification of the questions or misunderstands some points. Therefore, the study also used interviews to discuss with the experts about any unclear information. Having constructed the questionnaire, it is important to pilot it before giving it to experts to validate and review as it is difficult even for an experienced questionnaire designer to get a questionnaire completely right the first time. Questionnaires must be piloted on a small scale sample of people characteristic of those in the survey.

To pilot the validation and review, one experienced accessibility expert and two experienced designers/ developers responded to an online questionnaire. Based on their responses changes were made to both the content and system to improve the questions, response times and layout as summarised in Table III. The pilot study participants were shown all these changes and confirmed that they were satisfied with them.

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TABLE III. PILOT STUDY FINDINGS

Category of changes	Result of changes
Content	
Spelling and grammar mistakes	Correct and more understandable
Rewrite instructions	Clearer
Rewrite descriptions	Clearer
Add explanation of the technology suggestion tables	Help respondents understand why technologies have ticks or crosses in cells corresponding to requirements
Improve content	Make it clear and understandable without assuming knowledge
Change the image tables to html tables	Make the table accessible, now can copy the content in order to make change, can link to the websites were provided, can provide explanations in tooltip
System	
Remove the logic and always display comment box and question	System processing was slow therefore logic didn't display question before user moved on to next question and the processing icon at the top of page was out of view unless the user scrolled up
Choice, force entry to move on or just reminder	remind the respondents to provide the answer but allow blank entry

TABLE IV. THE ADVANTAGES AND DISADVANTAGES OF THREE USER EVALUATION APPROACHES

Approaches	Main Advantages	Main Disadvantages
1: Read scenario and design solution then read and understand TEIF & Self evaluate	- Less time for participants than approaches 2 and 3 - Designers may find designing more enjoyable than just reading and answering questions as in 1	- No opportunity to actually use the framework for design
2: Read scenario and design solution then read and understand TEIF then design solution again & build and get disabled person or expert understanding needs of disabled person to evaluate	- Designers may find it more enjoyable to design and develop and test and evaluate a real solution with disabled people - Developing a working technology solution and evaluating it with disabled users provides greater face validity to the evaluation	- Most time for participants as will spend much time to design and build the software
3: Read scenario A and design solution A then read & understand TEIF and suggested solution A then read scenario B and design solution B using framework and example solution design patterns (e.g., A, C, D, E) then add their solution to the patterns and Self evaluate	- Designers may find it more enjoyable and motivating and engaging than 1 or 2 by using framework with patterns to design a new solution to a new scenario. - Designers may find it more motivating than other approaches by taking part in helping their peers in designing technology and will be able to see the value of the framework for helping build a large number of patterns.	- Participants spend more time than approach 1

TABLE V. THE PROBLEMS AND POSSIBLE SOLUTIONS OF USER EVALUATION APPROACHES

Problem Type	Actual Problem	Possible Solution
Motivation	If it takes a long time to finish the task it's difficult to find the participants	- Reward (i.e., prize, put their name on published paper)
	Individual designers may get bored if just reading and answer the questions	- Get them to design because the nature of designers like designing more than reading - Inviting a group of people who have the same interest in designing and get them to interact so becomes a more interesting task - Help them to see how their work will be of value to others
Time	Individuals designing using the new framework take too much time	- Working in a team might be quicker
Understanding	Framework is difficult to understand	- Redesign the task so it helps understanding in as short a time as possible - Select participants with a good level of understanding of the task

B. Triangulation

Triangulation is a technique used to ensure the validity and credibility of the results [13] - [15] and methodological triangulation was used based on theory from existing frameworks, expert validation and review, and user evaluation. Validation is an important process particularly when an instrument is being developed to measure the construct in the context of the concepts being studied [16]. Without validation, untested data may need revision in a future study [17]. Checking reliability normally comes at the question wording and piloting stage as if an item is unreliable, then it must also lack validity [18], [19]. An expert review is a process asking the opinions, suggestions, feedback or comments from experts. For example, subject

