



Developing Empathy In The Academic Design Studio: Conclusions From An Empirical Study In Graduate And Undergraduate Programs In Industrial Design

By: **Fabio Andres Tellez**

Abstract

This paper presents the conclusions of an empirical study aimed at (1) identifying educational practices in the academic design studio intended to promote empathy in industrial design students, and (2) identifying a broad range of expressions of student empathy for users and stakeholders. The study was motivated by the importance that current human-centered design approaches give to empathy as an ability required to understand and connect with users and by the little empirical research that examines empathy development in design education. Methodologically, a mixed methods strategy was used to collect and analyze data from faculty and students in three undergraduate and graduate courses in industrial design offered by a major land-grant public research university in the southeastern United States. The findings of the study consisted of identifying strategies used by faculty to promote empathy in the design studio and categories of students' expressions of empathy. These findings informed the conclusions herein presented as recommendations for educators to promote student empathy in their design courses.

Tellez, F. A. (2019). Developing empathy in the academic design studio: conclusions from an empirical study in graduate and undergraduate programs in industrial design. Publisher version of record available at: <http://hdl.handle.net/20.500.12010/8608>

Developing Empathy in the Academic Design Studio: Conclusions from an Empirical Study in Graduate and Undergraduate Programs in Industrial Design

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ABSTRACT

This paper presents the conclusions of an empirical study aimed at (1) identifying educational practices in the academic design studio intended to promote empathy in industrial design students, and (2) identifying a broad range of expressions of student empathy for users and stakeholders.

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Author Keywords

Empathy; human-centered design; user-centered design; design education; mixed methods.

INTRODUCTION

Empathy is considered one of the most important abilities for social interaction. It allows individuals to adopt the perspective of others, understand and feel their thoughts and feelings, and respond accordingly. This ability is associated with pro-social behavior and is characterized by reducing aggression, violence, and bullying. Empathy is considered a trait of emotional intelligence, a precursor to healthy human relations, and a catalyst for civic engagement. Consequently, empathy can be considered an

instrument for resolving interpersonal differences and a skill that inhibits violence and aggression, fosters collaboration, and strengthens our social structures (Howe, 2013; Gerdes et al., 2011; Baron-Cohen & Wheelwright, 2004; Gordon, 2001).

In the field of design, empathy is central to current approaches to problem-solving such as human-centered design, user-centered design, participatory design, empathic design, co-design, and design thinking. Under these approaches, empathy is considered a fundamental ability for designers to acquire an in-depth understanding of people (i.e., end-users and other stakeholders) so that designed products, services, environments, systems, and experiences meet human needs, expectations, and aspirations. Likewise, empathy is integral to the design process; it enables practitioners to approach other people's realities and perspectives, uncover insights, and develop solutions informed and inspired by people's experiences and behavior. Additionally, empathy is considered an ability that promotes "people-centered" innovation, and a critical competency to deal with the complex socio-technical issues that humanity faces (Brown, 2009; Brown & Katz, 2011; IDEO, 2011; d.school, 2010; Plattner et al., 2012; Norman, 2014; Kouprie & Sleeswijk Visser, 2009; Dandavate et al., 1996; Carroll et al., 2010; Sanders, 2006).

The recognition of empathy as an essential skill for the practice of design under current human-centered approaches reveals an important aspect of the role that designers play—or are expected to play in representing and advocating for users and stakeholders in projects and organization. The designers' role has shifted from shaping the appearance of spaces, objects, and visual messages, to collaborating in the construction of interrelated systems—tangible and intangible—that are rooted in human and social experiences.

This shift has been part of a larger movement towards a postindustrial perspective (at least in the Western world) in which design has turned its focus from creating products to tailoring human-centered experiences. In this new scenario, design creates value by improving and enriching people's physical, emotional and social interactions with objects and environments. In this scenario, designers are required to have a profound understanding of people to create

meaningful products, services, experiences, systems, and environments (Krippendorff, 2006; Sanders & Stappers, 2008; Norman, 2014; Davis, 2016).

