A Framework for Selecting and Optimizing Color Scheme in Web Design

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Abstract  
Based on the foundation of color theory, the symbolism and human emotions commonly attached to color, and how these factors can directly influence business branding, we developed a framework that helps web designers to select and optimize color scheme for websites and web applications, while avoiding common pitfalls that drive customers away, and standing out in today’s fiercely competitive Internet marketplace. To evaluate the effectiveness of the framework, we conducted an experiment where subjects were asked to design the color scheme for a website. The experimental group was introduced to the web color framework before being evaluated, while the control group was evaluated based only off their personal knowledge and experience. We concluded with overall positive results in favor of the framework.

1. Introduction
Color, as a fundamental element of visual stimuli, has a substantial impact on the perception of what people see. Changing the hue or color scheme of any object will likewise have an effect on our emotional reaction. Web designers must pay careful attention to color theory and its effect on humans to develop successful websites. An effective color scheme will convey unspoken persuasion to the user with a positive effect on brand perception, and ultimately convert website traffic to sales. First, this paper will discuss color theory, the symbolism and emotions attached to common colors, color’s influence on business brand perception and content delivery, and how web designers can use such theoretical and practical knowledge strategically to their advantage and avoid common pitfalls that drive customers away. Second, the framework will be demonstrated and evaluated in an empirical study and its results aggregated and analyzed.

2. Color Theory
Color Theory describes colors and their meanings through symbolism and emotion, as well as color mixing and the visual effects of a specific color combination. Traditionally colors are shown in a color wheel, which separates colors into three main groups: primary, secondary, and tertiary. All variants of color originate from the three primary colors, which are red, yellow, and blue. Primary colors can be combined to create the secondary colors, which are green, purple, and orange. These secondary colors can then be mixed with each other or with the primary colors to create the expansive list of tertiary colors, which make up the numerous shades of color between the secondary and primary colors.

Colors can also be categorized based on warmth and therefore emotional attachment. Warm colors are those seen in fire or light, such as orange, red, and yellow. Cool colors are those seen in liquid bodies and at night, such as purple, blue, and green. Finally, neutral colors are those that do not fall under the above two categories and as a result do not entice a significant emotional reaction from viewers.

Many academic sources have addressed how different colors impact the effects of web design. For examples, Labrecque [15] described blue, a popular and safe primary colors choice for many websites and web apps: “Blue is linked to competence, as it is associated with intelligence, communication, trust, efficiency, duty, and logic. It is also seen as a secure color.” Chapman [5, 6, 7] described white, a common neutral color choice for backgrounds: White symbolizes purity, cleanliness, and virtue and gives the user a very peaceful and spacious conscience. White is a very safe, conservative color that is hard to be misused, other than overuse in absence of more exciting tones.

3. Color’s Effect on Business
3.1 Brand Perception
One of the most prominent ways color can influence the world of marketing is through brand perception. The colors used in a company’s brand strategy, and therefore website, will be one of the first natural impressions customers form on the entire organization. “More than 200 participants evaluated eight finance, eight legal, and eight medical websites on perceived trustworthiness. Each respondent was presented with an identical website that only different
on the used color scheme. Four different color schemes (red, blue, green, and black) were put to the test” [1]. The results found that the correlation, although small, was statistically significant between color and perceived trustworthiness. They also discovered that blue gained the highest positive response (recall above that blue is one of the most popular colors used in corporate websites) while black received the highest negative response.

On average, chromatic colors are seen as more pleasant and more likely to drive sales [14]. Additionally, 90% of instant judgments about products are made solely based on color alone. These three pieces of research demonstrates how something as simple as color can affect the successful adoption of a brand by the public.

3.2 Content Delivery

Color not only has an effect on brand perception, but also on site efficiency in content delivery to the customer. In an experiment [4], Brown et. al. asked users to answer three questions based on information available on a sample website. Two websites were used, one with both layout and color adaptations, and the other with neither. They found that “color or layout adaptations by themselves reduced average times and number of clicks compared to when there was no adaptation” [4]. if separate categories are color coded with each color making logical sense in relation to the object or service, then the user can find the information he or she is looking for much quicker and with less unnecessary clicks.

