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CULTIVATING A UNIVERSAL DESIGN MINDSET IN YOUNG STUDENTS

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ABSTRACT
Universal Design (UD) is an approach to promoting an inclusive society with equity as a central focus. With trends in globalization and population aging, it is critical to cultivate a UD-oriented mindset among younger people who will be responsible for promoting a more democratic and sustainable society. However, the challenge remains to convince students in higher education of the importance of UD. One potential reason is the common misunderstanding that UD is only dedicated to persons with disabilities, and thus, possibly due to the social stigma associated with disability, students deem UD irrelevant in many cases. Another potential reason is an unfamiliarity with the principles associated with UD as well as situations where they experience any inability or discomfort using a non-universally designed product, service or environment. On the other hand, human/user-centred design (UCD) is supported by the ISO standard 9241-210:2010 and has been more widely recognized as a fundamental approach to successful design and development of a product, especially in the field of human-computer interaction. The lack of a UD-oriented mindset may unconsciously limit the image of "users" within their knowledge, and hence the potential diversity in user traits or use situations could be neglected. In other words, if the students experience UD as beneficial for themselves, it could provide a useful basis for recognizing the importance and impact of UD. By taking two international student projects as cases, this study retrospectively discusses how such tactics may effectively cultivate a UD mindset among graduate-level students.

Keywords: Universal Design, Education, Case study, User Centred Design, Practice-Based Learning.

1 INTRODUCTION

Research on universal design (UD), user-centred design (UCD) and ICT accessibility provides a useful basis for examining the different approaches that may encourage or stimulate the adoption of UD by students in higher education as an approach to developing new ICT.

1.1 Universal Design (UD)

The United Nations defines UD as the design of "products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. "Universal design" shall not exclude assistive devices for particular groups of persons with disabilities where this is needed". However, despite near unanimous agreement on this definition of UD, framing UD within broader theoretical relationships remains a topic of debate among scholars. For example, Lid [1] poses a tripartite distinction between UD as a concept used in relation to human rights and legislation, projects and technical standards, and individual experience. Giannoumis [2] poses a competing framework and differentiates between the context, activities and individual and group characteristics involved in UD of ICT.

Practitioners and scholars have attempted to operationalize universal design in educational and architectural applications. In education, for example, CAST [3] has modelled universal design in learning based on a set of criteria that attempts to evaluate learning engagement, information representation and student action and expression. In architecture, research by Gossett, Gossett [4] gathered universal design criteria in a case study of office building construction. However, research has yet to emerge that operationalizes universal design in ICT.

This article argues that, in terms of ICT, universal design consists of two processes – i.e., the use of ICT and the design of ICT. The International Organization for Standardization (ISO) defines use in terms of effectiveness, efficiency and satisfaction [5]. According to ISO [5], effectiveness refers to "accuracy and completeness with which users achieve specified goals", efficiency refers to "resources expended in relation to the accuracy and completeness with which users achieve goals", and satisfaction refers to "freedom from discomfort and positive attitudes towards the use of the product". The next section focuses more specifically on the role of the design process.

1.2 User Centred Design (UCD)

Norman and Draper [6] laid out the fundamental tenets of an ICT design process that integrates and focuses on the user's needs. Scholars have gone on to conceptualize UCD as a long- and short-term approach to changing users' behaviours when they directly and indirectly interact with ICT [7]. Essentially UCD constitutes four fundamental aims [8]. First, UCD aims to make it easy to identify all potential actions or activities. Second, UCD aims to make actions or activities associated with the use of ICT and the outcomes of those actions or activities visible to users. Third, UCD aims to make it easy to appraise and understand the current state of the ICT. Fourth, UCD aims to provide a clear causal relationship between a user's intentions, actions, results and the interpretation of those results.

This article argues that a UCD approach can provide a useful operationalization of universal design as a process for creating new ICT. Fundamentally, UCD relies on the ability of ICT developers to understand the needs and experiences of ICT users [8, 9]. In other words, UCD processes integrate the activities of ICT developers with the experiences of actual users. The process of developing ICT builds on data drawn from real-life or simulated user experiences [8-11]. Benyon, Turner [9] argues for the use of personas and scenarios – i.e., based on data collected from users or drawn from the research literature – to inform ICT development in an iterative process. ISO [12] provides a useful taxonomy of methods for collecting data in a UCD process. According to ISO [12], usability methods may include both direct and indirect involvement of users.

1.3 Accessibility

UCD processes also relate to broader social, legal and practical efforts to promote access to ICT for persons with disabilities [13-20]. Scholars in this field typically investigate the barriers that persons with disabilities experience in using ICT [2, 21]. ICT accessibility research starts from the perspective that disability results from the attitudinal or environmental barriers that prevent or limit persons with disabilities from using ICT [20, 22-24]. This perspective stands in opposition to a more medicalized approach to understanding the needs of persons with disabilities, which typically focuses on an individual's impairments [25].

