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Eyes don't lie: understanding users' first impressions on website design using eye tracking

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EYES DON'T LIE: UNDERSTANDING USERS' FIRST IMPRESSIONS ON

WEBSITE DESIGN USING EYE TRACKING

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ABSTRACT

Websites are becoming more prevalent these days. They need to create a favorable first impression on the users during initial exposure. After allocating their attention to stimuli, users form a cognitive representation of the visual information leading to first impression. Hence, first impression is important to evaluate the effectiveness of a website. This research tries to examine the amount of exposure time needed to form first impression; identify the web design factors that influence the formation of users' first impression; study the emotional responses of users on website design; and finally understand the relationship between first impression and eye movement.

Eye movements on displays indicate spatial focus of attention. Eye tracking can provide fixation points where users focus their attention on stimuli. In this study eye tracking has been used to study users' first impression on website design. The study was conducted in two phases. In the first phase, participants were presented with the stimuli of twenty five university websites' screen shots of home pages on the eye tracker with no time restrain and asked to move on to the next stimuli when they feel that they have formed their initial impression of the website. On viewing each homepage, participants were asked to rate the page on their first impressions and emotional response. In the second phase, users were shown their gaze plots from the eye tracker device for the previous stimuli viewed, followed by a short interview. Twenty students from a mid west university were recruited to participate in the experiment.

Quantitative analysis was performed on the various fixation data extracted from the eye tracker as well as on the data collected from survey. Open coding was performed on the qualitative data obtained from the interview. The results show that first impressions are formed within 180ms after allocating their attention to stimuli. The qualitative analysis identified various issues with the website design and also revealed a number of ways in which the website design can be improved that affects impression.

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1. INTRODUCTION

First impression is defined as perceiver's cognitive representation of another person [2]. According to this definition, forming an impression is an active process in which the perceiver organizes the information available about the target to develop a coherent representation. This means that the perceiver gathers information about the target, organizes the encoded information and represent that information in memory in terms of cognitive structure. This cognitive representation forms the basis for the perceiver's judgments about the process [2].

First impressions are often pervasive and are powerful in various contexts such as psychology, medicine, usability, marketing etc. [3]. These initial impressions usually persist and evolve with time as well as influence users' attitude [4]. Today as there exist a number of websites, which offer various products and services to consumers on-line; they need to create a favorable first impression on the users during initial exposure [5]. Web users make instantaneous judgments regarding website based on initial impressions and usually make a decision to stay on the website or bypass it within the first couple of minutes [6]. Hence it becomes imperative on the part of web designer to create a visually appealing and luring website to draw the attention of its users. For any web interface, its homepage forms the first point of contact to its users [7]. The homepage is the face of the organization or brand [8] and therefore its design and look and feel is critical, as it affects the likelihood of users returning to the website in future and influences users' attitude [4,7,8].

Over the years, researchers have focused extensively on studying the various design characteristics of a website and its influence on overall web user satisfaction [9–11]. Various empirical studies have also shown that aesthetic dimensions of a website and its design features play an important role in influencing users' attitude [12], [13] and impression formation. Also, Lindgaard et al., (2006) in their paper determined how quickly people made judgments of visual appeal on mere exposure effect which is the effect within 1-5ms of exposure to the stimulus [3]. However, not much research has been conducted to study if the influence is as a result of users' first impression or due to a more elaborate examination of the website [14]. The study by Lingaard et al., (2006) ascertained that decisions are made within 50ms

of exposure, suggesting that the web designers have only around 50 ms to make a favorable first impression [3]. But the important role of attention allocation during impression formation has not been explained. Further, visual appeal has been found to be closely related to the concept of impression formation, but the design features in specific and the relationship between them needs to be further established and analyzed. Hence, this paper uses the continuum theory of impression formation to explain the role of attention on impression formation. This paper also tries to address the various shortcomings in current literature by determining design factors that influence users' first impression and examining its impact on users' impression and attitude through both quantitative and qualitative analysis.

The main objectives of this research are to examine the amount of exposure time needed to form first impression; identify the web design factors that influence the formation of a users' first impression; study the emotional responses of users on website design; and finally understand the relationship between first impression and eye movement.

2. LITERATURE REVIEW

2.1. FIRST IMPRESSIONS

First impressions have been very powerful in various contexts such as psychology, medicine, usability, marketing etc. [3]. Hence, first impressions can be defined in various ways according to the field of studies.

In marketing, first impression is defined as a quick evaluation made by the customer during the first few minutes of an encounter with a consultant. Hence, the first impression indicates the point of departure for a customers judgment of their consultant [15]. Consumers impression usually stays stable unless a significant change is observed [16]. This long-term effect of a first impression is sometimes referred to as a halo effect. Marketing literature agrees on the fact that the first impression is created during the first five minutes of an encounter [17], [18].

Likewise, from person-perception view in which attitude of a perceiver is studied when exposed to faces of people, Hamilton et al. (1980) define an impression as a perceiver's cognitive representation of another person and focus our inquiry on the cognitive processes involved in the development of that representation from the stimulus information available to the perceiver [2]. Willis and Todorov (2006) have taken specific trait impressions into consideration. They measured impressions on variety of traits that related to the property of facial appearance like attractiveness, trustworthiness, likeability, competence, and aggressiveness. They concluded that a minimal exposure time 100 ms is sufficient for people to make a specific trait inference from facial appearance. But increase in exposure time increases confidence in judgments that allows for more differentiated trait impressions. Finally they conclude with the fact that the trait impression people form on facial appearances is very fast and intuitive [19].

