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Feedback from Digital Systems Used in Higher Education: An Inquiry into Triggered Emotions

Two Universal Design Oriented Solutions for a Better User Experience

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Abstract. We illustrate in this paper some of the negative emotions experienced by students when interacting with digital systems in learning situations, where there is a lack of feedback, or the interaction with digital systems is faulty. The emotions are classified here as feelings of: neglection, frustration, uncertainty, need for confirmation, and discomfort. We proposed thereafter two solutions. The first solution focuses on the design of digital feedback from a system which should arouse positive emotions. We discuss this in relation to universal design principle 5, tolerance for error. The second solution we propose is to provide feedback mechanisms for user feedback (user input). This may be considered when the first solution is not possible.

Keywords. emotions, user feedback, feedb ack mechanisms, universal design, students; Higher Education

1. Introduction

Universal Design (UD) has often been linked to disability [1] [2] and Universal Design (UD) studies [3]. Discourses on disability were mainly from a medical and social model perspective [1]. However, UD is a carrier of democratic values where one should shift the focus from "accessibility for people with disabilities" to considering that there is *out there* "one population comprising people with various abilities and impairments" [39, p. 205]. However, while using a digital learning interface, users with or without any disabilities may encounter problems in their interaction with the digital interface itself. In the same way, students without any known disabilities may encounter challenges in their interaction with digital systems in learning situations.

The aim of this paper is to give an illustration on some of the feelings experienced by students in their interaction with a digital interface in a learning situation, where there is a lack of feedback, or the interaction with the digital system is faulty.

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The method used for learning about this was a workshop based on story dialogue method (SDM) [4]. The workshop theme was feedback in learning situations. The aim of the workshop was that students would develop individual and collective knowledge related to their own experiences, illustrated as stories, and the workshop theme. The participants illustrated their experiences through the form of stories. Providing a detailed description of all of the stories shared by participants is outside of the scope of this paper.

The contribution of this paper consists in arguing for the importance of designing with universal design in mind, while considering positive design, e.g. designing for positive emotions. Specifically, we propose two solutions: one which is design based and focuses on the design of digital feedback from a system, and the other on providing feedback mechanisms for user feedback (user input). Yet, we distinguish between these two types of *feedback: system* feedback and *user* feedback. Hence, the specific research questions to be answered in this paper are:

> *RQ1: What emotions do students without any reported physical, cognitive, or sensory disabilities experienced when interacting with digital systems in learning situations?* (problem formulation)
>
> *RQ2:*
> *a. How can the user experience in an interaction with a digital system, in a learning situation, be enhanced through positive design of universal design of digital feedback?* (possible solution)
>
> *b. When the user experience is not possible to be enhanced through positive design of universal design of digital feedback, is there any other solution?* (possible solution)

We continue in section 2 with defining the terms *feedback* as *feedback from digital system* and as *user feedback* (input from the user). This section also provides a brief on *emotions*. Thereafter we illustrate the current situation regarding the legislation and regulations with respect to Universal Design (UD) and use of ICT's in Higher Education (HE) in Norway. In section 3, we continue with a short description of the method. In section 4, we continue with some findings, by illustrating one example of a story shared by one of the participants. We also made here a classification of the emotions felt by students that emerged from the stories during the workshop (RQ1 is answered). Thereafter, we propose two solutions (RQ2 is answered). At the end, we present a summary and the conclusion.

2. Background

2.1. Defining feedback

Feedback is discussed in various disciplines: cybernetics and control theory [5], pedagogics and learning [6]–[9], organizational behavior [10], as well as in human-computer interaction (HCI) [11]–[17]. Feedback might be slightly different depending on the discipline where it is used. In cybernetics and control theory, we merely refer to feedback between parts of a system. In pedagogics and learning, we refer to feedback from course instructor to student, or the opposite, mediated through or without a digital interface. In organizational behavior, we merely refer to feedback between people. In HCI,

feedback is referred as from a system to a user. All these definitions can be defined through a general epistemological definition of feedback: "information about the results of a process" (Oxford English Dictionary, 2018). We defined in this paper feedback from the user as *user feedback* or *input,* whereas the feedback from digital interfaces as simply *feedback* or *system feedback*.