“Color is also an excellent way to show a continuing path; since we can interpret color information rapidly and with a high degree of precision (yellow brick roads are as useful in life as in film). Using the full rainbow of colors without meaning or association - a common occurrence on the Web - makes for poor visual hierarchies” [11]. Essentially, one can use color as a guide for how users are supposed to navigate the site in the most efficient way. “Saturated colors are exciting and dynamic. They attract a lot of attention and slow users down in their task. Saturated colors work well for buttons, links, alerts and system messages because in these situations want to grab the user’s attention” [2]. Saturated colors are exciting, dynamic, attract attention, and slow users down; they are best used for buttons, links, alerts and system messages. De-saturated bright colors are friendly, while De-saturated dark colors are serious, and both of them are professional, and keep users moving; they are best used for menus, headers, panels, and backgrounds.

4. Problems and Issues

Ultimately, with so many variables to take into consideration when deciding the implementation of color, mistakes are abundant. Of the five design elements (size, shape, color, position, motion), color is the most likely to be overlooked and misused [28].

The first major issue is using color to place emphasis on the wrong elements of a webpage [28]. When a user first views a webpage, certain areas should yearn for the user’s attention. If those areas are not the major assets or selling points of the content, then color is being misused. Designers should also look out for using too much or too little color on a webpage [28]. Overuse of color, such as filling every space with bold colors in place of neutral colors, will strain the eyes and create a knee-jerk reaction of overstimulation in the user. On the other hand, using too little color will fail to grab the attention of the user and may result in a loss of interest. These reactions are often captured through the use of eye tracking technology or heat maps, which track the user’s cursor movements. As noted earlier with contrast, designers should be careful not to use the wrong combination of colors [28]. The consequences of this ranges from reduced readability to downright ugliness. “If scripts and animation are battling for attention, adding unreadable type and bad color contrast is probably not going to help” [11].

Finally, and arguably the most importantly, web designers should make sure that the color scheme complements the message of the product or company. As discussed earlier in the paper under colors effect on brand perception, the color scheme simply cannot conflict with the company’s marketing strategy. The results of such an occurrence can be disastrous. Not only does this reduce the effectiveness of the website, but it reduces the effectiveness of the brand as a whole. As a result, web designers should pay very careful attention to which colors are used and study their emotional and symbolic meanings to confirm coherency with brand strategy.

5. A Framework for Optimizing Web Color Scheme

Agreed that the strategic application of color is paramount to the success of a website, how does one choose from an infinite range of possibilities? There are multiple variables to consider, some of which are not even related to the colors themselves. As a result, some designers simply use the satisficing decision method, in which they choose the first scheme that works to the designer’s initial satisfaction. The problem with this approach is the appropriateness of the designers decision is limited to the variables
considered and leads to a higher risk of the common mistakes outlined in the previous section.

Additionally, highly technical people, such as programmers and architects, are sometimes given web design responsibilities due to lack of other human capital. It is common knowledge in the IS field that IT projects are often considered to be late, over budget, and not aligned to the business. While the first two problems are out of scope for this research, the following framework aims to help novice designers to align web design decisions to the business and output visually attractive color schemes.

To solve this enigma, this research paper will attempt to build a framework (shown in Figure 1) to guide web designers through the filtration process. Resembling a funnel, this framework will start by crossing off irrelevant options based on business requirements. Next, color theory concepts will be applied to eliminate inappropriate choices. Finally, support layer tools will be provided to facilitate a precise, results-driven decision.

5.1 Business Requirements Layer

Before anything, web designers should have a solid understanding of the business and industry that their website will be supporting. Even the most masterfully designed color schemes will be unsuccessful if they do not compliment the needs of the client’s business requirements. In order to address this component, one should become familiar with the background of the organization and its industry, the target audience, and color schemes used by direct competitors.

5.1.1 Organizational Background. To start, developers should research the company, organization, or individual that the site will represent. He or she needs to have a solid understanding of the product, mission, market, personality, goals, priorities, and values of the subject in order to create an appropriate palette. This information is often available upon request from the client, or at the very least available in existing documentation, intranet sites, or legacy websites. “even when the client is not able to articulate their requirements precisely, they are at least able to understand whether a given design will address their needs” [16]. Lowe and Eklund [16] also recommend using a highly iterative development process for web design in order to accommodate fluctuating client needs and feedback requests.