In human decision-making and judgment literature, first impression is referred to as a cognitive confirmation bias [3]. Confirmation bias occurs when participants in the presence of very positive first impression may ignore negative issues and errors that they encounter later. In case of negative first impression, participants find it hard to accept the positive aspects. Hence, even if a website is highly usable and

provides very useful information presented in a logical arrangement, this may fail to impress a user whose first impression of the site was negative. By taking this theory in consideration, Lindgaard et al. (2006) conducted a study to determine the exposure time required for participants to form first impression and came to a conclusion that users take 50 ms to make a decision of whether they like or dislike what they see. They also studied some design factors that contributed to visual appeal.

2.2. IMPRESSION FORMATION

According to Hamilton et al. (1980), forming an impression is an active process in which the perceiver organizes the information available about a target person to develop a coherent representation of that person. This means that the perceiver gathers information about the target person, organizes the encoded information and represent that information in memory in terms of a cognitive structure. The cognitive structure formed in the memory represents the perceiver's accumulated knowledge about the target person. Hence, this cognitive representation forms the basis for the perceiver's judgments about the person [2]. Asch (1946) demonstrated through different observations that forming an impression is an organized process in which characteristics are perceived in dynamic relations, central qualities are discovered leading to the distinction between the perceiver and peripheral qualities [20]. From person-perception point of view, people form impressions of other from mere glimpses of behavior and a glance or a few spoken words are sufficient to form an impression of character [20–23]. Impression formation depends on how people judge others in terms of attractiveness and other cognitive characteristics such as trust worthiness and competence [23].

Continuum Model of Impression Formation: Fiske and Neuberg (1990) proposed a continuum model of impression formation in which attention to and interpretation of information mediate the underlying impression formation processes. According to the model, impression formation begins when perceivers assign the target to an initial category. Perceivers allocate attention to the target if the target is of at least minimal interest. If the target information is consistent with their expectations, perceivers then allocate attention elsewhere, and the impressions that is formed is from their knowledge of the target's specific characteristics. If the target information is inconsistent with their category-based expectations, they continue to

attend to the target in an attempt to recategorize the target. If they are successful in recategorizing the target, the will allocate attention elsewhere, and the impressions that they form will reflect their knowledge of the target's new category. If they are unsuccessful in recategorizing the target, they will continue to attend to the target and will begin to form impressions of the target by piecemeal basis [24].

Figure 2.1 shows the continuum model of impression formation for this study. Upon encountering a target, users immediately categorize the target on the basis of salient features. These features may be the design factors like color, images, use of font, font size, position of items and so on. After initial categorization, users may determine whether to go beyond the initial category and its immediate cognitive, affective, and behavioral associates. In order to interpret and distinguish the target as good or bad, users must examine other perceived attributes of the target, and they cannot do this unless they devote additional attention. Upon receiving additional information, users attempt to preserve initial categorization and finally users tend to express the cognitions, affect and behavior associated with the impressions resulting from the processes along the continuum.

Attention is a selective process. It is a mechanism that turns looking into seeing. It allows us to selectively process the vast amount of information, and also allowing us to prioritize some aspects of information while ignoring others by focusing on a certain location or aspect of the visual scene [25]. Once this information is processed, it is organized into a cognitive representation which leads to impression formation. Neisser (1976) has argued that user's perception consists of an interaction between a perceiver's schemata and the information available in the environment [26]. Schemata includes plans for collecting information and also the cognitive structures that respond to the information. Hence, perceiver's schemata first determine where their attention will be directed and then accommodate to the information once encoded.

2.3. FIRST IMPRESSION AND EYE-TRACKING

A bottom-up model of concept of visual attention explains that vision behave in a cyclical process [27]. Users see the entire scene of the provided stimulus in parallel through peripheral vision and in low resolution. Once the eyes find an interesting feature, eyes focus attention to perceive the feature under inspection in high resolution. But this model is not entirely effective because it fails to address

some of the questions like: 1) What are the features that attract attention? What is the link between attention and eye movements? Since attention plays an important role in the formation of impression, eye-tracking provides us with the fixation data and images that also help explain the above questions.

