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Looking for Alternatives: Challenging Assumptions in Design Education

Sheila Pontis
Karel van der Waarde

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SHEILA PONTIS
Keller Center for Innovation in Engineering Education, School of Engineering and Applied Science, Princeton University, USA
spontis@princeton.edu

KAREL VAN DER WAARDE
Institute of Visual Communication, Basel School of Design FHNW, Switzerland; Department of Communication Design and Digital Media Design, Swinburne University of Technology, Australia (corresponding author)
waarde@glo.be

Abstract
In this article, we argue that, in response to emerging societal, technology, and other global transformations, nine interrelated changes in the landscape of design are having an impact on design education in four principal areas: design practice, teaching arena, students, and pedagogy. We assert that these changes require a pedagogical model that can teach new designers how to navigate external shifts. Most of the changes we propose in this article have been discussed or even adopted previously, but they have never been introduced together as a comprehensive, overarching pedagogical approach. Through the analysis of two information design courses we introduce a student-focused, research-led, and science-based approach that will enable instructors to contend with these changes. Despite the success demonstrated by both courses, through students' work and course evaluations, these cases also highlight new challenges for design educators. We assert that the proposed approach could lead the implementation of some fundamental changes in design education, and we provide recommendations to adapt design education in a small step-by-step fashion. We end the paper with possible areas for further investigation, such as the relevance of teaching experience and identifying students' needs and motivations.

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Understanding the Current State of Design Education

The higher education system is evolving in response to cultural, technological, and economic changes, and to overarching global transformations.[1] Countries are now actively reforming their pedagogical models, moving away from standardized approaches and "a one-size-fits-all experience" toward new and individualized modes of learning based on what students learn, rather than on the time they spend in a classroom.[2] This approach is described as *heutagogy*, or self-determined learning.[3] Heutagogy places the student at the center of educational strategy, and focuses on cultivating students' autonomy, capabilities, and collaboration skills to prepare them to intervene in increasingly complex global contexts. Scholar Ken Robinson[4] asserts that we need a new educational paradigm modeled on criteria that model workplace complexity and ambiguity brought on by systemic flux and transformation, rather than on the traditional "us and them," "teacher and student," or "master and apprentice" of the industrial model. Educational reforms that rethink teaching strategies and debate future directions are already taking place. For example, medicine, law, and business educators have made major shifts in their pedagogical models.[5]

Design education has also responded to increasing complexity and systemic transformations. In general, the discipline's changes have been significant.[6] Our expanded curricula include less artifact driven problem solving strategies, as design problems have also changed;[7] stronger user-centered research focus; and new digital technology skills. There has been a marked shift towards a more constructivist, andragogical (adult focused), and collaborative teaching approach. Many institutions and programs offer project-based learning rooted in real-world problems, and increased student-teacher interactivity. However, the master-apprentice approach is still very common.[8]

In the past few decades, design education has been thriving globally.[9] Student cohorts have grown, and other fields including business, medicine, and science are showing a keen interest in design. More and more design educators are formalizing their collaborative relationships by creating joint initiatives such as the *Graphic Design Educators Network* (GDEN) in the UK, the *AIGA Design Educators Community* (DEC) in the USA, and the *Communication Design Educators Network* (CDEN) in Australia. Given this steady rise in proponents of design, it is possible that no further changes to design education are needed, and that existing learning models are still appropriate. However, several compelling, fairly recent publications[10] and journal articles[11] indicate the need for further or more major shifts in design education.

In this article, we look at the current state of design education, how it has changed, and how it should change. Design fields have become cross-disciplinary and multi-faceted, so it is challenging to arrive at concise definitions that firmly indicate the particular design areas our analysis applies to. Rather, we prefer looser terms for design domains or territories. Our focus is on design fields where students understand people's needs first, and create solutions that have short production times and can be built in classroom settings. The solutions tend to be small scale. Examples are tangible (lamps, chairs, maps, books), digital (apps, product interfaces), or intangible

1 Ken Robinson, "Changing Education Paradigms," Ted video, 11:40, from RSA Talk, October, 2010, accessed April 28, 2020, https://www.ted.com/talks/sir_ken_robinson_changing_education_paradigms; Jonathan Zimmerman, "Liberating the Liberal Arts," Stitcher podcast, 30:33, January 16, 2019, available at https://www.stitcher.com/podcast/higher-ed-now/e/58223136.

2 Jeffrey Selingo, *College (Un)Bound: The Future of Higher Education and What It Means for Students* (Las Vegas, NV: Amazon Publishing, 2015), xxiii.

3 Lisa-Marie Blaschke, Chris Kenyon, and Stewart Hase, *Experiences in Self-Determined Learning* (Scotts Valley, CA: CreateSpace Independent Publishing Platform, 2014).

4 Robinson, "Changing Education Paradigms."

5 Don Norman, "This Is the One Skill Designers Need to Develop Most in 2020," *Fast Company*, January 9, 2020, available at https://www.fastcompany.com/90449305/.

6 David Sless, "Design or 'Design' — Envisioning a Future Design Education," *Visible Language* 46, no. 1-2 (2012): 54–65, available at https://s3-us-west-2.amazonaws.com/visiblelanguage/pdf/46.1-2/design-or-designenvisioning-a-future-design-education.pdf.

7 Meredith Davis, *Teaching Design: A Guide to Curriculum and Pedagogy for College Design Faculty and Teachers Who Use Design in Their Classrooms* (New York: Allworth Press, 2017).

8 Davis, *Teaching Design*; Norman, "This Is the One Skill Designers Need to Develop Most in 2020."

9 Grace Lees-Maffei, "Reading Graphic Design in the Expanded Field: An Introduction," in *Reading Graphic Design in Cultural Context*, ed. Grace Lees-Maffei and Nicolas P. Maffei (London: Bloomsbury Publishing, 2019), 2–13.

10 Audrey G. Bennett and Omar Vulpinari, ed., *ICOGRADA Design Education Manifesto 2011* (Taipei: Icograda, 2011), available at https://www.ico-d.org/resources/design-education-manifesto; Sharon H. Poggenpohl, ed., "Envisioning a Future Design Education," special issue, *Visible Language* 46, no. 1-2 (2012): 8–156, available at http://visiblelanguagejournal.com/issue/154; AIGA DEC, "Examining Design Educator Pain Points. An Overview," AIGA, January 3, 2019, available at https://educators.aiga.org/aiga-dec-pain-point-research/.

(services, strategies). Outcomes are all said to have short lifespans because they can be re-designed after a day or a year. We call these fields of practice graphic design, product design, user interface design, digital design, social design, information design, and visual communication. Clearly defining each of these fields would fall outside the remit of our analysis, but we argue that although the boundaries of these fields have not been strictly delineated and each has specific needs, challenges, and requirements, they also have many commonalities. Throughout this paper, the term *design education* is used to refer to these design fields. If our comments or analysis refer to a specific design field, we clearly indicate it.

Although, there is no single, simple answer[12] to the question of what this new, self-determined learning approach for design might look like, the goal of this article is to indicate one possible way to discern the path forward. We first examine how external changes have impacted design practice, and how these changes have cascaded into core dimensions of design education. Then, we introduce an alternative pedagogical approach that "breaks the lineage from early craft guilds and drawing schools, while maintaining the focus on intellectual flexibility and concern for human values."[13] Through an analysis of two information design courses, we will illustrate how this approach looks in practice, and consider its benefits and limitations.

Aims and Methodology

To shed light on the points described in the previous section, our main research questions are

- How might we adapt design education to address current shifts in the world and continue to successfully provide future generations of designers with an appropriate foundation of knowledge, tools, and skills?
- What would a self-determined learning model look like for design education?

In this article, our aim is to

- Propose an alternative or supplemental pedagogical model rooted in heutagogy, in combination with user-centered research and scientific explanations.
- Demonstrate the application of the proposed pedagogical model through the analysis of two case studies focused on information design.
- Indicate benefits and limitations of the proposed approach, and recommendation for other design fields.

Method

Two current information design courses, designed within the past five years, serve as the basis for case studies intended to illustrate how the pedagogical model we present here can be implemented. The planning and design of these courses was based on substantial professional, teaching, and research experience.[14]

Additionally, we reviewed conference papers, TED talks, peer-reviewed journals, and books about design education,[15] creativity education,[16]

11 Norman, "This Is the One Skill Designers Need to Develop Most in 2020"; Guillermina Noël, "We All Want High-Quality Design Education: But What Might That Mean?" *She Ji: The Journal of Design, Economics, and Innovation* 6, no. 1 (2020): 5–12, DOI: https://doi.org/10.1016/j.sheji.2020.02.003. –

12 Norman, "This Is the One Skill Designers Need to Develop Most in 2020."

13 Davis, *Teaching Design*, 45.

14 Sheila Pontis and Michael Babwahsingh, "Improving Information Design Practice: A Closer Look at Conceptual Design Methods," *Information Design Journal* 22, no. 3 (2016): 249–65, DOI: https://doi.org/10.1075/idj.22.3.06pon.