5.1.2 Target Audience. An understanding of target audience is essential to the success of any business process. When it comes to color, one must realize that each color will have a different effect on individuals based on their background. “Cultural preferences and biases (i.e., colors, text vs. graphics, spatial orientation, among many others) impact what is deemed "user friendly;" thus, usability issues must take on a cultural context... For example, an American bank using a website to promote services for French investors may want to avoid the use of the color green, which some French may associate with criminality. On the other hand, the American bank may want to use green to attract Egyptian and Middle Eastern investors, as green has a positive connotation for them” [3]. A potential future area of research would be enhancing responsive web development to become “culturally-responsive”. This would mean that a website would identify a user’s geolocation to responsively design the sites layout and color scheme to be more aligned with the user’s local cultural beliefs and values.

Aside from color meaning variation, different audiences will have their favorite types of color. “Kids love neon colors, the green and yellow top the list. When we ask kids for ideas on new products, they shout, ‘make it green!’” [17]. A collection of research studies have found gender preferences in bright vs. soft colors, tolerance for achromatic colors, and tints vs. shades [29]. It is shown that men prefer bright colors while women prefer soft colors. Men are in general more tolerant of achromatic colors, which have no hue, than women. Finally, men prefer shades while women preferred tints.

Users with visual disabilities must also be considered. W3’s “Web Content Accessibility Guidelines 2.0” report that “Guideline 1.4 Distinguishable: Make it easier for users to see and hear content including separating foreground from background“ It suggests do not use color “as the only visual means of conveying information”, instead, try “indicating an action, prompting a response, or distinguishing a visual element” [9].

5.1.3 Competitor Schemes. It is important to be familiar with the schemes of one’s competition for three reasons: individualization, consistency, and
legality. “Whether you want to convey belonging within the traditional guard of your industry, or you want to stand out from the competition with your color scheme, getting a sense of the tones and textures used by comparable companies is a great start in your planning process for online branding” [12]. It is imperative to have a scheme that lets the client stand out from the rest of the crowd. Individualism can be had by small yet bold accent colors that contrast what is used by the competition. However, to some degree, one should have a scheme that is consistent with what is expected in the client’s industry.

Caution must be taken on the side of consistency, however, due to legality. While there is no history of one company being successfully sued by another for copying color schemes, the Supreme Court has decided that color schemes can now qualify to be a registered trademark after the Qualitex co. vs Jacobson Federal Appeals court case [24]. In this case, Jacobson, who was a competitor to Qualitex, chose to market themselves in a similar color scheme to Qualitex’s green and gold. Qualitex attempted to sue Jacobson for this, claiming that the color scheme was their protected asset and connects to their brand identity. While Qualitex did not successfully sue Jacobson, the case led to the court’s decision to allow color schemes as registered trademarks. As a result, any web designer who decides to be more consistent with the client’s competitors should make note of which competitors have their color schemes trademarked and weigh the risk of infringement before making any decisions.

5.2 Color Theory Layer

With a solid understanding of the necessary business requirements, one can begin to explore color options. While there still may seem to be too many possibilities to consider, there are a few important factors to consider that can help narrow down one’s choices. In this paper, these factors will be categorized as number of colors, color harmony, and text overlay.

5.2.1 Number of Colors. A single color can be used in multiple shades and gives a very uniform look, but may not grab enough attention from the user. In order to introduce variety into a single color mix, use a monochromatic color scheme, which uses “different tones, shades and tints within a specific hue” [7]. A two-color scheme, with a dominant and highlighting color, is balanced and powerful when executed correctly. For the best effect, use a subtle, more neutral color as the dominant color and an aggressive, bolder color as a highlight. On this note, keep in mind that which colors are complimentary or analogous and pair them accordingly. Three-color schemes are common and popular due to their balance between visual attractiveness and complexity. When using a triadic color scheme, most literature [18, 27] and seasoned web designers recommend a 60-30-10 rule, which states that primary color should be used on 60% of the website, the secondary color should be 30%, and the accent color should be 10%.

More than three colors can be used in a scheme, but as the number climbs higher, each color’s usage loses significance and consistency becomes harder to maintain. Therefore, it is best to use a neutral, dominant color such as grey, white, or black for the background and then use the other colors as a mix of primaries, secondaries, and highlights to organize between different groupings of content.

