American Journal of Art and Design
2020; 5(2): 50-58
http://www.sciencepublishinggroup.com/j/ajad
doi: 10.11648/j.ajad.20200502.15
ISSN: 2578-7799 (Print); ISSN: 2578-7802 (Online)

Transforming Learning Through User-Centered Design Research Methods

Jon Spruce*, Martyn Evans

Manchester School of Art, Manchester Metropolitan University, Manchester, United Kingdom

Email address:
j.spruce@mmu.ac.uk (J. Spruce), martyn.evans@mmu.ac.uk (M. Evans)

*Corresponding author

To cite this article:
Jon Spruce, Martyn Evans. Transforming Learning Through User-Centered Design Research Methods. *American Journal of Art and Design*. Vol. 5, No. 2, 2020, pp. 50-58. doi: 10.11648/j.ajad.20200502.15

Received: June 26, 2020; **Accepted**: July 8, 2020; **Published**: August 5, 2020

Abstract: This paper considers how design educators can harness the evolving nature of design practice to enhance learning for design students. It sets out the reasoning for embedding user-centered design research methods in the curriculum, describes the potential of these methods to transform learning and, as a result, better prepare graduates for their future career. Project-based learning was employed to explore the potential impact of embedding user-centered design research methods in the curriculum. Two project-based case studies, conducted with undergraduate design and design and marketing students in separate UK universities, illustrate how user-centered design research methods have been applied across traditional discipline boundaries. We report on student experiences immediately, and longitudinally (12 months) after the completion of the projects. Thematic analysis of semi-structured interviews with students on completion of the projects revealed that a more holistic understanding of the design process was developed through the use of user-insights generated as a result of engagement with these methods. While this process had caused positive tensions and recognition of the need to move beyond the self and to put themselves in other people's shoes, the insights generated informed subsequent design activity and provided a clearer link between research and design development. After 12 months, thematic analysis of follow-up interviews revealed changes in design practices through adoption of structured user-centered methods had led to an enhanced appreciation of contextual factors and underpinned and better justified design decisions. Detailed analysis of the findings informed the development of a *Transforming Learning Framework* which articulates how the adoption of user-centered design research methods shapes students longer-term understanding of, and approaches to, design. This framework conveys how new frames of reference and critical reflection led to an enhanced design skillset and mindset and as such provides new insights that have the potential to advance understandings of pedagogic practice. Finally, the research revealed that exposure to user-centered design research methods enhanced sensitivity to, and awareness of, user needs; increased understanding of context and the breadth of issues relevant in early stages of the design process; and amplified students confidence helping better prepare them for professional practice.

Keywords: User-centered Research Methods, Transformative Learning Framework, Project-based Learning, Design Practice, Design Pedagogy

1. Introduction

Design practice continues to evolve and adapt to the fast-moving context in which it operates yet design curricula is not always able keep pace with such practices [1]. This paper considers how industry practices can be used to inform the nature of design curricula and describes the impact of the introduction of user-centered design research methods on student understanding of design and design processes. It presents an overview of the evolving industry and educational contexts of design, and details the increasing importance of the user in the design process. A description of the research approach is provided to convey how project-based learning was employed through two case studies involving undergraduate students in separate UK universities. Thematic analysis of semi-structured interviews with students immediately, and longitudinally (12 months) after the completion of the projects generated insights

regarding how the introduction of user-centered design research methods shaped student experiences and their longer-term understanding of, and approaches to, design. Iterative analysis of the data, underpinned by transformational learning theories, informed the development of a Transforming Learning Framework which communicates the development of students design skillset and mindset. The paper concludes with a discussion regarding how the introduction of these methods has helped to increase students awareness of user needs and their role in the design and development process and as a result, better prepare students for their future career.

2. The Evolving Contexts of Design – Industry, Education and the User

Working practices in the design profession have changed significantly in the 21st century with designers increasingly taking responsibility across the entire life of projects – from concept to commercialization [2]. At the same time, multidisciplinary collaboration has become commonplace in many areas of design, impacting the porosity of design disciplines and fostering the growth of new hybrid forms of design. As a result of these changes, traditional discipline boundaries in design, or what Maeda [3] refers to as 'classical' design disciplines including fashion, graphics, interior and product, have become increasingly blurred and hybrid in nature.

The growth in multidisciplinarity has acted to broaden the remit of design [4] bringing together different design disciplines or connecting design to other fields. Drew [5] asserts that "a multidisciplinary approach means drawing from multiple disciplines to redefine problems and reach solutions based on a new understanding of complex problems. By bringing different perspectives and experiences to the table, we can generate better solutions with better understanding".

