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Mixed Method Research Procedure for Design Education

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Abstract
We address the need to provide rigorous research training within design education by presenting a methodology for utilizing both qualitative data and quantitative data within an integrated research procedure. Rigorous research training is needed because many of today's designers work on socially and politically complex problems that traditionally were framed as technical problems. Consequently, designers require training in applied social and behavioural science research to address bias and test their ideas before implementing them. In our view, such research training can be successfully supported through designers learning to construct sound and strong arguments for their designs. To illustrate our argument we provide a proposal for a research methods course for addressing human-centred design aimed at undergraduate design education.

Keywords: mixed-methods design research, design education, theory of argumentation

1 Introduction

When designers must innovate to create designs such as a new mobile phone for an unfamiliar culture, or a poster that must quickly and effectively communicate an important message to a diverse audience, or an architectural design that makes a critical contribution to material culture, then designing is complex. It is complex because the designers must integrate knowledge from different domains and collaborate with different stakeholders to address cultural, social, behavioural, and political issues and meet people's needs in a human-centred and ethical way. Hence, as more and more parts of the world become the subject of human intervention, more and more complex issues become the subject of design. Accordingly, the design process has changed, and the generally received view of design and what the design process entails, no longer seems suitable within human-centred design practice. According to Rittel [1, 2], the received view frames the design process as a method of problem solving by reduction to analyse the problem and then construction to synthesise the solution. However, Rittel claims that this model is not a realistic account of the design process when people are involved. People have different values and worldviews and, therefore, the problems that designers are faced with can no longer be synthesized into a singular solution. Differences between people need to be taken into account if a long lasting and resilient design is to be created. However, just how such human-centred design work that takes different views into account should be done, remains under-theorised. Furthermore, design education lacks

appropriate courses for teaching design students the skills and literacies they need to deal with complex human-centred design work [3]. In this paper, we focus on what facets are needed in design research education to address this gap and we end by providing a proposal for a research course addressing human-centred design aimed at undergraduate design education. We argue that a research course which employs argumentation theory in combination with a mixed methods research approach will provide design students with some of the skills and literacies they need to do deal with complex human-centred design work.

We propose that, rather than applying a formal problem solving method, human-centred design is better understood as a form of argumentation that creates knowledge. Simon [4] describes designing as: "[devising] courses of action aimed at changing existing situations into preferred ones". The design-as-problem-solving view takes mathematics as the model of reasoning; however, this approach is not human-centred because it concerns the geometric method of demonstration of theorems consistent with the universal rules [1, 2]. In contrast, human behaviour is diverse and differs between multitudes of conditions, which cannot be explained with universal rules. Arguments, on the other hand, are aimed at influencing particular audiences towards particular values to undertake actions. When designing for humans, changing existing situations means changing human behaviours.

A useful way to convince someone to change his or her behaviour is by providing a good argument [15]. As such, a human centred design in the form of an end product can be seen as an argument that influences humans' behaviours. For example, a rubbish bin along side of the road in the shape of a basketball net convinces the user to throw rubbish in the bin and not on the ground, through making it a fun activity. In order to convince the audience and consequently activate intended behaviour, the design needs to be compelling enough. Thus, sound and strong arguments are needed that convince the audience. At the basis of sound and strong arguments lies knowledge. As Friedman [5] points out "[to] change existing situation into preferred ones, we must understand the nature of preferred situations and the principles through which we achieve them". Hence, there is a need for knowledge in design on which design decisions can be based. Knowledge is created through bringing understanding out of experience and into critical comprehension. This process of knowledge conversion from tacit to explicit forms can be supported by research.

Research in design has progressed beyond questions such as: *what form or material is needed to conduct heat in a toaster?* Or *what shape of juicers extracts the most juice from an orange?* To questions such as *what makes a toaster look beautiful?* Or *what makes interaction with a design pleasurable?* Or *how can we influence people to throw away their rubbish in the bin instead of on the street?* Because real behaviour is very contextual, designers can no longer rely on naïve psychology that assumes that *what I as a designer prefer, must be what everyone prefers* [3]. Hence, designers need to do research to acquire knowledge of anthropology, sociology, human behaviour and psychology. The research that designers should do, however, differs from fundamental research disciplines. Designers do not have the role to contribute to scientific knowledge as such, but are generally more interested in using knowledge to address a specific situation. For example, designers are not interested in answering the question *what constitutes pleasurable interaction?* But rather *what pleasurable interactions can be employed in a design to make people use a rubbish bin?* Even though more fundamental knowledge helps designers to suggest certain interactions that may be pleasurable, they need more knowledge to assess which behaviours are pleasurable in a specific context and whether those behaviours elicit intended behaviours. Hence, design researchers need to create knowledge on new and rather specific areas relevant to design and

at the same time the knowledge created through that research will then provide all facets needed to create a good argument justifying the design as an end product. We argue that a mixed methods research approach in design provides designers with the knowledge necessary to provide good arguments to justify their design claims. Therefore, we propose to employ argumentation theory in combination with mixed method research (quantitative and quantitative) in design research education.