Eye-tracking systems nowadays are inexpensive, reliable, more sophisticated and precise enough to increase an interest in the use of eye-tracking for various usability studies [28], [29]. Eye-tracking studies have focused on web-based stimuli as well as computer interface by having participants engage in typical information search on web pages or on several computer interfaces. For instance, Russell (2005), conducted

```
┌─────────────────────────────┐
│       Encounter target      │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│           INITIAL           │
│        CATEGORIZATION        │
│     Occurs immediately upon  │
│        perceiving target     │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│  Allocate ATTENTION to the  │
│      attributes if target is of │
│   minimal interest or relevance │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│  CONFIRMATORY CATEGORIZATION │
│  Occurs when available information is │
│   interpreted to be consistent or non- │
│  diagnostic with respect to current category │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│        Category-based        │
│       affect, cognitions,    │
│         and behavioral       │
│          tendencies          │
└─────────────────────────────┘
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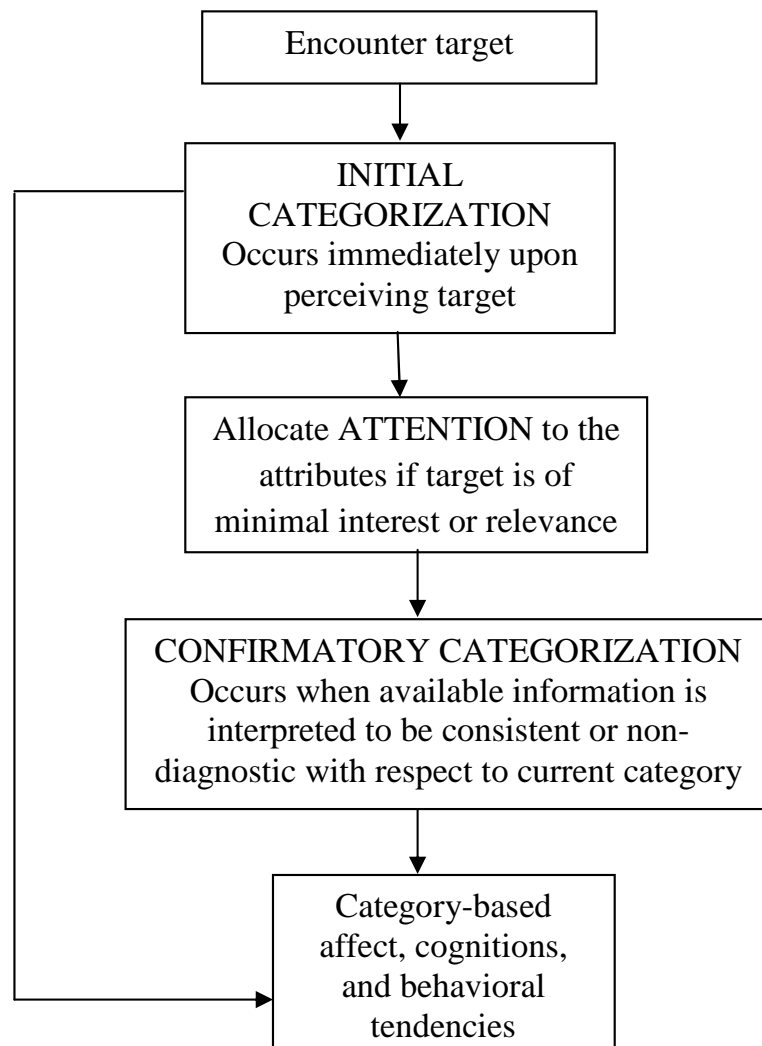
Figure 2.1. The Continuum Model of Impression Formation

a comparative usability test between three websites of a similar domain by recording participants' eye movements while they were introduced to each site's homepage. The eye-tracking data revealed which aspects of the website received more visual attention and what order they were viewed [28]. Likewise, Goldberg and Kotval (1999), have provided a framework for eye movement data analysis techniques by using a computer interface. They evaluated several measures based upon eye movement locations and scanpaths to assess their validity for assessment of interface quality. Results indicated that well organized functional grouping of buttons had shorter scanpaths. The poorer interfaces resulted in more, but similar duration fixations and also produced less efficient search behavior than the better interface.

Eye movements on displays indicate spatial focus of attention. The eyes naturally fixate upon areas that are surprising, salient or important through experience [30]. Janis-zewski and Warlop (1993) conducted an eye tracking study to assess whether the order of product versus filler displays in a television commercial influences one's attention to that product [31]. The other eye tracking analyses conducted by Lohse (1997) indicated that while scanning advertisements on telephone yellow pages, quarter page ad displays were much more noticed that text listings, and color ads were perceived more quickly, more often, and longer than black and white ads [32].

Gaze also plays important role during impression formation. Gaze offers the monitoring, regulatory, and expressive function. The monitoring function indicates that we always try to acquire information from someone in the gaze direction. The regulatory function on the other hand controls the exchange of the utterance floor, whereas the expressive function is used to convey information to the person who interacts [33]. Fukayama (2002) proposed a gaze movement model based on three gaze parameters like amount of gaze, mean duration gaze, and gaze points [34]. Subjects evaluated the impressions created by nine gaze patterns produced by altering the gaze parameters. The results indicated that reproducible relations exist between the gaze parameters and impressions.

2.4. FIRST IMPRESSION AND DESIGN FACTORS

Simplifying a users task by conforming to certain conventions of Web site design has been one of the concerns of usability engineers [35]. McCarthy et al. (2004) explains this by mentioning Jacobs Law of Web user experience:

"Users spend most of their time on other sites. Thus, anything that is a convention and used on the majority of other sites will be burned into the users brains and you can only deviate from it on pain of major usability problems."

This implies that identifying Web site design factors is essential to simplify user experience and attract users to the Web site. McCarthy et al.(2004) identify static display factors such as layering, separation, color and contrast that draw eye to important pieces of information on the website while users are navigating the menu to search for information [35]. They also identify motion, animation, spatial arrangement of the objects and so on. Yoo and Jin (2004) identify short scrolling texts, search box, web mail, number of color, background color, and number of image, sequential appearance of text and then image and use of different fonts as the factors that must be considered to design a good home page [7].