Despite the central role that empathy plays in society and the design field, there is little empirical research that examines empathy development in the fields of design and design education. The scarcity of research in these areas represents a gap in the literature that was addressed by the study presented herein. Specifically, the study explored the development and expression of student empathy for end-users and stakeholders in specific instances of design education aiming at (1) identifying educational practices in intended to promote this ability in industrial design students, and (2) identifying a broad range of expressions of student empathy for users and stakeholders.

Ultimately, the goal of the study is to contribute to the discussion of how to educate a new generation of designers that serves others. With this purpose in mind, the study explored the following research question:

RQ: How do teaching and learning practices in the industrial design studio promote the development and expression of student empathy for users?

rQ1: How do faculty reflect concern for the development of student empathy for users in the context of the industrial design studio?

rQ2: How do students express their empathy for users in the context of an industrial design studio?



Figure 1. Visual representation of the implemented research strategy.

METHODOLOGY

The study was conducted using a simultaneous mixed methods design driven by its qualitative component (notation: QUAL + quan) as defined by Morse (2002; 2010). This research strategy combines qualitative and quantitative techniques that are used simultaneously, but the former is dominant and drives the research project. By using this research strategy, trustworthiness of study results is strengthened by providing a quantitative perspective on the qualitative data and a qualitative perspective on the quantitative data.

As seen in Figure 1, a variety of methods for data collection and analysis from different traditions were combined to investigate the questions defined before. From a qualitative perspective, the study implemented an ethnographic

strategy using techniques such as participant observation, semi-structured interviews, discourse analysis, and document analysis. From a quantitative approach, the study implemented quasi-experimental and correlational strategies, using techniques such as questionnaires and surveys for data collection, and correlations and analysis of variance (ANOVA) for data analysis.

Site and Participants

The fieldwork for this study was conducted during one academic semester at a major land-grant public research university in the southeastern United States. A total of 60 individuals participated in this study, including 46 undergraduate students, 12 graduate students, and two faculty members. The participants were naturally divided into three groups according to the courses they were taking

or teaching. These courses consisted in (1) a basic design studio taken by undergraduate students; (2) an advanced design studio taken by graduate students; and (3) a lecture course on human-centered design taken by undergraduate and graduate students. The study used different techniques with each group, as seen in figure 2.

Group 1 was comprised of the 22 students taking the basic design studio and their instructor. The studio was a six-credit course that undergraduate students in industrial design take in their fourth semester. Before this studio, students completed a year of design fundamentals with students from other design majors and a semester of basic industrial design. The objective of this studio was to introduce students to the theories, methods, and language of industrial design through elementary problems in form and function, using various materials and media.

In the semester during which data was collected, students worked on five projects: (1) the design of a condiment organizer for a local restaurant; (2) the design of a kitchen utensil based on the needs of a particular user; (3) the design of a shoe for African children, manufactured with African materials and production processes; (4) the design of a fashion shoe for developed markets, manufactured with African materials and production processes; and (5) the design of a product based on students' observations throughout the semester.

Participants in Group 1 were selected on the basis of their relatively limited exposure to human-centered design methods, the introductory nature of the studio, and the access that the instructor provided to the researcher.

Group 2 was comprised of the 11 students taking the advanced design studio and their instructor. The studio was a six-credit course that master students in industrial design

take in their second year. The objective of this studio was to foster students' understanding of context and stakeholders by framing insights, exploring concepts, and developing solutions in an iterative process.

During the semester when the data was collected, students worked on two projects: (1) the design of a simulator to test sports bras; and (2) writing a proposal to conduct design research on a workforce-related issue.

Participants in Group 2 were selected on the basis of the focus of the studio they were taking on applying human-centered design methods, their exposure to different academic and professional experiences, and the access that the instructor provided to the class.

Group 3 was comprised of 29 students taking a lecture-based course on human-centered design and their instructor. This course was a three-credit class that undergraduate students in industrial design take in their junior or senior years. This course is also taken by graduate students in the master program as an elective. The objective of this course was to introduce students to the spectrum of human physical and cognitive capabilities as they relate to user interaction with designed products and environments.

