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The Use of Card-Game Design to Teach Universal Design Theory

Richard HERRIOTT[a,1]
[a] *Design School Kolding*

ORCiD ID: Richard Herriott https://orcid.org/0000-0002-1891-6645

Abstract. This paper discusses the use of a card-game design task to teach the implementation of Universal Design (UD) principles to undergraduate students. The underlying assumption is that in order to implement UD methods, designers need to select the right tools to gather information and they need to understand the theoretical basis of the tools chosen. The aim is to bridge the theory/practice gap by getting students to actively consider how each aspect of their design research contribute to the implementation of the theory. Work by Herriott (2023) shows that design researchers are not consistent in explaining or making transparent the underlying reasons for why a UD tool was chosen. UD theory is also somewhat weak on the topic of implementation, a necessary element of design theory according to Jones & Gregor (2007). The didactic purpose of the card-game design was to encourage students to become conscious of the reason they chose the design tools eventually used in their course project. It was also to examine how, from a UD theory standpoint, implementation of UD could be enhanced since this aspect of UD theory appears to be in need of reinforcement. The students developed in class a card-game which could be used to create and advance their designs and also to retrospectively analyse them upon completion. The in-class discussion of what was required for a game also focused students´ attention to the elements of UD and their possible implementation. The work shows that more time is needed to explain game design; mapping of UD concept to game affordances is necessary; the course learning outcomes require addition of demonstration of theory-to-implementation

Keywords. Universal Design, design theory, tools of inquiry, design process.

1. Introduction

This paper is a preliminary report on part of on-going research into improving UD practice. The intention here is to provide a preliminary description of a means to explore ways to make the link from theory to practice stronger. Vavik notes that "to become a professional designer one has to have theoretical knowledge, practical skills and professional experience" [1, p.1]. Wilson et al. [2, p.619] note that "uptake of inclusive design in industry is limited, with designer awareness of the approach and its associated methods and tools noted as barriers to its uptake". Wilson et al. [2, p. 626) also write that there is "scope for improvement surrounding the communication of basic ID theory". This paper may go some way to help communicate UD ideas in class.

[1] Corresponding Author: email: rhe@dskd.dk. Design School Kolding, Ågade 10, 6000 Kolding, Denmark.

The basis of the research was a study into the use of theory, defined by Jones & Gregor [3], which found that "that design researchers working on design for disability and universal access need to explicitly identify the structure of their theoretical content" [4, p.139]. Theory related to implementation was the under-emphasised element. Implementation means putting the theory into effect, using design methods and tools [3]. This resulted in a follow-up study [5] into the link between implementation and design tools. The link from theory to tool selection was found not to be very strong. The next phase led to an (ongoing) series of class-room based teaching experiments for design students in Denmark (3 classes at bachelor level) and Turkey (1 bachelor and 1 master´s) classes. The focus on the link between theory and practice led to a decision to use game design, argued for by Majuri et al. [6] as means to strengthen the link between design "tools of inquiry" [7] and the supporting theory. The work represents an attempt to make explicit that there is a link from UD theory to the tools used and on to the type of data gathered (quantitative, qualitative, mixed methods). See Figure 1, below:

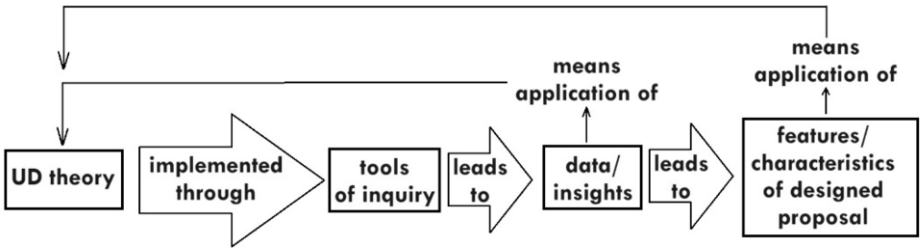

Figure 1. Mapping UD theory to game design features/principles.

This paper reports on teaching with the 2nd year BA industrial design students of the UD course. The class size was 17 students (which is in line with Dong´s [8] recommendation that smaller classes are better for teaching ID.