On the other hand, Lindgaard et al. (2006) mention that besides focusing on the usability of the Web site, web designers should ensure that they meet users perception and the products create a positive first impression. Hence, aesthetics, beauty and visual appeal are other factors that designers need to take into consideration while designing the Web site and the lack of these factors may create negative first impression no matter how usable the website is and regardless of the quality of information it may contain [3]. Likewise, Kim and Fesenmaier (2008) examined the persuasiveness of destination Web sites through an investigation of users first impression. Effects of design factors of tourism websites on first impression formation were studied. The design factors considered were informativeness, usability, creditability, inspiration, involvement and reciprocity [36]. Faraday (2000) on the other hand describes the process of viewing a web page as a cognitive process. In order to understand good design, we must first understand the cognitive processes. He also mentions that websites are made up of complex combination of perceptual elements like static and animated media, text and image, colors, fonts, grouping and spatial layouts. Hence, creating a visual hierarchy through the proper management of these perceptual elements can guide users in viewing the page [37].

Hu et al. (2004) define first impression as a subattribute of satisfaction which decides a consumer's image of a product or a company [38]. They mention that positive/good impression of a business-to-consumer (B2C) web page is an important component of consumer satisfaction. If consumers get a bad impression of a web

page, they tend to stop browsing or won't return anymore. Hence, the importance of impressions has been emphasized in the design of various products or services. Impressions of the web pages influence customer's desire to purchase. Since services or products are supplied to customers through web pages that act as an interface between the seller and buyer, a positive impression can play an important role in attracting audiences to the web page and turn them into customers [38].

2.5. FIRST IMPRESSIONS, EMOTION AND WEBSITE DESIGN

An impression has been defined as an "emotion state or feeling" of an audience, which is elicited by a B2C web page when the audience visits the web page for the first time [38]. Consumers apply both holistic (emotional) and analytic (cognitive) judgment in the decision to buy a product [3]. Hence, emotion and impression go hand in hand. Creating a good impression produces pleasant emotion; creating a bad impression produces unpleasant emotion [39].

Several studies have supported the association between emotion expressions and trait impressions. Knutson (1996) asked perceivers to make trait ratings of six trained actors posing happy, sad, angry, fearful, and disgust expressions. The results indicated that actors posing happy expressions were perceived to be high in dominance and affiliation. Likewise, high dominance and low affiliation were attributed to actors posing angry and disgusted expressions, and low dominance was attributed to actors with fearful and sad expressions [40]. On the other hand, Friedman (1979) found that ratings of actors posing happiness, surprise, anger and sadness could be distinguished along the dimensions positive-negative and dominant-submissive [41]. Laser and Mathie (1982) showed that schematic faces in which the facial features were experimentally manipulated were perceived as having different affective states and traits. For example, faces with thick, low eyebrows were judged to be angry as well as stern, determined, and stubborn, whereas those with thin, high eyebrows were judged to be cheerful, warm and friendly [42].

Website design that consists of elements like color, shapes, images or videos play an important role in changing user's perception of the website [43]. Consumer oriented websites that match the social and emotional perceptions of users are expected to increase trust and more engaging [44]. Further, Cyr et al. (2009) have emphasized the importance of hedonic or emotional elements to user enjoyment or loyalty [45].

Lindgaard (2007) explains that aesthetic of a nicely designed website leads to a pleasant experience which is related to emotion. The emotional experience in turn leads to thoughts on the first impression - how it is formed, how long it lasts for, and its effect on any other unrelated activities such as liking a person or even a website [46].

3. RESEARCH DESIGN

3.1. RESEARCH METHODOLOGY

This research used mixed-methods design approach. Mixed methods is a procedure for collecting, analyzing, and "mixing" or integrating both quantitative and qualitative data at some stage of the research process within a single study for the purpose of gaining a better understanding of the research problem [47], [48]. Mixing both kinds of data within one study is based on the rationale that neither quantitative nor qualitative methods are sufficient by themselves to capture the trends and details of a study. By combining quantitative and qualitative data, both complement each other and allow for a more robust analysis, taking advantage of each [49], [50].