5.2.2 Color Harmony. In any color scheme that uses more than one color, the designer must choose between a few different methods of selecting from the color wheel. As discussed earlier, analogous colors are those that sit next to each other on the color wheel while complimentary colors are those that are directly opposite of each other. In addition, the designer can also choose a split complimentary, triadic, tetradic, or custom theme. Split complimentary schemes are analogous colors to the complimentary color, or simply the colors that sit next to the opposite color [5, 6]. “Triadic schemes are made up of hues equally spaced around the 12-spoke color wheel” [7]. Tetradic schemes essentially use two analogous colors in combination with their complimentary colors. These are very hard to implement and are therefore not recommended unless the designer is confident about the combination. A custom color scheme is simply any combinations that exist outside of the scope of the above schemes. An appropriate implementation cannot be recommended as success lies case-by-case.

Harmonizing colors can be difficult to discover, and guidance can vary between researchers. From a foundational standpoint, Chevreul’s principles of harmony and contrast of colors [8] is one of the most influential in this area of study. On the note of color harmony, Schloss and Palmer [26] summarize Chevreul’s explanations of the primary types of harmony to test for as “(1) harmony of scale for colors that are similar in lightness and the same in hue and (2) harmony of hues for colors that are the same in lightness and similar in hue. Harmony of contrast includes: (1) harmony of contrast of scale for colors that differ significantly in lightness and are the same in hue, (2) harmony of contrast of hues for colors that differ in lightness and are similar in hue, and (3) harmony of contrast of colors for colors that are different in hue and different in lightness (although the lightness difference is claimed to be auxiliary)” [26]. While the judgment of what qualifies as harmonious or
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to dive deeper into the color value 2)) + (maximum (Blue value 1, Blue minimum (Blue value 1, Blue value 2))
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middle-aged adults, and elderly adults and “the ageing effect in background and text color, respectively. On a
related note, Saito et. al. [25] researched color visibility on a white background across different age groups.
They grouped participants between young adults, middle-aged adults, and elderly adults and “the visibility of 21 chromatic web-safe colors on a white background was examined using a psychological methodology, i.e. a paired comparison” [25]. From this experiment, they learned that “the ageing effect in the visibility increase the effect of the contrast and decreases the effect of the chromaticity” of color on a website [25].

Ridpath & Chisholm [23] took this concept of readability a step further by creating an algorithm that takes the RGB values of a given text color and background color to calculate whether there is enough contrast for acceptable readability [23]. The algorithm is made up of two formulas: brightness and difference. The brightness formula is as follows: “((Red value X 299) + (Green value X 587) + (Blue value X 114)) / 1000” [23]. If the resulting value is more than 125, then the color pairing passes this test. The difference formula is the following: “(maximum (Red value 1, Red value 2) - minimum (Red value 1, Red value 2)) + (maximum (Green value 1, Green value 2) - minimum (Green value 1, Green value 2)) + (maximum (Blue value 1, Blue value 2) - minimum (Blue value 1, Blue value 2))” [23]. If the resulting value is more than 500, then the color pairing passes this test. If either test is not passable, then the color pairing does not have adequate contrast to be acceptably readable.

5.2.3 Text Overlay. To dive deeper into the color palette, the designer must also decide the overlay of text and background. Common sense dictates that the text should have an acceptable level of contrast when compared to the background for readability. Apart from the conservative black text on white background, there are endless combinations that can be used. Nishiuchi et. al. [19] took on the question of what color combinations are the most optimal, excluding black and white. After conducting their research, they found that “the best coloration is the background color in the cold hue group and the character color in the warm hue group” [19]. Therefore, combining blues, purples, and greens with reds, oranges, and yellows is optimal for the background and text color, respectively. On a related note, Saito et. al. [25] researched color visibility on a white background across different age groups. They grouped participants between young adults, middle-aged adults, and elderly adults and “the visibility of 21 chromatic web-safe colors on a white background was examined using a psychological methodology, i.e. a paired comparison” [25]. From this experiment, they learned that “the ageing effect in the visibility increase the effect of the contrast and decreases the effect of the chromaticity” of color on a website [25].