2. Literature review

This section consists of a short review of 1) UD, 2) UD in education, 3) gamification and 4) gamification in relation to teaching accessibility. Defined many ways, UD is design to accommodate a wide a range of cognitive and physical capabilities, the user´s wish for autonomy and self-actualisation. The terms Inclusive Design (ID), Universal Design (UD) and Design For All are viewed as being synonymous in much design research literature [9; 10, p.3; 11, p.93; 12, p.2; 13, p.2]. The term UD will be used here.

2.1. Universal Design, teaching of

Some research into teaching UD addresses what are called frameworks [1, 8, 14] or strategies [15, 16] while others look at the use of design tools [16, 17]. Some papers such as [8, 2, 14, 16] consider both. None cover the link from theory to tool use. Frameworks and strategies refer to high-level structures to help conduct teaching. Dong [8] describes how to position UD in courses (separately or integrated), how to get students to relate to disability and how imagine realistic situations. Vavik [1] presents the essential

elements of the inclusive design process but doesn´t go into much detail about the pedagogic methods. Watchhorn [15] discusses how to integrate UD teaching into interdisciplinary courses for building design ("architecture") and occupational therapy students. The strategic aspect of this work lay in the use of a variety of methods of teaching: in-class lectures, on-line resources (narrated slide shows), links to external resources and "interactive interviews with key stakeholders" [15, p. 482]. There was also a full-day class on virtual and real-life simulation of wheelchair use and vision impairment. Students also used a virtual-world simulation with common barriers found in real life. To be noted here is that to evaluate the teaching, the students were asked to report on their own change in awareness of UD. Scott et al. [16] inquire into how effectively UD is taught. Unusually for a building design course, there was clearly stated an assumption about inquiring into user groups by "engaging with them" (15, p.1). Participatory design is cited for one project and for another, a series of workshops with feedback from local citizens on the design proposals. One of the projects did not involve users, and was concerned with designing inside the framework of regulatory compliance. Rieger and Rolfe [14] describe a learning framework for teaching inside the context of building design. The means used in the coursework, involved users of various capabilities, student journals, qualitative and quantitative questionnaires, and studio project work. The article´s premise is that UD teaching is mostly limited to "fake personas, building codes and anthropometric data" [14, p.359] . The relevant part of this research is the structure for what is terms "authentic learning". Those feature are summarized as collaborative a real application, complexity, a broad range of data sources, supportive tutors and a chance to reflect on the work (14, p 360).

Turning to ways to teach inclusive design research tools, Dong [8] reports on the use of personas and scenarios to teach larger classes and the use of people with disabilities in smaller classes. The strategies are focused on UD as a general concept and a general approach. Rieger & Rolfe [14] listed different teaching methods for doing inclusive design: lectures, questionnaires, anthropometrics, sensory activities (e.g. simulating blindness), site analysis with a blind person, modelling, readings and reflective journals. Oleson et al. [17] focused their work on a design tool rather than the theory of Universal or Inclusive Design itself. The paper reports on pedagogical content knowledge (PCK) and identified the main approaches relevant for this. This work was conducted in relation to human-computer interaction (HCI) with a focus on software design looking specifically at implementation of the GenderMag inclusive design inspection method. Wilson et al, [2] investigate inclusive design education on a general level. Based on a survey of UK design courses, Wilson et al. found the tools used for teaching were simulation tools, ethnography, user-participation, "on-line resources", personas and observation methods. Note the dual use: tools of inquiry used *for* teaching and *to* gather design data.

2.2. Gamification, general points about

Gamification is an approach that uses rules-based or free play behaviours in various settings to encourage different mental approaches and actions [18,19]. Majuri *et al*. [6] note the effectiveness of gamification for human engagement and write that "it is not surprising that gamification has been especially addressed and implemented in the realm of education where supporting and retaining engagement is a constant challenge." Huotari & Hamari [18] are among the earliest to try defining gamification [19, p.9).

Huotari & Hamari [18, p.25] proposed a definition of this, though one related to service design: "Gamification refers to a process of enhancing a service with affordances for gameful experiences in order to support users' overall value creation.". Deterding *et al* [19, p.9] suggest it is the "use of game design elements in non-game contexts". Majuri *et al*. [6], write that the interest of studies has been on quantifiable factors such as course and assignment grades (rather than, say, content or non-quantitative objectives.

2.3. Gamification, use in teaching

A survey of the use of gamification in teaching is presented in Majuri *et al*. [6, p.11]. Only one of the measured behavioral and psychological changes in [6] involved something akin to learning, namely knowledge transfer. That doesn´t quite describe the change in mental state one might be aiming for (in this paper, the understanding of theory in relation to UD).

