

A Qualitative Study of Design Students' Color Tool Use

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Abstract

Background Previous studies have suggested that the use of tools in design improves the efficiency of the design process and the quality of the design outcomes. In light of these trends, a variety of color tools were introduced and developed for design experts. However, little attention has been paid to students' perceptions and needs in relation to color tools. A lack of understanding of user needs for color tools could result in weak attempts to deliver useful data to users.

Methods This study presents the results of an in-depth inquiry into students' use of color tools in design work. A qualitative and exploratory study was conducted by means of 10 semi-structured interviews with first-year and senior students.

Results The findings of this study included four themes: (a) students' views on color in design, (b) students' color-decision process, (c) students' dissatisfactions and requirements with current color tools, and (d) types of useful color data considered by students. Students showed a consensus view on the significance of color in design to deliver target messages and to enhance their design stand out in the market. Most of the students' color-decision processes included four stages: concept development, color data gathering, exploration, and color choice. However, two out of the 10 students reported different color-decision processes. The students delayed their color decision at the final design stage because they felt anxious and a lack of confidence about their color choice. With regard to satisfaction with the current color tools available, students reported that most tools needed improvement. Students identified three types of color data (color meaning, color trend, and color printing) as important in their design process. Preferred tool types and various ideas for color tools were also suggested.

Conclusions There is a gap between what students need from color tools and what the existing color tools provide. The findings indicate that available color tools may not be suitable for educational purposes.

Keywords Color Tool, Color Data, Design Students, Qualitative Study, Colorful Design Trend

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Citation: Won, S. (2022). A Qualitative Study of Design Students' Color Tool Use. *Archives of Design Research*, 35(3), 69-79.

<http://dx.doi.org/10.15187/adr.2022.08.35.3.69>

Received : Feb. 14. 2022 ; **Reviewed :** May. 04. 2022 ; **Accepted :** May. 17. 2022
pISSN 1226-8046 **eISSN** 2288-2987

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1. Introduction

To support designers' color decisions, previous color studies have investigated and suggested a variety of color tools serving different functions and features. Bartneck and Clark (2015), for instance, developed a semi-automatic color analysis tool for brand logos. Hutchings et al. (2012) investigated a color quantification tool for the total appearance of a design for comfortable and effective living and working spaces. Wästberg and Billger (2016) considered a tool for demonstrating color appearance. Correa et al. (2016) explored an online tool to detect color misconceptions. Although these tools were developed by exploring which features of a color tool support design practice, they are predominantly intended for use by design experts. Tools for experts tend to assume that their users already have sufficient experience and knowledge, and they tend to overlook educational attributes (Ramollari & Dranidis, 2007). Thus, students' needs may not be effectively fulfilled by existing color tools. In other words, little attention has been paid to students' perceptions and needs in relation to color tools. In tool development, design approaches, such as user-centered design (Goodman-Deane et al., 2010) and user-led innovation (Truffer, 2003), highlight the in-depth understanding of users' needs because they pay attention to users' aspirations (Cooper, 1999). It is also argued that a narrowly defined user can help create more usable and useful products that reflect specific user needs (Marshall et al., 2015). A lack of understanding of user needs for color tools can only result in weak attempts to deliver useful data to users. The present study therefore adopts a qualitative approach to provide in-depth understanding of students' uses and aspirations in relation to color tools. To address this, the following research questions were formulated.

RQ1. How design students decide colors in design process?

RQ2. What color data and tools are used by design students?

RQ3. What are design students' perceptions and expectations of color tools?