The scope of design has also expanded from a traditionally narrow focus on aesthetics and function to include strategic considerations such as service improvement, brand positioning and business model innovation [6, 2] fostering a problem finding, as well as problem solving, role [7]. An increased application of design research approaches in the fuzzy front end of the development process [8] has moved designers 'upstream' and is helping organizations define the nature of the 'problem' as well as how to respond to it [7].

Alongside this increasing remit for design, what has become more prevalent is the emphasis placed on people as triggers for innovation – be they users or wider stakeholders [9] – where behavioral insights are used to inform design and development processes. In the 21st century notions of people-, human- or user-centered design are now commonplace within design and development processes [10]. The increased importance within the innovation process of providing people within meaningful experiences when using products and services has given rise to people-centered design approaches including user experience (UX) and user interaction (UI) becoming a recognized expertise within the discipline.

Undergraduate design education continues to be largely conceived on the traditions of well-defined classical disciplines [11] that shape curricula and ensures that project-based learning remains the primary pedagogic approach. Traditionally offering limited interaction between design disciplines, undergraduate education still attaches value to tangible artefacts [12] over intangible processes as the output of project-based learning. But the picture is complex, evolving and even conflicting.

There has been calls for more interdisciplinary educational practices in design where outputs can be intangible services not physical products [13] in order to address wicked problems [14] although this is often in addition to classical design disciplines rather than instead of. Norman [13] claims that "design schools do not train students about complex issues, about the interlocking complexities of human and social behavior, about the behavioral sciences, technology, and business" and as a result, graduates are ill-prepared for entry into the profession [15].

In the landmark review of creativity in business, Cox [16] highlighted design as the link between creativity and innovation and reinforced the need for designers to develop business awareness. Pryce & Whitaker [17] note that employers cite an ongoing problem around business skills in design graduates including "lack of commercial acumen, industry awareness, understanding of manufacturing processes, or an ability to work within the constraints of business". Increasingly graduates are being called upon to possess high-level design skills as well as a comprehensive understanding of the relationship between design and the broader business context [18].

Within design disciplines, teaching practices have evolved over many years to include the foundational knowledge, skills and understanding essential to students' creative and professional development in order to prepare them for entry into the profession. This becomes deep rooted in the teaching cultures of design disciplines and changes to curricula often lag behind the more fluid needs and practices of the profession.

With over 40 years of collective experience of design teaching, the authors have recognized that while user-centered research is commonplace in design practice, its inclusion in undergraduate design curricula is still not widespread. In terms of the relevance of user-centered research to contemporary design curricula, we have characterized this regarding the nature of and level participation of the user, thus:

1. Understanding behaviors: The application of user-centered research involves studying users to develop understandings of their behaviors in order to generate insights that form a starting point for design and development activities. The goal is to enable a greater understanding of user issues to be discovered, leading to new insights and opportunities for innovation. Engaging students in research activities that identify opportunities

prior to the formulation of a defined design brief based on understanding of user behaviors results in less prescriptive outcomes. Use of different toolkits to frame user-centered research, such as IDEO's Field Guide to Human-Centered Design [19] for example, is becoming more prevalent and provides students with a breadth of understanding of observational methods including shadowing, fly on the wall and the use of analogous situations, as well as participatory methods using camera journals, role play, personal inventories, and sort card exercises. Such approaches provide tangible ways to observe users towards the identification of insights that are particularly useful in the early stages of the design and development process [20, 21].

2. Fostering participation: Participatory approaches are based on the principle that "those who are invested in the success of a design should be included in the design decision-making process" [22] in a democratic way. Such participatory and collaborative approaches are most commonly found within product design teaching [23] but remain less common to many other areas of design education, as many traditional design methods often ignore the user within the design process [24]. Their aim is to foster a connected creative experience between designers and end users such that all parties feel their input influenced key decisions. Engaging the user as an integral aspect of the creative process, either as 'subject' in the case of user-centered design, or 'partner' in the case of participatory design [25] redefines the designer as an agent within a process of 'collective intelligence' [26]. Within the design curriculum, collaborative and participatory activities can be challenging, as they confront students with unfamiliar views, perspectives, and cultures often beyond their existing frames of reference. Leading students to what Berger [27] described as students reaching their 'learning edge' or what Meyer and Land [28] describe as the introduction of 'troublesome knowledge' within their learning experience provide new frames of references which have the potential to change worldviews. This may lead to the formation of new understanding and often a change in perspective as existing assumptions are transformed through the learning process.

We have characterized the nature and level of participation of the user above as distinct approaches although we recognize that there is clearly overlap and students are able to develop the capacity to view this in a holistic manner once they have been introduced to user-centered research principles. Without a structured curriculum that enables students to know the user and optimize their involvement in the design process, there is a danger that the whole user experience is not addressed effectively.