15 Charles L. Owen, "Design Education in the Information Age," *Design Issues* 7, no. 2 (1991): 25–33, DOI: https://doi.org/10.2307/1511404; Nigel Cross, *Engineering Design Methods: Strategies for Product Design*, 3rd ed. (Chichester: John Wiley, 2000); Nigel Cross, "Design as a Discipline," in *The Inter-Disciplinary Design Quandary Conference*, Leicester: De Montfort University, February 13, 2002; Nigel Cross, *Designerly Ways of Knowing* (Basel: Birkhäuser, 2007); Gui Bonsiepe, "The Uneasy Relationship between Design and Design Research," in *Design Research Now: Essays and Selected Projects*, ed. Ralf Michel (Berlin: Birkhäuser, 2007), 25–40; Davis, *Teaching Design*.

16 Robert J. Stenberg, "Teaching for Creativity," in *Nurturing Creativity in the Classroom*, ed. Ronald A. Beghetto and James C. Kaufman (Cambridge: Cambridge University Press, 2010), 394–414.

education and pedagogy,[17] and instructional design.[18] Although not an exhaustive literature review, we gained a better understanding of the evolution and current state of higher education and design education, primarily in Europe and North America. We found that the need for change in design education has been a topic for discussion for more than twenty years,[19] but still, there seems to be a lack of concrete advice in the form of structural models or practical strategies that can ballast the required change. In response, we have brought together a set of techniques, approaches, methods and models from outside the design domain that might support design education reformers and provide guidance for change.

Nine Fundamental Changes (in the Field of Design, and Elsewhere) that Need Educators Attention

We argue that nine interrelated shifts in the design education and practice system should be critically reviewed and considered in relation to the future of design education. Due to their strong interconnections, it is hard to analyze each change in strict isolation, but we have grouped these changes within four dimensions of the design education ecosystem (see Figure 1): professional practice, teaching arena, students, and teaching approach.

17 For example, see Robinson, "Changing Education Paradigms"; Selingo, *College (Un)Bound*; Zimmerman, "Liberating the Liberal Arts."

18 Ruth Colvin Clark and Chopeta Lyons, *Graphics for Learning: Proven Guidelines for Planning, Designing, and Evaluating Visuals in Training Materials*, 2nd ed. (San Fransisco, CA: Pfeiffer, 2011).

19 Gunnar Swanson, "Graphic Design Education as Liberal Art: Design and Knowledge in the University and the 'Real World,'" *Design Issues* 10, no. 1 (1994): 53–63, DOI: https://doi.org/10.2307/1511656; Ken Friedman, "Design Science and Design Education," in *The Challenge of Complexity*, ed. Peter McGrory (Helsinki: University of Art and Design Helsinki UIAH, 1997), 54–72; Karel van der Waarde and M. Vroombout, "Communication Design Education: Could Nine Reflections Be Sufficient?," *Visible Language* 46, no. 1-2 (2008): 8–35, available at https://s3-us-west-2.amazonaws.com/visiblelanguage/pdf/46.1-2/communication-design-education-could-nine-reflections-be-sufficient.pdf; Norman, "This Is the One Skill Designers Need to Develop Most in 2020."

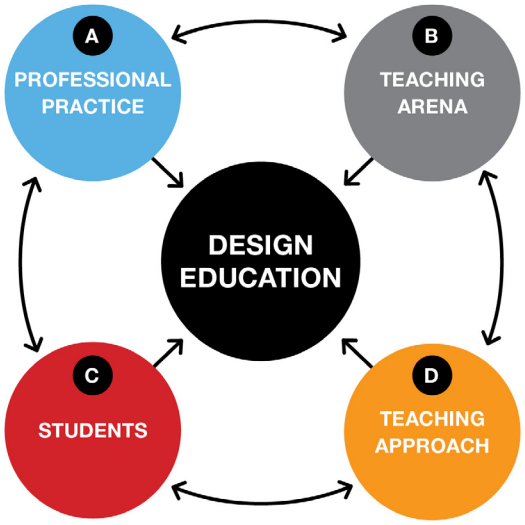

Figure 1
Changes that influence design education can be grouped into at least four interrelated dimensions. © 2020 by Sheila Pontis.

A. Professional Practice

Any major changes in professional practice will automatically require changes to what and how design is taught, because "curricular decisions determine the entry employment qualifications of new practitioners" and "designers' abilities to evolve as professionals and informed citizens across careers that last fifty years or more."[20] Recently, two key changes have shaped professional practice on multiple levels.

Design Problems Have Become More difficult to Frame, and Increasingly Ill-Defined

The first is that design problems are more and more difficult to frame, and increasingly ill-defined. Design activity, and particularly information design, involves questions about various design process dimensions.[21]

- **Problem:** What challenges do people encounter?
- **People:** Who do designers design for? Who are the people and what do they need?
- **Context:** How, where, and when will these people accesses the information?
- **Content:** What needs to be communicated? What is the message?
- **Solution:** What do designers make? What is the process? What are the results? How do these results add value? What is the impact?

As economic, societal, and technological challenges become more complex, which they clearly have over the last thirty years,[22] the answers to these questions have changed considerably. For example, designers do not create solutions in isolation anymore, nor are solutions necessarily tangible.[23] Charles Owen pointed at this change back in 1990s[24] when designers started seeing problems whose solutions lie beyond artifact creation, in the design of systems and strategies. More recently, in most cases, there is not even a concrete problem to solve. Both problem spaces and solutions tend to be made up of multiple, connected systems[25] of concrete artifacts and more intangible experiences and services. Problems and opportunities are rarely simple and clearly-defined, and so designers' roles can vary from project to project.

Consequently, the "focus is no longer on material systems—systems of 'things'—but on human systems, the integration of information, physical artifacts, and interactions in environments of living, working, playing, and learning."[26] The outputs, process, values, and criteria have all fundamentally shifted as design problems have become less defined and their contours harder to delineate. Some fundamental principles have remained the same, but more complex ranges of problems demand a more rigorous and systematic way of working, multiple problem-solving strategies, and the use of a broader set of tools and methods. This leads us to the second fundamental change that design education must contend with.

Problem Scopes and Scales Have Broadened, and Now Require Cross-Disciplinary Teams

Because ill-defined problems lack distinct boundaries, framing them adequately and addressing them requires greater effort, and often involves

20 Davis, *Teaching Design*, 46.
21 Sheila Pontis, *Making Sense of Field Research: A practical Guide for Information Designers* (Abingdon: Routledge, 2019), 4.
22 Poggenpohl, "Envisioning a Future Design Education."
23 Davis, *Teaching Design*.
24 Owen, "Design Education in the Information Age"; Charles Owen, "Design Research: Building the Knowledge Base," *Design Studies* 19, no. 1 (1998): 9–20, DOI: https://doi.org/10.1016/S0142-694X(97)00030-6.
25 Hugh Dubberly, "Connecting Things: Broadening Design to Include Systems, Platforms, and Product-Service Ecologies," in *Encountering Things: Design and Theories of Things*, ed. Leslie Atzmon and Prasad Boradkar (London: Bloomsbury, 2017), 158.
26 Richard Buchanan, "Design Research and the New Learning," *Design Issues* 17, no. 4 (2001): 3–23, DOI: https://doi.org/10.1162/07479360152681056.

larger and more diverse teams whose members offer different knowledge, perspectives, and expertise. Cross-disciplinary teams have become the norm. Design skills are often used to help other professionals better understand the meaning of situations, for instance by mapping complexity, drawing meaning from data, and visualizing perspectives. In education, each field of study is still delimited according to relevant boundaries and values, while in professional practice, individuals from various domains are increasingly working together as teams.[27]

Because design problems can vary so wildly in scope and scale, it is quite difficult to reliably establish suitable course content. Meredith Davis refers to this as the "ever-widening gap between what is taught . . . and the global context in which it is practiced."[28]

Education needs to evolve if it is to properly train designers to deal with new types of problems, and do so collaboratively.

B. Teaching Arena

The increasing complexity in the scope and scale of new types of design problems, and the need for multidisciplinary responses has triggered a wave of interest in design skills acquisition. In the past, students would enroll in design school to become professional designers or work in a related industry. Now students enroll in design classes for that plus many other reasons. To address this demand, design education has expanded beyond art and design schools,[29] and this is redefining the design teaching arena as illustrated in Figure 2.

27 Rowan Conway, Jeff Masters, and Jake Thorold, *From Design Thinking to Systems Change* (London: RSA, Action and Research Centre, 2017), available at https://www.thersa.org/globalassets/pdfs/reports/rsa_from-design-thinking-to-system-change-report.pdf.

28 Meredith Davis, "Relevance in a Complex World — Icograda Design Education Manifesto," in *ICOGRADA Design Education Manifesto 2011*, ed. Bennett and Vulpinari (Taipei: Icograda, 2011), 73, available at https://www.ico-d.org/resources/design-education-manifesto.