Thus this research was conducted in two phases.In the first phase participants were presented the stimuli and were asked to rate each of the homepage on certain impression factors and their emotional responses. Quantitative data was collected from the participant's ratings on both impression factors and emotional responses. In the second phase of the experiment, users were shown their gaze plots from the eye tracker device for the previous stimuli viewed, followed by a short interview. Qualitative data were collected from the interview to identify the design factors that influence users' first impressions and also to understand the relationship between first impressions and eye movement.

3.2. STIMULI USED

In this study, 25 websites were selected from a number of universities of the United States that offer Law (Figure 3.1) as graduate or undergraduate degree. University websites were chosen for the following reasons:

1. These sites vary in levels of visual appeal and design features. They received less public exposure and traffic required to better understand first impression.

2. University websites are followed more closely by the younger generations, and in today's scenario, it is essential to study and understand factors effecting the younger populations perceptions and first impression.

3. Compared to many other websites, university websites are neutral in terms of gender preference, therefore, allowing us to test these websites with both female and male participants.

The websites chosen were picked from the top five tiers of university ranking lists and from different regions of United States. Five websites belong to the first tier university ranking, five from second tier and five from third tier, five from fourth tier and the remaining from fifth tier. Screen shots of the twenty five websites were taken on Mozilla Firefox browser and were presented to the participants in random order to mitigate any order effects. For this an Intel based computer with 96 dpi, 17 inch monitor with a resolution 1024*768 pixel and 32 bit true color was used. It can be argued that the stimuli (screen shots of home pages) used could bias users opinion as it does not provide all features that are available in actual web environment. However, as the objective of the study is to understand users' first impressions, lack of actual web environment will not influence users' responses and results obtained.

3.3. SUBJECTS

Twenty students from a mid west university were recruited to participate in the experiment. The participants recruited for this study were required to have a normal vision with no color blindness. Also, it was mandatory for them to speak and

Figure 3.1. Screen shots of home pages of universities that offer Law as undergraduate or graduate degree

understand English. The student sample can be considered as a perfect choice as the stimuli considered are university website home pages. Besides, they also possess the required skills and web experience that fits well in studies of Internet usage. Table 3.1 summarizes the demographic attributes of all the participants who participated.

3.4. DATA COLLECTION

The study was conducted in laboratory setting with each session lasting for duration of 60 minutes. Participants arriving at the lab were briefed about the experiment and the set up. Once they were comfortable with the entire procedure, they were asked to sign a consent form. Before the start of the experiment, each

Table 3.1. Demographics of participants

Gender	Responses	Percent(%)
Male	15	75
Female	5	25

Age	Responses	Percent(%)
18 and younger	0	0
19-24	10	50
25-36	10	50
37-45	0	0
46-55	0	0
56 or older	0	0

Highest Level of Education Completed	Responses	Percent(%)
High School/GED	1	5
2-Year College Degree (Associates)	0	0
4-Year College Degree	10	50
Master's Degree	9	45
Other	0	0

Internet Usage Experience	Responses	Percent(%)
Less than 6 months	0	0
6 to 12 months	0	0
1 to 3 years	2	10
4 to 6 years	2	10
7 years or more	16	80

individual participant's eyes were calibrated using the eye tracker. Also a short questionnaire was provided to fill in data regarding the participant's demographics. The stimulus was then presented on the eye tracking monitor to collect data on participant's eye movements and fixation points. A set of twenty-five home pages were displayed in random order. No time restrain was imposed on the stimuli. The user was asked to view each home page for the duration they desired. They were asked to move on to the next stimuli when they feel that they have formed their initial impression of the website. On viewing each homepage, participants were asked to rate the page on their impression and emotional response.

In the second half of the experiment, participants were shown their gaze plots for each of the homepage. The participants were then interviewed and asked questions based on the observations made from their gaze plots to obtain additional responses.

3.5. MEASURES