2 State of Design Research

Qualitative research is often used to explore new areas and is therefore widely used in design research. Through interviews, observations or other qualitative techniques designers can identify what kind of interactions users of products could use and which ones are appropriate. However, basing a design claim on qualitative data only has a pitfall similar to naïve psychology—the wrongful assumption that results can be generalized over a larger group of people. Often qualitative research is done with a small sample of people, because often the size of the sample is determined to be enough once particular topics or themes start to repeat themselves. After all, the aim of qualitative research is exploring new information and identifying factors of interest. Accordingly, there is a relatively large chance for sampling error to occur—the sample is not representative of the population [11, 12]. This chance of sampling error is especially of concern when dealing with complex human behaviour and when the aim is to use acquired knowledge and implement it into designs to be used by people.

Quantitative research, on the other hand, tries to resolve the problem of sampling error through choosing large enough samples and choosing them wisely. Therefore, results obtained through research are more safely generalized and design claims based on quantitative data have a higher chance of actually addressing needs of users. However, quantitative research aims to test hypotheses derived from theory and fundamental knowledge and are often very singular (testing one independent and one dependent variable only) and the theory or knowledge needed to construct relevant hypotheses within the design discipline often do not exist. Hence, both qualitative and quantitative research approaches have their positive contributions to design knowledge: qualitative research identifies factors relevant to specific contexts and quantitative research makes it possible to create design claims with an understanding of their certainty; however, both approaches also have potential pitfalls. Basing design claims on qualitative data may not address the actual needs of users and quantitative research cannot be performed by lack of specific knowledge relevant to the area of design to base hypotheses on. Accordingly we can conclude that existing methodologies that focus only on qualitative research, such as interviews and focus groups, or quantitative research, such as questionnaires and experiments do not suffice. This conclusion is consistent with Norman's [3] assertion that new or different research approaches should be developed within the design discipline that aim to answer the specific research questions that concern designers. Next to that, there is the need to educate our future design researchers in research methodology that enables design research to establish itself as a research practice of its own and of significance [5]. We claim that a mixed method research design can provide a comprehensive way for designers to do research relevant to their discipline. Furthermore, we argue that teaching mixed methods in undergraduate design education will not only help students answer relevant research questions, but will provide students with means to create strong and sound arguments for their design claims.

3 Mixed Methods Research Designs

Mixed method research refers to the use of both qualitative research and quantitative research within one research design to answer the same research question. Different approaches within mixed method research can be distinguished based on either priority or implementation of data collection [6-11]. In essence, priority can be given to either qualitative or quantitative research or equal weight can be placed on both within the research design. Implementation of data collection refers to the choice to either collect or interpret qualitative and quantitative data concurrently or sequentially. The major mixed method designs derived from combinations of these two factors are: triangulation, embedded, explanatory and exploratory [12].

Triangulation occurs when both qualitative data and quantitative data are interpreted simultaneously to provide more reliable results. Embedded research seeks to clarify the results obtained with one type of research with the other type of research. This can happen either sequentially or concurrently and the choice of which one is used to clarify the other depends on the research question. In an explanatory design a quantitative research phase is followed by a qualitative phase whereby the qualitative results explain the quantitative results. The quantitative phase informs the questions or sampling of the qualitative phase [11, 12]. Exploratory designs start with qualitative research and those findings are subsequently validated by quantitative results. Typically, the factors or outcomes identified in the qualitative phase are applied to a larger and more diverse sample in the quantitative phase [12]. This latter approach is often employed in relatively unstudied areas [13].

The nature and uniqueness of situations often addressed by designers call for an exploratory research approach. The qualitative research can identify factors relevant for the specific context in design while quantitative research can then assess the certainty of those factors and test the design claim put forward. When qualitative and quantitative research is integrated within a research design, the arguments for design claims produced are both sound and strong.