2. Theoretical background

2.1. Colorful design trend

An increasing number of products have become more colorful in recent decades (Leeuwen, 2011). In particular, cellphones, pre-packed food, kitchen utensils, and clothing with various colors are constantly being created and introduced. Given this trend, choosing an appropriate color is an important decision in design. Careful discretion is therefore vital when deciding on colors in design because they help to capture consumers' attention, affect preferential judgments, and convey meanings at the point of purchase (Kauppinen-Räsänen, 2014; Takahashi & Kawabata, 2018). In relation to the attention-capturing attribute of color, past research shows that color helps viewers to find an object quickly. In Zeki's experiment (1999), the brain's response to visual stimuli, such as color, motion, and shape, were measured. The results showed that when people see an object, they perceive color first rather than the shape and movement of the object. In another experiment, Eriksen (1952) measured the search

times for objects using three visual aspects: form, color, and size. The results presented that color is very important for locating objects. With regard to the aesthetic attributes of color, color preference is personal and subjective (Kauppinen-Räsänen, 2014). For instance, blue, which is the most favorite color in general (Yu et al., 2018), can tempt consumers to pick blue-colored designs that bring them pleasant memories or thoughts. Color also has a communicative attribute. In particular, color conveys messages about products' and companies' identities. For example, when we go to a shop to buy shampoo, we tend to select the product on the basis of the information conveyed by from the package color rather than by reading text descriptions. A green package generally conveys idea relating to freshness, nature, environmentalism, and organic produce (Mo et al., 2018; Nugraha, 2019). If the product has an attractive green color, it could convey positive information and sell well. Apart from product information, color also helps in establishing a company's corporate image (Hynes, 2009). When people see a company's logo, they infer something about the company's philosophy and strategy from the color (Caivano & Lopez, 2007).

2. 2. Color tools

Design is the creative process of developing new products or improving existing objects. To complete their work, designers use many tools (Atman et al., 2007), and utilizing color tools can be one way to help designers with color choices. Color tools generally include color data (Hutchings et al., 2011) and they can be divided into 13 categories, as shown in Table 1. A previous study suggested that design experts identified five types of color data (color harmony, perception, meaning, psychology and printing) as important in their design process (Won & Westland, 2018). Moreover, color tools come in a variety of formats, such as websites, software, mobile apps, and books. Websites offer users with abundant pictures and color data. However, they tend to be comprehensive and less reliable for finding the necessary data for use in the design process (Wästberg & Billger, 2016). Software mostly provide functions that change the colors of interior images to see how they look. Although software provides a specific and relatively reliable color data, since they are generally developed for use by design professionals, students may find them difficult to use (Ramollari & Dranidis, 2007). Most mobile apps are handy to use but they tend to be used less professionally, such as changing the color of an individual's photo, and sometimes it costs to access them. Books and journals offer color data based on research, but students may struggle to understand academic publications on color because they typically involve statistics.

Table 1 Definitions of the 13 types of color data (Won & Westland, 2018, p.389)

Types of color data	Definitions
Color in art and design	Colors in well-known paintings or design works
Color harmony	Color combinations that arouse a pleasing effect
Color history	How a particular color was developed
Color and light	Principles of light, such as wavelengths and frequencies
Color meaning	Meanings associated with certain colors
Color measurement	Measuring the properties of color or the use of color measurement devices
Color notation	Color numbers or names to describe or communicate color
Color perception	How color draws people's attention
Color preference	People's favorite colors
Color printing	The quality and techniques of color printing
Color psychology	Affective, cognitive, and behavioral responses linked to specific colors
Color theory	Systematic frameworks and rules intended to explain color
Color trend	Colors which are on-trend or popular

2. 3. Color tools for design students

A number of studies have claimed that the use of tools in design improves the efficiency of the design process and the quality of the design outcomes (Bartneck & Clark, 2015). However, there is little research on color tools for educational purposes. Advanced designers and students may have different needs for a color tool because their design processes and methods tend to be different (Atman et al., 2007; Shooter et al., 2000). For instance, it would be interesting to ask, for certain colored objects, why designers choose particular colors. The answer may be simple because experienced designers “know” which colors would be best suited for particular designs (Smith, 2001). Otherwise, advanced designers figure out the appropriate color choice and strategy by collecting color data from various sources and tools, such as company reports, design guidelines, and digital software (Goodman-Deane et al., 2010; Wodehouse & Ion, 2010). However, students are not allowed to access these color materials, and professional tools could be too complex for educational purposes (Ramollari & Dranidis, 2007). Consequently, students with little design experience and limited access may rely on the internet, which has many unreliable sources concerning color data, and they may struggle to find adequate colors. Thus, a color tool study to provide support for students would be needed.

