Different types of design tools in design education

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Abstract. Design tools assist designers in their practice and enhance or streamline their abilities: for example, computer software, printed canvases, websites, mobile applications, card sets, or physical prototypes. Designers can use these tools for different functions like empathizing with people, getting to know the context they are working with, or making strategic decisions to find solutions for certain problems. In this paper we focus on describing different types of design tools: information-based tools – those that convey methodology or theory that is relevant for the design process –, inspirational tools – those that, for example, display existing solutions to inspire designers –, tangible tools – those that trigger discussions about form, materiality, and use of design interventions and their evaluation –, and process-based tools – those that are not necessarily discipline specific but that are used to collect, store, or analyze data throughout the design process. We conducted a small survey with a sample of university teachers in the field of design, asking them about their experiences with these kinds of tools in class, focusing on ease of use and value for education. While limited, our results suggest that design tools are valuable in facilitating complex knowledge and making it actionable, and in triggering thought processes in students, but that the onus should be on processes rather than on specific tools to avoid fixation. We also present examples of design tools in practice. Further research can continue this work by extending our understanding of how these instruments are used and the benefits they present in the classroom, and produce guidelines to optimize their impact.

Keywords: Design Tools, Design Education, Knowledge Facilitation.

1 Design tools

1.1 Types of design tools

Design tools are instruments that assist designers in their practice [1] and can be many things according to their function [2, 3, 4]: they can be something to sketch (e.g., a software), to inspire (e.g., a website), to inform (e.g., a booklet), to teach methods and procedures (e.g., a card set), to generate and envision or test ideas (e.g., physical prototypes), to gather information and understand users/contexts (e.g., canvases), etc. Design tools are “compact vehicles of data, often with game elements, that deliver

methods of working, inspire with ideas or solutions, and summarize complex information in a format that is possible to handle" [5, p. 3], used to make the design process less abstract [4].

Design tools help designers understand problematics, empathize with users, and map contexts, are useful to streamline complex theoretical models and ideas, and can help to arrive at more and more focused ideas faster, or to evaluate resulting concepts or ideas. They can also be useful to communicate within design teams or with stakeholders about design visions and expected outcomes. These tools are developed both in research and in industry contexts, serving the needs of designers and the design process (a well-known example of this is the company IDEO).

Digital design tools can have different presentations like websites and mobile applications, and contain information about taxonomies or models to be used in the design process. An example of this is the Negative Emotion Typology (Fig 1). This tool aims to inform designers about the full spectrum of emotions in order to create rich experiences, using linear and non-linear text, movie clips, cartoon vignettes, and typical expressions of people experiencing each emotion.

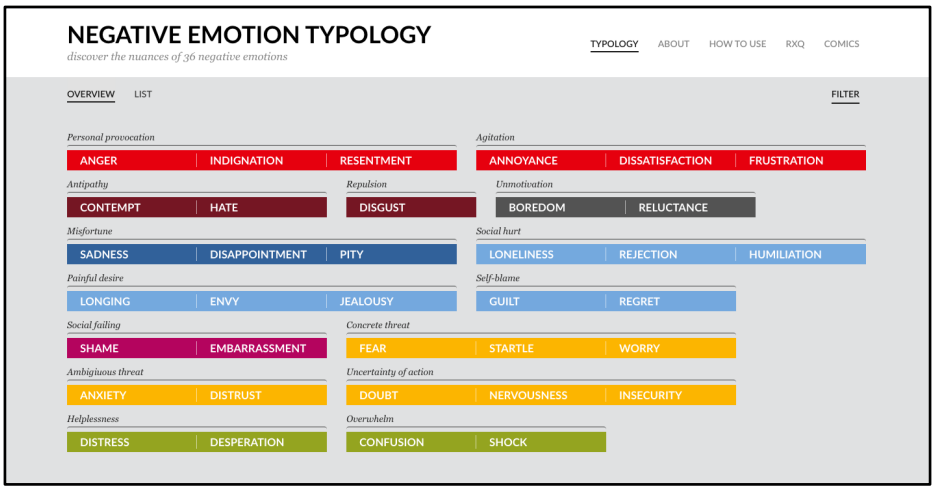


Fig. 1. Negative Emotion Typology (source: http://emotiontypology.com).