Given the landscape of design continues to evolve, this presents challenges for the new skills and knowledge needed by designers which in turn has implications for the nature of design curricula [29]. In this context, the focus of this paper is the design of products, services and experiences where the application of design addresses user experience in order to understand implications for design education.

3. Our Research Approach

We adopted project-based learning [30] as the vehicle for exploring the potential of embedding user-centered design research methods in the curriculum, providing students with a structured methodology to generate user insights to inform idea generation in the early stages of the design process. This approach aimed to promote learning by exposing students to new research techniques that could 1) underpin the research and ideation phases of the design process, and 2) bring contemporary design industry practices into the curriculum.

Projects were generated by creating real world contexts in which students worked in teams to generate tangible design solution to concrete problems. One project included external clients who provided real world issues that they wanted the students to provide solutions to; the other project used a real world setting that mimicked the live project by setting a challenge that was realistic and aligned to the type of project conducted in the design industry. Sara [31] states that "the introduction of an external collaborator, usually a client for the project, represents the fundamental shift from a typical academic project to a project that can be seen as live.". As the 'live-project' is a well-used approach in design education [32], this aligns with one of the central characteristics of project-based learning, namely that "students learn best by experiencing and solving real-world problems" [32]. According to researchers [33, 34], project-based learning involves the following:

1. students learning knowledge to tackle realistic problems as they would be solved in the real world
2. increased student control over their learning
3. teachers serving as coaches and facilitators of inquiry and reflection
4. students (usually, but not always) working in pairs or groups

Moreover, Blumenfeld et al. [35] state that an essential component of project-based learning is that it results in a series of artefacts or products which is critical to effective learning where "artefacts are representations of the students' problem solutions" [35]. These artefacts are concrete and explicit and can be shared and critiqued allowing others to provide feedback enabling students to reflect upon their learning [35].

In response to the research aim, activities were conducted in three phases: 1) initial establishment of the project context; 2) team-based development of research insights and design proposals; and 3) a post-evaluation of the projects to explore the students reflections upon the impact of the projects which informed final reflections. Analysis of the findings enabled the development of a *Transforming Learning Framework* which provides opportunity to articulate how the adoption of user-centered research methods shapes students longer-term understanding of, and approaches to, design.

3.1. Case Studies

Two projects were selected as case studies. The first case study involved undergraduate students from a BA (Hons) Spatial Design program in the second year (of three) of their studies working in disciplinary teams. Their project focused on generating design proposals that explore the future of airline passenger experience, specifically the Boeing 787 'Dreamliner'. The second project was undertaken by disciplinary teams of final year undergraduate students (in their third year of study) from a BSc (Hons) Marketing and Design program. Their project focused on the brand repositioning of a skin care product within the adult market that has a long-standing heritage as a provider of baby skin care solutions. In line with the operationalization of real-world projects [31], the two case studies are summarized thus:

Table 1. *Case Study 1.*

Case Study 1: Spatial Design
Sourcing of project: The project was developed to meet the aim and learning criteria for the module; the off-campus site for the project build was negotiated by staff, and materials sourced prior to the module launch
Academic context: Run as a project within a 24 credit module in the first semester of second year (level 5) of three-year undergraduate Spatial Design degree
Students: Work in six groups, comprising three students per group
Group allocation: Determined by tutors at the outset of the project based on awareness of students skills to provide balanced skillset across groups
Project initiation: Students organize a series of user-centered research activities, generating defined project briefs based on flight scenarios
Assessment: Students are assessed at the end of the project via group presentations, a group report and individual written reflective reports

Table 2. *Case Study 2.*

Case Study 2: Marketing and Design
Sourcing of project: Client determined through negotiation between students and staff against collaboration pre-established criteria; student 'pitch' potential clients to staff with final decision made by students in response to feedback
Academic context: Run as a project within a 30 credit module across two terms in the final year (level 6) of three-year undergraduate Marketing and Design degree
Students: Work in two inter-program groups comprising four students
Group allocation: Determined by tutors at the outset of the project based on awareness of students skills to provide balanced skillset across groups
Project initiation: Students organize face-to-face meeting with client; students develop own brief for project
Assessment: Students are assessed at the end of the project via group presentations, a group report and individual written reflective reports

The curriculum for both projects focused on introducing a range of user-centered design research methods into the initial stages of the module to allow students to develop understanding of their application in the real world. In line with design industry practices, the embedding of such methods aimed to provide students with a structured means of identifying user insights that could then be used to inform the generation of design ideas, particularly during the 'fuzzy front end' of the design process.