In the semester during which data was collected, students had lectures and completed exercises covering various topics on ergonomics, human factors, and human-centered design.

Participants in Group 3 were selected on the basis of the course's focus on how human capabilities relate to user interaction with designed products, the relatively large number of students taking this class compared to the smaller number of students that take design studios, and the access that the instructor provided.





















DATA COLLECTION PER GROUP OF PARTICIPANTS		RESEARCH METHODS (QUAL+quan)					
		 Participant Observation	 Semistruct. Interviews	 Discourse Analysis	 Document Analysis	 Background Survey	 Empathy Questionnaire
GROUPS OF PARTICIPANTS	Group 1 (n=22) Basic Industrial Design Studio						
	Group 2 (n=11) Advanced Industrial Design Studio						
	Group 3 (n=29) Human Centered Design Course						

Figure 2. Synthesis of research techniques used with each group.

Data Collection and Analyses

Data collected through these techniques consisted of documents gathered from participants (e.g., course syllabus, students' slides), field notes taken during participant observation sessions (i.e., studio sessions), audio recordings from interviews, and audio and video recordings from students' presentations. By contrast, data collected through quantitative methods consisted of student scores in the Interpersonal Reactivity Index questionnaire (also referred to as empathy questionnaire), students' answers to a survey intended to determine their academic background, and qualitative data that was quantified (e.g., number of students' references to users in their visual presentations).

To analyze qualitative data, it was organized, transcribed, and coded using MAXQDA, a software program for qualitative data analysis. An initial phase of qualitative coding was intended to identify general teaching and learning practices and potential sources and categories of students' expressions of empathy for users. In this phase, categories used to code the data emerged from the data themselves. Initial codes were selected, sorted and organized to direct the second phase of coding, in which a focused coding strategy was used. The initial and focused coding processes were accompanied by the writing of memos (or "memoing"). These memos included preliminary analytic notes, codes definition, questions regarding the process or the data, tentative categories of analysis, and other ideas that occurred during the process of coding.

To analyze quantitative data, a combination of data display and analysis of variance (ANOVA) were used. Initially, student scores were displayed using box plots to visually identify the differences in pre-test and post-test per group of participants. After conducting this visual analysis of scores, data were subjected to a two-way ANOVA. This test was used to determine the significance of the difference in scores between the pre- and post-test and between the three tested groups. To analyze the academic background survey and the qualitative data that was quantified, basic descriptive statistics were used. These analyses provided a summary of the academic background of students in each group, and a synthesis of identified codes and categories in qualitative data subjected to thematic analysis.

Additionally, students' IRI scores and a selection of quantified qualitative data were analyzed from a correlational approach. Through the calculation of the Pearson Product Moment Correlation (PPMC), or Pearson's correlation, the degree of relationship between IRI scores and individual variables extracted from qualitative data was determined (Crano & Brewer, 1973).

FINDINGS

Findings from the data collection and analyses were organized in two main categories that correspond to the research questions. These categories of findings were (1) faculty's educational practices in the industrial design studio, and (2) students' expressions of empathy for users.

Faculty's Educational Practices

Three major educational practices were observed in the studied courses including the brief, the research, and the dialogue and discussion. The exploration of these components aimed at understanding how faculty reflect concern for the development of student empathy in the context of the industrial design studio.

The Brief

In the observed studios, the brief was used by faculty as a mechanism to establish the conditions of the project and, consequently, create the conditions for students to develop and express empathy for users. The brief defined the problem addressed by students, established the priorities to address said problem, and structured the activities that students undertook.

In Group 1, the brief was used to structure activities and conversations with students, inviting them to consider and adopt the perspective of users and stakeholders; introduce the design problem progressively as a sequence of smaller, manageable issues that allowed students to learn sequentially from realities different from their own; and propose problems that balanced the use of students' prior knowledge with the exploration of new realities intended to challenge students' preconceptions.

However, based on the analysis of students' expressions of empathy, the briefs in this studio were less effective in creating the conditions for empathy to emerge because they focused on aspects other than the user and user-related issues. User-student interaction was not reinforced in all projects for practical reasons (i.e., lack of time for thorough research and lack of access to people and context in some cases) and projects relied on secondary sources of information rather than on primary sources. In one case, students were asked to identify problems from their personal experiences and in their own environments, rather than in contexts that were unknown or unfamiliar to them.