Finally, gamification for teaching UD (or accessibility). Earlier work on gamification and for communicating UD includes [20] and [21]. This relates to digital accessibility and the game design is screen-based as are Buratti *et al*. [22] and Buratti *et al.* [23] Lorgat *et al.* [24] report on using gamification in teaching accessibility for software design students, "a gamified quiz composed of situations or questions". This work then deals with UD-type material but is primarily about delivering factual material.

An important concept in gamification is that of motivational affordances [6]. These are the aspects of the game that encourage play: accumulating points, for example, to signal progression and achievement. The other point to note is that much work in gamification involves quantifiable outcomes e.g. grades and assignment completion. In this paper, the interest is not on quantifiable outcomes but how a game can be used to explain theory´s relation to tools of inquiry, data and design outcomes.

From this background, the question is whether one can use a game design with appropriate motivational affordances to help convey ideas of UD (theory, tool use and data gathering). Another aspect of this is that the students are asked to develop the game structure rather than the structure being provided by the teacher.

3. Experiment with game design - method

Prior to any instruction on UD, the students were asked to draw a design process. These diagrams were collected and stored. About 20 days into the course, the students had begun their design work and to consider the data they needed to gather in relation to their project. The instruction to the class began with a refresher on the main points of UD. Some principles of game design were explained. Games are primarily about making strategic choices. Game designer Sid Meier [25] said that "a game is a series of interesting decisions". A game needs to have options which are not clearly superior such that there are several pathways to a good result. A game needs to be balanced such that there is a reasonable chance for all players to achieve a win. Finally, skill must be balanced with luck – enough skill to make the game challenging, and enough luck to add some random interest so as to lead to varied outcomes [26, 27, 28].

The instruction was for the class to act as a group to design a game that could communicate the application of UD principles. The class were asked to consider the mechanism by which the a game could embody aspects of the design process. The students were supplied with sheets of Canson card in ten colours, coloured markers, glues, craft blades, a radius cutter (for rounding the cards´ corners), pencils, and marker paper. While the class worked, the author made a prototype game using the same guidance. At the end of the class, the students´ proposal was explained and tested. The game was compared to the teacher´s attempt. One the last day of course, students were again asked to draw a design process. The diagrams were collected and stored. The initial design process diagram was compared to the one done at the end of the course, focusing on instances of design tool use. The students´ 10-slide visual presentations were checked for instances of design tool use.

4. Data and Analysis

The process diagrams from the first and final day of the course were compared. Any design tools e.g. user-interview, sketching, prototyping, were counted. For the first set of diagrams, the average number of design tools named was 4.13. In the second diagram, the average number of design tools named was 8.6. Only one student did a second diagram with fewer named design tools on it than on their first diagram. In the first round of process diagrams there were more outcomes (e.g. "the model", "data". "sketches" and "information") rather than design tools e.g. sketch, model-making, mind-mapping. In the second set the tools used occupy more of the project description (e.g. mood board, make prototype, interview, observe etc). This implies the students are thinking more about what design tools they had been engaging with. The project presentations (10 slides per student) were analysed. The average number of design tools used was 7. In the presentations there was a less emphasis on the design tools than in the diagrams. Perhaps students wished to avoid repetition.

Turning to the card games from the classroom exercise: the student card design consisted of a conversation game intended to spur design discussion. It had cards for:

1) UD design characteristics (e.g. equitable use, flexible use, simple to use, low physical effort, etc.)
2) Capability/Constraints (e.g. memory, social skills, technical knowledge, speech, mobility, vision, etc.)
3) Situation/task (e.g. put on clothes, taking a shower, cleaning the home, send a text, etc.)
4) Design tools (e.g. focus groups, concept mapping, K/J method, interviews, design ethnography, prototyping, personas, etc.).

Additional cards consisted of design challenges e.g. design a stairlift, a coffee canister, or reacher grips. UD theory was communicated in the product challenge discussions prompted by the cards taken e.g. was there UD principle at stake in the design challenge? Which capabilities were relevant or which kind of design tool was needed to get information to solve the design challenge? The play approach of the students didn´t

include the kinds of game affordances one might expect, such as accumulating points or progression. It was a game in the sense of a conversational aid or discussion prompt. It followed the pattern of other card sets used in design e.g. the 6C model [29]) or the Design Guide to User Ecosystem Thinking [30]. The design created by the teacher (the author) consisted of a set of seven UD principles cards (see Fig. 2 below).