The Convention on the Rights of Persons with Disabilities (CRPD) similarly conceives of disability in way that is consistent with UCD approaches [26]. Essentially, the CRPD refers to disability as an evolving concept that results from the interaction of persons with impairments and the attitudinal and environmental barriers that prevent them from using, among other things, ICT. According to the approach used by Benyon, Turner [9], UCD focuses on a user's interaction with technology in a particular environmental context. UCD principles start from the perspective that the development of ICT is a socially organized process. By adopting a UCD process, ICT developers have the opportunity to take into account the diversity of user experiences, including the experiences of persons with disabilities

From the perspective of disability rights scholars, enabling persons with disabilities to participate in society, on an equal basis with others, requires mainstreaming accessibility provisions in law and policy [24, 27]. This article draws on a legal conceptualization of mainstreaming to suggest that promoting UD of ICT, requires educational service providers to integrate UCD principles in technology-related courses. This article seeks to examine retrospectively whether and to what extent mainstreaming UCD principles in ICT education can consequently promote universally designed ICT.

2 METHODS

2.1 Comparative case study

This article examines whether and to what extent mainstreaming UCD principles can promote universally designed ICT by comparing two cases where students were required to create a new ICT

solution. Research has shown that case studies provide a useful approach for examining a current phenomenon in context, where investigators have limited to no control over events [28]. George and Bennett [29] describe case studies as an "instance [case] of a class of events [phenomenon]". Yin [28] describes case studies as empirical inquiries that "investigate a contemporary phenomenon in-depth and within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident". Case studies thus provide a holistic examination of real-life events and a useful research design to investigate complex social phenomena [28].
While a single case study provides an opportunity to conduct an in-depth examination of a phenomenon in a unique context, comparisons between cases have been shown to enhance the research design by providing a basis to examine the differences and similarities among the cases [30, 31]. This article compares the design processes and experiences of the students in the two groups. This approach provides an opportunity to identify any explicit similarities or differences in the use of UCD processes and to identify and confirm the adoption of any implicit norms of UD. The case selection in this paper reflects what George and Bennett [29] have explored as the "most similar" comparative case study design. According to the authors, most similar research designs compare cases that resemble each other as much as possible to identify patterns and changes that differ. In this paper, two cases of ICT design were selected as most similar due to the pedagogical approaches used by the instructor, the international background of the students and the focus on ICT development.

2.2 Qualitative data

This article uses documentary data from the project reports produced by the two cases of ICT design [32, 33]. The cases consisted of two student groups who were participating in an exchange program hosted by the Department of Computer Science at the Oslo and Akershus University College of Applied Sciences. Both cases were from 2015, and one occurred in the Spring and the other in Autumn semester. The first group consisted of two Polish (one in computer science and the other in business and technology), one French (packaging engineering), and one Mexican student studying in Spain (industrial development and product design). The second group consisted of two German (One in industrial engineering and the other in business informatics) and two Dutch students (one in business mathematics and the other in E-technology).
The research question the students in both of the projects tackled was "How can information and communication technology provide a solution in a case of a medical emergency in a foreign country?" Although the students were all fluent in English, they were temporally staying in a country where the national and commonly used language was not their own. The setting of "medical emergency" is a situation that could happen to anybody, anywhere and at any time. Additionally, the project team consisted of students with different cultural and disciplinary backgrounds as described above. The combination of these settings enabled the students to act as potential users of such solutions and at the same time enabled them to think of the diversity of both the users and their use situations. In both projects, the supervisor first provided the students with introductory background information about the research question as well as general instruction about the UCD process – based on ISO9241-210:2010. Afterward, the students had the freedom to focus on and utilize their preferred methods using limited time and resources. The two project reports consisted of 71 pages plus 16 pages of appendices of text from the first group, and 55 pages with 26 pages of appendices of text in the second group. The second group additionally included 19 pages of source code written in a programming language - PHP.
This article uses different forms of thematic analysis to examine the documentary data. Thematic analysis was used to identify consistent and overarching topics that cut across the two groups [34]. In addition, this article uses process tracing as a form of analysis to connect the approaches to UCD, which were discussed in the class, to the documentation in the report, which described the design process. Process tracing provided a useful approach for analysing the data by allowing the investigators to identify the changes in the students' mind-sets and to verify the implicit adoption of universal design principles in practice [35].