Printed design tools are often in the shape of canvases, booklets, or card sets and contain information that is relevant for the design process and/or methods to understand the users, stakeholders, and/or contexts. An example of this is the Book of Dilemmas for Designers [6] (Fig. 2). This booklet aims to provide information about dilemmas and methodology to design with dilemmas, and contains linear and non-linear text, diagrams with pictograms, cartoon vignettes, infographics, and images of existing design solutions.

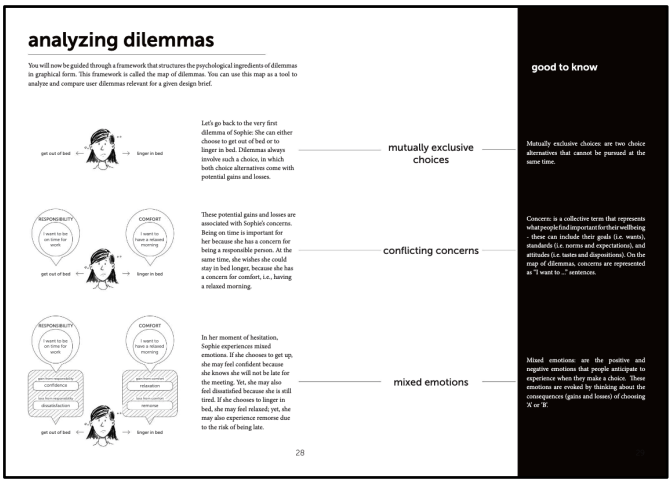


Fig. 2. Book of Dilemmas for Designers (source: www.designwithdilemmas.com).

Toolkits are a combination of different tools that complement each other in providing information and inspiration. An example of this is the website and card set SIM toolkit [7] (Fig. 3). This toolkit focuses on introducing symbolic meaning in the design process to support users' happiness, and has a combination of linear and non-linear text, as well as images and colour coding.

Fig. 3. SIM toolkit (source: www.designwithmeaning.org)

Tangible design tools are dynamics that are mediated by objects. An example of this is the Venture Tower Game [8] (Fig. 4). This tangible model encourages a participatory construction of a joint venture among small company owners.

Fig. 4. The Venture Tower Game (source: [9]).

1.2 **Using design tools in education**

Reasons for the use of design tools in design education have been previously explored [5], and include that:

- *Designers think visually*: these tools generally have a strong visual or physical focus that accompanies linear text, which is a way to better engage designers since these tend to be visual thinkers [10, 11];
- *Creating mental images supports learning*: the visual or physical component of design tools helps construct, together with textual elements, a richer mental image of concepts [12] that might otherwise be complex or difficult to grasp for designers;
- *Synthesis makes knowledge* (*more*) *actionable*: design tools often offer ways to make theoretical knowledge actionable through methods, games, and other exercises, which tends to work well with visual and practice-oriented disciplines like design [5];
- *Collaborative learning*: design tools engage students and designers in learning and creative environments, fostering learning communities based on shared knowledge [13].

Still, some questions remain whose answers can be a valuable contribution to design pedagogy studies: is it preferable to teach theory and methodology to design students through design tools (versus a traditional approach of using textbooks, lectures, scientific articles, etc.)? Is it a valuable resource to add to class or, instead, it should be left to design professionals to use in practice? What are potential pitfalls of this approach (in the classroom)?

In this paper we report a study by which we aimed to take a first look at these issues and contribute to characterizing the use of different types of design tools in design education. We conducted a survey to design teachers in several universities focused on the value and ease of use of design tools.