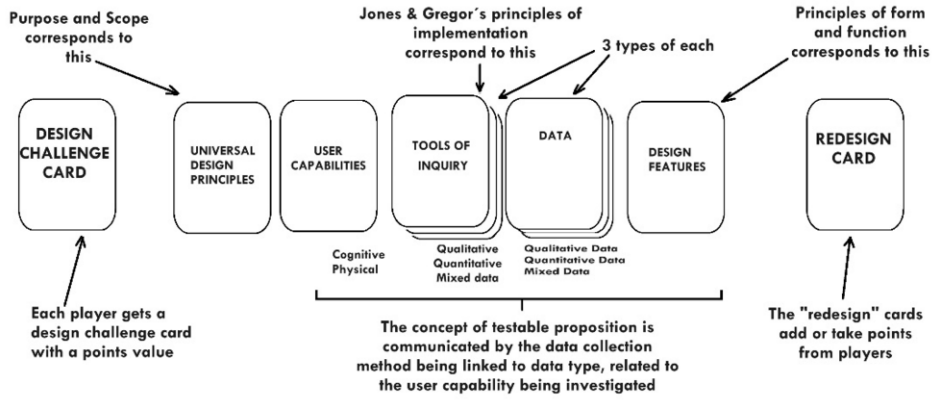

Figure 2. Teacher´s design card set. The middle five cards have assigned points. The points must match the value on the design challenge card. The "redesign" cards (right) allow the players to confiscate points from other and/or add points to their own set.

The aim of the game was for each player to acquire the points required by the design challenge card. This was done by picking up, putting down from the deck or taking cards from other players. The game afforded gaining points towards a winning quantity; it also allowed competitive play element in that players could add to others´ points requirements (simulating adding features) or take points from them (simulating unsuccessful research). The first player to have the correct total of points, right type of data and matching UD principle card wins the round. The other value of the card sets (both students' and teacher's) was the use as diagnostic tool in project discussions. Following the morning class, students had project feedback. Both the card sets structured the conversations about what design research tool was needed to solve the existing design problems. It was also possible to analyse the elements of the projects, using either set. That way the students could understand what elements worked in their project up to that point.

5. Conclusion and discussion

This paper should be taken as merely a brief glimpse into approaches to UD pedagogy. The research was dealt with strengthening the relationship between students´ understanding of the link between UD theory, UD implementation and the outcome of their design projects. Further work on this approach should make the theory-tools-data-feature chain more explicit. As it is, it is at best circumstantial. The citing of more instances of design tools (from about 4 to about 8) shows greater awareness of the tools; it only implicitly supports the notion the tools were chosen with theoretical reasoning in mind. A less interesting way to direct attention to this is to create a tabulated document to structure the theory-data-tools-feature chain. The designer would list the features and

then supply the corresponding meso-theory, design tool, data type (quantitative/qualitative/mixed) that led to that feature.

One of the peer reviewers asked about the relation of the teaching experiment to the learning outcomes. Space doesn´t allow a full analysis of the demonstration of the learning outcomes in the course description; however, the student responses indicated the achieving this outcome: "to have knowledge about universal design methods and principles", corresponding to the students using an average of 8.6 design tools to achieve a universally designed proposal. The examiner and censor who assessed this course work reported a high level of satisfaction with the work presented. They reported (informally) that in the exam presentations the students focused on UD design principles, user capability and data gathering.

The following points emerge from this brief initial experiment. One, since designing a game to explain abstract theoretical content requires the mapping of two sets of rules together [20] this has to be explained more clearly; neither sets of rules are directly equivalent so this requires judgement. Two, that more time is needed for students to understand the concepts of game design if they are to map them onto the concepts of UD. Further experimentation with this teaching will set aside more time to allow a second iteration of the game and more time for testing. Three, even if the student game design does not produce a concept as good as expected, it still provides an avenue for discussion. This could be questions such what is it that is not working in the game in relation to the learning outcome? How can the game be made more realistic and given a rule to drive it forward?

Finally, the aim of the exercise is not to teach game design – the aim is to find a game-based mechanism that can capture elements of the chain of concepts leading to application of UD ideas via UD design tools from the theory they are grounded in. This preliminary work will be followed up with a more elaborated method and teaching plan.

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