29 AIGA DEC, "Examining Design Educator Pain Points."

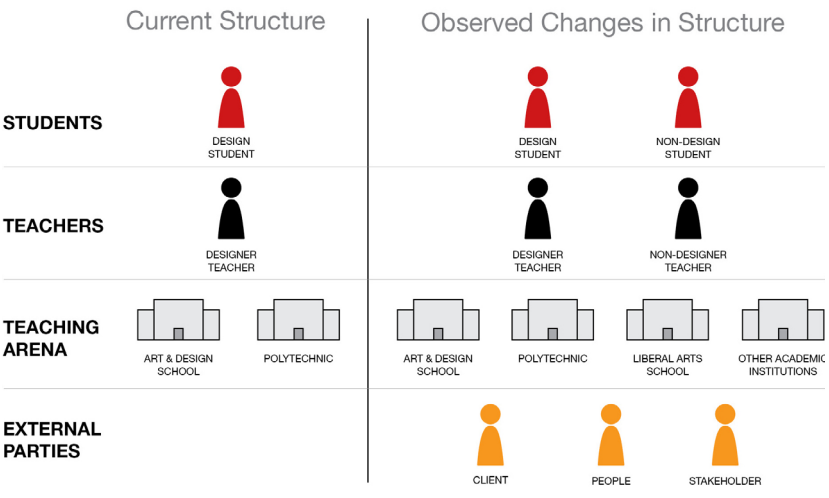

Figure 2
The evolution of design education based on the changes outlined in this article. The term *design students* refers to students who study design because they are interested in pursuing a design career, while *non-design students* refers to students who study design for other reasons. *Non-design teachers* refer to instructors who teach design but have no formal design training. © 2020 by Sheila Pontis.

Design Education Has Broadened and Diversified

Generally, formal design education has almost always been taught either at private art and design schools (the Elisava School of Design in Spain, for instance, or Parsons School of Design in the US) or at universities/colleges specialized in art or design (such as the UK's University of the Arts, London, or Royal College of the Arts).[30] But in recent decades, new types of design problems have prompted designers to work more closely with professionals from other disciplines as wide ranging as anthropology, psychology, medicine, human computer interaction, law, and policymaking.[31] As a result, design is now taught at many different types of institutions. This is the third change that impacts design education: design education has broadened and diversified.

This integration of design into teaching institutions that have not taught design before has led to a wider range of course approaches, levels, and formats; from self-contained and elective courses not attached to departmental programs to required courses on which other courses in a program build.

Pedagogical Training and Research Experience Have Become Essential Requirements for Teaching Design

We could argue that design now carries the same weight as other academic disciplines because it is being integrated and taught at university level. This has prompted design educators to conduct research and publish more frequently. While this has increased the number of scholarly publications, the distribution across design fields seems unequal. As an example, a substantial number of publications can be found dealing with design in general,[32] with user-centered engineering, and with product design.[33] However, peer reviewed academic papers about graphic design research or visual communication design research are still more difficult to trace and categorize.[34] This could partly be due to the unclear definition of boundaries between fields, but unquestionably indicates that there are differences between design fields.

Despite the growing number of design faculty and adjuncts with formal pedagogical training, research experience, and doctoral degrees, many design educators struggle to consolidate their academic activities. The lack of a robust foundation within the design community has prevented us from (1) establishing explicit boundaries between fields, (2) articulating the goals of each field, and ultimately, (3) grounding design decisions on theoretical and scientific explanations. That instability might be one reason design educators have difficulty convincing other faculties or external organizational leaders to take design work and research seriously, and seriously enough, in some cases, to provide funding for it. To many, design is a subjective field of study mainly based on self-expression instead of on research evidence or established psychological principles.[35]

The arena of design education has widened considerably. In university settings, faculty are expected to invest in other academic pursuits in addition to their teaching, for example by conducting research studies, publishing work, and advising students.[36] Until recently, it was possible to work part time in higher education and part time as a professional designer, but the

30 This of course depends on the delineation of the term "design." Geographic, historic, sectoral, and lexical variations make it impossible to generalize.

31 Teal Triggs, "The Future of Design Education — Graphic Design and Critical Practices: Informing Curricula," Design Open Data, accessed April 28, 2020, https://designopendata.wordpress.com/portfolio/the-future-of-design-education-2011-teal-triggs/.

32 For example, Cross, *Designerly Ways of Knowing*; Bonsiepe, "The Uneasy Relationship between Design and Design Research"; and Design Research Society proceedings, https://www.designresearchsociety.org/tags/proceedings.

33 See Owen, "Design Education in the Information Age"; Cross, *Engineering Design Methods*; Cross, "Design as a Discipline"; Anne Bruseberg and Deana MacDonagh, "New Product Development by Eliciting User Experience and Aspirations," *International Journal of Human-Computer Studies* 55, no. 4 (2001): 435–52, DOI: https://doi.org/10.1006/ijhc.2001.0479; Alan Hevner, "A Three Cycle View of Design Science Research," *Scandinavian Journal of Information Systems* 19, no. 2 (2007): 87–92, available at https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1017&context=sjis.

34 For example, see Christopher Frayling, "Research in Art and Design," *Royal College of Art Research Papers* 1, no. 1 (1993/4): 1–5, available at https://researchonline.rca.ac.uk/384/3/frayling_research_in_art_and_design_1993.pdf; Jorge Frascara, *Design and the Social Sciences: Making Connections* (London: Taylor & Francis, 2002); Robert Harland, "The Dimensions of Graphic Design: In Theory," in *Proceedings of Rigour and Relevance in Design: Proceedings of the International Association of Societies of Design Research 2009 (IASDR 2009)* (Seoul: Korean Society of Design Science, 2009), available at https://www.researchgate.net/profile/Robert_Harland2/publication/228697810; Sheila Pontis, "Metascience: A Paradigm for Postgraduate Communication Design Research," *Iridescent: Icograda Journal of Design Research* 2, no. 1 (2012): 30–51, DOI: https://doi.org/10.1080/19235003.2012.11428501.

35 AIGA DEC, "Examining Design Educator Pain Points," 15.

36 James Corazzo et al., "The Challenges for Graphic Design in Establishing an Academic Research Culture: Lessons from the Research Excellence Framework 2014," *The Design Journal* 23, no. 1 (2019): 7–29, DOI: https://doi.org/10.1080/14606925.2019.1682446.

pressure to perform as a professional academic has asked many to recalibrate their focus. It simply has become too much.

C. Students

The third group of changes that are influencing design education is related to the nature of today's students, their motivations, and their interests.

The Number of Students Enrolled in Design Courses Is Increasing

The growing interest in learning design skills at both undergraduate and graduate levels is attracting more students, resulting in larger classes. This means design educators need to spend more time preparing classes, grading, and assessing student work. In practice, rapidly growing class sizes usually increases faculty reliance on adjuncts. But frequently adjuncts have little pedagogical experience as they are focused on building a professional practice or are just starting their careers in higher education. This can make coordinating teaching objectives, and planning budgets, allocating resources, and developing teaching standards challenging.[37]

Student Populations Are More Diverse, Variedly Motivated and with Different Levels of Expertise

The diversity within groups of design students has increased too. Students' domains range from business, to science, engineering, politics, and medicine, to name but a few. As we mentioned above, they enroll in design classes for different reasons, and with different goals and interests. Although formal, research-based evidence is necessary, the main reasons for enrollment seem to be because they find design education techniques refreshing, they want to experience a more creative learning environment, or they want to learn new ways of problem solving.[38] As a result, students come to class with different levels of motivation and interest. Some are concerned with learning how to become successful designers, while others see design education merely as a contractual path to a degree and ultimately a job.[39] For a creative practice like design, students' motivation to learn and do the work is essential for a fruitful experience.[40] Managing increasing motivational disparity in the classroom—from apathetic to utterly driven—has become a massive challenge for instructors. Furthermore, students' backgrounds, previous educational achievements, and age also greatly differ. For example, graduate students might come from different global regions, many of them having degrees and expertise in other areas. Additionally, a growing number of students with recognized mental health disorders, disabilities, dyslexia, and ADHD make teaching even more complex.[41]

The classroom focus and dynamics have changed too. Before, in an introductory class, certain core concepts were new for all the students, whereas now the baseline greatly differs from one student to the next, and from one class to the next. Some students may have never heard of or been involved in a design critique, for example, or are unfamiliar with the concept of iterations.

The increasing number of students, their varying motivations, and their varied range of characteristics indicate that long-established pedagogical models need to be re-evaluated and reconsidered.

37 AIGA DEC, "Examining Design Educator Pain Points."
38 Alane Jordan Starko, *Creativity in the Classroom: Schools of Curious Delight*, 6th ed. (New York: Routledge, 2017).
39 Davis, *Teaching Design*.
40 Stenberg, "Teaching for Creativity."
41 AIGA DEC, "Examining Design Educator Pain Points."

D. Teaching Approach

As the student population becomes more diverse, new approaches, strategies and skills are needed to equip future designers, and so different approaches to teaching are needed too.