5.3 Support Layer
From the above two layers, one should be able to make an initial decision or be left with just a few options to choose from. The purpose of the support layer is to aid one in ensuring that the final choice is one that is both precise and results-driven. This final section of the framework will cover alternative schemes, scheme generators, and A/B testing.

5.3.1 Scheme Generators. Sometimes, designers do not have the time, expertise, or resources to hand pick the colors that will make up their scheme. Fortunately, there are a few scheme creating tools available on the Internet that can expedite this process. “there are numbers of support tools available on the Internet, such as Adobe Kuler (http://kuler.adobe.com/). Most of these tools are based on conventional colour harmony theories such as “complementary”, “analogous”, “split complementary”, “triadic” and “tetradic” ... While these online systems provide the user with possibilities of generating potentially harmonious colour schemes, they are incapable of giving advice as to whether a colour scheme suits the design requirements” [20]. Their final statement is important to remember, as these generators are only useful once the web designer has narrowed down their options to colors that are appropriate and compliment the business requirements of his or her client.

While it isn’t the most comprehensive generator, Adobe Kuler can still be considered the “industry standard” due to its aesthetics, age, and polished look. It consists of a large color wheel with color sliders that will automatically adjust the other colors as the designer drag one based on whichever color rule selected (analogous, monochromatic, triad, complementary, compound, shades, and custom). It also allows the user to explore schemes that others have shared in public.

Another great tool that has a more comprehensive feature set is Color Explorer. While its base scheme generator is limited to RGB sliders as opposed to Adobe Kuler’s interactive color wheel, it has a very useful tool for extracting colors from any image. One can simply upload an image and the page will generate a color palette that matches the image very well, with the option of adjusting the refinement of the colors, as well as the number of colors to be extracted. This is very useful for designers who have a large, central image for the site that will need a scheme that harmonizes with it.

The popular opinion of the future work environment is that computers simply cannot replace humans in creative design. However, tools such Adobe Kuler and Color Explorer prove that the technical capabilities of these programs have the
potential to develop sufficiently creative outputs that may replace lower level human designers.

5.3.2 Alternative Schemes. Regardless of how confident one is in his or her color scheme choice, it is always wise to have alternatives prepared in the event that the client does not agree with the first choice. “to avoid any problems and especially to meet the deadline it is very wise for a designer to prepare several alternatives of color schemes” [21]. With so much effort put into choosing an initial scheme, how does one approach preparing alternatives as well? The solution can be found from two sources: alternates and variants. One may recall making a choice between a couple colors when composing the initial scheme. From this, one can simply replace his or her first choice with their second choice and have a new alternative readily available.

Sometimes, a client is lukewarm towards the idea of a given scheme but is not fully convinced that the exact hues, tones, or shades selected will be optimal. Instead of simply replacing the colors all together, a more precise way to appease the client is to create variants. “thereupon, if it is possible to change a color scheme according to the impression that was decided by a discussion with a client, work time can be reduced”. However, composing variants that do not negatively affect the harmonious balance of a scheme can be challenging. To address this, Yamazaki and Kondo [30] construct a formula-driven method of calculating a variant using Kansei scales.

5.3.3 A/B and Multivariate Testing. While theoretical concepts are great to use as a guide, test results serve the most important information that is also specific to one’s use case. Clients have a much stronger understanding of numbers than technical jargon, so oftentimes one must turn to testing tools to demonstrate the effectiveness of different color schemes on real-world business. Two great testing methods one can consider using are A/B testing and multivariate testing.

A blog post entitled “The Button Color A/B Test: Red Beats Green” by Joshua Porter [22] is often referenced on the discussion of A/B testing. In his post, Porter [22] benchmarked two sites that were completely identical excluding a “Get Started Now!” button, which was green in one site and red in the other. After 2,000 visits, “the red button outperformed the green button by 21%” [22]. This example demonstrates the power of A/B testing, which is the practice of evaluating the effectiveness and efficiency of one singular component of a website by benchmarking two versions of the site that are identical in every other way. Porter is wise, however, to point out the following: “do not go out and blindly switch your green buttons to red without testing first. You should test colors on your page and with your audience to see what happens. You might find something interesting in your data that we don’t have in ours” [22].