In Group 2, the brief was treated differently in the two projects that were developed. In the first project—the design of a device to test sports bras—the brief clearly defined the problem to be addressed by students and provided a robust structure for them to explore the experiences of users and stakeholders. In the second project—the research proposal addressing a workforce-related problem—the brief provided an open framework for students to define a topic of their personal interest and the strategy to address it in preparation for their thesis project.

Based on the analysis of student expression of empathy, the brief of the first project was more effective in creating the conditions for empathy by proposing a problem that pushed students to consider other people's experiences and concerns; requiring students to conduct research from primary sources and interact directly with users and stakeholders; providing a thorough definition of research methods that structured students' research activities; and

proposing a situated problem that offered students access to users and context. On the other hand, the brief of the second project was less effective in creating the conditions for empathy because it focused on developing planning skills, relied on students to decide the problem to address and methods to be used and was perceived by students as a low-stakes project that received less time and attention from students and faculty.

The Research

In the observed studios, research methods and activities were used by faculty to promote students' exploration of the problem, users, and context with the purpose of informing and inspiring the design processes they followed. Research was especially well suited for promoting conditions for developing empathy, since it required students to explore and understand the experience of users and stakeholders under a variety of methods of inquiry.

In Group 1, the research was considered instrumental by the instructor for developing students' understanding of the problem, context, and users, but in practice, the opportunities for empathy that research created in this studio were limited. Research from secondary sources was used in all the document projects, and research on primary sources received especial attention on the first project (design of condiment organizer), in which students were constantly asked to conduct observations and interviews with potential users of condiment organizers. Also, the third project (design of a show for African children) challenged students in the lack of access to context and users, for which they substituted arguably secondary sources. And the fifth project (design of a product based on students' observations of their context) proposed students a problem-observation method that limited the spectrum of people to observe and with whom to interact.

It is necessary to highlight that the promotion of student empathy for users was not part of the learning objectives of this studio and, consequently, the difficulties described should not be assumed as a measure of the level of success of this studio.

In Group 2, research was used by the instructor in to foster empathy especially in the first project (design of a device to test sports bras). In promoting user-student interactions and by asking students to thoroughly plan and rehearse the research activities they conducted, faculty exposed students to an exhaustive process of planning that required the adoption of users' perspectives and preserved the dignity, autonomy, safety, and equality of participants. Also, a considerable amount of time and effort was devoted by the instructor to help students in preparing their interactions with participants in the field. By contrast, the research in the second project was less structured, received less attention, and was left to students' initiative. As a consequence, not all the students engaged in research from primary sources, with some relying on personal experiences to inform the research proposal.

Based on the analysis of students' expressions of empathy, the research conducted for the first project was more effective in creating the conditions for empathy to emerge because it promoted many more interactions between users and students than the rest of the documented projects combined (including projects undertaken in the basic design studio). This suggested that students had greater exposure to users and stakeholders in this project and, consequently, more opportunities to develop empathy.

The Dialogue and Critique

In Group 1, the promotion of student empathy through the dialogue and critique occurred in small-group discussions guided by the instructor. During these discussions students had the opportunity to raise their concerns regarding the welfare of users and stakeholders. Even though student feedback was integral part of small-group discussions, it is uncertain to what extent giving and receiving feedback promoted student empathy for users or the degree to which sophomores were sensitive to the role of users in any design process. Based on the study's framework, it was assumed that having empathic discussions about users and stakeholders in small-group meetings encouraged student empathy.

However, a thematic analysis of the studio's outline for project presentations suggested that user-related issues were not a priority in students' presentations, which leaves little space for the critique to be considered as an aspect used to promote empathy for users in the Basic Industrial Design studio. At the curricular level, this and other factors raised questions regarding how and when concern for users should be introduced in the industrial design undergraduate curriculum.