Spatial design and marketing and design have well established disciplinary norms that typically do not necessarily foreground the user in the research phases of the design process. Conventional practice within spatial design education is aligned to architectural philosophy and practice, developing spaces that afford the provision of human activity but not deriving solutions from an understanding of user requirements. Marketing and design would commonly focus on the relationship between design and business providing solutions that demonstrate both creative and business awareness often utilizing design as a driver for innovation but do not focus on establishing actual user requirements or the study of existing users as a vehicle for ideas generation.

An introduction to user-centered design research was delivered to both cohorts via formal lectures and related workshops detailing a range of methods and real-world examples. This included observational techniques of shadowing, fly on the wall, and the use of analogous situations with participatory methods including use of camera journals, role play, personal inventories and sort cards. Exposure to a wide range of approaches provided students with a toolkit of user-centered research methods to draw upon. The double diamond design process (comprising two 'diamond' phases of divergent and convergent thinking) popularized by the UK Design Council as a framework for innovation [6] was introduced to help students organize research data towards identifying user insights. The key focus was to highlight how user-centered research can be a trigger for the development of design solutions.

Upon completion of the projects, semi-structured interviews conducted with students captured their initial responses regarding the role of user-centered design research methods in the design process. One year on, a longitudinal study asked students to reflect on the project experiences and consider the longer-term impact upon their design process. Both sets of responses were open coded and thematically analyzed and the results presented under the themes emerging from the data itself.

3.2. Case Study 1: Spatial Design

The Spatial Interactions module was selected as it provides students with the opportunity to explore cultural and behavioral trends and to investigate how people interface together within specified user scenarios. The module also engages students in the organization and dynamics of collaborative group work. The project invited students to generate design proposals that explore the future of airline passenger experience. Boeing's 787 'Dreamliner' airplane was selected to provide a real-world passenger environment, enabling students to examine actual flight routes, passenger scenarios, and specified interior dimensions. The project's

delivery over a six week period aligned to the phases of the UK Design Council's double diamond model, focusing attention on the first diamond of activities involving discovery and definition of opportunities via user-centered research activities, then in the second diamond providing students with the opportunity to develop a series of design concepts tested at 1:1 scale through a soft modelling exercise.

The students explored different flight types (long or medium haul) and a range of passenger scenarios (single, couple or family travelers). Each group sought secondary data in-line with their specified scenario in addition to primary interviews conducted with flight attendants and a range of passengers. The research subjects were asked to recall flight experiences, record their preparations for travel and asked to consider human factors needs – physical, procedural and cognitive. From this data, mock-ups of travel scenarios were generated to visualize different flight experiences, along with development of passenger personas. An info-graphic based poster was produced by each scenario group highlighting key research findings along with a narrated movie of passenger experiences providing qualitative personal insights of travel experiences.

Figure 1. *Images of the 1:1 scale build exercise testing spatial concepts.*

3.3. Case Study 2: Marketing and Design

This design research focused module provided students with opportunities to conduct a team-based design-led research project that addressed real world need of an UK organization. An understanding of the value of design research was developed through engagement with a client that was selected by each team. The exact nature of the client need was determined through direct engagement with the organization and supported through an academic mentor. Student teams met weekly with their mentor who adopted a facilitator role. Teams were required to: 1) identify a client organization, 2) determine a real world need that the client organization was facing, 3) develop a design-led research project to address this need, and 4) report back to the clients at regular intervals and in conclusion via a client summary report and presentation. The project duration was six months with four students per team.

The project broadly followed the double diamond research process and blended design and marketing research methods. Methods used included intercepts, online-questionnaire, camera journals, shadowing, news article analysis, ethnography, user testing, and concept prototyping. The team were able to develop insights into user perceptions and triangulate their findings through a combination of design and marketing methods. For example, the use of an online survey provided an explicit opportunity for participants to convey their perceptions of the Sudocrem brand while these perceptions were also explored through shadowing and ethnographic activities. The blend of these methods provided a well-developed level of confidence in the findings.

Figure 2. *Images from the project presentation.*

4. Research Findings: Responses and Reflections

On completion of the projects, the impact of the introduction of user-centered research methods into the design process on students learning was explored in two ways: 1) responses to the projects immediately after completion regarding changes to their understanding of the design process, and 2) reflections after 12 months with regard to the extent to which the projects had shaped their longer-term approach to design.