4 Argumentation theory

We commonly think of an argument as a dispute or a conflict, however in research an argument is more like a thoughtful conversation through which you explain ideas [14]. An important difference between an everyday conversation and a research argument is that while in research we are expected to make claims that are new or important enough to be interesting to our readers, we also have to explain why we believe our claims are significant and so we must provide good reasons and evidence [15-18]. According to Toulmin [15, 19], an ideal argument is both *sound* and *strong*. In order to create sound and strong arguments they should offer the following elements:

- A claim, what you want your audience to believe
- Grounds, the reasons and evidence why they should believe it
- A warrant, a general principle that explains why your evidence is relevant to your claim
- Backing, the body of accepted knowledge of a field or the values of a culture that provide the foundations that authorize the reliability of the warrant
- Qualifications that make your claim and evidence more precise
- Rebuttal, counter arguments, limitations

In the Toulmin model, every facet of an argument serves to support claims. Claims are statements that aim to convince someone to change their mind about something or to undertake a course of action [15]. Because most people resist changing their mind, especially

about things they feel are important, we need to provide supporting evidence and also expand our argument with two more elements: warrants and backing. Including these three facets will increase the *soundness* of an argument [15].

The warrant of an argument is a general principle, assumption, or premise, that bridges the claim and its supporting evidence connecting them into a logically related pair [15, 20]. A warrant does not answer questions about whether the evidence is accurate but about whether the evidence is relevant to the claim. However, a warrant is neither self-validating nor beyond question. We must demonstrate that the warrant is reliable and relevant. We can do this by adding another element to the model of the argument—backing. Backing is the body of accepted knowledge of a field or the values of a culture that provide the foundations that authorise the reliability of the warrant [15]. It is the broad body of knowledge, experience, or set of cultural values that is presupposed by anyone who accepts a particular warrant. Once we have demonstrated that all the elements of our argument are present and connected we have formulated a *sound* argument. However, we can ask further questions about the *strength* of those connections.

Because the connections between the evidence, warrant, and backing are not absolutely irrefutable, we have to provide qualifications for our claims [15]. When we provide qualifications, we limit the certainty of our conclusions, stipulate conditions in which our claim holds, and address readers' potential objections. Whenever we make a claim that is true only under certain conditions or when the link between the claim and the evidence is only probably true, we owe it to our readers and ourselves to qualify our arguments appropriately. Good reasons and thoughtful qualifications help to convince our readers that we are trustworthy, because we acknowledge the obstacles that interrupt the connection between our evidence and claim [15].

Designers often base their designs on design claims without providing both sound and strong arguments [3]. This is the case because designers often lack the skills and literacies they require to obtain the knowledge needed to provide all facets that comprise a cogent argument. We argue that designers can create that knowledge, and consequently can provide both sound and strong arguments for their design claims, through employing a mixed methods research approach.

5 Combining mixed methods and argumentation theory in a coherent educational framework

Designers need to propose innovations in view of their consequences; meaning they need to take into account how their designs affect the complexity of human culture. Hence, designers have a lot of responsibility and need to be convincing in their designs to be able to change current situations into preferred ones. Therefore, we argue that when involved in the activity of human-centred design, designs can be viewed as arguments that convince people to employ certain behaviour. The research that designers do to acquire the knowledge needed to design for a specific situation can provide designers with all facets that comprise a sound and strong argument. We argue that the research activities included in an exploratory mixed methods research approach can map onto all of the facets necessary for sound and strong arguments.

More specifically, the claim in Toulmin's argumentation model is the design claim on which a final design brief is based (e.g., interaction with the design needs to be pleasurable). The evidence, warrant, and backing are provided through qualitative research that identifies the factors relevant to the design problem at hand (e.g., people indicated that throwing things in

the rubbish bins is not usually a pleasurable experience). Finally, the qualifications are provided through quantitative research in which hypotheses are tested based on themes that emerge from qualitative research (e.g., it is *very likely* that making the interaction pleasurable will make people use the rubbish bin, because 95 % of the people (N=200) indicated they were more inclined to use a basket ball net instead of a rubbish bin). Furthermore, having the skill to specify the individual facets of cogent arguments also supports critical reflection to identify limitations and counter arguments.

6 Course proposal

Based on above outlined arguments for combining argumentation theory and mixed methods research in design education we now propose a structure for an undergraduate course. Even though we actually ran the course with undergraduate students at a School of Design, our main aim here is to provide a course proposal for how to integrate argumentation theory and mixed methods research in design education. We based the development phases of our course on Fink's [21] framework for developing a course. Our course proposal follows Earley's [22] structure for a syllabus for mixed-methods research course.

6.1 Learning goals for the course

The aim of the course is to educate the students in the skills and literacies of design research. Upon successfully completing the course the students obtain the skills and literacies to:

1. Identify the relationship between methods for investigating the relevant contexts, and decision-making processes for given design problems.
2. Prepare a design proposal based on relevant contextual investigative research methods, awareness of ethical issues, and appropriate decision-making processes.
3. Report on the project showing evidence of relevant investigative research methods and decision-making processes.