2.2. Emotions

Picard (1997) defined affective computing as the field that is connected to emotions [19]. The field refers merely to «"how *computers* [are] able to recognize, express, and "have" some of these "feelings"» [19, p. 3]. In the same way, faulty interaction with digital systems in a learning situation, where there is a lack of feedback, or the systems do not work, influence the emotions felt by the user. While Picard (1997) merely referred to how computers can *recognize* or *express* feelings, we note in this paper that users may be affected of negative feelings or emotions when the digital interfaces do not take into account designing for positive emotions. Thus, we argue that this type of interactions may be placed within affective computing. However, before going any further, we would like to point out that some authors have classified emotions into several types: see for instance Plutchik (1982) that has distinguished among eight type of emotions (i.e. fear, anger, sorrow, joy, disgust, acceptance, anticipation, surprize), while others have classified them as ambivalent, e.g. positive and negative [21]. While psychologists may distinguish amongst emotions and feelings, we stick in this paper to the epistemological definition from Oxford English Dictionary. This means that we will use interchangeably the terms *emotions* and *feelings*, for illustrating the results of a sensation in response to a mental stimulus [22]. The stimulus in this case is a faulty interaction with a digital system, where there is a lack of feedback, or the system does not work.

2.3. Universal Design

Universal Design (UD) has been associated with the work of Ronald Mace on accessibility, and designing for "all people of all ages" [23]. Historically, a lot of focus has been on accessibility in buildings and the build environment, whereas in the later years, this focus has immersed into other areas, such as design of ICT's. An action plan regarding universal design was introduced in Norway in 2009 [24]. Amongst the prioritized areas were ICT's, communication policy, young people, and research and investigation. A regulation regarding the UD of ICT solutions has been introduced already since 2013 in Norway [25], and updated as of 2017 [26]. This regulation also includes ICT-solutions used in education and training sector [26]. Specifically, it refers to information that should be published or made available through the use of ICT's, internet based solutions that shall use a Uniform Resource Identifier (URI) and which uses the Hypertext Transfer Protocol (HTTP protocol) or likewise, and digital learning interfaces that should be used in pedagogical work, to support learning activities [25]. The change made on this regulation during 2017, came into force as of January 1st, 2018. The change says that the education and training sector is obliged to ensure that new ICT's solutions within this sector, should be universally designed at latest one year since the regulation came into force, whereas existent ICT's solutions should be universally designed as of January 1st, 2021 (Knarlag, 2017; Kommunal- og moderniseringsdepartementet, 2017, based on *own translation from Norwegian*).

3. Method

We held a workshop with interaction design students, at master level. Neither disability of any form was a criterion for taking part in the workshop, nor disabilities were reported during the workshop.

The workshop theme was feedback in learning situations. The workshop was based on the in-depth narrative method, called story-dialogue method (SDM) [4]. The workshop was held as a half day workshop.

The objective of the workshop was that each of the participants would bring a pre-prepared own story related to the workshop theme and share it with the other participants in a structured manner, following a reflective and abstracting theorizing process. It was structured into five steps: (1) story-telling, (2) reflection circle, (3) structure dialogue, (4) reviewing the story records, and (5) creating insights cards representing theory notes. To document the process, story cards were used in the form of post-its for steps (2)-(5). Some of the researchers' reflections on using the SDM in this type of setting, and further recommendations were described in [28].

4. Findings

We illustrate here one of the stories on the use of faulty digital systems where there was a lack of feedback that triggered negative emotions in a student. The story is related to the use of Vortex web-publishing system [29] as a learning platform. The participant has used the system in the first course as part of her master studies. Due to various pre-set privileges, the participant could not upload her assignment although her peers were able to do that. At the same time, there was a lack of feedback from the system on what the problem was. Being in the start of her university studies, and not knowing whom to contact this was frustrating for the participant. The participant herself noted on a story card:

> *"I chose this story because it was my first experience with delivering an assignment at UiO."*

Another participant reflected on the story:

> *"First experience at UiO → problematic. Everything will be like this with Vortex?"*

The other participants shared similar stories where they encountered challenges when in the interaction with a digital system, there was a lack of feedback, or the interaction was faulty. During the workshop' steps, the participants named both verbally, and on the story cards, that they experienced various emotions in breakdown situation when the digital interfaces did not work. We classified the identified emotions from the story cards into experienced feelings of: neglection, frustration, uncertainty and stress, the need for confirmation on *being on track*, and feelings of discomfort. Table 1 below illustrates examples on the findings based on the story cards written by the participants.¨