Multivariate testing, as the name implies, takes A/B testing a step further by evaluating multiple variables at once. This can result in more complex results that show, for example, which header and text color combination is the most effective instead of simply evaluating each of those variables independently of each other. This can avoid the issue of selecting combination X2 instead of the optimal combination Y3 simply because component X by itself appears to be more effective than component Y. Visual Website Optimizer is a service recognized by many industries as a go-to tool for fine-tuning web elements. On their website, they list numerous case studies of companies that were able to increase their target metrics using tools such as A/B testing and multivariate testing. For example, Beamax, a Belgium based company that manufactures and distributes projection screens for home cinemas and meeting rooms, was able to increase its click through rate by 53% by using A/B testing on the color of their links [10].

5.4 Creativity

Walt Disney once said, “You can design and create, and build the most wonderful place in the world. But it takes people to make the dream a reality.” The purpose of the proposed Web Color Framework is not to discard or disrespect a designer’s creativity or aesthetics, but rather to help the designer to enhance his creativity work by connecting them to their audience and seeing a more objective and complete picture. Through years of learning and practicing, professional designers may have already been intuitively applying this framework in any new proprietary web design processes. On the other hand, novice designers who lack such knowledge, skills, experience, or access to industry-level resources may struggle, and this framework could fill in the blanks, and help them make better decisions on Web color schemes that are not only creative but also effective.

6. Evaluation

The Web Color Framework is a unique attempt at aggregating numerous sources of web design knowledge into one singular tool. While its sources of knowledge are established, the framework needed to be evaluated to validate that its creation was aligned to fill a real world knowledge gap.
An empirical experiment was conducted to demonstrate and evaluate the usefulness and relevance of the proposed Web Color Framework. In this study, students primarily from the college of business, science, and engineering in a U.S. public university were asked via email invitation to complete an online survey composed using Google Forms. Student participants were randomly assigned to either the control group or experiment group. The experiment group was first asked to read an overview of the Web Color Framework, how to use it for creating a color scheme for websites, and then they completed a quiz to assess whether they had mastered the knowledge. The control group wasn’t given the aforementioned training. Both the control and experiment group were then given a company description and were asked a series of questions to assess their ability to conceptualize a color scheme for the design of the fictitious company’s website. The goal of the experiment was to measure the Web Color Framework’s impact on students’ analysis of relevant business information, conceptualization a color scheme, and rationalization of their choices. The online survey questionnaire contained 18 - 34 questions including Multiple Choice, Fill in the Blank, and Short answer questions, and was estimated to take 15-30 minutes to complete. To incentivize participation, students who completed the survey fully were given the opportunity to enter their school-provided email address into a drawing for one of five $10 Starbucks gift cards.

### 6.1. Survey Questionnaire

The survey questionnaire contains a total of 27 questions for the control group, and 33 questions for the experiment group. The questions fell under 6 categories: Web Framework Quiz (experiment group only), Business Understanding, Color Scheme Generation, Justification, Reflection, and Demographics. The web framework quiz consisted of five questions that only the experiment group was given. This was to assess the overall comprehension level of the provided training. The Business Understanding category assessed the student’s ability to pull relevant information out of the summary of a fictitious company as it relates to the color scheme brainstorming process. The Color Scheme Generation category directly captured students’ choices when creating a color scheme, including how many colors, which colors, what variants of each color, and text and background color. The Justification category captures how students would test their schemes and their reasoning behind their choices. The Reflection category captures students’ thoughts about the difficulty of the activity as well as how useful the web framework was to them (experiment group only). Finally, the Demographics category captures general information about the students.