Master-Apprentice Pedagogical Models Do Not appropriately Prepare Students for Today's Design Challenges

In the craft world, the master-apprentice model still works well, because change is slow.[42] But some of the developments affecting design today show that it is time for that model to receive an upgrade.[43] Most design schools today combine aspects from more traditional teaching approaches, referred to as *Education 1.0*, with aspects of problem-based approaches, referred to as *Education 2.0*.[44] While the shift to *Education 2.0* does expose students to problem solving, collaboration, and learning by doing, design programs still do not place students at the center of their educational processes—it is rare for students to decide what and how they want to learn. Today, "the teacher is still the orchestrator of the learning."[45]

In the master-apprentice (*Education 1.0*) model, the role of design educators is to pass on knowledge and determine good and bad design criteria.[46] This often follows a one-way format: students learn by attempting to master a set of basic technical skills without asking critical questions. Most of the activities are not related to day-to-day professional practice; they are delivered in isolation, with no interaction with other key parties or stakeholders involved in the process. Clients, potential users, economic and legal considerations, and cultural and societal perspectives are rarely included.

Other schools have transitioned to *Education 2.0*, and use a problem-based approach using real cases or made-up projects, with both pre-defined and selected by the instructor. This approach helps students to put learnings into practice. However, it has little practical relevance, as teaching occurs predominantly in a studio providing a safe learning environment. This does not prepare students to deal with ambiguous or ill-defined situations they are likely going to encounter beyond the educational setting. In addition, most interactions are between the instructor and students, and do not provide students with a chance to experience cross-disciplinary collaboration or apply research techniques.

Learning through Fictitious Projects Is Not Enough to Navigate Real Life Situations

The focus of design education has already started to shift towards teaching students how to make things that effectively communicate, add value, and address the problem at hand, rather than only look good.[47] However, as Steven Heller describes in his work *Teaching Graphic Design*,[48] many courses still teach using fictitious project briefs. A design's impact on society, compliance with relevant legislation and standards, financial implications, and potential user experiences and interactions are not automatically considered. Fictitious projects do not prepare students to deal with the complexity of real-life situations, because their variables are fixed, based on the assumption that users are a homogenous group who interact with a designed solution in a uniform manner.

42 Hugh Dubberly, "Input for Updating the Icograda Design Education Manifesto," in *ICOGRADA Design Education Manifesto 2011*, ed. Bennett and Vulpinari (Taipei: Icograda, 2011), 80, available at https://www.ico-d.org/resources/design-education-manifesto.

43 Robinson, "Changing Education Paradigms"; Norman, "This Is the One Skill Designers Need to Develop Most in 2020."

44 Jackie Gerstein, "Moving from Education 1.0 through Education 2.0 towards Education 3.0," in *Experiences in Self-Determined Learning*, ed. Lisa-Marie Blaschke, Chris Kenyon, and Stewart Hase (Scotts Valley, CA: CreateSpace Independent Publishing Platform, 2014), 84–86.

45 Gerstein, "Moving from Education 1.0 through Education 2.0 towards Education 3.0," 88.

46 Friedman, "Design Science and Design Education."

47 Davis, *Teaching Design*.

48 Steven Heller, *Teaching Graphic Design* (New York: Allworth Press, 2003).

Assessment Criteria Based on Visual Quality Can No Longer Be Used to Comprehensively Assess Students' Learning

In most courses, assessment depends on the instructor's criteria and tends to be focused solely on the visual quality of design solutions created by students. Jorge Frascara and Guillermina Noël stress that "Most schools keep on exclusively trusting the judgment of the instructors when it comes to evaluating the work of students."[49]

When the learning focus was on creating a tangible deliverable for a fictitious project brief, these criteria were appropriate. Now that the need to deal with real-life situations is more pressing, developing tangible solutions is relevant, while the need for skills such as strategic thinking and teamwork has become paramount. This means that assessing students' learning mainly on the visual quality of the final solution is less appropriate because we cannot know if the student has adequately learned all steps of the design process. According to Audrey Bennet, "We should evaluate design outcomes on their positive or negative impact on society instead of only on their imagined potential to bring about social change or their formal aspects."[50] Similarly, Robert Harland and Phil Sawdon say of grading systems that "when more detailed written feedback to students is becoming the norm, team teaching is seen as beneficial to staff and students alike, specialist subjects seek interdisciplinary working, and institutional collaboration is encouraged, the need for a framework of common terms that represent levels of achievement is timely."[51]

These final three changes demonstrate that design teaching approaches need to be reconsidered. The conventional approach—hypothetical projects introduced and assessed in a studio environment, and taught within a master-student hierarchy—needs critical attention. We must assess students' work based on criteria that go beyond aesthetics and are more aligned with a range of different achievement levels.

Introducing a Student-Focused, Research-Led, Science-Based Approach to Design Education

In the previous sections, we presented nine changes that are having an impact on design education. The findings indicate that design education can no longer rely upon outdated standardized approaches, or even new ones like project-based learning, at least not solely. Not surprisingly, some educational institutions have already responded to the field's emerging needs by modifying their curricula and course offerings. But the current design teaching arena highly varies from one institution to another.

In line with Norman,[52] we argue that a change in design education should bring a variation of pedagogical approaches that provides a more individualized learning experience and better prepares future generations of designers to tackle real-life situations. We have some suggestions, summarized in Figure 3, for ways to address the changes we discussed in the context of the four design education spaces they impact.

49 Jorge Frascara and Guillermina Noël, "What's Missing in Design Education Today?," *Visible Language*, 46, 1-2 (2012): 41, available at https://s3-us-west-2.amazonaws.com/visiblelanguage/pdf/46.1-2/whats-missing-in-design-education-today.pdf.

50 Dubberly, "Input for Updating the Icograda Design Education Manifesto," 77.

51 Robert G. Harland and Phil J. Sawdon, "From Fail to First: Revising Assessment Criteria in Art and Design," *Art, Design and Communication in Higher Education* 10, no. 1 (2012): 67–88, available at https://repository.lboro.ac.uk/articles/From_fail_to_first_revising_assessment_criteria_in_art_and_design/9335336.

52 Norman, "This Is the One Skill Designers Need to Develop Most in 2020."

DIMENSIONS EXAMINED	CHANGES THAT HAVE TRANSFORMED THE FIELD	IMPACT ON EDUCATION SETTING	SUGGESTIONS TO ADDRESS CHANGES
A PROFESSIONAL PRACTICE	1 **Design problems have become more difficult to frame, and increasingly ill-defined**	• A wider range of skills and knowledge is needed to navigate complex environments, and define and frame problems	• Create a deeper understanding of the design process • Focus on problem efinition • Add user-centered research throughout • Establish stronger cross-disciplinary collaboration
	2 **Problem scopes and scales have broadened, and now require cross-disciplinary teams**	• Cross-disciplinary interactions are needed to train students for many roles and tackling varied types of problems	
B TEACHING ARENA	3 **Design education has broadened and diversified**	• Increased demand for more diverse structures and resources • Increased need for understanding the science and the way designers' think	• Develop a design mindset • Form a stronger scientific foundation • Disseminate teaching experience to develop stronger community
	4 **Pedagogical training and research experience have become essential requirements for teaching design**	• Combining research, education and practice has become harder for design educators, researchers and practitioners	
C STUDENTS	5 **The number of students enrolled in design courses is increasing**	• Design educators cannot spend enough quality time with students	• Co-create activities • Explain the basics • Encourage peer feedback and assessment
	6 **Student populations are more diverse, variedly motivated and with different levels of expertise**	• New techniques are needed to teach to very different levels of design skill sets, interests and motivation in the classroom	
D TEACHING APPROACH	7 **Master-apprentice pedagogical models do not appropriately prepare students for today's design challenges**	• Traditional design educators' methods and techniques do not place students at the center	• Explain new rules and and expectations • Use the world as the classroom • Work with real life problems • Assess the entire design process
	8 **Learning through fictitious projects is not enough to navigate real life situations**	• Problems pre-defined by the instructor do not prepare students to deal with ambiguity	
	9 **Assessment criteria based on visual quality can no longer be used to comprehensively assess students' learning**	• Demand for assessment criteria that account for very different backgrounds and skill sets	

Figure 3
Overview of the nine changes that influence design education, and our suggestions based on a self-determined pedagogical approach.

A. Professional Practice

Design education must reconsider the skills, areas, and topics that will adequately teach future designers how to approach today's complex, unframable design contexts. The following four suggestions are likely to expand students' toolkits and problem-solving capabilities.

Create a deeper understanding of the design process. Classes that increase students' awareness of the design process—including exploratory and evaluative user-centered research, analysis and synthesis, conceptual design, prototype and detail design, and implementation—should be an integral part of introductory courses. This knowledge would help students

better understand the different variables involved in the design process, how they impact each step, and why a proposed solution did not work as planned.[53] Students would see the value of the early steps in the process, spending the needed time to make sense of the problem and understand people's needs.