Impression factors were 5-point semantic scale questions adopted from [38] and [3]. The 19 representative impression factors and their antonyms were used as bipolar dimensions to evaluate all the twenty-five university home pages in the main study (see A.1).

Users' emotional responses (valence - arousal) were collected using the SAM technique(see B.1 and B.2). The Self Assessment Manikin (SAM) is a pictorial assessment technique developed by Lang (1980) to measure a person's affective states such as pleasure, arousal, and dominance to diverse range of stimuli [1]. Figure 3.2 and 3.3 depict SAM for two affective dimensions - Valence and Arousal. The SAM for valence ranges from a smiling figure to a frowning figure while arousal is represented from excited figure to sleepy figure.
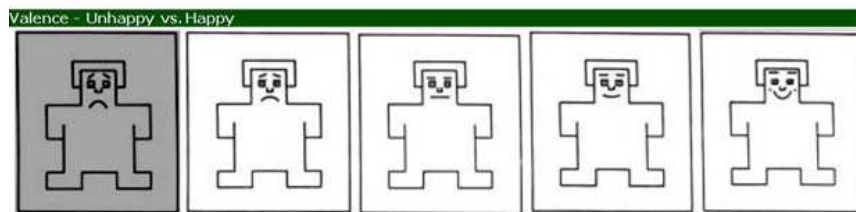
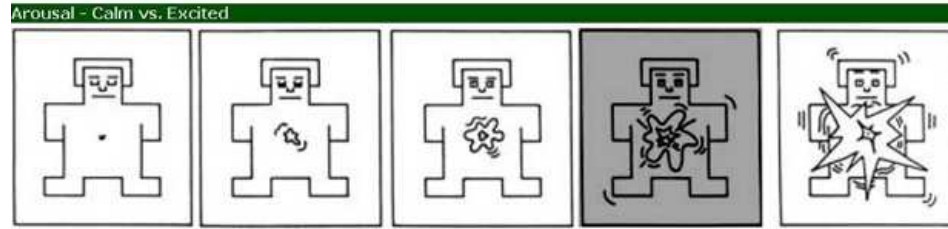

Figure 3.2. SAM to rate valence [1]

Figure 3.3. SAM to rate arousal [1]

SAM is a widely adopted technique in measuring a user's affective states as it is independent of verbal rating and hence can be adopted even in non- English speaking cultures. Also it does not require complicated statistical analysis [51] and can be used in different contexts, such as obtaining reactions to pictures, advertisements, sounds and other stimuli. In our study we used the SAM technique to measure users' emotional responses as it is simple and inexpensive in implementation and easy to analyze.

A Tobii 1750 eye tracker system was used to capture users eye movements and fixation points. In the absence of glasses, lenses or headgears, the Tobii eye tracker 1750 helps in gathering reliable data without hindering participants performance during the course of evaluation. Besides capturing users eye movements, subjective data regarding the homepage visual appeal, design features and users attitudes were also measured with the help of self reported measures administered, followed by interviews after each phase of the experiment.

Eye tracking is the process of measuring either the point of gaze of the motion of an eye relative to the head. An eye tracker is a device for measuring eye positions and eye movement. Although eye tracking technology has existed for centuries, modern day eye tracking can not only be used in a laboratory, but in homes, schools and businesses where it aids in research and analysis and is also used for interacting with computers as well as with friends and family.

Eye tracker works by reflecting invisible infrared light to a user's eye. The reflection pattern is then recorded with a sensor system, calculating the exact point of gaze using a geometrical model. After determining the point of gaze, it can be visualized and shown on a computer.

Eye tracker has been applied in various fields for analysis. For example: cognitive science, psychology, medical research, market research and usabilities studies like evaluations of advertising, package design, software or web usability. Eye tracking technique is not only used for the purposes mentioned above, but it is also used for interaction. People can control a computer and make things happen without using the mouse or keyboard and by just looking at it called eye control. Hence eye tracking is the emerging technology with limitless future.

4. DATA ANALYSIS AND RESULTS

4.1. QUANTITATIVE DATA ANALYSIS

Quantitative Data Analysis was conducted using SPSS.

4.1.1. Time to First Fixation. Time to first fixation was extracted from eye tracker by considering each screen shot of website as an AOI. Descriptive statistics shows a mean of 2.66 seconds (Table 4.1) which means that it took an average of 2.66 seconds for the participants to allocate their attention to the web pages.

4.1.2. First Fixation Duration. First fixation duration is the duration of the first fixation on an image regardless of whether it is the only fixation or the first of multiple fixations on an image [52].First fixation duration was extracted from the eye tracker for all twenty-five websites. The mean of time to first fixation is 180 ms (Table 4.2), which indicates that the eyes fixated for an average of 180 ms during which the brain interprets the visual information from the eyes and a cognitive representation of that information is formed indicating formation of first impressions. Hence, it took 180 milliseconds for the participants to form first impressions on the web pages.

4.1.3. Impression Factors. Impression factors ratings from participants were obtained over twenty-five websites. The scaling of the five intervals was quantified by assigning the values -2, -1, 0, 1 and 2 to the intervals. The score was then normalized to $+_-1$. Impression factors evaluated with only zero responses are omitted as not meaningful. The normalized score for a user is equal to the actual score divided

Table 4.1. Descriptive Statistics for time to first fixation

	N	Mean	Std. Deviation	Std. Error Mean
time to first fixation	25	2.661	2.149	.430

Table 4.2. Descriptive statistics for first fixation duration