#### Table 1: Survey Questions By Categories

<table>
<thead>
<tr>
<th>Category 1: Web Framework Quiz (Experiment group only)</th>
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<tbody>
<tr>
<td>1. Which of the following is not a layer of the web color framework?</td>
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<td>2. T/F: Men tend to prefer soft colors and tints while women prefer bright colors and shades.</td>
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<td>3. Which of the following is NOT an appropriate description of color meaning?</td>
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<td>4. Which of the following guidelines are correct according to the 60-30-10 rule?</td>
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<td>5. T/F: When using any other combination of color other than black text on a white background, in general, it is better to use warm colors (red, orange, yellow) for the text and cool colors (green, blue, purple) for the background.</td>
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<tr>
<th>Category 2: Business Understanding (Business Requirement Layer)</th>
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<td>Please list any relevant information from the company background that you find to be important for the color scheme choices. (Students were given a fictitious company description)</td>
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<tr>
<th>Category 3: Color Scheme Generation (Color Theory Layer)</th>
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<tbody>
<tr>
<td>1. What base color would you use for the background of the website?</td>
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<td>2. What variant of your background color would you like to use?</td>
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<tr>
<td>3. Would you like the background color to be a gradient?</td>
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<tr>
<td>4. How many colors would you like to use for the color scheme (excluding background)?</td>
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<tr>
<td>Questions 5-7 repeat a number of times based on answer to the previous question.</td>
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<tr>
<td>5. What base color would you like to use for the X (X = first to fourth) color?</td>
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<td>6. Which variant (either tint or shade) of your X color would you like to use?</td>
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<td>7. What percentage of the website would you like to be in your X color?</td>
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<tr>
<td>8. What base color would you like to use for the text of the website?</td>
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<tr>
<td>9. Which variant (either tint or shade) of your text color would you like to use?</td>
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<th>Category 4: Justification (Support Layer)</th>
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<tr>
<td>1. Would you create alternative color scheme options for this client?</td>
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<td>2. How would you test the color scheme to see if it is effective?</td>
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<td>3. Please explain the reasoning behind your color scheme choices.</td>
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<th>Category 5: Reflection</th>
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<tr>
<td>1. How difficult was it for you to make the above color scheme choices?</td>
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<tr>
<td>2. How useful was the web color framework in this activity? (Experiment group only)</td>
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<th>Category 6: Demographics</th>
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<tbody>
<tr>
<td>1. What is your gender?</td>
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<tr>
<td>2. What is your major?</td>
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<td>3. What is your class standing?</td>
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<tr>
<td>4. How would you rate your web design skill level?</td>
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### 6.2 Rubric

A rubric was developed to standardize grading across all metrics. Each answer corresponding to the question in the Web Color Framework Quiz (experiment group only), Business Understanding, Color Scheme Generation, and Justification categories listed in Table 1 were assessed and graded based upon
theories and literature discussed in Section 5. For example, using Adobe Kuler as a visual reference to measure the harmonious matching of color, we graded each response on how well the color choices aligned to any of the color harmony rules (complimentary, analogous, split complimentary, triadic, and tetradic). Aside from this comparison, maximum points were only awarded to color schemes that aligned to one of the more complex color harmony rules (such as triadic or tetradic). The score ranges vary between each item, with point values of 0-1, 0-3, and 0-5. The 0-1 score range simply denotes between a correct and incorrect choice. Line items with a 0-5 score range have a much broader range of answers and complex subjectivity in evaluation while line items with a 0-3 score range have a narrower range of answers and are less complex to evaluate. Due to the 10-page length restriction, the detailed rubrics are not included here however can be provided upon request.

6.3 Demographics

Sixty college students took the survey, forty-five valid responses were received, among which twenty-three were in the control group and twenty-two were in the experiment group. For both Control and Experiment groups, females slightly outnumbered males, more than half (70%) were juniors and seniors, and a large majority (90%) rated their web design skill level as “Low” to “Medium”. Overall, this sample fairly represents of the demographics of business students, with a healthy incorporation of computing major students (Computer Information Systems, Computer Science, and Engineering) to measure the framework’s effectiveness on general college students, including both technical and non-technical disciplines.

6.4 Results

As shown in Figure 2, overall the experiment group outperformed the control group by 11.08%. The most substantial areas of improvement were in the areas of Company Evaluation (65.07%), Number of Colors to Use (24.06%), and Harmonious Matching of Colors (14.83%). There were two areas of moderately negative improvement: Text (-7.75%) and Other (-4.84%).

In the Company Evaluation category, this finding implies that the Web Color Framework greatly improves students’ ability to analyze a company and list important attributes that must be given consideration when putting together a color scheme. In other words, the experiment group has a stronger focus on the core of the business than the control group. The framework training in this case taught students the importance of business requirements in web design: something that many novice designers naturally overlook in this process. They learned that a focused approach to understanding their client gives them a solid foundation for choosing individual colors later.