Focus on problem definition. Explicitly teaching the difference between problem finding and problem solving should be tackled early in design education. By understanding the differences between *presented problem situations* (fictitious project briefs), *discovered problem situations* (problems identified when something went wrong), and *created problem situations* (situations yielding opportunities for improvement)[54] students would learn how to discover, create, and formulate problems in a variety of ways. Similarly, adding systems thinking and creative thinking courses to curricula, and encouraging students to question rather than passively work on a given challenge, would strengthen their problem definition skills. This wider set of tools would give students enough oversight to determine how to act in ambiguous situations.[55]

Add user-centered research throughout. Design solutions have impact beyond the designer-client relationship. Being aware of the magnitude of this impact, and being able to predict, measure, and balance its implications has become imperative.[56] Similarly, designers should know not only how to generate prototypes, but also how to verify if prototypes work as intended. And adding research as an integral part of the design process would help students further develop research and application skills. For example, students could identify people's needs and test the modalities and understanding of design solutions, even when these are not tangible artifacts, like a strategy or model. This instruction could take place when students learn and practice basic research methods, and also as they gather firsthand data through interviews and observations. Analyzing, recording, presenting, and reporting findings would support the various steps in the design process by providing objective evidence and external input.

Establish stronger cross-disciplinary collaboration. Robinson[57] and Norman[58] agree that learning how to collaborate is essential for growth and understanding the world. The creation of exercises and assignments that foster collaborative learning and interactions (with students in the class, with students or faculty in the same and other departments, or with people outside the learning environment) would increase conversations with other disciplines and expose students to other ways of thinking and problem solving, better preparing them for working on cross-disciplinary teams. This would also result in more effective collaboration and teamwork, and readiness to adapt to different roles, leading to more authentic learning.

B. Teaching Arena

As design expands into other domains, the focus of design education should involve more than teaching technical skills. The aim should not be to merely teach how to design the best solution, but to think like a designer and collaborate to create a solution that helps the intended users achieve their intended goals. We discuss three suggestions that combine aspects

53 Pontis and Babwahsingh, "Improving Information Design Practice."
54 Jacob W. Getzels, "Problem Finding: A Theoretical Note," *Cognitive Science* 3, no. 2 (1979): 167–72, DOI: https://doi.org/10.1207/s15516709cog0302_4.
55 Stenberg, "Teaching for Creativity."
56 Audrey G. Bennett and Andrew Rarig, English version of "ICOGRADA Design Education Manifesto 2011," in *ICOGRADA Design Education Manifesto 2011*, ed. Bennett and Vulpinari (Taipei: Icograda, 2011), 27, points 7 and 8.
57 Robinson, "Changing Education Paradigms."
58 Norman, "This Is the One Skill Designers Need to Develop Most in 2020."

of traditional Art and Design schools[59] with the traditional university core skills of developing a critical mind and facilitating dialogue.

Develop a design mindset. Understanding how designers think and see the world would contribute to developing an appropriate mindset. Thanks to the lively, ongoing discussion around design thinking,[60] some of the ways designers' think have become more transparent and familiar. However, design theory must be taught in combination with doing, so students more fully appreciate what the practice involves.

Form a stronger scientific foundation. Ken Friedman stresses the need to add a scientific lens to design education[61] as a way to develop a problem-solving process rooted in effective methods. Explaining design effectiveness based on science would help to objectively indicate what good and bad design entails, and add credibility to the design process. Adding cognitive and psychological scientific theories and explanations to design curricula would give instructors frameworks to explain how design decisions can support people's behaviors and needs. This would give students a deeper understanding of their own practice, and provide the terminology to articulate the value of their work to other professionals.

Disseminate teaching experience to develop stronger community. Every academic institution must endeavor to capture and document, reflect on, and analyze learning experiences, which should also be published and shared with the wider academic population and other institutions. Setting time aside (formally) to analyze and reflect on students' experiences and work would be a step towards that direction. Learning activities that encourage exploration and investigation (rather than the production of rigid learning outcomes) will also provide a clearer way of assessing course quality and also students' level of content acquisition, via their reflections and critical analyses.

C. Students

All these changes indicate that a transition towards *Education 3.0* will partly be based on self-determined learning. The following suggestions would contribute to helping students take their education into their own hands.[62]

Co-create activities. Personalized educational models involve students in designing their own learning content and process.[63] This model has instructors and students co-design the course syllabus and create learning activities in line with students' needs and interests. Tailoring learning activities explicitly ensures that all students are able to develop competency incrementally, and leaves space for stronger students to improve and explore more advanced approaches. Students' input and feedback on course development would enable instructors to address their specific needs, and enable teachers and learners to determine individualized learning objectives[64] and a more flexible course syllabus. Listening to students and paying attention to their learning evolution is the starting point to implementing this suggestion.

Explain the basics. To be able to support students across the range of their levels of experience and expertise, curricular content should cover a wide range of knowledge[65]—everything from basic visual examples and key dates in design history to explanations of how design might collaborate with

59 Jenny Waller, *Art as Extra-Ordinary Science: A Paradigm for the 21st Century* (London: Clink Street Publishing, 2016).
60 Buchanan, "Design Research and the New Learning"; Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation* (New York: Harper Collins Publishers, 2009).
61 Friedman, "Design Science and Design Education."
62 Gerstein, "Moving from Education 1.0 through Education 2.0 towards Education 3.0."
63 Stewart Hase, "Skills for the Learning Leader in the 21st Century," in *Experiences in Self-Determined Learning*, ed. Lisa-Marie Blaschke, Chris Kenyon, and Stewart Hase (Scotts Valley, CA: CreateSpace Independent Publishing Platform, 2014), 11.
64 Gerstein, "Moving from Education 1.0 through Education 2.0 towards Education 3.0."
65 Davis, *Teaching Design*.

other disciplines. For example, some key concepts that need explaining are how to give feedback, why and when creating sketches and drafts is useful, how to work with visual thinking, and how to develop solid observation skills, among others. These design fundamentals should be taught early on so that students begin developing and nurturing design sensitivity.

Encourage peer feedback and assessment. Peer assessment contributes to a collaborative model of teaching and learning.[66] It concerns students directly with their own learning and develops their metacognitive skills.[67] Peer feedback helps build a sense of (design) community in the classroom and a deeper understanding of why design decisions are made. By critically analyzing and evaluating the process and quality of someone else's work, students critically reflect on their own practice and understanding of core concepts and principles. Through the assessment process, and by reflecting on the feedback they receive, students can identify gaps in their learning and solidify their notion of key concepts.

D. Teaching Approach

Adopting an *Education 3.0* approach would move design education away from teaching standardized content to a disembodied, unmotivated student body, and towards a personalized teaching model that supports individual growth. Here we make some suggestions for ways to enhance fundamental teaching practices.

Explain new rules and expectations. Instructors would become the guides, and students the authors, drivers, and assessors of their learning experiences.[68] Similarly, Icograda suggests that the role of a design educator would shift from knowledge provider to mediator who inspires and facilitates orientation for a more substantial practice.[69] Instructors can set expectations and then guide students throughout the journey, but without substantial student involvement and commitment, the road to professional capacity will be extremely steep and ultimately lead to failure.

Newly developed expectations will need to be clearly communicated at the beginning of a class. For example, students might be expected to show a proactive attitude, or play a direct and active part in curriculum development and the design of activities, assessments, and grading.[70] Some students may need time to adapt to these new rules, and to the experience of creating their own learning experiences, given that they have been exposed to standardized education for so long.[71]

Use the world as the classroom. Teaching a large portion of design courses outside the university realm plants the seeds of students' involvement in the wider professional community. It also helps them understand the synergy between knowing, doing and being.[72] For example, clients can work alongside students doing their projects, or invite them to their companies and organizations to conduct research, gain better understanding of the problem at hand, or observe real-life work interactions. Additionally, students would understand how theoretical components (terminologies, procedures, frameworks, principles) relate to practical situations and to their burgeoning practices, deepening their understanding of how professional practice interacts with theory.

66 Dorothy Spiller, "Assessment Matters: Self-Assessment and Peer Assessment" (Teaching Development Unit, Hamilton, New Zealand, 2012), 3, available at http://cei.ust.hk/files/public/assessment_matters_self-assessment_peer_assessment.pdf.

67 Thomas Cochrane and Vickel Narayan, "Cultivating Creative Approaches to Learning," in *Experiences in Self-Determined Learning*, ed. Lisa-Marie Blaschke, Chris Kenyon and Stewart Hase (Scotts Valley, CA: CreateSpace Independent Publishing Platform, 2014), 149–70.

68 Gerstein, "Moving from Education 1.0 through Education 2.0 towards Education 3.0," 91.

69 Bennett and Rarig, English version of "Icograda Design Education Manifesto 2011," 29.

70 Blaschke et al., *Experiences in Self-Determined Learning*.

71 Stenberg, "Teaching for Creativity"; Blaschke et al., *Experiences in Self-Determined Learning*; Davis, *Teaching Design*.