In Group 2, the dialogue and critique were characterized by featuring a spectrum of faculty-student interactions that were used by the instructor to raise students' awareness regarding user-related issues and promote empathy-related behaviors and skills. The empathy-related behaviors promoted by the instructor in this studio were as follows: identifying all users and stakeholders involved in a problem; considering and acknowledging their different perspectives; caring for the welfare of participants; being respectful with potential users and representing their voice with dignity; expressing concern for users and stakeholders and showing sensitivity to issues that affected them.

The instructor promoted empathy-related behaviors by using the following strategies: alternating modes of faculty-student interaction; proposing the use of empathic research methods (e.g., "a day in the life"); suggesting preferred courses of action that would provide an empathic understanding of users and stakeholders; modeling empathic behaviors; redirecting student attention toward user-related issues; engaging students in empathic discussions; and using positive and negative reinforcements to promote empathic attitudes and behaviors in students.

Student's Expressions of Empathy

Students' responses to the educational practices that they experienced in the observed studios were explored, paying special attention to student discourse, their use of images, and their application of research methods in their projects. The exploration of students' responses aimed at uncovering how they express empathy for users in the context of an industrial design studio.

Variations in Empathy Measures

In general, changes in pre- and post-test scores were not statistically significant according to the Two-way ANOVA that was conducted. The only statistically significant difference that this test showed was in perspective-taking (PT) scores between Group 2 (advanced design studio) and Group 3 (lecture based-course on human-centered design). These results suggest that when students were exposed to similar content in a studio setting compared to a lecture-based course, the gains in perspective-taking (PT) were significantly higher in the studio.

However, it is important to note that the groups were relatively small, and they were not equivalent in number of students, gender composition, and student academic backgrounds. Also, some of the students in Group 2 took the lecture-based course on human-centered design during the semester of observation. As a consequence, these findings are not conclusive, and more research is needed to validate them.

Verbal Expressions: Describing Users

Students in Group 2 showed greater tendency to address user-related issues in their discourse than students Group 1. Likewise, since familiarity and similarity are factors strongly associated with empathy, and students in Group 2 used more specific terms to refer to users than students in Group 1, it was concluded that use of language in Group 2 reflected greater empathy for users than the language used by students in Group 1.

Regarding the use of student discourse as evidence of empathy for users, it was concluded that the analysis of student discourse is enriched when it is complemented by the analysis of other data. Additionally, according to data collected from Group 1, there is a positive and strong relation between the frequency with which students refer to users and their empathic concern (EC) scores. However, more research needs to be done to test this finding with a larger population and at different educational levels.

Graphical Expressions: Depicting Users

Students in Group 2 showed greater tendency to depict users and stakeholders in images used in their presentations than students in Group 1. Likewise, it was found that, in average, Group 2 presented three times more original images than students in Group 1. This finding suggests that students in Group 2 had increased opportunities to develop empathy for users by sharing experiences with them while taking pictures, documenting observation

sessions with said pictures, and selecting each image to be presented to the class.

However, it is crucial to note that students taking, selecting, and presenting images depicting users has only the potential to increase students' opportunities to empathize with users and stakeholders. These actions cannot be interpreted automatically as graphical expressions of empathy. To determine whether or not the use of images suggests student empathy for users, it is necessary to evaluate the context and student discourse and actions.

Operational Expressions: Interacting with Users

Students in Group 2 had greater exposure to users and stakeholders than students in Group 1, and, consequently, more opportunities to experience empathy for users. By comparing the number of user-student interactions that occurred in each project with the respective project brief, it was found that student engagement in research activities was highly related to the brief of each project. This means that in order to promote user-student interactions that create opportunities for student empathy, it is necessary to structure research activities in the project brief that allow for such interactions.

IMPLICATIONS FOR DESIGN EDUCATION

As mentioned in the Introduction, the ultimate goal of the study reported herein was to contribute to the discussion of how to educate a new generation of designers that are empathetic towards end-users and stakeholders to serve them better and develop more innovative products, services, environments, systems, and experiences.

