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VITALISING HEALTH PROMOTING TECHNOLOGY FOR ELDERLY IN DESIGN EDUCATION

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ABSTRACT
In this paper, we *reflect* on *developing* a *course* in design of *health promoting technology* for elderly, within the field of Tangible Interaction Design (TID). The pedagogical goal is to develop profound design education in an important, complex and new evolving field, which lies in the intersection between diverse *health* perspectives, *technological* possibilities and *cultural* values and expressions. A field with goals beyond tools, functionally and biomedical health, into increased vitality and quality of life for individuals. Through reflections on teaching and cycles of courses, and many years of research, we have acquired insights in what qualities courses in this field should have, regarding *Learning models*, *Teaching resources* and *Tools,* to be successful. In short, it can be formulated as "the closer to reality, the better results", regarding both student deliverables and learning outcome.

Keywords: Tangible Interaction Design, Health Technology, Internet of Things, Health Promotion, Well-being, Quality of Life, Health, Multi-sensory, Participatory Design, Elderly Care

1 THE FIELD - TEACHING DESIGN OF HEALTH PROMOTING TECHNOLOGY

In this paper, we *reflect* on the *development* of a *course* in design of *health promoting technology* for elderly, within the field of Tangible Interaction Design (TID). Tangible interaction is an area rapidly evolving. From the first vision of the *ubiquitous computer* formulated by Marc Weiser in the late 80's [1], through Hiroshi Ishii's focus on the tactile *user interface* [2] to Eva Hornecker's increased focus on the tactile and bodily qualities of the *tangible interaction* [3]. It was first mainly a technological perspective that developed to include more industrial design aspects such as materiality, aesthetics, shape and sensory qualities.

Health and welfare technology is also a rapidly developing field, due to the demand for increased efficiency and quality in health care. There are great expectations towards what Internet-of-Things and robots can offer, which makes it an increasingly more important field for design. What *type* of technology depends on our view on health and health goals.

The medical field focuses on technology that monitors biomedical data, such as blood sugar, blood pressure and weight. However, when moving from medical treatment to care homes and everyday life, a deeper reflection of health is needed. Traditionally, one divides health into a biomedical and a humanistic health perspective [4]. Biomedical is health from a medical perspective focusing on disease, diagnosis and measurements, while the humanistic looks at the whole human being from the individual's own perspective, focusing on resources and strengths [4]. Health promotion is the process of enabling people to increase control over their health and its determinants, and thereby improve their health and wellbeing [5]. With this health perspective, experience of *mastery* and *self-efficacy* is important [6] [7]. Within elderly care, a person-centred perspective is therefore increasingly important [8], where fundamental psychological and social human needs such as love, comfort, identity, occupation, inclusion, and attachment are emphasised. This has led to an increased focus on health promotion activities, e.g. music appreciation as creative and social activities [9]. Within the Health Technology field, some focus on changing the attitudes or behaviours of the users through persuasion and social influence [10], so called "Persuasive Technologies". Others inspired by Positive Psychology intend to evoke positive and flourishing experiences and thereby quality of life. These directions are called ''Positive Computing'' [11] and "Positive Technology" [12]. Both directions are relevant to our work, but have so far, to a little extent, worked with tangible and sensorial interaction.

The courses we have developed over 7 years are all research-based, in the area of health promoting tangible interaction design for persons with special needs. We have focused on *music* and *multi-sensorial interaction.* In our research, we have experienced a shift *from* viewing the thing as a *tool*, such as a musical instrument [13], to become an *empowering, hybrid digital and physical environment* [14]. A hybrid of physical and virtual technologies that offer the *user many roles* to take and many *health promoting actions* and paths to make. From a Universal Design perspective, this requires to teach students an extension of standard guidelines and the Seven Principles of Universal Design [15].
The E&PDE community has explored related questions. Berg [16] used *ceramic art* objects, and Sjovoll & Gulden [17] used *gaming, drama* and *writing* to promote well-being. Neither used computer mediated tangible objects in participatory design for health promotion. Nor did they, as we, design directly with the elderly users. DeGrande used tangible interaction in the *ideation process,* while we focus on the *use-process* [18]. Others have explored the use of *open learning platforms* such as Arduino and Raspberry Pi, to develop physical prototypes [18] [19], which take students a long time to learn and master. We used a *high-level custom-made platform* that offered the students opportunity to realise *advanced testable prototypes*, and to focus on design rather than on technological issues [20].