72 Cochrane and Narayan, "Cultivating Creative Approaches to Learning," 151.

Work with real-life problems. Real problems force students to work with real constraints. These are the ideal conditions for students to learn by doing, and enable them to reflect on their own practice, and become familiar with the professional context of the problem. Interest-based learning, such as through projects and exercises that provide the freedom for students to select a topic, increases students' involvement, motivation and curiosity in the class.[73] In the same way, working with real-life assignments with real clients motivates and increases students' level of autonomy.

Assess the entire design process. As the educational focus shifts, it is essential to more accurately assess students' learning.[74] Assessment criteria should take students' growth, thinking, the work developed at every stage of the design process, and students' ability to work around constraints into account.[75] These criteria focus on more intangible skills (e.g. conceptualization, lateral thinking, making connections) which support the development of students as reflective design practitioners.[76] And more holistic assessment criteria enable more objective feedback.[77]

In the next section, we examine how a student-focused, research-led, and science-based approach works in practice.

A New Approach to Information Design Courses

The design education approach we describe above suggests major changes that some may see as arduous to implement. In this section, we analyze two information design courses that have been designed using the proposed teaching approach, to illustrate how implementation looks in practice. The courses are *Design for Understanding* taught at Princeton University (United States), and *Healthcare Information Design* taught at Basel School of Design (FHNW, Switzerland).

Design for Understanding

The *Design for Understanding* course (EGR381) was created in 2017 by Dr. Sheila Pontis as an elective at the School of Engineering and Applied Science to expand the design curricula at Princeton University. Students take the course, which is open to all student levels across 36 majors, to learn how to create visual explanations and communications that facilitate understanding. None of the students has a design or arts background, and so this introductory information design course was designed with a strong focus on process. It combines fundamental design principles with the basics of cognitive science and sensemaking. The course emphasis is on learning how to create a clear narrative or explanation, conceptual design, and information organization rather than on learning technical skills or tools.

The class is taught weekly during spring semester. It runs over a twelve-week period. Students are placed in a studio environment. They receive mini-lectures, do hands-on exercises, participate in group discussions, and have weekly texts to read that deepen their knowledge about key design principles, theories, and concepts. During the first three weeks, students learn how the brain processes information, the role of mental models, how

73 Gerstein, "Moving from Education 1.0 through Education 2.0 towards Education 3.0."

74 Stenberg, "Teaching for Creativity"; Davis, *Teaching Design*.

75 Grant Ellmers and Marius Foley, "Introducing Reflective Strategies Informed by Problem-Based Learning to Enhance Cognitive Participation and Knowledge Transference in Graphic Design Education," in *Proceedings of ConnectED 2007: International Conference on Design Education* (Sydney: University of NSW, July 9–12, 2007), available at https://scholars.uow.edu.au/display/publication19467.

76 Donald A. Schön, *Educating the Reflective Practitioner* (San Francisco: Jossey-Bass Publishers, 1988); Susan Giloi and Pieter Herzog du Toit, "Current Approaches to the Assessment of Graphic Design in a Higher Education Context," *International Journal of Art & Design Education* 32, no. 2 (2013): 256–68, DOI: https://doi.org/10.1111/j.1476-8070.2013.01758.x.

77 Jane Trustram, "Jotta's Design Director Jane Trustram on the Redesigning Graphic Design Education," *Design Week*, March 16, 2012, https://www.designweek.co.uk/issues/december-2011/jottas-design-director-jane-trustram-on-the-redesigning-graphic-design-education/.

visuals support learning, dual coding theories, and the connection between the sensemaking process and the information design process.

To develop a design mindset and practice sensemaking, students work without digital tools for the first part of the course and keep a visual journal (or write blog posts) throughout the semester where they analyze and redesign self-selected examples from the real world. Two short projects (posters, booklets) and a final project (visual story and presentation) expose students to the realities of design work. Short projects assess students formative learning (design basics: visual composition, use of visual variables, understanding of Gestalt principles), and the final project aims at summative assessment by demonstrating semester-long learnings (create visual explanations, define arguments, develop visual narratives). While project briefs and design constraints (format, tools, timeframe) are pre-defined, students choose the topics they want to work with. These have included quantum computing, fertility, caffeine consumption, chlorination, what to do after graduation, and how batteries work, among others. This approach places students as content experts as many work with topics related to their junior papers or senior thesis, for which they have conducted extensive research.

The projects are aimed at specific, intended audiences for each project: typically novices unfamiliar with the topics the students have to explain. Throughout the project cycle, students visit relevant locations to get a deeper understanding of the audience needs, and to conduct interviews. Target audience members visit the class halfway through the project cycle to provide feedback, and again at the end to help test final outcomes. During last year 2019's class, students also worked closely with external content experts to help them better understand the information they were trying to explain and visualize.

For the final project, students create a 6-minute visual story that helps convey a deeper understanding of a topic they are passionate about which is often misunderstood. Students use different types of data to explain and build an argument, present hard evidence, uncover needs, surface areas for improvement, and indicate possible ways forward. Before the end of the story, they have to propose a solution to one of the issues they highlight and clearly articulate a call to action. Students work on this project for four weeks, initially by gaining familiarity with the chosen topic, gathering data, and defining the story structure. The project involves three key milestones before students start designing: 1) define a **story goal** to summarize what they want to explain, 2) create a **story outline** to indicate general flow and key ideas — this step helps students design the narrative, determine the sequence of ideas, and identify the type of data they will need to support each claim; and 3) create the **storyline** and **design rules** as a storyboard where each frame illustrates the content and main message of each slide. Students select a color palette, font families, and the types of imagery that they will use. At this point in the process, students start thinking about visual ways to make content and data more accessible. The storyline helps them articulate what content will be explained in each slide and how it will be displayed — as images; graphically illustrated charts, process flows, or

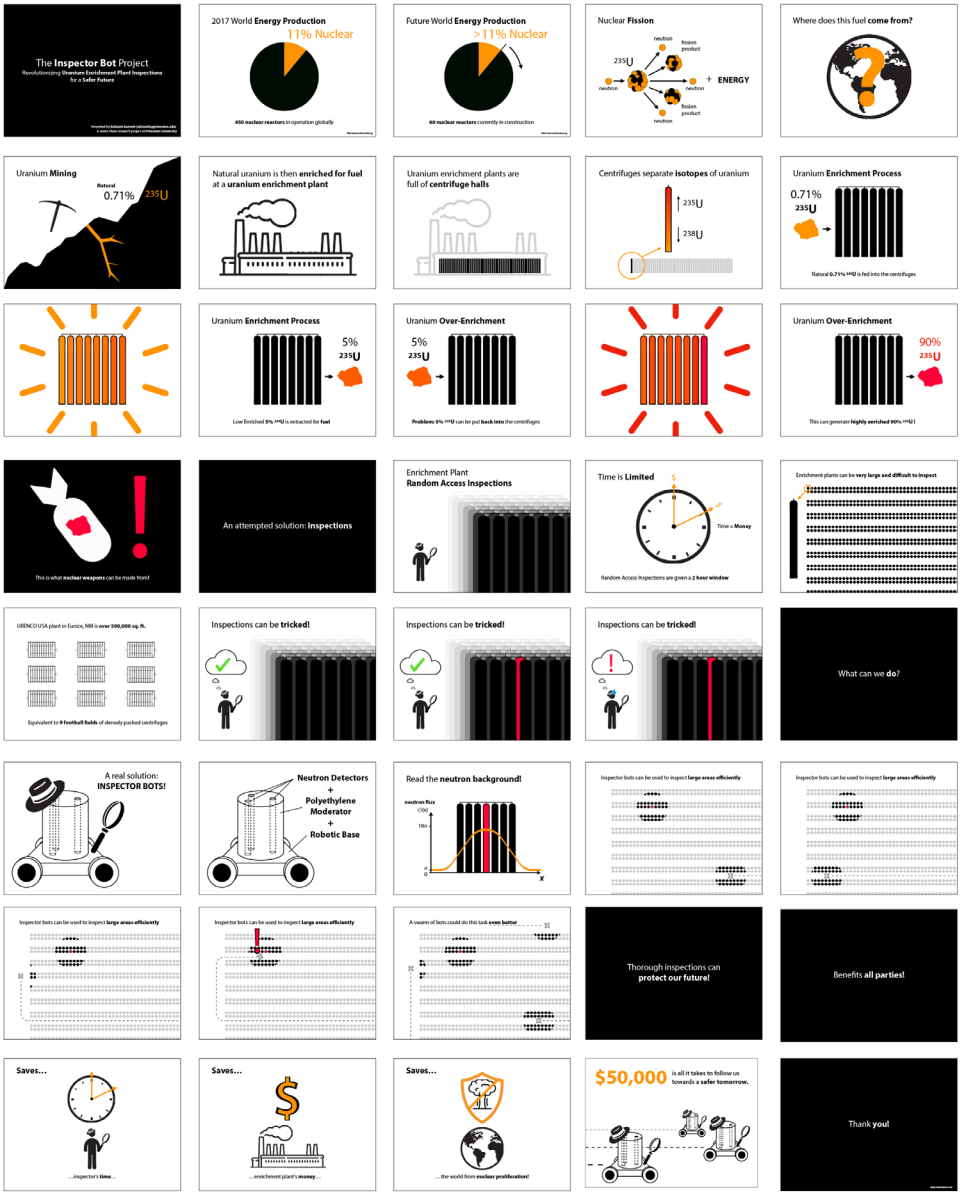

Figure 4
Project created by Design for Understanding student Raheem Barnett in the spring of 2018. The original format is a 40-slide presentation; here all slides are shown as an image to illustrate the narrative flow of the story. The goal for Raheem's project, *The Inspector Bot Project Revolutionizing Uranium Enrichment Plant Inspections for a Safer Future*, was to clarify and explain a specific problem related to uranium reactors and how a proposed solution would improve uranium enrichment plant inspections. The final grade was comprised of Raheem' process based on the completion of specific milestones and final story delivery.

timelines; or text. While the initial storyline changes throughout the process, it gives students direction and helps them to move from words to visuals. Next, students create a first **complete draft**. At each milestone, students share their work with another student for feedback. By telling the story and explaining their thought process to another person, students identify initial assumptions, gaps in the story, and areas for improvement.