4.1. Student Responses at the End of the Project

Case studies engaged students in different approaches to design than they would have more commonly been exposed to within other elements of their programs of study. In doing this, the authors explored opportunities for the transfer and adoption of user-centered design research methods beyond traditional discipline boundaries in line with emergent design practices. Following the completion of the projects, feedback was obtained from each student on their experience of using these methods within a project-based learning context. Three questions informed the semi-structured interviews, namely: 1) Their reflections on the project experience, 2) Comparison to other projects they had undertaken, 3) What impact they felt the methods had upon project outcomes. The responses were analyzed and have been synthesized into the following four themes:

4.1.1. Challenged by Introduction of New Methods

All students found the introduction of user-centered research methods challenging, particularly the aspects of the research that were heavily participatory alongside the need to work in teams. Many students felt uncomfortable in the initial 'discover' stages of the double diamond process due to unfamiliarity with the user-centered research methods. Many students also initially thought that placing so much emphasis on research was unusual, perhaps due to their previous experiences of conducting project-based research. Students were challenged to break out of their 'comfort zone' and extend their awareness and explore the application of a range of design research methods. This was in contrast to many students previous experiences of research as being something 'to be tolerated' as part of the design process and which often yielded little insightful results. Student feedback was positive as they felt that the combination of user research methods (which they were unfamiliar with) and their more familiar discipline-oriented methods (in which they had a stronger grounding) was central to the success of the projects.

4.1.2. Research Providing Valuable Insights for Design

It was clearly evident in the responses that the translation of research data into meaningful user insights was greatly assisted by the use of design-led methods and the subsequent analysis of human experiences, values and behaviors. User-centered research insights thus provided more solid 'anchors' for design ideas to be built on, with a clearer rationale for development, providing a firm basis for evaluation and refinement of design proposals. It was evident that user-centered methods can be effective when used in conjunction with more traditional research approaches such as quantitative empirical studies and broader secondary data gathering, triangulating and more usefully contextualizing qualitative findings. Some students suggested that they found it easier to transfer their findings into meaningful insights and then subsequent design ideas that provided a 'better fit' as they were focused in response to identified issues, observed behaviors and qualitative insights. In this way, the research provided "more rewards" than they usually experienced. Client feedback from the Sudocrem project was extremely positive and brought about a change in the company strategy. The client provided specific feedback that the triangulation of research findings was the key factor in taking on board the recommendations.

4.1.3. Positive Tensions

Introducing user-centered methods created some positive tensions and 'troublesome knowledge' within the students learning experience. In looking beyond their own initial responses for design directions they were forced to investigate and respond to others needs or values ahead of their own conceptions of what might be needed. The predominantly qualitative nature of the research data being gathered required a great deal of dialogue within each group to analyze and cross-reference participant responses across the variety of research methods conducted. Analysis of data involved lengthy discussions and more in-depth evaluation of results, ultimately building a consensus within each group to determine the most appropriate design concepts to be pursued for further development. The sharing and acceptance of 'others' viewpoints, informed and steered creative responses, becoming an important element of the group process.

4.1.4. Holistic Understanding of the Design Process

Students reported a more holistic understanding of what the design process involves including commercial realities, broadening their view of design research and the methods that can be utilized to support their practice. Subsequently, for a number of students, their mental map of the design process changed. Key to this was perhaps the realization that design begins long before sketching ideas or even before a comprehensive design brief itself is established. Most usefully, the projects appeared to provoke questioning amongst the students around the nature of design, the act of designing, and what the designer's toolkit should therefore consist of.

Students acknowledged that while the introduction of user-centered research methods was challenging, overall it had proved a positive and beneficial experience in promoting new understandings of approaches to the design process.

4.2. Student Reflections After 12 Months

The authors conducted a longitudinal study 12 months after

the completion of the projects to understand the extent to which these methods impacted on the students' approach to design. Semi-structured interviews enabled a qualitative assessment of the extent to which the introduction of user-centered methods continued to have influence upon the students ongoing practice.

The interviews were structured around three key questions: 1) Are the methods introduced still being applied? 2) Are user-centered approaches integral to their design and creative processes? 3) Has there been an impact upon their approach to design? Analysis of the interviews identified that responses fell into two key areas:

4.2.1. Adoption of a User-centered Approach

The adoption of user-centered methods provided the ability to recognize user issues and integrate these approaches into the design process. This provide a structured mechanism to challenge assumptions, resulting in more robust and relevant design outcomes. One respondent stated "I struggled to follow things before these methods were introduced. The design process is more clear and easier to understand and I explore a range of options much more now". The use of user-centered research methods was also viewed as making the creative process more efficient, where effective research led to user insights that generated 'better' solutions. All respondents stated an ongoing feeling of benefit, noting that using user-centered research methods has made it easier for them to generate relevant design ideas that are more readily defendable to critique. Another respondent stated "I have almost more respect for the research part of the design process now by understanding its importance". Responses indicate that the adoption of user-centered research methods had positively impacted the ability to effectively understand and navigate the design process, enhanced their design skillset and increased confidence in tackling complex design challenges.