2 DEVELOPING THE COURSE - CYCLES OF REFLECTIONS

2.1 The Method - Reflection in and on Teaching

The course has been developed in a reflection-in-action and on-action manner over many years. In this context we have structured our thinking and insight-development along two dimensions, the course *framework* and the *process,* for two specific master courses. We arranged the two courses at two different learning institutions within Interaction Design, at AHO and NTNU, in Norway. The course framework is the kind of *learning model* we use, the *learning objectives,* the structure and *plan*, as well as *teaching resources* and *tools* we offer the students. In the *process* part, we focus on the students' *insight gathering*, the *ideation* process, *concept* development and *results*, both the students' results, design wise, as well as learning outcomes and their satisfaction.

2.2 The Course Background

At AHO, we have taught Tangible Interaction Design (TID) for Master students in Industrial Design since 2005. Since this was a 5-year Industrial Design education, Interaction Design and Tangible Interaction Design were elective courses. Today, TID is organised under Interaction Design, but we are constantly experiencing how the development of *hybrid design is expanding*, which is an argument to organise Tangible Interaction Design, over Industrial Design, Interaction Design and Service Design.
The course we are presenting here was developed within an ongoing research project [20]. The first years, the courses run in collaboration with the Textile Department at National Academy of the Arts. We then focused on the aesthetic qualities of e-textile and musical interaction. However, art students had never worked with such tasks, in groups, or with such technology, so the course entailed major challenges, although the aesthetic qualities of students' final work were excellent. We have developed 5 generations of technological platforms over the years starting with Arduino and Apple iPod as the running computer, ending up with Texas Instruments Beagle Bone Black because of the heavy demands of external sensors and dynamic musical wireless interaction (see Figure below).

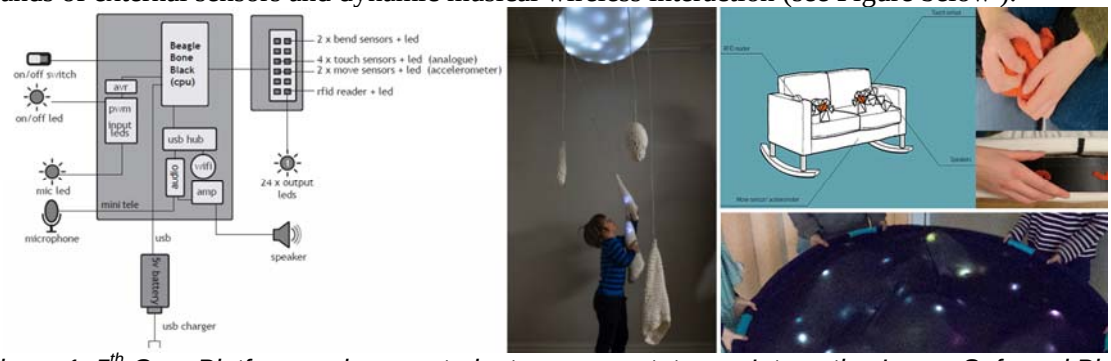

Figure 1. 5th Gen. Platform and some student course prototypes: Interactive Lamp, Sofa and Play Parachute

2.3 Course 1 - Vitalising Welfare Technology (AHO)

The following is a description of the first health promoting technology for elderly course that we arranged at Oslo School of Architecture and Design (AHO) in the autumn 2015.