3. Methods

This study was designed to seek detailed descriptions of students' experiences and expectations in relation to color tools. In order to gain students' detailed opinions on color tools, face-to-face interviews were adopted with a semi-structured and open-ended format.

3. 1. Participants

A convenience sample of 10 first-year and senior students (male=2, female=8) in various fields of design including graphics, products, and fashion was recruited. The number of participants in this study was based on the number of participants generally suggested in previous studies. It is suggested that meaningful data can be obtained from six interviews (Guest et al., 2006). Thus, the author decided that 10 interviewees would be an appropriate

sample size for this study.

3. 2. Interview procedure

All students were provided an information sheet and signed the informed consent form to participate in the study. Interview venues were selected on the basis of students' preferences, and all interviews were recorded with their permission. The interviews generally lasted for between 60 and 90 minutes. An interview guide was used based on previous studies, and it consisted of four sections covering students' color-decision process, satisfaction with existing color tools, types of useful color data, and suggestions for color tools.

3. 3. Data analysis

For the current study, a thematic analysis approach was used as a data analysis method. All interviews were recorded and transcribed verbatim. To organize the transcribed data from the interviews, Braun and Clarke's five sequential steps (2006) were used as follows. Step 1): reading repeatedly to fully understand the entire data set. Step 2): generating a list of initial codes from the data. Step 3): sorting the initial codes to main themes and sub-themes. Step 4): amending the themes to create a coherent pattern. Step 5): identifying and naming the essence of each theme.

4. Results

4. 1. Students' views on color in design

There was broad consensus among students about the significance of color in design, although there were differences in degree, from quite important to very important (Table 2). With regard to the reasons provided, three themes emerged, namely the communicative, attention-capturing, and aesthetic roles of color in design. The communication theme involved the idea that color can convey brand messages and product information. The attention-capturing theme involved the idea that color can help attract consumers' attention. The aesthetic theme involved the idea that color can affect people's preferences and that an entire design image can be changed by even a single color.

Table 2 Students' views on color in design

Importance of color	Quotations
(1) Color is important.	"I think color is very important. It looks very different even though I only changed the position of a single color." [ID 3]
(2) Color is not the most important thing.	"It is important, but it is not the most important." [ID 6]
Reasons	
(1) Color communicates meanings <ul style="list-style-type: none">· Brand messages· Product information· Emotional responses (moods and psychology)	"It carries meanings of brands and products." [ID 2] "There are colors that are closely related to different seasons." [ID 5] "It also affects moods, emotions, and psychology." [ID 10]
(2) Color attracts attention	"It can catch your eye." [ID 1]
(3) Color is related to aesthetics <ul style="list-style-type: none">· Color preference· Whole design impression	"Some people like yellow so they will buy yellow." [ID 6] "One single color can change the whole design image." [ID 3]

4. 2. Students' color–decision processes

With regard to the way in which students plan and decide on colors in their general design process, the students can be divided into two groups. As shown in Table 3, the majority of students reported that they plan their colors at an early stage and go through four steps in selecting colors: concept development, color data gathering, exploration, and color choice. The concept development stage includes identifying essential issues and generating initial ideas. The color data gathering stage involves collecting lots of images and associated words. The exploration stage includes assumptions about the data gathered, such as which colors are commonly used or differentiated in product categories, which colors are harmonized or trendy, and what colors convey what meanings. Finally, the color choice stage involves deciding on colors from among a set of alternatives that suit the shapes, materials, proportions, and layout of the design. Two of the ten students said, however, that they mainly used black-and-white to sketch and build the concepts and only decided on the colors at the final design stage. These students expressed feelings of anxiety and a lack of confidence when selecting colors.