2 Method

A small survey was sent out to different university networks with the aim of characterizing the use of design tools in design education. The questions were as follows:

- How many years of experience do you have teaching design? (Answer options were: less than 3, 3 to 10, more than 10);
- Do you have experience using design tools in class? (Answer options were: yes or no, or only used once);
- What types of tools have you used in class? (Answer options were: card set, canvas, website, mobile application, other [asking to specify]);
- How would you describe your experience using design tools overall, in terms of ease of use? (Answer with a Likert scale of 1-5, 1=very difficult, 5=very easy);
- How would you describe your experience using design tools overall, in terms of their value for the class? (Answer with a Likert scale of 1-5, 1=not worth it at all [not beneficial or detrimental], 5=very much worth it [very beneficial]);
- Do you believe it facilitates the teaching of complex information (e.g., theoretical models or ideas from other disciplines)? (Answer options were: yes or no, other [asking to specify]);
- In what type of setting do you introduce design tools to the class (e.g., ideation, theory learning, conceptualization, evaluation)?; and
- Do you have any additional information you would like to add about your experience using design tools in class?

3 Results

15 university design teachers responded to the survey, of which 53% had over 10 years of teaching experience (66% had, at least, three years of teaching experience). All participants had experience using design tools in class, with only one having a limited experience of one time use.

While we aimed to focus this survey on *design* tools (i.e., domain specific to some extent) as described above, participants also described other types of tools they applied in class with students (Fig. 5):

- The majority (80%) mentioned using canvases;
- A large part (73%) referred to using card sets;
- More than half (60%) used websites;
- About one fourth (27%) mentioned mobile applications; and
- Less than 10% mentioned using other tools: physical prototypes, social media platforms, interactive scaling, games, Google tools (Google Docs), and software like Microsoft Excel.

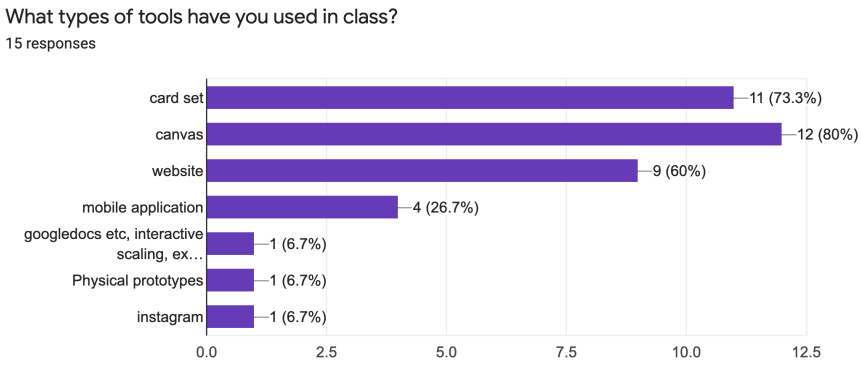
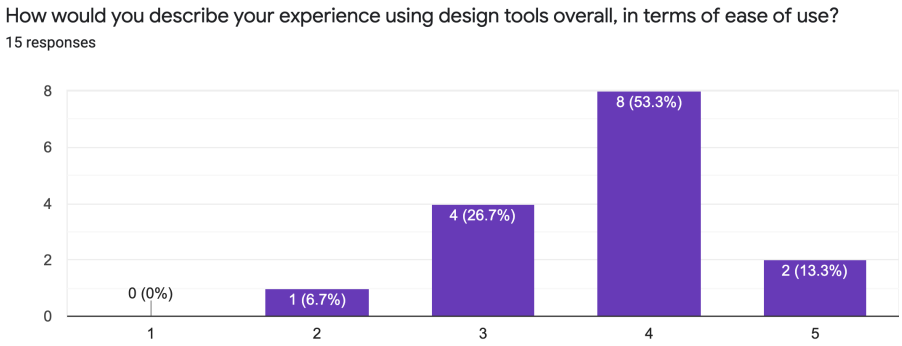


Fig. 5. Types of tools used in class.