2.3.1 Framework

Background. The first course in design for elderly was "Vitalising Welfare Technology", which indicates both the goal and scope. It was a 3-week module in a half-year *master course* in *Tangible Interaction Design*. Most students had Industrial Design background, with competence in shaping materials from a user functionality point of view. They had limited knowledge in Interaction Design, both in technology and design for motivating interaction. It was a stated goal to give students practical design competence in multi-sensorial interaction, i.e. material embedding of sensors to create sensory and aesthetic user experiences.

Learning model. Learning-by-doing a practical design task in an Arts and Crafts tradition, and with a user-centred approach. The task was to design concepts for health promoting technology for residents at a care home as a main group. The main goal was to improve vitality, and reduce passivity and isolation. Students had to work in groups and use a custom-made technology platform [20] and choose one of six user contexts (rooms), at the care home. The work was collaboration between Design and Occupational Therapy students. The end delivery was a 20-minute presentation and testable prototype, exhibited and tested in the care home on the last day. The managers at the care home and teachers in Design and Occupational Therapy collaborated in formulating the task, which gave the task a valuable anchoring and quality.

Tools. An advanced technological platform (Figure 1), developed in the 5-year research project Rhyme [20], and technological help, represented limitations regarding type of sensors and content, but more time to focus on design. A rich amount of relevant materials, crafts books and health related papers.

Teaching resources. Daily design mentoring by course tutor, who was a researcher in the RHYME project. Support from technical developer during the last 2 weeks. Access to Occupational Therapy teacher and resources at the care home on students' demand.

2.3.2 Process

Time plan. A 3-week course. 1st day: Introduction to theme, task and overview lectures. 2nd day at the care home: Morning introduction, tour and observation. Workshop afternoon. Additional lectures in relevant areas and visits to research centre to explore welfare technology. 2nd week: Each group presented 3 concepts. End presentation and exhibition of one fully functional prototype at care home.

Insight gathering. In meeting staff and elderly persons in an introductory meeting, tour and workshops at the care home. Through frequent dialogue between students in Occupational Therapy and Design. In continuous contact with the care home throughout the course. From lectures, reading literature and visit to the research centre for care.

Ideation. The ideation workshops were arranged at the care home the second day of the course, which was a little premature. Both students in Design and Occupational Therapy, researchers, health personnel, residents and visitors participated. The workshop was pre-structured focusing on *actors*, *user experiences*, *actions* and *materials/media*. This gave the process clear goals, which was important with participants with such diverse backgrounds and motivations. Some residents with dementia were a little bit confused, but gave the students first hand input and familiarity with the actual users.

Development of ideas to concepts. 1-2-1 ideas on handout-forms after the workshop were shared between all seven groups. The week after, each group structured the ideas into 3 concept directions. The manager and professionals chose the concept the students should develop further.

Evaluation of prototypes. Each of the seven groups developed one fully functioning prototype that was exhibited and tested on the last day at the care home, e.g. an interactive sofa playing selected music when rocking, an interactive tangible video wall and a musical soft lamp installation for co-creation with kids (Figure 1). The students first presented (20 min) their work to a large public audience.

2.3.3 Course 1 - Reflection and Insight

This course had a number of good qualities and some poorer, which should be recognised. First we believe that the course was too short, compared to earlier 4-weeks courses. The students did not have

the opportunity to work one week *individually,* with *material explorations* and *expressions*, *without complex functional requirements*, which was unfortunate. The managers at the care homes decided what concepts the students should develop further. This had some negative consequences, since a few students felt forced to work with a project they lacked motivation to do. The good thing was that we got a variety of design solutions, and avoided negative competition on the same concept topic.
The students reached good results due to *continuous multidisciplinary collaboration* with the Occupational Therapy students, which was very fruitful. But due to many students the groups became too large. The ideal, from our experience, is 3 students in each group.
The custom-made technology platform [20] and technology resources offered opportunities to create advanced functional prototypes, which increased the students' aspirations and created pride of the outcome, which was very positive and necessary in a field as complex as this one. Obligations to present and exhibit on a particular date *at the care home* created a push and experience of high demands on the design solutions, which was positive for strengthening quality of the results.