3 FINDINGS

3.1 Stakeholder involvement: Focus on diversity

Following the principle of the ISO9241-210:2010, both projects focused on the direct interaction of users of the ICT solutions – i.e., ICT to contact medical emergency services. Hereafter, we define

those who take a contact to an emergency centre as “callers”, while those who receive the contact at the emergency centre as “call takers”. The first group carried out an online survey to collect information based on the real experiences of emergency calls from abroad. In total 48 participants responded to the survey. Fifteen of the respondents had such experiences. The rest of the respondents answered other questions such as whether they check the medical emergency number when going abroad or how much they would like to pay for an assisting app for a smartphone if available in the market. The first group also contacted emergency care services at Oslo University Hospital for an interview. Unfortunately, the interview was not carried out due to the difficulty in scheduling.
The second group took over the contact information and interviewed the responsible person at the emergency centre at an early phase of the project. They tried recruiting informants with real experiences of an emergency call abroad, but they could not find any. Instead, they used the report of the first group as a source of information.
Both groups designed questions to ask in the survey and the interview to the emergency centre based on a literature review. In both projects, the students confirmed that the information they learned from the literature was in line with the experience-based information drawn from the survey and the interview. Although the second group could not find anyone with real experience in making an emergency call abroad, they included in total 46 persons in the evaluation of their prototypes.
For recruiting participants in the survey and the prototype evaluations, both groups adopted the principle of including people with as diverse backgrounds as possible within the limited time frame. The reports did not mention anything about cognitive or physical disabilities of informants. However, taking advantage of being in an international environment, the students leveraged their social networks online, to reach informants with diverse language, education, and age backgrounds.

3.2 Design and evaluation process

The two groups approached differently to specifying user requirements as part of a UCD process. The first group carried out market research in addition to the literature search and the survey described above in the first phase. They conducted a “5-why analysis” to investigate the root causes of the challenges experienced by both callers and call takers [36]. Their intention was to propose the fewest number of solutions possible that could support the broadest possible diversity of caller situations. The students chose this method instead of using time to make and evaluate prototypes. As a result, the first group suggested three ideas; smartphone application, S.O.S. panel, and real-time translation. Smartphone applications enables communication without verbal communication. S.O.S. panel with touch-panel display provides a function for a caller to choose a language that the caller understands. The panel can be used even if one does not have a mobile phone or the mobile communication coverage is not well. Real-time translation would enable verbal communication in user’s own language for both a caller and a call taker.
The second group chose to work on further development of the idea of a smartphone application proposed by the first group. The group identified the user needs for the application – i.e., that users need to communicate only and all necessary information in the shortest possible time in a stressful situation. Thus, the requirements that they initially set already included usability and accessibility design principles. For example, the requirements included making the interface “clear, one question at time”, “big letters”, “good use of colours”, “Use of big buttons”. The “clear” question indicates that the question can be interpreted in the expected manner and not in other ways. This applied other design elements such as images expressing emergency and its cause, as well as texts shown on any step in the communication procedure.
The iterative design and evaluation process of prototypes, made the project members even more aware of importance of employing designs that will ensure high accessibility and usability. Examples include use of both images and text, use of only black and white colours for images, and setting a “back” button at the same position throughout the steps in a different colour scheme from the other buttons to go forward in the procedure. The project members searched for universal icons to express various emergency cases and their causes, but they could not find any.
Another remarkable design feature is that the choice of shown language can be changed throughout the steps. This design was implemented so that any other person than the user or the one who initiated the communication process, can take over. Finally, the team implemented the fourth and final design of the prototype as a web application working on a smartphone’s web browser. The finished prototype could be shown in five different languages (English, Dutch, German, Spanish and Norwegian) in all

the pages except for "medical instructions" that could be only implemented in English, Dutch and German.

4 DISCUSSION AND CONCLUSION

This article sought to explore the role of UCD principles as a catalyst for promoting UD of ICT. This article used two cases of student projects to demonstrate the relationship between UCD principles and UD learning outcomes. The first project explored a variety of potential situations and conditions where medical emergencies occur. The second project focused on the design of a mobile application where the students' considered a variety of user backgrounds, abilities, and situations. This article concludes that 1) the two cases provide empirical evidence where UD was successfully promoted as a latent learning outcome; and 2) design-based courses could enhance students' imagination of user diversity and usability contexts, where UCD principles are mainstreamed as a natural feature of course assignments.

In addition, this article provides a useful basis for future research. As Dong [37] argues, incorporating UD principles into applied student projects can lead to more improved learning outcomes when compared to treating UD as a special topic. This article confirms this view and suggests further that UCD principles provide a basis for involving real or potential users in ICT development. As scholars have suggested, real users' voices are a powerful source in the design process and they expand students' imaginations [38, 39]. This article confirms the value of involving stakeholders as a means for ensuring accessibility and promoting universal design and demonstrates the feasibility of involving stakeholders in student ICT development projects. The authors argue that UD education should not remain as a specialized and independent topic but rather be implemented and mainstreamed as an integral component of each subject where design matters.

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