As a consequence, the considerations presented as follows intend to shed a light on how to create design learning environments that promote the development of empathy in future generations of designers. It is important to note that these considerations are intended to inform design education practices at the classroom and project levels (which were the units of analysis of this study), but not at the curricular level.

Implications for the studio

One of the most important aspects that needs to be addressed in promoting students' development of empathy in a design learning environment is to declare it as an explicit learning objective. This needs to be followed by defining specific learning outcomes that describe empathic behaviors that students are expected to develop and demonstrate as core competencies for the field. Likewise, it is necessary to define evaluation criteria aligned with empathy-oriented learning objectives and outcomes. As was evidenced in both design studios analyzed, even though faculty declared the importance of addressing user-related issues in the studio and promoting students' sensitivity and empathy for users, in the evaluation criteria of some of the projects analyzed these aspects were disregarded and, consequently, poorly addressed by students in their projects.

Implications for students' evaluation

As mentioned before, if empathy is considered an objective that is worthwhile to pursue through design education, then it needs to be present in the evaluation criteria both at the course and the project levels. One of the difficulties in assessing “soft abilities” such as empathy is determining concrete behaviors that can be observed and evaluated by the instructor. This study provided a sample of verbal, graphical, and operational manifestations of empathy in the development of design projects that can be extrapolated to other educational environments. However, it is important to emphasize what has been said before: it was found that establishing the manifestation of student empathy requires triangulating several data points taking into consideration the use of language, images, and methods. Likewise, this study offers research methods (e.g., discourse analysis, document analysis, field notes) that can be used as classroom assessment techniques applicable in evaluating students' development of empathy in industrial design education settings.

Implications for teaching practices

Even though it was not analyzed in the study due to lack of data, there is an indication that in the observed settings students progressively adopted some of the discipline-specific language used by instructors (especially at the undergraduate level). As a consequence, a strategy to promote student empathy for users is to include and reinforce user-related issues through the use of language by the instructor. If students are seldom exposed to user-related issues in their dialogue with faculty, and if user-related issues are not reinforced throughout the course of study, then these issues are less likely to be addressed by students.

The use of user-oriented language needs to be accompanied by user-oriented practices intended to expose students to the experiences of others. This can be achieved through the use of design research methods that promote user-student interactions such as interviews and observations. Even though co-design and participatory design methods were not observed or documented in the studios reported in this study, such methods promote intense user-student interactions as the user adopts progressively more active roles in the design process (as Liz Sanders suggests: from customers to co-creators).

Additionally, the design problems offered to students need to be situated and accessible. This means that in order to promote user-student interactions, students should address real problems in which they have access to the context. As seen in the design of a shoe for African children—a project with great potential for empathy—the lack of access to the context and stakeholders prevented students from having deep and meaningful insights into the experiences of users rich in opportunities for the expression of empathy.

In conclusion, based on the study findings, if empathy is considered a learning objective that is worthwhile to pursue

in design learning environments, then the educational practices put in place to develop that objective need to be aligned, oriented to promote user-student interactions, and, most importantly, focused on equipping students with the tools to approach and understand and connect emotionally with users and stakeholders.

STUDY SCOPE AND LIMITATIONS

A major limitation of this study is the generalizability of findings. The study explored three courses in the same industrial design school for one semester. Even though some of the phenomena documented in these studios have been reported in literature and in informal conversations with design educators from schools all over the United States, it is not possible to generalize the findings presented in this study to all instances of industrial design education. Instead of generalizability, this study hopes to inspire further investigations in similar settings.

Another limitation of the study is its scope. This study reported situations that occurred within three design courses for a semester. Situations that occurred out of this frame of reference were disregarded as well as the experiences leading to student enrollment in these courses. This situation also means that students' personal lives were not taken into consideration in the study, as well as the rest of curricular and extracurricular activities in which they were engaged during the data collection phase of the study.

Additionally, changes in student empathy were documented at the beginning and at the end of the study, assuming that the educational experience to which students were exposed would have immediate effects on their behavior and attitudes toward users and stakeholders. The pre- and post-test model inherited from the medical field does not necessarily apply to educational contexts where changes are not evident immediately after the “treatment,” but these can take years to manifest. That represents an implicit challenge in conducting educational research that can be addressed by conducting a longitudinal study in which student empathy is documented for months and even years after the educational experience ends.