Table 1. Feelings experienced by the participants when there was a lack of feedback or the feedback was improper

Feeling	Example
Neglection	A story card explains how one participant would feel neglected when there is no feedback at all: "Feeling as the user is neglected. Feedback is important."
Frustration	One of the story cards say that his/her stories can be related to another participant's story: "added up frustration" On another story card was noted frustration when not getting the digital systems to work: "Frustration at not getting <<bang for bucks>>.", meaning that it was not worth the money/energy/time, i.e. the participant's resources. Another story card says: "Feelings of frustration when the system does not work and you are pressured by time." Another card sees the use of systems as barriers: "Systems → problem → it causes a lot of frustration. Systems as barriers."
Uncertainty	One card explained how every other student would be able to interact with the digital system, except for the participant making the card, due to lack of proper feedback from the technology: "No feedback creates uncertainty when everyone else <<just gets it right>>. This can be stressful." Another card explains how one feels about him/herself when a system does not work: "To be trusted that it's the system. Not me that is wrong." And "How can I be wrong about something so simple?"
Need for confirmation on "being on track":	A card is describing it: "The need to know if you are doing the right things – feedback." Another card says: "feedback is important to know if you did something well or wrong so you know how you can proceed further."
Discomfort when a system does not work right:	Even though you are right, constantly having to complain about minor issues might feel uncomfortable." "No getting any feedback at all (minor issues might not be discovered) → you feel uncomfortable → I feel like that."

5. Discussion

We illustrated that students experience negative emotions described as feelings of: neglection, frustration, uncertainty, need for confirmation, and discomfort, when using digital systems in Higher Education. This answers our first research question:

> RQ1: *What emotions do students without any reported physical, cognitive, or sensory disabilities experienced when interacting with digital systems in learning situations?*

This type of emotions was experienced by students in learning situations in interaction with digital systems, due to either lack of feedback or faulty interaction. We have illustrated through a concrete example the story from one participant with her experience with Vortex, when submitting the first assignment as part of her master studies. Amongst the UD for learning (UDL) principles, which is an adjacent part of UD, is also the principle of multiple means of engagement [30]. This principle refers to how students can be engaged or motivated to learn [30]. But how can students be engaged or motivated to learn when the digital interfaces used *trigger negative emotions*, as we have seen in our findings? Moore (2007) discussed the work of Rose & Meyer about teaching students in the Digital Age, supporting this idea that barriers for learning lie within the inflexibility of how the educational material is taught and the methods that are used [31]. In the case exemplified here, this refers to the use of digital interfaces in learning situations that are inflexible, i.e. see the submission of assignment that was not possible; at the same time there was no feedback from the system informing the user what was wrong.

We propose further to look at how Universal Design (UD) could prevent this type of situations when interacting with the system triggers these type of feelings. First, we propose to look at principle 5, tolerance for error and design for positive emotions (section 5.1). This will answer the first part of our second research question:

> *RQ2a.: How can the user experience in an interaction with a digital system, in a learning situation, be enhanced through universal design and digital feedback?*

Second, we propose to look at how feedback mechanisms supporting user feedback (input), when the design does not support tolerance for error (section 5.2). This will answer the second part of our second research question:

> *RQ2b.: When the user experience is not possible to be enhanced through universal design and digital feedback, is there any other solution?*

5.1. Preventing faulty interaction through design of digital feedback

UD is based on seven (7) principles [32], [33]. Amongst these is tolerance for error, principle (5). This principle focuses on four guidelines [34]. Two of them are: "providing warnings of hazards and errors" (guideline b) and "providing fail safe features" (guideline c) [34]. We could say that a warning is a form of textual or visual cautionary notification about a possible undesired situation occurrence. However, this principle and its guidelines do not address concrete solutions on how this should be implemented in digital interfaces.

One way of approaching this is through digital feedback. However, we argue for that digital feedback should arouse positive emotions through its design. While a lot of research has been done regarding the affective design for the hedonic digital interfaces, such as entertainment websites (e.g. games), or interfaces that are used during leisure time, less of this type of research has been done on the utilitarian digital interfaces, such as

governmental websites [35]. We would like to extend the governmental category to digital interfaces supporting learning in Higher Education, but also digital interfaces in general. According to [35], negative emotional experience during the interaction with digital interfaces can lead to other consequences [35]. For instance, elderly users may experience *fear* when the feedback from the digital interfaces is improper or is lacking [17]. In our findings in this paper, we illustrated a series of negative emotions experienced by students in their interaction with digital interfaces. Transferring this to a learning situation, and coming back to UDL principle of engaging students in learning and motivating them, in a long-term perspective, this possibly may affect the students learning.