4.2.2. Appreciation of Context and Increased Criticality

The adoption of user-centered design research methods also contributed to a change in mindset for a number of the respondents, described by one as "seeing beyond the immediate to more contextually inform decisions and therefore being able to critique design ideas more effectively". Another respondent stated that "by drawing upon research processes, when I look at random objects or spaces now, I can visualize in my mind who, what or why they were designed for", demonstrating an increased degree of criticality being applied as a result of adopting these methods. Respondents reported they felt much more able to critique and assess their own design proposals with a greater regard and sensitivity to others needs, considering the extent to which user insights were, or were not, being addressed. Another participant asserted that "without a doubt, human centered research is integral to what we do so I try not think about the end product but allow the research findings to guide and inform design ideas". This indicates an increased sense of confidence in applying a structured design process where the use of research to underpin and validate the appropriateness of design proposals was recognized.

5. Transforming Learning Framework

The research findings point to clear changes in how students understand the design process as a result of exposure to user-centered design research methods and as such, learning has been transformed. Fundamental to principles of transformative learning is that we do not make long-term changes as long as what we learn remains within our existing frames of reference. As transformative learning is the process of learning through changes in viewpoint and approach, we have drawn upon these theories [36-38] to conceptualize a *Transforming Learning Framework* (Figure 3) to better understand and articulate how the adoption of user-centered research methods shapes students longer-term understanding of, and approaches to, design.

This conceptual framework articulates instrumental levels of learning in steps 1 and 2, as the introduction of user-centered methods informs the students existing design process, boosting their design skillset by enabling the generation of more relevant and defendable design ideas. Steps 3 and 4 of the framework articulates more integrative levels of learning as the longer-term adoption of user-centered methods enhances an understanding of the design context, adding critical sensitivity to decision making and fostering a transformation in design mindset.

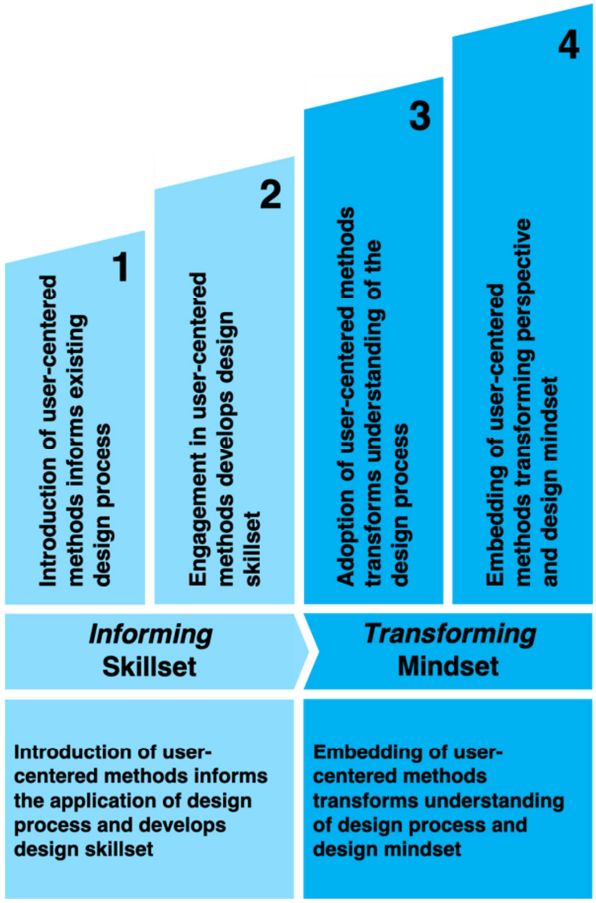

Figure 3. *Transforming Learning Framework.*

An important part of transformative learning is for individuals to change their frames of reference by reflecting on their assumptions [39] in order to change worldviews. User-centered approaches to design involves critically analyzing the underlying premise of user issues, context or opportunity to provide new insight leading to alternative solutions by redefining problems from different perspectives. This process of enquiring and reflecting upon others needs affords students to become more self-aware and critically reflect upon their own assumptions within the design process, promoting a transformation of perspectives.