In addition to the creation of a design output (see Figure 4 for example), students also submit a process reflection report for each project where they explain the rationale behind the design decisions they made and provide visual evidence of the completion of specific project milestones. Each project is peer-assessed and assessed based on students' process and the level of depth, growth, and understanding shown in the reflection essay.

Healthcare Information Design

The *Healthcare Information Design* course started as a twelve-week, once a week class, focused on research for master's students. Students come from different countries, speak different languages, and have a wide range of first degrees. The course, initially developed by Dr. Karel van der Waarde, has been taught for five consecutive years in Basel in collaboration with Dr. Paloma López Grüninger. It was taught at the master's level twice in Breda (The Netherlands) and once in Melbourne (Australia). The course is now offered as a more intensive class running from six or seven weeks (depending on the calendar) for 1.5 days per week.

At the beginning of the course, students bring a collection of examples that provide information about health or healthcare. These are all very mundane bits of information: simple instructions for yoga, leaflets about medicines, packaging for contact lenses, and advice on health and safety. In the first lesson, there is a substantial number of artifacts — most of questionable design quality. They appear at first sight to be sufficient, but they do not really enable people to act appropriately. The original example is in most cases only a symptom of a far larger issue between organizations or companies and their customers. Students have to analyze their examples, determine the aims of one of these, establish the user actions that the chosen example intends to support, formulate questions, and interview at least six people to confirm that their final perspective about an example is more than their personal opinion in that it is also supported by some evidence. These interviews also reveal that the interpretation and use of the information in the example is problematic. The examples are also tested with eye-movement recording technology in the *usability laboratory* of the Fachhochschule Nordwestschweiz (FHNW) — the wider context for the master's course. This technology adds more evidence about how people read and use visual information. More importantly, it provides a basis for discussion about the reliability of data and the influence of test panels on results. Halfway through the course, students start to design an alternative presentation of the information that focuses on supporting appropriate actions. The use of illustrations, rewriting the text, reconsidering the structure, and finding out in which context the design would be used are all part of the redesign(see Figure 5 for example). A second round of six interviews usually confirms that the objective of improving one action has been achieved. This simple approach frequently raises new and unexpected questions, and reveals how people's reactions can inform visual design decisions.

The main aim is to focus on a combination of activities: observing, presenting, writing, designing, interviewing, and critically discussing. In the assessment, the arguments that students provide to support their design decisions, the way they structure their arguments, and the delivery of these arguments in presentations and reports are separately graded, and designing is a relatively small but essential part. One of the advantages of this approach is that students who do not have a traditional design background can still be assessed. Students receive individual feedback about what went well during each activity, and about what needs attention.

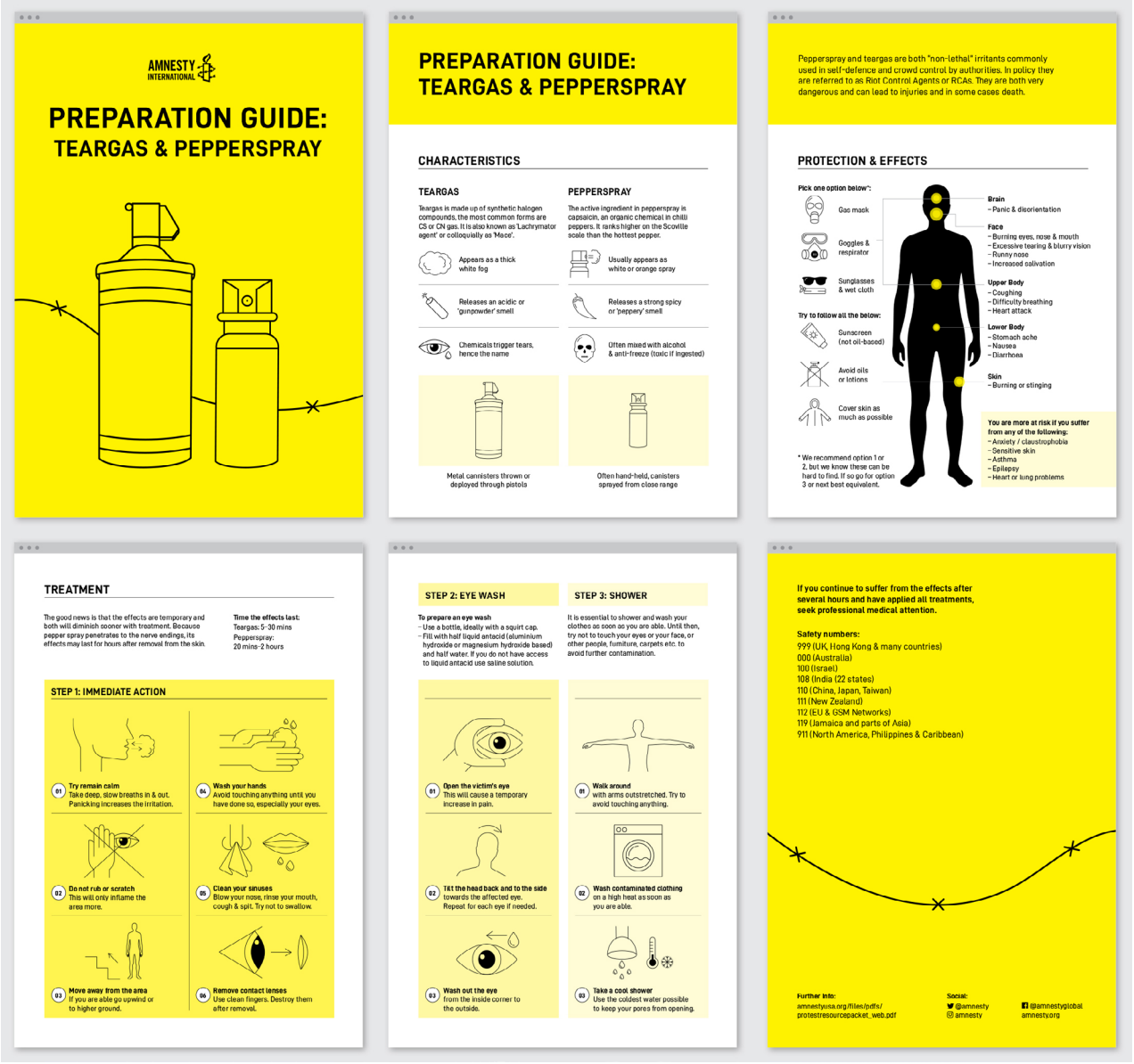

Figure 5
Project created by Frances Lucas, a research student in the 2019 Visual Communication and Iconic course at FHNW-Basel. The baseline goal of this project was to provide convincing evidence that redesigned visual information undeniably improves a single action for a single user. Frances's starting point for this project were Amnesty International's instructions for how to deal with the effects of teargas and pepper spray. © 2019 by Frances Lucas.

Implications of Adopting the Approach

It is unquestionable that a large-scale transformation in design education would take time and effort, but changes implemented from the bottom up might be a way to gradually implement change. The cases above illustrate how some of the proposed suggestions work in practice in the context of information design education. Information design has very specific needs, including a strong emphasis on conceptual design and information organization, which may or may not be relevant to other design fields. However,

78 Clark and Lyons, *Graphics for Learning*.
79 Stenberg, "Teaching for Creativity"; Clark and Lyons, *Graphics for Learning*.

there are many commonalities with other design fields such as the need to understand the basics of science, give relevant feedback, and focus on real life problems, that make learnings from this analysis widely applicable.

Let us consider some of the implications of adopting a student-focused, research-led, science-based approach, which we have derived from our experience teaching *Design for Understanding* and *Healthcare Information Design*.