2.4 Course 2 - Health Promotion Technology connecting elderly with children (NTNU)

The following is a description of the second course that we arranged at NTNU in the autumn 2017.

2.4.1 Framework

Background. Since 2016 NTNU has taught TID at the 2-year MA programme in Interaction Design in the course in Design, Creativity and Innovation. The course has on- and off-campus students, with diverse educational and cultural backgrounds. Most students lack experience in TID. We introduced TID with practice-based learning in a Makerspace environment. The learning goal was to develop skills to design, ideate and prototype in TID for health promotion with children and elderly persons.
Learning model. The module focused on user-centred, practice-based design. The task formulated by health and design researchers, was to design physical prototypes that promote health for elderly, inspiring communication with children. Interviews and observations were used to understand and relate to users. Written evaluations were used to create reflections. Teacher-selected groups of 3-5, based on aesthetical, technical and language skills, with one Norwegian speaking student per group.
Tools. The open learning platforms Arduino and Raspberry Pi, 3D printer, wood, paper, textiles, music, electronics, sensors, actuators such as motors and lighting. All buyable in an online catalogue.
Teaching resources. Access to some technical help, health researchers and practitioners (nurse, occupational therapist), elderly persons, and children for one day at a care home. Course responsible was researcher from the RHYME project with experience from the AHO course. Access to tangible robot companion pets, books on ideation methods [21], innovation and philosophy of technology.

2.4.2 Process

Time plan. Activities day 1-35: Meet health researcher day 1. Interview elderly, children, staff, 4 hours at care home day 7. Ideate, design prototypes, University Makerspace, day 8-20. Present 3 concepts, demo prototype for staff at care home, 2 hours, day 21. Deliver written reports day 35.
Insight gathering. Observations, open interviews participative activities (soft bowling, baby song, children choir, physiotherapy and Arts and Crafts) at daycare and elderly centre.
Ideation. Groups developed ideas based on Game storming [21], and double diamond processes.
Development of ideas. On-campus students developed 20 ideas that lead to 12 concepts (2-3 per group) and 4 tangible and testable prototypes. Off-campus students developed 10 ideas, 6 concepts and 3 paper and physical prototypes.
Evaluation of prototypes. Students demonstrated their prototypes, e.g. an interactive outdoor feeding house for birds with indoor controls, and sensory singing plants with shared responsibilities for watering. Design researchers at NTNU and health practitioners at the care home did oral evaluation of the prototypes. Two off-campus groups presented and got feedback from local health staff. Students reflected on the result in a group project report and their process in an individual report.

2.4.3 Course 2 - Reflection and Insight

The *practice-based learning* succeeded in groups that initially agreed on work forms, but not where this lacked. This implies that the course should be more detailed structured, due to the complexity of the field, to ensure and communicate the expectations and strengthening the course quality. It is important to define groups based on gender, age, and skill levels in *aesthetics, technology* and

Norwegian language in order to secure a good process. Students wanted more time to discuss *basic health issues*. The 4 +2 hours allocated to meet users was not enough to create relations with the elderly and to test out prototypes. Due to the *long distance* to the care home, students didn't revisit the care home which led to less understanding of the users and the design task. In the AHO course we experienced how valuable the free contact between the care home and the resource persons was for the students and the course results. In the open Arduino and Raspberry Pi *development platforms*, students had to programme and build electronics, in order to achieve tangible prototypes that users could interact in. Compared to the AHO students, with focus on design and users with advanced custom-made platforms (Figure 1) and technical help, NTNU students with a *more technical focus achieved less advanced design* solutions. This implies that either should technical programming training be increased, or a more advanced and easy to use sensor platform is used instead. In opposition to the AHO course, NTNU included some material exploration before the main task, but this was not enough to give the students confidence in shaping the complex hybrid and tangible material. The part with material explorations should therefore be expanded. Off-campus students' results were weaker because they got less material experiences, less feedback from users, staff and couldn't share experiences with fellow students.
In opposition to AHO, NTNU did have a written part to be delivered 2 weeks after the design assignment. This offered the students both time and opportunity to process the gained knowledge on a deeper level, both group-wise and individually. This was very positive and should be included in future courses.