6. Conclusions

This paper has considered how design educators can harness the evolving nature of design practice to enhance learning for design students and in doing so better prepare them for their future career. The findings indicate a number of transformative benefits resulting from the exposure to user-centered design research methods providing students with:

1. An enhanced sensitivity to, and awareness of, user needs: Providing students with the ability to discover previously unmet needs means that the resultant design proposals are more readily defendable as they address an identified and real user need. As a result, students have an enhanced skillset that is able to provide solutions that have credibility and relevance and no longer meet assumed user needs.
2. Understanding design as a broader set of activities: The projects involved opening up the 'fuzzy front end' of the design process, and by doing this, modified students mental map of design with the realization that development of new products, services or experiences begins a long time before ideation and concept generation.
3. An appreciation of context: Recognizing that design as an activity is accountable to views and factors beyond those of the individual designer requires the confidence to move beyond the self and challenge well understood processes in order to maximize the appreciation of stakeholder and contextual issues.
4. Preparation for professional practice: In enabling students to move from being 'feelers' to 'knowers' through a more informed approach where there is an increased ability to better justify why THIS solution rather than another. The application of user-centered design research methods offers a process-informed rather than a process-driven approach, developing the ability to engage effectively with clients in justifying decision making.
5. Increased confidence and control: In navigating the often precarious 'liminal' phases of the design process, applying user-centered design research methods in triangulation with other established research and development methods narrows the field of uncertainty experienced by many students (and practicing designers) thereby providing a stronger base for design proposals.

Responses evidence that user-centered considerations continue to be integral to students' design skillset and have transformed their mindset through recognizing different ways of looking at issues and contexts, adopting others viewpoints and generating new perspectives for themselves. Our findings identify a positive impact upon not only the application of user-centered methods to inform instrumental skills development but also transforming mindset in understanding the subject terrain and the contexts within which it operates.

The responses gathered within this study of a project-based learning approach suggest that the adoption of user-centered methods can promote both an enhanced design skillset and transformation of mindset through challenging student's existing frames of reference, and that extending these frames of reference can promote the development of higher-level learning, such as analytical, critical, and reflective abilities that hold currency within design and professional practice. The Transforming Learning Framework provides a mechanism to articulate how through consideration of issues *beyond the self,* students are able to develop new user-centered frames of reference that can shape both the how they apply this learning in their design processes and how ultimately, they understand how they design.

While our findings are not generalizable due to the small sample size, we recognize opportunities to extend this study across a range of design disciplines and project contexts to increase reliability and validity.

References

[1] Redström, J (2020). Certain Uncertainties and the Design of Design Education. She Ji: The Journal of Design, Economics, and Innovation, Vol. 6, Iss. 1, pp. 83-100.

[2] Innovate UK. (2016). Design in Innovation: Early stage interventions. Available at: https://admin.ktn-uk.co.uk/app/uploads/2017/01/DesignBook_FINAL_web-version.pdf. Accessed: 11 April 2020.

[3] Maeda, J. (2018). Design in Tech Report 2018. Available at: https://designintech.report/wp-content/uploads/2019/01/dit2018as_pdf.pdf. Accessed: 15 May 2020.

[4] Design Council. (2010). Multi-disciplinary design education in the UK: Report and recommendations from the Multi-Disciplinary Design Network. Available at: https://www.designcouncil.org.uk/sites/default/files/asset/document/multi-disciplinary-design-education.pdf. Accessed: 11 April 2020.

[5] Drew, C. (2019). What is a multidisciplinary approach to design? Available at: https://blog.wearefuturegov.com/what-is-a-multidisciplinary-approach-to-design-b5f62a28b804. Accessed: 12 April 2020.

[6] Design Council. (2019). What is the framework for innovation? Design Council's evolved Double Diamond. Available at: https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond. Accessed: 15 September 2019.

[7] Melles, G., Anderson, N., Barrett, T., and Thompson-Whiteside, S. (2015). "Problem Finding through Design Thinking Education." In Blessinger, P. (Ed.) Inquiry-Based Learning for Multidisciplinary Programs: A Conceptual and Practical Resource for Educators Innovations in Higher Education Teaching and Learning. Emerald Group Publishing.

[8] Weiss, L. (2002). Developing Tangible Strategies. Design Management Journal. Vol. 13, No. 1, pp. 33–38.

[9] Kelley, D., and Kelley, T. (2015). Creative Confidence: Unleashing the Creative Potential within Us All. Harper Collins.

[10] Marsh, S. (2018). User Research: A Practical Guide to Designing Better Products and Services. London: Koogan Page.

[11] Fleischmann, K. (2008). Overcoming disciplinary boundaries in undergraduate design education: Preparing digital media design students for collaborative multidisciplinary research practice. ACUADS Conference, Australian Council of University Art and Design Schools. Adelaide, Australia.

[12] Swanson, G. (2020). Educating the Designer of 2025. She Ji: The Journal of Design, Economics, and Innovation, Vol. 6, Iss. 1, pp. 101-105,

[13] Norman, D. (2010). Why Design Education Must Change. Available at: https://www.core77.com/posts/17993/why-design-education-must-change-17993. Accessed: 17 December 2017.