Participants found design tools easy to use in the classroom context (53% selected 4 out of 5 on a Likert scale, 1=very difficult and 5=very easy) and valuable or very valuable (40% selected 4 out of 5, and 40% selected 5 out of 5 on a Likert scale, 1=not worth it at all [not beneficial or detrimental], 5=very much worth it [very beneficial]) (Fig. 6).



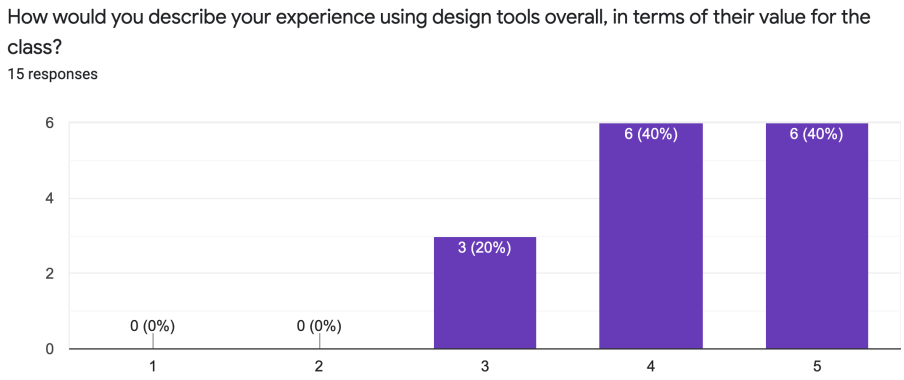


Fig. 6. Ease of use and value of tools in class.

The large majority (87%) agreed with the statement that design tools can facilitate the teaching of complex information, like theoretical models or ideas from other disciplines, with one participant pointing out that it "*depends on the tool*," however, noting that it is often worth the try.

Participants were asked about the type of setting in which they introduced the tools to students and responded:

- In all stages of the design process;
- For observation;
- For ideation/conceptualization;
- For reflection on the process;
- For data analysis;
- For communication;
- In theory/methods learning; and
- For evaluation.

We can identify several types of design tools from the survey (Table 1), namely, information-based design tools, inspiration-based design tools, tangible design tools, and process-based tools.

Table 1. Types of design tools used in education

Type of tool	Function	Types of platforms	Uses in the design process	Examples*
Information-based	Provides theory and/or methodologies to optimize the design process	• Card sets • Booklets • Canvases • Websites • Mobile applications	• Understanding the user/ context • Integrating theoretical concepts • Communicating in teams	• Book of Dilemmas for Designers (Fig. 2) • SIM toolkit (Fig. 3)

Inspiration-based	Triggers inspiration through display of existing solutions or storytelling	• Websites • Booklets • Card sets	• Creating a design vision • Benchmarking existing solutions • Ideation/ brainstorming	• Plex Cards • Emotional Granularity card set
Tangible	Trigger discussions and exploration of form, materiality, use; evaluate and test ideas	• Physical prototypes • Arduino • Building sets	• Exploring materials • Exploring forms • Exploring uses • Prototyping/ mockups	• Lego Serious Play • Franzis Raspberry Pi Maker Kit Elektronik
Process-based	Practical databases for collecting, storing or analyzing data throughout the process	• Canvases • Questionnaire tools	• Understanding the user/ context • Collecting and storing information through the entire process (about the user, context, process, etc.) • Data analysis	• User empathy canvas • Google docs • SPSS

*Some examples were mentioned in the survey, others were added for completeness; the examples were chosen to illustrate a category, but are often a part of more than one.

Next, we highlight the main comments participants had about the use of design tools in design education, grouped in topics:

Design tools make complex knowledge "digestible" and actionable

Participants mentioned how impactful it is to incorporate tools in the facilitation of theory-based content:

"*It's been a game changer for my design history course*."

Design tools need to be applied in order to be useful, and that application needs to be well explained

Understanding tools' content may be reinforced when students learn more about it by doing something:

"*The demonstration of tool usage, including application techniques, needs to be conveyed*."

"*Even though* [the] *usage of a tool might be complex* (…) *repeated application does seem to deliver an understanding*."