These learning outcomes are aligned with learning activities and assessments, following Biggs and Tang's [23] constructive alignment approach. According to Biggs and Tang [23]:

> 'Constructive' comes from the constructivist theory that learners use their own activity to construct their knowledge as interpreted through their own existing schemata. 'Alignment' is a principle in curriculum theory that assessment tasks should be aligned to what it is intended to be learned, as in criterion-referenced assessment… The intended outcomes specify the activity that students should engage if they are to achieve the intended outcome as well as the content the activity refers to.

Furthermore we took the principle of efficiency, meaning that we assume that most students will probably only do the minimum work required to get the grades they want. Consequently, we tried to only include activities that directly aligned to assessments and learning outcomes.

6.2 Content of the course

The course follows three phases: in the Secondary Research project the students clarify the research to define goals to obtain learning outcome 1; in the Primary Research project the students describe phenomena to understand the world to obtain learning outcomes 1 and 3; in the Design Brief project the students prescribe action to form an argument to obtain learning outcomes 1 and 2.

The total duration of the learning and teaching of course is twelve weeks, and the workload is twelve and a half credit points. The total contact time is thirty-six hours for the semester, and

students are expected to spend twelve and a half hours of total study time per week on this unit. In the first project, Secondary Research, students identify a research topic to investigate during the semester and are introduced to the Toulmin model of argumentation that underpins the structure of the research design. The second project, Primary Research, forms the core learning and teaching of the course. The students learn about and carry out original primary research according to our integrated mixed methods research design. Based on secondary research students formulate a topic of research and a design claim in the form of a main research question. In the qualitative research phase, students administer self-documentation kits to prime interviewees and then conduct interviews on their topic. Data analyses begin by coding the raw interview and self-documentation kit data using sticky-notes, and then progressively categorizing the coded data until 4-6 summarizing themes emerge. During the quantitative phase, students translate the themes into hypotheses. These hypotheses are then tested with the help of a quantitative questionnaire. Data analyses involve descriptive statistics and data visualization techniques. These results are then interpreted and form the basis for the formulation of qualifiers. The outcome of the primary research project is a full sound and strong argument for a design claim. The qualitative research phase provides the students with the evidence, warrants, and backing for their claims. The quantitative phase provides the students with the qualifications for their arguments. The third project, Design Brief, focuses on communicating the arguments for their design claims and illustrating their potential for innovation within design practice. The students transform the arguments from their primary research into scenarios that illustrate proposals for their design claims.

6.3 Class Room Activities and assessments

The learning and teaching is organized each week as a one-hour lecture giving general principles and examples, and a two-hour tutorial with specific activities. The activities provide immediate feedback that the students can then translate into their major assessments. Each tutorial group was lead by an instructor (either a post-doc or PhD student) who guides the students' topics within their research specialisation. Feedback is rubric based and focuses on meaningful and useful feedback [24]. The rubrics provide grade related descriptors that "describe holistic quality measures of performance" [24] aligned with each grade level (Fail (F) 0–49%; Pass (P) 50–59%; Credit Pass (CP) 60–69%; Distinction (D) 70–79%; and High distinction (HD) 80–100%). For each grade, a descriptor is provided that outlines the depth and breadth, critical thinking, and academic and professional conventions required. In addition students are provided with HD level exemplars so that they can see how the aspects of the tasks can be demonstrated in assessable outputs. The major assessment for Project 1 is a critical review of a scholarly journal article so that students apply the principles of argument theory to an existing argument. The major assessment for Project 2 is to conduct the primary research, describe their research process, describe their findings, and identify limitations of their approach. Project 3 is a digital media presentation where the students articulate their arguments through scenarios. Scenarios are used because they communicate the facets of an argument: they provide a call to action, are based on values as well as facts, and are aimed at specific audiences. We believe that in human-centred design activities the design brief should take the shape of a sound and strong argument and therefore believe that a design brief in the shape of a scenario is the best choice. In human-centred design, the issues that designers address are controversial rather than self-evident because the design activity should take into account that people have different worldviews and values, and so proposed designs are only probably true rather than necessarily true. Consequently, human-centred design briefs are best addressed through arguments rather than formal logical demonstration.