- **Student-focused courses give students more autonomy, but their motivation and commitment greatly impact the quality of their work.** In both the Princeton and Basel courses, the actual design component does not occupy the central role, but is part of a larger process. Students are expected to undertake a range of activities to encourage transfer of learning[78]—the making of a visible and tangible prototype is only one way of fostering this knowledge lateralization. For example, students gather data and select topics or areas they want to work on, identify and define a problem, conceive and create solutions, and test them with real audiences. They write weekly journal entries or blog posts analyzing and benchmarking examples to understand what good design involves, and also write reports and prepare presentations. These activities help smooth out otherwise substantial differences among students related to background, knowledge, design skills, and interests.

  In line with prior research,[79] students' motivation and commitment to learning greatly determine the success of a student-focused course. For example, an important difference between the courses we analyze here is that the Princeton course is an undergraduate-level class where students enrolled because they are interested in learning more about design, but their understanding of the practice is very limited. The Basel course is a graduate-level class where students choose to learn more about an area that they are already familiar with or know what it involves. In contrast, students at Princeton University enroll in *Design for Understanding* as a fifth class which means that it is not directly connected to their major (there is no Design department in the university).

  A student-focused course requires that instructors learn how to navigate ambiguity in the classroom and how to be flexible and responsive enough to pivot a situation if students do not respond as expected. This indicates a necessary period of adaptation. When we started teaching our courses, we spent time adapting to our new roles, as we transitioned from knowledge keepers to guides, and found the balance between planning what each class session would look like and keeping an open mind to make changes on the spot.

- **Research-led courses require a stronger collaboration with other parties (clients, other departments, audience, content experts), or instructors with hybrid backgrounds.** For these courses, research occupies a central role. Students actively search for and generate data to support assumptions and design decisions as not all information is available within the studio space before and during the project. Students engage

in user research to identify needs, collect feedback, and test solutions. In line with Teal Triggs's suggestion, some projects will "include the participation of targeted communities that have local knowledge which can inform and shape a project and solution."[80]

The Princeton course is taught by one instructor plus one teaching assistant; the Basel course by two instructors. All three of the instructors have hybrid backgrounds: we are trained as designers, have completed PhDs in design, and have substantial experience in higher education, professional practice, and academic research. Working with human centered research is an intrinsic part of our design process, which made it easier to add research as part of our courses curricula.

- **Science-based courses demand better preparation from design educators but can increase professional practice quality and success.** In both the Princeton and Basel courses, students gain familiarity with the science and theories that support design decisions. For example, in Design for Understanding, dual coding theory,[81] the role of Gestalt principles,[82] and cognitive processes involved in visual learning[83] are discussed early on in the class to provide scientific underpinning for design decisions. Furthermore, anchoring learning objectives with relevant scientific principles helps close the gap between design practice and university standards. In a scientific university environment, it is expected that content and principles taught in a class are rooted in evidence and objective criteria. Students respond better to objective feedback based on scientific explanations than on comments that could otherwise be based on personal taste alone.

  Planning and designing these courses involved a big learning curve: we needed to gain a deeper and more conscious understanding of our own practices and design processes. We also had to gain familiarity with relevant cognitive science theories and psychological principles to be able to explain to the students why we do what we do. Although we have gained familiarity with the basics, we also work closely with content experts and professionals from other disciplines who act as guest lecturers. They support students' sensemaking process, provide feedback throughout project cycles, and review work in progress. Their input greatly enriches students' learning experience in ways we cannot. Learning knowledge beyond the traditional design domain may very well be a time-consuming barrier to teaching science-based courses, but this knowledge could also improve communication with clients as we are better equipped to objectively articulate our design decisions.

Conclusions and Pathways Forward

Throughout this paper, we have analyzed how changes in professional design practice contexts, the design teaching arena, design student bodies, and design teaching approaches are impacting design education overall, and have made suggestions about how educators can address these changes. None of these suggestions is completely new. Many have been identified

80 Triggs, "The Future of Design Education," 125.

81 Allan Paivio, "Mental Imagery in Associative Learning and Memory," *Psychological Review* 76, no. 3 (1969): 241–63, DOI: https://doi.org/10.1037/h0027272.

82 Max Wertheimer, "Principles of Perceptual Organization," in *Readings in Perception*, ed. David C. Beardslee and Michael Wertheimer (Princeton, NJ: Van Nostrand, 1958), 115–35.

83 Clark and Lyons, *Graphics for Learning*.

prior to this article,[84] and discussed at educational conferences.[85] Others we have adapted from creativity literature[86] and non-design related work.[87] Our contribution is the combination and introduction of these suggestions as a student-focused, research-led, science-based educational approach.

We demonstrated the application of this approach by examining two existing information design courses taught at Princeton University and Basel School of Design. Both courses prove that it is possible to successfully teach design using alternative models to traditional ones. Starting small by redesigning existing courses or designing new courses with the suggested approach was discussed as one way to actively begin changing design education. However, it is clear that this analysis only scratches the surface. A more in-depth examination is needed to compare both courses on more granular levels and assess further implications of a self-determined pedagogical approach in other design fields.

Additionally, our analysis revealed that teacher preparation, student motivation, and actor collaboration are key interrelated pillars undergirding success with this approach.

Preparation. The proposed pedagogical model may appear to some as deceptively chaotic, given its flexibility and dynamism. Teaching design using a student-directed approach will require greater preparation upstream: the instructor will need to design individualized syllabi (assignment, activities, class flows) and plan and coordinate with external collaborators (such as clients and content experts). Expanding the teaching toolkit with new techniques and methods, and deepening the understanding of one's practice were indicated as key to addressing the needs of more heterogeneous, ambiguous, and flexible class environments, and instructors' capacity to address a wider range of student questions. We found that this extra work and preparation helped improve the quality of our design practice as well, as we have expanded our awareness of why things do not always go as planned.

Motivation. The more diverse (background interest, skill level) the student population, the harder it is to keep each student motivated. Bringing students into the class development process, creating projects related to their interests, and letting students choose the topic to work with were indicated as possible strategies to inspire motivation. Working with real clients and real users are other ways, as this helps them understand the value of feedback and making informed decisions.

Collaboration. While adopting interest-based learning would remove the pressure of finding topics that students would be passionate about, it could make giving feedback challenging as instructors would need to become familiar with many topics at the same time. Similarly, it may be taxing for instructors to gain familiarity with all the relevant theories and principles that inform a specific design process. Closely working with professors from other disciplines or bringing content experts into the classroom are ways to share knowledge and provide appropriate feedback to students.

These pillars also indicate limitations and fresh challenges of implementing the proposed approach that need to be recognized. First, instructors with little teaching experience could find these new student-teacher

84 For example, see Ellmers and Foley, "Introducing Reflective Strategies Informed"; Trustram, "Jotta's Design Director Jane Trustram on the Redesigning Graphic Design Education"; Giloi and du Toit, "Current Approaches to the Assessment of Graphic Design in a Higher Education Context"; Davis, *Teaching Design*.

85 For more information, see "AIGA Design Educators Community Conference: Decipher," AIGA, September 27, 2018, available at https://educators.aiga.org/event/2018-aiga-dec-conference-decipher/.

86 For example, see Stenberg, "Teaching for Creativity."

87 For example, see Gerstein, "Moving from Education 1.0 through Education 2.0 towards Education 3.0"; Cochrane and Narayan, "Cultivating Creative Approaches to Learning."

dynamics arduous. Pedagogical training and a minimum of prior classroom experience would become requirements. Students will also require very clear explanations of how a newly-adopted approach would work, and of any new rules and expectations placed upon them.

Furthermore, we have based the "success" of the approach on student evaluations and comments from a very small sample (two courses). Although there are other courses and workshops using similar approaches, it would be beneficial to conduct formal academic studies to assess the validity of this student self-directed approach to design education. To address this gap, increasing the focus on design education research would help build on this analysis and examine other relevant dimensions such as the type of questions students ask, the type of difficulties and struggles they encounter, design results (effectiveness and quality), and differences in educational systems between (for instance) the US and Switzerland. Further studies could investigate what other forms a teaching approach with these characteristics would look like, study their benefits and limitations, learn more about students' needs, barriers to change and identify other ways to improve design education. As a starting point, the above nine changes and four dimensions could provide an initial outline for a research agenda. Each change could be further investigated to understand the full extent of its impact in each design field and whether it manifests across geographical areas, and to establish best practices. These studies would provide support to others who would like to develop courses with a similar approach.

To conclude, as Norman[88] points out, design is a rapidly changing practice. Adapting or creating new courses to address all of the changes discussed throughout this article will continue to be a challenge because the landscape of design practice continues to shift and adapt to external changes. Our case studies could be seen as roadmaps that serve as a reminder to design educators that evolving how we teach is both possible and productive. Working with a flexible and dynamic approach would allow room for accommodating future transformations.

88 Norman, "This Is the One Skill Designers Need to Develop Most in 2020."

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There are no conflicts of interest involved in this article.

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