matter experts are asked to check content of questionnaires or appropriateness of wording and terminology of items [20]. The validation of the Technology Enhanced Interaction Framework was considered by two groups: designer/developer experts and accessibility experts. The design experts focused on the main and sub-components while accessibility experts focused on checking the accessibility aspects. After the expert review and validation, user evaluation involving real users (designers) will be used to evaluate the Technology Enhanced Interaction Framework. Ryan and Deci [20] stated that there are two types of motivation: intrinsic motivation, which refers to motivation that is animated by personal enjoyment, interest, or pleasure and is usually contrasted with extrinsic motivation, which is manipulated by reinforcement contingencies. Normally, extrinsic motivations are rewards (e.g., money) for showing the desired behavior, and the threat of punishment when misbehaving. In order to engage the participants to become interested and engaged in a task which involves spending a lot of time thinking about and understanding a new idea, both intrinsic and extrinsic motivation and Interaction Design components need to be considered. An important issue that can arise when users evaluate a new idea or concept using a prototype system is that they evaluate the system rather than the idea. Using a low fidelity prototype (e.g., paper) rather than a high fidelity prototype (e.g., a functioning website) can sometimes help the user focus on the idea rather than the system. However some users may find it more difficult to evaluate the potential of an abstract concept or idea than a concrete product [21]. Possible ways in which the designers/developers might evaluate the Technology Enhanced Interaction Framework will be considered before finally deciding on the method to be used. The advantages and disadvantages of three of these possible approaches are summarized in Table IV and problems of motivation, time and understanding and their possible solutions are presented in Table V.

IV. CONCLUSION AND FUTURE WORK

Issues of motivation, time and understanding when validating and evaluating the Technology Enhanced Interaction Framework were identified through a literature review and piloting questionnaires and interviews. Changes to content, system and approach were made in order to address these issues. Future work will involve detailed analysis of expert review and validation findings and the implementation of a motivating approach to user evaluation. The updated user evaluation plans based on the analysis of the findings will also be presented at the conference.

REFERENCE

[1] A. J. Dix, "Computer supported cooperative work - a framework," Springer Verlag, pp. 23-37, 1994.

[2] B. R. Gaines, "A conceptual framework for person-computer interaction in complex systems," Systems, Man and Cybernetics, IEEE Transactions on, vol. 18, pp. 532-541, 1988.

[3] E. Berne, Games People Play – The Basic Hand Book of Transactional Analysis, New York, Ballantine Books. 1964.

[4] A. Dix, "Challenges for Cooperative Work on the Web: An Analytical Approach." Computer Supported Cooperative Work (CSCW), 6**,** 135-156, 1997.

[5] A. Dix, J. Finlay, D.G. Abowd, and R. Beale, Human-Computer Interaction, Madrid, Spain, Prentice Hall, 2004.

[6] D. Laurillard, Rethinking University Teaching: a framework for the effective use of educational technology, London, Routledge, 1993.

[7] E. Rukzio, B. Gregor, and S. Wetzstein, "The Physical Mobile Interaction Framework (PMIF)." Technical Report LMU-MI-2008-2, 2008.

[8] Y.T. Sung, K.E. Chang, H.T. Hou, and P.F. Chen, "Designing an electronic guidebook for learning engagement in a museum of history." Computers in Human Behavior, 26**,** 74-83, 2010.

[9] D. Vyas, A. Dix, and A. Nijholt, "Role of Artefacts in Mediated Communication", CHI 2008, Florence, Italy: ACM SIGCHI, 2008,

[10] K. Angkananon, M. Wald, and L. Gilbert, "Technology Enhanced Interaction Framework", 6th Annual International Conference on Computer Games, Multimedia and Allied Technology. pp 30- 35, 2013.

[11] K. Angkananon, M. Wald, and L. Gilbert, "Designing Mobile Web Solutions for Interaction Scenarios Involving Disabled People", Advances in Computer Science, 2013.

[12] K. Angkananon, M. Wald, and L. Gilbert, "Using the Technology Enhanced Interaction Framework for Interaction Scenarios involving Disabled People" 2nd International Conference on Advances in Information Technology, 2013.

[13] L. Cohen and L. Manion, Research methods in education: Routledge, 2000.

[14] H. Altrichter, A. Feldman, and P. S. Posch, Teachers investigate their work; An introduction to action research across the professions: Routledge, 2008.

[15] T. O'Donoghue and P. K. O'Donoghue, Qualitative Educational Research in Action: Doing and Reflecting: Routledge, 2003.

[16] D. F. Polit and C. T. Beck, "The content validity index: are you sure you know what's being reported? Critique and recommendations.," 2006.

[17] H. Coombes, Research Using IT. New York: Palgrave, 2001.

[18] J. Bell, Doing Your Research Project A guide for first-time researchers in education, health and social science. England: Open University Press, 2010.

[19] C. Ramirez, "Strategies for subject matter expert review in questionnaire design.," presented at the the Questionnaire Design, Evaluation, and Testing Conference, Charleston, 2002.

[20] R. M. Ryan and E. L. Deci, "Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions," Contemporary Educational Psychology, vol. 25, pp. 54-67, 2000.

[21] Y.-k. Lim, A. Pangam, S. Periyasami, and S. Aneja, "Comparative analysis of high- and low-fidelity prototypes for more valid usability evaluations of mobile devices," presented at the Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles, Oslo, Norway, 2006.

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