Further, [36] supports this idea of the role of positive emotions in design, in chapter 6 of their book *Positive Computing: technology for Wellbeing and Human Potential* (2014). They describe D. Norman framework for distinguishing between different levels of design: visceral, behavioral, and reflective level (D. Norman in [36]).

The visceral level refers to the look and feel of a product, including how the user experiences it (D. Norman in [36]). At the visceral level, we have observed that the users have experienced negative feelings of neglection, frustration, uncertainty, need for confirmation, and discomfort.

The behavioral level refers to the way the user engage in the interaction with the digital interface, including feedback from the system (D. Norman in [36]). At the behavioral level, we could observe from our findings that one of the trigger of these feelings was due to lack of feedback, or faulty interaction.

The reflective level includes the own impressions and judgements about the product (D. Norman in Calvo & Peters, 2014). We argue that for a positive experience at visceral and behavioral level, reflective design is needed. Reflective design is defined by Sengers et al., (2005) as being based on critical reflections, on how users experience the world – in our case the interaction with digital systems [37]. Coming back to UD principle 5, tolerance for error, besides providing the user with warnings and error messages in the form of feedback, we suggest that the principle should also embed the consideration of positive emotions.

5.2 Preventing faulty interaction through providing feedback mechanisms for user feedback (input)

In the European Union (EU) directive 2016/2102, paragraph §12 on accessibility of websites and mobile applications for public services is stipulated that ICT's solutions should comply with minimum standards and guidelines for the accessibility, enabling as many people as possible to use those, without the need for special adjustments (EUR-LEX, 2016). Paragraph §46 indicates that such websites or mobile applications should include feedback mechanisms that facilitate user feedback, i.e. *input* from any users in case the website or the mobile applications do not comply with the accessibility requirements [38]. Example of such a failure could be that the file format is not accessible. In the case of a notification, the public service entity should answer the request within a reasonable time [38]. Transferring this to the Higher Education context would mean that the digital interfaces used for learning should support feedback mechanisms, i.e. input from the users when digital interfaces are not universally designed or accessible. This should be high on the agenda of the universities' digital systems destined for students' learning, when design solutions are not possible through principle 5 with regard to positive emotions (section 5.1). We suggest that this is important to be taken into

consideration due to the new regulation that came into force in Norway, as of January 1st, 2018, described in section 2.

6. Summary and Conclusion

The change regarding the UD of learning environments law in Higher Education can be classified as a change at societal macro-level [39]. But on a micro-level, we still need to understand how these digital systems affect the users – regardless if they are disabled or not. The participants in this study did not have any reported disabilities, but they still encountered problems when interacting with the digital system. We have illustrated, in this paper, on a micro-level, some of the emotions experienced by students when interacting with digital systems in learning situations, where there is a lack of feedback, or the interaction with digital systems is faulty. The emotions are classified here as feelings of: neglection, frustration, uncertainty, need for confirmation, and discomfort. We proposed thereafter two solutions. The first solution focused on the design of digital feedback from a system. Based on this study, it seems that fulfilling the minimum WCAG requirements [40] may not be enough in the future. We illustrated this through the example of UD principle 5, tolerance for error, which we called system feedback. We concluded that our impression is that digital interfaces should also arouse positive emotions through their design. For instance, studies show that in the near future, Artificial Intelligence (AI) could be used in academic and research libraries in the upcoming years, as shown by [41]. In the future, these library services could be tailored and "designed on the fly" for a diverse group of users, with the help of AI [42, p. 1065]. Another study presented a similar AI library service blueprint [42]. For that reason, we think that it seems that we should consider other aspects besides the functional part of universally designed digital interfaces used in Higher Education, such as the affective part of these interfaces. However, we noticed that this solution might not always be possible. We proposed therefore a second solution which should provide feedback mechanisms for user input, also called user feedback. This should be considered when the first solution is not possible. We acknowledge however that further research is required in this area and therefore we encourage others to expand the touched points in this paper.

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