"*In my experience, sometimes explaining the tool is not enough, you need to let the students get to know how to use it*."

"*I like them when they are open and explained thoroughly*."

Design tools can and should be adapted to the needs of the designer(s)

"*It is both great to have a repository and adapting them to the particular settings of each project*."

"*Tools are nice but a designer needs to make them their own* (*adapt them to their needs*)."

Participants also pointed out some negative aspects of using tools in class:

"*Students experience the method or theory to be learned themselves, which is a great activity*. *The hidden danger, however, is that students think they will always need this tool for that activity*."

4 Design tools in practice

To expose some of these ideas in a more concrete way, we are going to present three cases that show the use of design tools. The first one is during the ideation process of an academic exercise to explore emotions through food [14]; the second one is during the concept validation phase of a digital piggy bank [15]; and the last one is a collaborative learning environment to explore digital media [13].

As part of an academic exercise, a group of design students were asked to explore emotions through food. The exploration had four phases, in which they had to conceptualize a set of emotion by creating a narrative, exploring the aesthetical universe and defining a concept. With the concept, students had to fill in an ideation template to record different kinds of inputs: "Idea explanation" that explained the what it was, what was the expected experience, and what shape it had; "Relation to the emotions" that explained elements taken from the narrative and moodboard explorations; and the "Development of the idea" that explained what edible DIY-materials were going to be used, how were they going to validate it, and what process they were going to follow to achieve that. This template was used to guide the development process.

The second example is a project, part of a Master dissertation, using design tools throughout, called Billy Cash, by Santiago de Francisco (Fig. 7). During this project different kinds of tangible models were used to explore the concept behind saving money in a more meaningful way. The purpose of the tangible models was to simulate situations related to saving money, and to allow participants to reflect upon their own experience [15, 16]. Models were complemented with moodboards that showcased formal and conceptual features of the different design concepts.

Fig. 7. Digital piggy bank prototypes and moodboards (source: [15]).

Finally, there were the Design Challenges held by the Universidad de los Andes Design School, in which students are faced with a close brief and short times for experimentation (Fig. 8). The main objective was that during that time, students could fully experience a full loop of a design process. Students had to experiment with different tools to build interactive prototypes with wiring (Wiring Challenges were designed as a learning experience around interactive media" [13, p. 367]). The time restriction made students share resources that create learning communities.

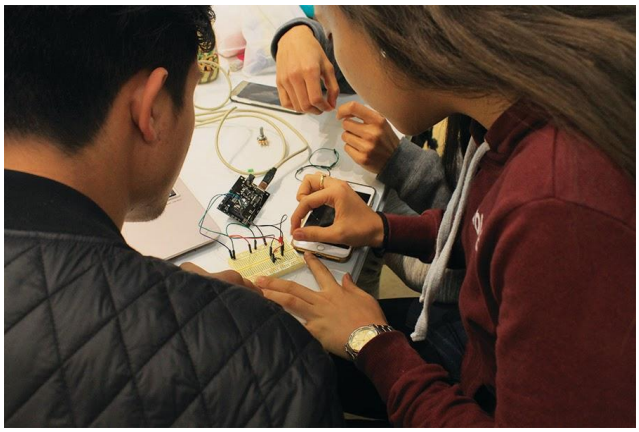


Fig. 7. Interaction Design Challenge 2018
(source: https://www.flickr.com/photos/designchallengesuniandes/)

5 Discussion and conclusion

Design tools can be valuable and relatively easy to implement in the design classroom. The study reported here, while small (with both a small sample and with limited depth) provides clues to how introducing design tools in design education may affect the facilitation of theoretical and methodological information to design students, and the creation of a sense of community.

We identified four types of design tools used in design education, as shown in Table 1:

- Information-based design tools;
- Inspiration-based design tools;
- Tangible design tools; and
- Process-based tools (not necessarily discipline specific).