For Harmonious Matching of Colors category, these results show that using the Web Color Framework allows students’ to gain a better understanding of color theory (a discipline usually reserved for art majors) and therefore develop schemes that are more visually attractive by about 25%. This fact alone is great support for the Web Color Framework, as improving color harmony skills is one of the most important target metrics that the framework attempts to improve. The framework training outlined the most common associations human have with each color and the various approaches to pairing colors harmoniously. The students in the experiment group applied this new knowledge to their responses and made slightly more appropriate choices.

The third area of substantial improvement, number of colors to use, implies that students in the experiment group had a better grasp of the balance between uniformity and complexity in their color schemes. They learned from the framework training that the 60-30-10 rule is a great rule of thumb when using three-color schemes and applied that knowledge to their responses to conceptualize well-balanced color choices. The Company Evaluation and Harmonious Matching of Colors categories are the core focus of the Web Color Framework and it is therefore of great satisfaction to discover substantial positive results from this experiment.

While there were two areas of negative improvement, their significance is less so than the areas of improvement. The Text category’s scores imply that students’ ability to choose an appropriate text color that is also readable did not improve. This result could have been driven by the design of the questions, which results in confusion from both the students’ perspective when answering the question (“what do these questions mean?”) and the researcher’s perspective when grading the results (“which of their colors will this text be on top of?”). The Other category score was largely due to variations in how students’ described the reasoning behind their choices and how they would test their scheme. The score implies that students’ ability to test and justify their color scheme choices did not improve. Because these two subjects are only a secondary focus of the Web Color Framework, it is possible that students’ in the experiment group primarily absorbed new information from the core of the framework overview, as it relates to color harmony and appropriateness to the business.
Narrowing the scope to just the experiment group, we found a significant positive correlation between the quiz scores and survey scores (Pearson Correlation .492*, Sig. 2-tailed .020, N=22). That means students who received a higher score on the knowledge check quiz outperformed those who scored lower on the quiz. This positive correlation also suggests that the Web Color Framework helped students make better Web color scheme decisions.

Finally in the Reflection category, when asked the question “How difficult was it to make the choices?”, both control and experiment groups reported the task was somewhat difficult (47% Control, 57% Experiment). When asked the question “How useful was the Web color framework?” 93% found the framework to be useful to some degree in the exercise.

7. Limitations

While the results of the study are overall in favor of the framework, there are a few limitations that are important to note. Most importantly, a sample size of forty-five students is less than ideal under the study of statistics in reference to tools such as the t-test. One factor that contributed to the small sample may be that the survey requires participants to solve problems, i.e., designing the website color scheme for a given business, rather than to answer simple opinion-based questions, therefore it takes considerable amount of time of the participants to complete, while offering them little incentives, i.e., a chance to win one of the three Starbucks gift cards.

Additionally, because the study utilized Google Forms to collect restricted and text-based input, the web color scheme generation comparison was only conceptual; We did not control or instruct how student participants should perform the task of creating a color scheme for the website, for example they can use a web design software to create a prototype or a real website that can be displayed on browser. In an ideal scenario, students would be asked to utilize a custom website builder to dynamically create a color scheme for an actual website. However, this method of study was deemed impracticable due to the lack of time and funding of this study.

Finally, the rubric and evaluation technique introduced subjectivity into the analysis. To prevent biased grading, responses were scrambled so that the researchers did not know which group each response was from while grading. However, even with this precaution, the rubric is not a black and white tool that can dictate one color scheme as definitively more appropriate in all situations than another.

8. Conclusion

This paper summarized color theory, demonstrated the effect of color on business, and constructed a framework to serve as a reference for web designers. The three-tier framework resembles a funnel where designers consider business requirements, reference color theory, and take advantage of support tools to make a highly appropriate and specific choice for a color scheme. Through a Google Forms survey, twenty-two students in an experiment group were trained with the framework and their responses were compared against twenty-three students in a control group. The results suggest that the framework overall improved student’s web color scheme conceptualization skills with some minor design limitations. While content serves as the most important asset to a business, color acts as a delivery agent straight to the consumers. An effective implementation of color on a company or organization’s website is essential to upholding positive brand perception and encouraging brand loyalty. Web designers who make use of this framework will have a comprehensive point of reference and should increase their chances of making an optimal color scheme decision that attracts customers and converts website traffic to sales.

9. References