7 Preliminary results of our application of the course in education

The course we taught is called Methods of Investigation. It is taught at the School of Design, at Swinburne University of Technology, Melbourne, Australia. The cohort consists of approximately 250 first year undergraduate students per semester. The students come from variety of design and communication majors including industrial design, communication design, advertising, media and communications, interior design, public relations, media studies, product design engineering, digital media design, film and television, and games and interactivity. The course is the only course in all the programmes that is specifically concerned with teaching primary research, and it is the only course specifically focused on teaching design research. Furthermore, the course provides training for capstone applied research courses in final years of the students' programmes.

This context of the course has disadvantages and an advantage. First, because it is a diverse cohort, it means that we have to develop a research design that is useful for students from disciplines as different as product design engineering and public relations. Furthermore, most of the students have just come out of high school, meaning they have very naïve understanding of the nature of design. An advantage is that we get them while they are young, meaning that they are willing to try new things.

7.1 What happened

7.1.1 Preliminary results of student evaluations

Students provided feedback in the Student Feedback Survey (SFS) that highlights several notable aspects for the course. The Student Feedback Survey (SFS) is available online to students through their My.Swinburne portal [25]. The survey is made up of two parts: Part A, which relates to the individual staff member, and Part B, which relates to students' experience of the unit overall [25]. Through discussion and reflection on the students' comments from Part B of the survey, we identified three significant insights.

First, through an overall comparison between the student feedback from the old 2013 course and newly revised 2014 course, we found that the majority of the feedback from 2013 related to organisational and structural aspects while, in 2014, the feedback was more content related. For example students from 2013 reported that the best aspects of the course were: "Being able to choose your own topic", "Working in a team", "Lectures being posted on lectopia, the learning objectives and material are very well set out on blackboard". While in contrast, student comments in 2014 stated that the best aspects were for example: "I highly commend the professors who put this unit together because I now have a better understanding of what it means to do extensive research beyond the use of the internet", "learning how to assess data and make informed decisions", "It offered good insight into research methods and the importance of them". Hence, we argue that we were successful in aligning the assessment and tasks with the intended learning outcomes.

Second, we found that several student comments corroborate our conjecture that if designers do not learn skills and literacies of social research methods then they will remain within the boundary of naïve psychology and the limitations this implies for creating human-centred design claims. For example, one student claimed that the course was not relevant to a career in graphic design: "I signed up to do graphic design not to do a psychology/maths subject… Would be a much greater help if this subject was replaced by another subject that is ACTUALLY RELATED to what I'm studying… [the course was] not helpful to me aspiring to have a career in design", and according to another student "there is nothing at all that can be taken from this that will aid students in find work and develop in the industry of the field

of design". While we contend that these comments support our conjecture that designers unintentionally adopt a naïve psychological approach to design, we acknowledge that in the future we could communicate the importance of social research for design practice more clearly.

Third, the level of conceptual and analytical thinking that we required was perhaps too high. In the future we should support students in developing their conceptual and analytical skills by, for example, providing illustrations that more clearly connect the theoretical principles laid out in the lectures with the concrete design activities undertaken during the tutorials. For example, one student commented "The tasks, especially Toulman [sic.], were difficult to complete", and another student remarked that "The lectures… and tutorials are not cohesive in terms of content".

7.1.2 Reflections on the course

Several aspects need some attention in the future. For example, students showed some difficulties with the high analytical and conceptual framework of the course. These are students that just came from high school and are only now introduced to analytical and conceptual thinking. In this course, the mapping between Toulmin's argumentation model and its relevance to design had to be explained thoroughly. Also the need for quantitative research on top of qualitative research was not immediately accepted as relevant to design. Surprisingly, reactions to the introduction and subsequent understanding of specific aspects relevant to quantitative research (e.g., hypotheses formulation and statistics) did not seem disproportionate from the other learning activities. This is probably because students are not aware of the lack of use of quantitative research in the domain of design and thus their reactions to it is not subject to a *familiarity bias*.

8 Conclusion and Future Research

In this paper the aim was to outline how a combination of argumentation theory and mixed methods research would provide students with the literacies and skills to perform human-centred design. We argued that mixed methods research would provide the knowledge needed to create sound and strong arguments to support design claims. To show how mixed methods research and argumentation theory could be implemented we developed an undergraduate course proposal. In order to show whether said implementation indeed provides students with intended knowledge we need to perform further research. Accordingly, the intention is to thoroughly assess whether the integrated mixed method design research aligned with Toulmin's argumentation theory framework indeed produces qualitatively better and more suitable design briefs for human-centred designs. We aim to assess this through applying mixed methods research ourselves, wherein we analyse the cogency of the design briefs of the both the old and the new cohorts of students, and then quantitatively validate our findings through questionnaires disseminated among students from those two cohorts.

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