[14] Laakso, M., & Clavert, M. (2014) Promoting creativity and design thinking skills among university students. Finland: Aalto University Design Factory. pp. 215-228.

[15] Meyer, M., and Norman, D (2020). Changing Design Education for the 21st Century. She Ji: The Journal of Design, Economics, and Innovation, Vol. 6, Iss. 1, pp. 13-49.

[16] Cox, G. (2005). Cox Review of Creativity in Business: Building on the UK's Strengths. London, UK: HM Treasury.

[17] Pryce, V., and Whitaker, J. (2011). Restarting Britain: Design Education and Growth. London, UK: Design Commission.

[18] Design Skills Advisory Panel. (2007). High-Level Skills for Higher Value. London, UK: Design Skills Advisory Panel.

[19] IDEO. (2015). Field Guide to Human-Centered Design. Available at: https://www.ideo.com/post/design-kit. Accessed: 07 March 2020.

[20] Wormald, P. (2011). Positioning industrial design students to operate at the 'fuzzy front end': Investigating a new arena of university design education. International Journal of Technology and Design Education, Vol. 21. pp. 425-447.

[21] Celikoglu, O., Krippendorff, K., and Ogut, S. (2020). Inviting Ethnographic Conversations to Inspire Design: Towards a Design Research Method. The Design Journal, 23:1, 133-152.

[22] Payne, A. (2016). "Participatory Design." In Edwards, C. (Ed.) The Bloomsbury Encyclopedia of Design. London: Bloomsbury Academic. pp. 36-37.

[23] Milton, A., & Rodgers, P. (2013). Research Methods for Product Design. London, UK: Laurence King.

[24] Charlesworth, E. (2018). Walking The Talk: From theory to practice in delivering community based design education. The International Journal of Art & Design Education. Vol. 37, Iss. 2, pp. 253-264.

[25] Sanders, E. (2002). "From user-centered to participatory design approaches." In: Frascara, J. (Ed.) Design and the Social Sciences. USA: Taylor & Francis.

[26] Fuad-Luke, A. (2009). Design Activism: Beautiful Strangeness for a Sustainable World. Abingdon, Ox: Routledge.

[27] Berger, J. (2004). Dancing on the Threshold of Meaning. Journal of Transformative Education. Vol. 2, No. 4, pp. 336-351.

[28] Meyer, J., and Land, R. (2003). "Threshold concepts and troublesome knowledge: linkages to ways of thinking and practicing." In: Rust, C. (Ed.), Improving Student Learning - Theory and Practice Ten Years On. Oxford: Oxford Centre for Staff and Learning Development (OCSLD), pp 412-424.

[29] Ericson, Å., Bergström, M., Larsson, A., and Törlind, P. (2009). Design Thinking Challenges in Education. Proceedings of ICED 09, the 17th International Conference on Engineering Design, Vol. 10, Design Education and Lifelong Learning. Palo Alto, CA, USA: The Design Society.

[30] Krajcik, J., and Blumenfeld, P. (2006). "Project-Based Learning." In: Keith Sawyer, R. (Ed.) The Cambridge Handbook of the Learning Sciences. (2006). Cambridge: Cambridge University Press.

[31] Sara, R. (2011). Learning from Life – Exploring the Potential of Live Projects in Higher Education. Journal for Education in the Built Environment, Vol. 6, Issue. 2, pp. 8-25.

[32] Vega, V. (2015) Project-Based Learning Research Review. Available at: https://www.edutopia.org/pbl-research-learning-outcomes. Accessed: 01 April 2020.

[33] Barron., B. and Darling-Hammond, L. (2008). Teaching for Meaningful Learning: A Review of Research on Inquiry-Based and Cooperative Learning. USA: George Lucas Educational Foundation.

[34] Thomas, J. (2000). A review of research on project-based learning. San Rafael, CA: The Autodesk Foundation.

[35] Blumenfeld, P., Soloway, E., Marx, R., Krajcik, J. Guzdial, M., and Palincsar, A. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. Educational Psychologist. Vol. 26, No. 3-4, pp. 369-398.

[36] Cranton, P. (1996). Professional Development as Transformative Learning: New Perspectives for Teachers of Adults. San Francisco, California: Jossey-Bass.

[37] Taylor, E. (1998). Transformative Learning: A critical review. ERIC Clearinghouse on Adult, Career, & Vocational Education (Information Series No. 374), 80 pages.

[38] Mezirow, Jack. (1991). Transformative Dimensions of Adult Learning. San Francisco, CA: Jossey-Bass.

[39] Mezirow, J. (1997) Transformative Learning: Theory to Practice. New Directions for Adult & Continuing Education. No. 74, USA: Jossey-Bass.