“At the final stage, I consider the colors because color is the hardest thing for me.”
[ID 2]

“Color is hard to decide. I have a fear of choosing the wrong colors. I want to express A through color, but it can be changed to B.” [ID 6]

Table 3 General color–decision process

Importance of color	Quotations
Step 1: Concept development · Identifying constraints · Sketching and drawing · Coming up with initial ideas for a solution	“I start building a concept of design ... more concrete ideas.” [ID 9]
Step 2: Color data gathering · Selecting color resources and tools	“I do research on images, products, and people.” [ID 7]
Step 3: Exploration · Assumptions about color alternatives · Matching colors	“I look at how this color matches that color ... consider forms, shapes, fonts, proportions.” [ID 3]
Step 4: Color choice · Selecting colors to use among alternatives · Determining whether a solution meets design problems or constraints	“The reference I look at would be product colors on shelves. I look to see what kinds of combinations have already been used and maybe come up with a new one.” [ID 4]

4. 3. Students' dissatisfactions and requirements with current color tools

Regarding students' opinions on the current color tools, students reported that they were dissatisfied with them, and various new ideas for color tools were suggested, such as tools that provided data on recommended colors, color semiotics, color names, and color trends (Table 4). The students also identified the need for automatic simulation tools that could help to generate many color combinations, apply colors on their sketches, and provide a three-dimensional display. Moreover, students would like tools to provide data in one location to work efficiently because data is scattered at the moment.

Students also stated that the main sources of their color data were the internet and websites, and the most preferred tool type was the digital tool, such as software, websites, and apps, rather than non-digital publications. Pictures were the most preferred data type since they helped the students to come up with new ideas and inspired them when considering associated colors. Students also reported that research data on color are essential for collecting customers' responses.

"I prefer websites because I can actually see how they look and compare them with one another." [ID 2]

"I prefer software because books are too professional." [ID 6]

Table 4 Students' dissatisfactions and suggestions on current color tools

Dissatisfactions	
(1) Needs improvement	"I've never found it to be well structured." [ID 9]
(2) Lack of awareness	"I don't know them well." [ID 8]
(3) Not easy to access	"Books and reports are expensive." [ID 5]
(4) Scattered	"It is hard and takes time to find information." [ID 7]
(5) Unreliable Suggestions	"It is difficult to trust data on internet." [ID 10]
Suggestions	
(1) Colors and palettes by color meanings, cultures, product categories, and design fields	"When you think about chocolate, you can also put on happy, see the colors and relevant words." [ID 6]
(2) Recommended colors	"Direct suggestions for colors would be useful." [ID 4]
(3) Various images	"I prefer something visual like photos and palettes." [ID 9]
(4) Research data on color	"I need color data based on consumer surveys." [ID 10]
(5) Color simulation tool that allows you to apply multiple colors to the design you are working on	"Color simulations would be helpful. They make various color combinations...and a three-dimensional display." [ID 3]
(6) Color names	"I think names definitely, because specific names have different colors." [ID 1]
(7) Explanations and text	"I need explanations as to why specific colors and tones are right." [ID 1]
(8) Not scattered	"If there is a tool that could put information on one site, it would be helpful to work efficiently." [ID 7]
(9) Updated	"Many resources include out-of-date information." [ID 3]
(10) Easy to access	"I want easy access to color resources as a student." [ID 2]

4. 4. Type of useful color data considered by students

The students reported three types of color data that they considered important in their design process. The most frequently mentioned color data type was color meaning, followed by color trend and printing (Table 5). Reasons were provided for the importance of these three types of color data. Most students said they needed color data in order to have confidence in their color decisions. They also stated that the color data were helpful for selecting colors in a short amount of time and for teaching and guiding them about how to use colors for consumers in different cultures.

Table 5 Types of useful color data and reasons reported by students

Types of color data	Quotations
(1) Color meaning	"I want to know cultural differences. For example, in western countries, they like white candles to decorate their house, but in our culture, we only use them when people die" [ID 6]
(2) Color trend · Product colors on shelves · Good selling colors	"I look at products on shelves." [ID 4] "In a product's life cycle, when it is short, I can see the color trends." [ID 3]
(3) Color printing	"Companies will print their packages so I will use tools to find the exact colors." [ID 9]
Reasons	
(1) Confidence in color decisions	"There is a risk. You have to consider the market and people." [ID 10]
(2) Save time on color choices	"We try various color combinations. Information makes this process quick and easy." [ID 3]
(3) New inspirations	"I collect information to get inspiration and build concepts." [ID 9]
(4) Understanding other cultures and acquiring color knowledge	"I need Information that explains about color meanings in different cultures." [ID 8]