3 CONCLUDING - CLOSER TO REALITY, BETTER DESIGN

In this paper we *reflect* on the *development* of a *course* in design of *health promoting technology* for elderly, within the field of Tangible Interaction Design.
Tangible Interaction Design as a design field is constantly evolving. One perspective is to regard it as an extension of Product Design, including digital and computational materials. Another as a specialisation of Interaction Design, focusing on physical user interfaces and embodied interaction. Service Design thinking is also an important dimension, since increasing health over time is the implicit goal, and technology is often part of healthcare services.
Health and welfare technologies are in strong growth, as health care invest heavily in technology to increase their efficiency and quality. Therefore, it is important to develop the best possible design education for this significant area. The design courses we discuss in this paper are developed over years in close relation to ongoing research, and the teachers have researched the field for over 10 years. The close relationship with multidisciplinary, action-based research has been an important prerequisite for the development of the courses. The relationship is reciprocal. Each year the students contributed by testing the potentiality and constrains of a new generation of technology (platform), before it was developed further to prototypes in the research project.
Through several iterations and versions of this course, we have reached insights and conclusions we consider important in health promoting technology design education: The most significant conclusion is the importance of *practical problem-based project teaching,* where students in groups *co-create* solutions, in a *participatory design* manner, with relevant professionals and *users*, *caregivers* and families. It is also important to base the course on *basic health sciences*, where the students gain a deep understanding of what health is, diverse perspectives on health and what *health promotion* is in this landscape in relation to concepts such as biomedical health, public health, quality-of-life and well-being.
From a Universal Design perspective, it is important that the students gain a deep user understanding, and learn the *difference* between seeing users as *patients with diagnoses* and disabilities, to consider them as *persons with resources*. Resources that can be strengthened with technology, to live healthy and qualitative lives, that they *define themselves*. And where vitality and empowerment are important health dimensions. This is an area with great potential for using cultural expressions, e.g. music.
From our different iterations, we found that it is important that the *student project brief* is co-created and *co-written from several viewpoints*: user, relatives, diverse practitioners and related academic fields, to ensure the professional depth and design opportunities from many perspectives.
From many courses, we found that *the more advanced* the tools, such as the technological platform was and the more *technical help,* the design students were given, the more *focus* they could put on the

design challenge and solutions, and not on the technical issues. This resulted in better and more thorough design solutions that the students became more satisfied with.

To give the student a *grounded understanding* in the design opportunities and challenges in such a complex field as Tangible Interaction Design, it was best to give them a *material task* the first week, before introducing them to users and health promotion. This in order to give the students practical hands on *understanding and experience with the design material* of Tangible Interaction Design.

We observed how important *proximity* to the *users* and the user *place* is for the quality of the course. Where there is an *easy* and *informal possibility* for the students to have *regular* and *direct* contact with the user and resource persons at the user place, care home.

This resulted in *better design solutions* because of deeper user and health related knowledge, social commitment and motivation, which the frequent and close interaction gave.

It is important to work in *mixed group*s, where the *teachers divide* the students based on design *knowledge* (aesthetics, form, technology, communication), *cultural* and language background, *gender* and *age*.

Research-based courses can help the students feel more motivated because they experience *contributing in developing the knowledge field*, with their perspectives, ideas, questions and solutions. They become *more motivated* because they feel that they are at the forefront of development, which is the core of the design field, where *improvement* and *innovation* is ethos. *Interdisciplinary course*s with other related fields, such as Occupational Therapy in our case, are demanding both socially and logistically, but also help to *increase the quality* of the course considerably, and are therefore highly preferable. Since our pedagogical goal was to evoke interest and develop design competence about health promoting technology for the elderly, our conclusion in short was: The closer to reality the better the education, both regarding technology, use situations, practitioners, and relevant research fields.

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