Finally, another limitation regarding the scope of the study is that it focused on students' use of language, images, and methods. The artifacts they designed were not reported in the study since they reflected circumstances different to empathy development such as students' developing skills in form-making, limitations in students' use of design software or prototyping materials, and imitation of current design trends or products in the market. Additionally, there were limited opportunities to connect student comments to their choices about form, thus confirming intent to craft artifacts as expressions of empathy. In the study setting, the analysis of designed artifacts would have required additional information to be adequately interpreted, such as written reflections from students explaining their design decisions, which were not part of the data collection strategy.

REFERENCES

1. Simon Baron-Cohen. 2011. *The Science of Evil: On Empathy and the Origins of Cruelty*. Basic Books, New York.
2. Simon Baron-Cohen and Sally Wheelwright. 2004. The empathy quotient: an investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of autism and developmental disorders* 34, 2: 163–175. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/15162935>
3. Tim Brown. 2009. *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. Harper Business, New York, NY.
4. Tim Brown and Barry Katz. 2011. Change by Design. *Journal of Product Innovation Management* 28, 3: 381–383.
5. Maureen Carroll, Shelly Goldman, Leticia Britos, Jaime Koh, Adam Royalty, and Michael Hornstein. 2010. Destination, Imagination and the Fires Within: Design Thinking in a Middle School Classroom. *International Journal of Art & Design Education* 29, 1: 37–53. <https://doi.org/10.1111/j.1476-8070.2010.01632.x>
6. William D Crano and Marilyn Brewer. 1973. Correlational design. In *Principles of Research in Social Psychology*. McGraw-Hill, New York, 91–113.
7. D.School. 2010. Bootcamp Bootleg. Retrieved from <http://dschool.stanford.edu/use-our-methods/the-bootcamp-bootleg/>
8. Uday Dandavate, Elizabeth B Sanders, and Susan Stuart. 1996. Emotions matter: user empathy in the product development process. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 40, 7: 415–418.
9. Meredith Davis. 2016. “Normal science” and the changing practices of design and design education. *Visible Language* 50, 1.
10. Karen E. Gerdes, Elizabeth a. Segal, Kelly F. Jackson, and Jennifer L. Mullins. 2011. Teaching Empathy: a Framework Rooted in Social Cognitive Neuroscience and Social Justice. *Journal of Social Work Education* 47, 1: 109–131.
11. Mary Gordon. 2001. Roots of Empathy. *Canadian Children* 26, 2: 4–7.
12. David Howe. 2013. *Empathy: What it is and why it matters*. Palgrave MacMillan, New York.
13. IDEO. 2011. *Human Centered Design Toolkit*. IDEO.
14. Merlijn Kouprie and Froukje Sleswijk Visser. 2009. A framework for empathy in design: stepping into and out of the user’s life. *Journal of Engineering Design* 20, 5: 437–448.
15. Klaus Krippendorff. 2006. *The Semantic Turn: A New Foundation for Design*. Taylor & Francis, Boca Raton, FL.
16. Janice M. Morse. 2002. Principles of Mixed Methods and Multimethod Research Design. In *Handbook of Mixed Methods in Social & Behavioral Research* (1st ed.), Abbas Tashakkori and Charles Teddlie (eds.). Sage Publications, Thousand Oaks, CA, 189–208.
17. Donald A. Norman. 2014. Why DesignX? *Core77*. Retrieved from http://www.jnd.org/dn.mss/why_designx.html
18. Hasso Plattner, Christoph Meinel, and Larry Leifer. 2012. *Design Thinking Research: Measuring Performance in Context*. Springer, Berlin, Germany. <https://doi.org/10.1007/978-3-642-31991-4>
19. Elizabeth Sanders. 2006. Design Research in 2006. *Design Research Quarterly* 1, September: 1–8.
20. Elizabeth Sanders and Pieter Jan Stappers. 2008. Co-creation and the new landscapes of design. *CoDesign* 4, 1: 5–18.