5. Discussion

5. 1. Color tools and students' confidence in their color choices

The majority of students reported that they needed color tools for self-confidence and self-assurance regarding their color decisions. Two out of the 10 students reported that they put off their color selection until the end of the design process because they were not confident about their choices and expressed concern and uncertainty about their choices. These results indicate the link between color tools and students' confidence in color decision. This also confirms previous studies' finding that useful data can help designers make better and more confident decisions (Paese & Sniezek, 1991; Todd & Benbasat, 1992). Given the strong demand for a color tool and the difficulty students face in color decisions, color tools reflecting students' needs, design processes, and goals are required to support students' color choices and strategies.

5. 2. The gap between the expectations and reality of color tools

Another major finding from this study is that students were unsatisfied with the current color tools, and they reported that the available color tools need modification. Specifically, students perceived them as scattered about the internet and difficult to trust. Data gathering is an integral part of the design process (Atman et al., 2007), and the efficiency and effectiveness of the design process rely predominantly on the data and tools that designers use (Bartneck & Clark, 2015). Students' dissatisfaction with current color tools could result in a lack of use of color resources and tools, and students may end up generating design outcomes without the benefit of tools.

5. 3. Translating color research to practical color data for students

One unexpected interview outcome in the present study was that students needed research data from evidence-based color research. Students need to make clear and effective color decisions through objective color data on consumer thinking and behavior. However, academic color resources may be too scientific and difficult for them to understand. If research data on color can be developed with an understanding of students' design activities, it would contribute to supporting students' design practices.

5. 4. Differences between students and design experts

With regard to data type, the present study showed that students consider three types of color data as important in their design process: color meaning, color trend, and color printing. According to a previous study (Won & Westland, 2018), design experts value different types of data, such as color harmony, color perception (to capture attention), color meaning (to deliver brand messages), color psychology (to create consumer responses), and color printing (for the design outcome), and they gave negative responses about color trend because they are just a marketing concept from color forecasting companies. In terms of tool type, in the present study, students identified software as a useful tool format while past research (Won & Westland, 2018) reported that design experts liked websites the most. The results show that students and design professionals may have different views and needs in relation to color data and tools.

5. 5. Implications

The results of the study have several implications for color education. For color educators, the rich descriptions of the color data and tools students use, seek, and need provide ideas about what and how to teach design students about color. The findings of this study suggest that students would benefit from color education dealing with color theories or practices in relation to color meaning, color trend, and color printing. Moreover, the current study showed that research data on color are important for students but that they may have difficulty understanding academic color-related publications. Educators could come up with new ways of teaching, such as workshops or tutorials, to help students to gather research data on color.

6. Conclusion

The present study provided a detailed examination of students' uses and perceptions of color tools in the design process. The results are categorized into four topics: the role of color in design, the color-decision process, dissatisfactions and required attributes on current color tools, and three types of useful color data (color meaning, color trend, and color printing). The current study also found a gap between what students need from color tools and what the existing color tools provide. In line with recommendations from Ramollari and Dranidis (2007)'s study on students and tools, the present study highlights that understanding design students' expectations is critical for developing color tools that reflect those requirements. The results from this study also indicate that available color tools may not be suitable for

educational purposes. It is important for educators and tool developers to pay attention to the results obtained in this study because they may be useful for understanding the complexity of students' color-decision activities and their color tool needs. These findings in the context of design students and color tools supports the existing literature around the role of user experiences in digital tool development (Cheng, 2019). Little attention has been paid to color tools for design students, and in this sense, this study makes an important contribution to the existing design literature. The research detailed the use of color in students' design process and identified the characteristics of color data and tools that students needed. Thus, this study contributes to the literature of students' color tool experiences and extended the understanding of students' perceptions from color tool developments for experts. This study has a limitation of the data set from a quota sample. To generalize the results, further work with a larger and homogeneous sample is needed to augment the results that the present study has produced.

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