The most distinctive characteristics of information-based design tools are their easy-to-use practical approach to information, using non-linear text (Fig. 8), pictograms (e.g., images, icons; see Fig. 9), and color coding. Two different issues that information-based design tools potentially focus on are knowledge transfer and knowledge actionability, containing theory and methodology to make the design process more complete. Designers think visually and visual information, when together with other mediums of communication, helps understand and retain information. As such, the predominant non-linear data in information-based tools such as posters or card sets is a potentially more appealing and engaging alternative for design students to study theory than, for example, text books or scientific articles [5].

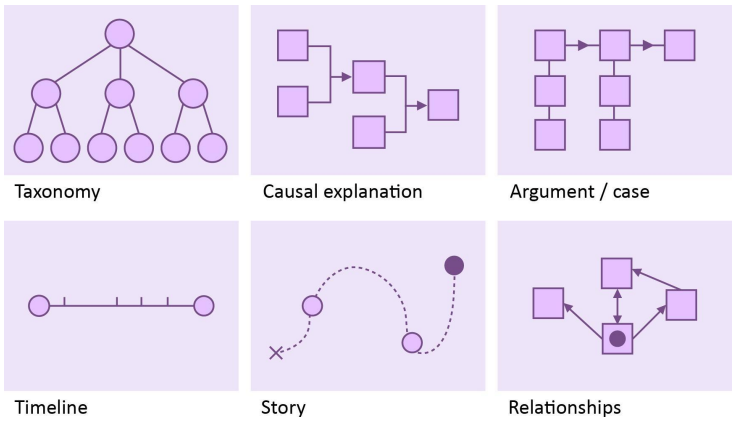


Fig. 8. Examples of non-linear display of information (based on [17, p. 13]).

Fig. 9. Examples of pictograms used in design tools (source: Crossing Cultural Chasms card set [18]).

Inspiration-based design tools trigger design students through display of existing solutions or storytelling, which can be useful for creating a design vision for a project, benchmarking existing solutions, or creating a strategy for a specific problem. These types of tools also rely heavily on images and text to convey narratives about users, contexts, and products.

Tangible design tools help mediate different kinds of conversation. These conversations do not have to happen orally, as Harbraken and Gross [19] introduced with the idea of silent games [20]. One example is the Lego Serious Play kit. By introducing Lego tiles, participants are able to interact with the conversation. These tools allow designers to build abstract concepts as well as concrete structures. The importance lies in the tangible memory that is built upon those interactions. The conversation allows learning and reflecting about the decisions. This kind of experiential learning is very effective in terms of, not only visualizing solutions, but also validating them in a way.

Process-based tools are more generic, meaning they are not necessarily originating in the design discipline, and are used for data collection, storage, and analysis. A design-based example is the User Empathy Canvas, which offers a structured approach to user data collection with icons, fill-in spaces, and the option to add linear and non-linear text. Other examples include Google docs, or other tools like online questionnaire tools that allow for the management of data within the design process.

Besides making complex knowledge "digestible" and actionable, to be successful in the design classroom design tools can and should be adapted to specific needs. Moreover, it is through their usage that they are understood and that application needs to be well explained. However, using a design tool is not designing. In the end, one of the main purposes of teaching with design tools, should be to foster students to build their one research tools.

Previous research has introduced design tools (six canvases based on well-established design methods) in a *non-design* class (psychology), with interesting results in terms of outcome (solutions for specific contexts) [21]. Moreover, the tools used in that exercise were also perceived positively by students through a questionnaire about the tools' clarity, usefulness, and potential [22].

Further research could focus on introducing design tools in the design classroom and observe and rate the impact of this pedagogical modality in terms of the students' perception, the outcome of their work, and from the point of view of the teacher.

Moreover, the ubiquitous digital means that surround us today can be put to good use in organizing such tools in banks for students to use and learn from, so future

research could also focus on establishing or studying such platforms,[1] such as Miro, Mural, or Figma.

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[1] Several websites compile and suggest tools for designers; e.g., https://arqdis.uniandes.edu.co/top-10-design-toolkits-que-son-y-para-que-podemos-utilizarlos/)

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