	N	Mean	Std. Deviation	Std. Error Mean
first fixation duration	25	.180	.03451	.00690

Table 4.3. Descriptive statistics for favorable and unfavorable websites based on impression factors

	websites	N	Mean	Std. Deviation	Std. Error Mean
impression factors	1.0	16	2.5619	.28442	.07111
	2.00	9	3.4578	.22438	.07479

by the maximum possible. The maximum possible score is given as the number of factors receiving at least one nonzero score multiplied by 2.0. Thus the normalized score ranges from -1 to +1. Hence, the scores obtained from normalization indicate the degree of favor. The higher the number, the more likely it is favored. Thus, the positive scores obtained from normalization on the websites were considered favorable websites, whereas the negative scores obtained were considered as unfavorable websites. Sixteen websites were identified as favorable, and nine websites are identified ad unfavorable. An independent samples test was conducted to compare the mean impression factors of websites that were classified as favorable and unfavorable. The descriptive statistics indicate that 16 websites have mean of 2.56 which indicate that websites have positive impression and rest of the websites have negative impression (Table 4.3). Since the Levene's Test is not significant (p=0.523), we assume that the variances are approximately equal. Based on the results of our Levene's test, we see that there is a significant difference between two groups (p=0.000) which also indicates that participants have positive impression towards favorable websites and negative impression towards unfavorable websites (Table 4.4).

4.1.4. Total Fixation Duration. Data on total fixation duration on each website by all participants were extracted from the eye tracker. Total fixation duration is the total amount of time spent in each page. The mean of total fixation duration is 19.20 seconds (Table 4.5) which indicates that participants spent an average of 19.20 seconds on the web pages after forming their first impressions.

To study the relationship between total fixation duration and users' impression, regression was conducted (Tables 4.6 and 4.7). Independent variable was exposure time while the dependent variable was impression factors. The result indicated that overall impression was significantly influenced by total exposure time (t= -2.328, p= .029).

Table 4.4. Independent samples test between favorable and unfavorable websites based on impression factors

		Leven's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2 tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
fixation duration	Equal variances assumed	.420	.523	-8.111	23	.000	-.89590	.11045	-1.12439	-.66742
	Equal variances not assumed			-8.681	20.197	.000	-.89590	.10320	-1.11104	-.68077

Table 4.5. Descriptive statistics for total fixation duration

	N	Mean	Std. Deviation	Std. Error Mean
total fixation duration	25	19.197	2.433	.48652

Table 4.6. ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.189	1	1.189	5.421	.029
	Residual	5.046	23	.219		
	Total	6.235	24			

a.Predictors: (Constant), total fixation duration
b.Dependent Variable: impression factors

Table 4.7. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.642	.760		6.106	.000
	Fixation duration	-.092	.039	-.437	-2.328	.029

a.Dependent Variable: impression factors

Average total fixation duration of participants on both favorable and unfavorable websites was also calculated (Table 4.8). An independent samples test was conducted to compare mean total fixation duration of participants over 25 favorable and unfavorable websites (Table 4.10). The descriptive statistics indicate that favorable websites (indicated by 1) have mean of 19.99 and unfavorable websites (indicated by 2) have mean of 17.78 (Table 4.9). Since the Levene's Test is not significant (p=0.213), we assume that the variances are approximately equal. Based on the results of our Levene's test, we see that there is a significant difference between two groups (p=0.026) which indicates that participants spend more time on favorable websites with positive impression than unfavorable websites with negative impression.

4.1.5. Total Fixation Duration on Areas of Interest (AOI). Areas of Interest (AOI) were identified based on the literature on what areas of a home page attracts attention most [53], [54]. Seven AOIs were identified (Figure 4.1). After

Table 4.8. Total fixation duration on favorable and unfavorable websites

Favorable Websites	Unfavorable Websites
21.67	19.67
19.46	13.72
23.59	19.78
22.91	22.04
18.44	18.08
20.22	16.64
18.98	18.98
20.01	14.22
16.53	16.93
19.81	
19.46	
16.65	
20.95	
21.03	
21.07	
19.08	

Table 4.9. Descriptive statistics for total fixation duration on favorable and unfavorable websites

	websites	N	Mean	Std. Deviation	Std. Error Mean
total fixation duration	1.00	16	19.991	1.924	.481
	2.00	9	17.784	2.702	.901

identifying seven AOIs, fixation duration (in seconds) for all the AOIs were extracted from the eye tracker and summed over all twenty-five websites. AOIs were then ranked in descending order (Table 4.11). The result indicate that users spend more time on main menu than other areas of website. The AOI are given below:

1. AOI-1 → logo

2. AOI-2 → main menu

3. AOI-3 → Search

4. AOI-4 → Social Networking Links

5. AOI-5 → Main picture

Table 4.10. Independent samples test for total fixation duration between favorable and unfavorable websites

		Leven's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2 tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
fixation duration	Equal variances assumed	1.639	.213	2.380	23	.026	2.20681	.92736	.28841	4.12520
	Equal variances not assumed			2.161	12.661	.050	2.20681	1.02116	-.00531	4.41892

Figure 4.1. Areas of Interest

Table 4.11. Ranking of areas of interest according to fixation duration

Rank	AOI	Fixation Duration in seconds
1	AOI-2	6.48
2	AOI-6	6.44
3	AOI-7	6.03
4	AOI-4	5.95
5	AOI-1	5.94
6	AOI-3	5.59
7	AOI-5	5.25

6. AOI-6 → Body of the website

7. AOI-7 → Bottom of the website

Figure 4.2 and Figure 4.3 show the common trend in participants' fixation. The figures below show that participants tend to focus more on main menu and body
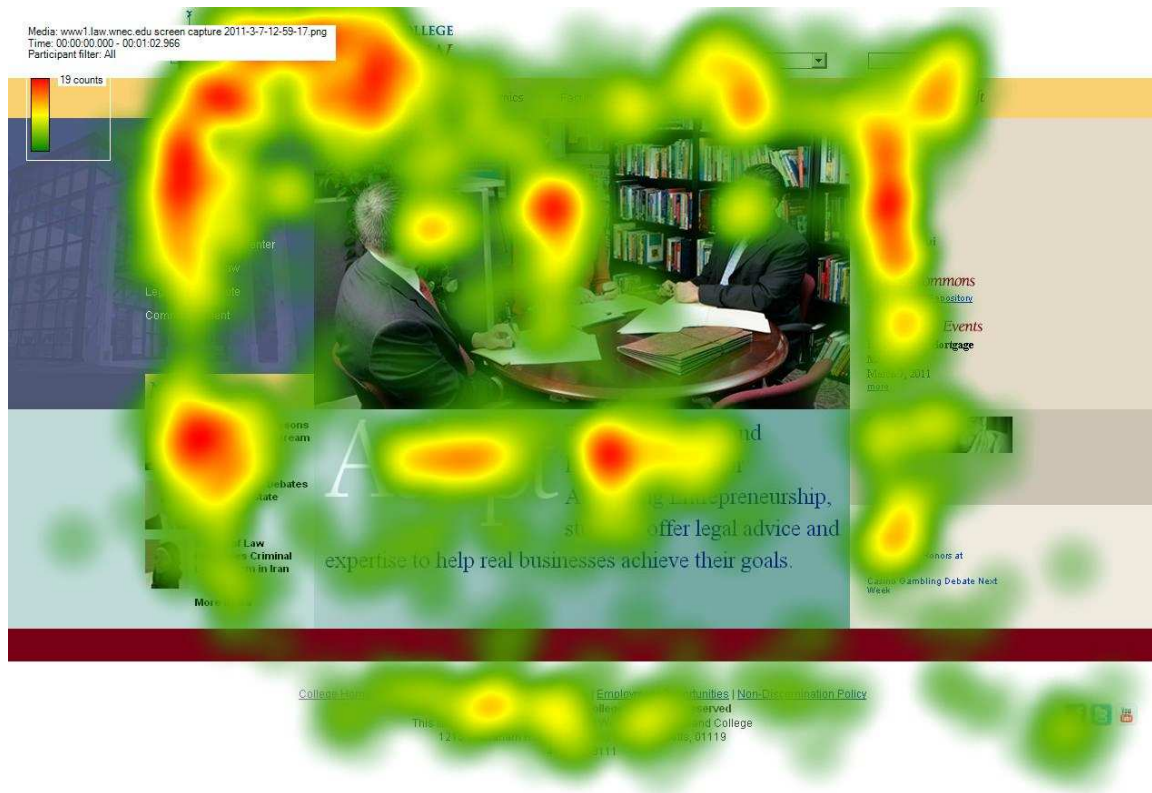
Figure 4.2. Aggregate heat map showing areas of highest fixation count

of the text followed by bottom of the website where contact information is usually provided. It is also important to note that logo, media like pictures and videos, social networking links and the search button should be prominent on the home page, since users seem to focus on these areas.

4.1.6. Emotional Responses. Emotional responses (valence and arousal) obtained from SAM were calculated for both favorable and unfavorable websites. Arousal ranged from calm to excited and valence ranged from unhappy to happy. An independent samples test was conducted to compare the mean emotional response of participants on both favorable and unfavorable websites in terms of arousal (Table 4.13). The descriptive statistics indicate that favorable websites (indicated by 1) have mean arousal of 2.46 and unfavorable websites (indicated by 2) have mean arousal of 2.02 (Table 4.12). Since the Levene's Test is not significant (p=0.162), we assume that the variances are approximately equal. Based on the results of our Levene's test, we see that there is a significant difference between two groups (p=0.004). The result
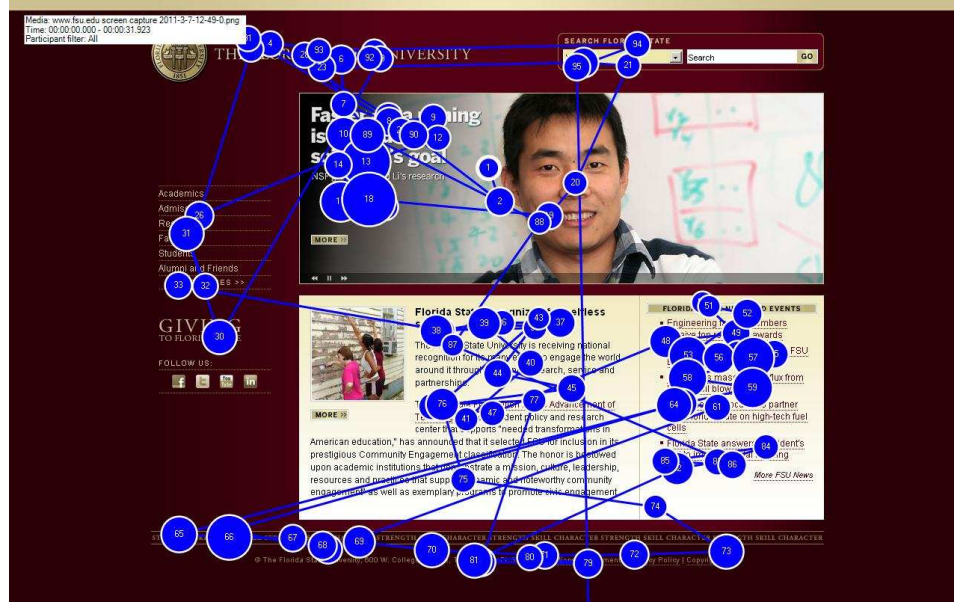
Figure 4.3. Gaze plot of a participant showing areas of highest fixation count

Table 4.12. Descriptive statistics for arousal between favorable and unfavorable websites

	websites	N	Mean	Std. Deviation	Std. Error Mean
arousal	1.00	16	2.4594	.18549	.04637
	2.00	9	2.0167	.49371	.16457

indicates that participants get more excited when they observe favorable websites than unfavorable websites.

A second round of independent samples test was conducted to compare the mean emotional response of participants on both favorable and unfavorable websites in terms of valence (Table 4.15). The descriptive statistics indicate that favorable websites (indicated by 1) have mean valence of 3.43 and unfavorable websites (indicated by 2) have mean valence of 2.62 (Table 4.14. Since the Levene's Test is not significant (p=0.555), we assume that the variances are approximately equal. Based on the results of our Levene's test, we see that there is a significant difference between two groups (p=0.000). The result indicates that participants have pleasant experience with favorable websites than unfavorable websites.

Table 4.13. Independent samples test for arousal between favorable and unfavorable websites

		Leven's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2 tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
arousal	Equal variances assumed	2.091	.162	3.245	23	.004	.44271	.13644	.16047	.72495
	Equal variances not assumed			2.589	9.290	.029	.44271	.17098	.05776	.82766

Table 4.14. Descriptive statistics for valence between favorable and unfavorable websites

	websites	N	Mean	Std. Deviation	Std. Error Mean
valence	1.00	16	3.4344	.23994	.05999
	2.00	9	2.6278	.20480	.06827

Pearson correlation between impression factors and arousal and valence were calculated (Table 4.16 and Table 4.17). The analysis of the correlation matrix indicates that the relationship between impression factors and arousal is very strong (r=-0.886) and significant (p=0.000). Likewise, the relationship between impression factors and valence is also very strong (r=-.956) and significant (p=0.000). Since impression factors ranged from positive to negative and arousal negative to positive, the negative correlation indicates that as users experience negative impression, they become calmer and vice versa. Likewise, the negative correlation between impression factors and valence indicates that as users experience negative impression, they become unhappy. Pearson correlation between arousal and valence were also calculated and a strong and significant correlation (r=0.883, p=0.000) between them is observed (Table 4.18).

4.2. QUALITATIVE ANALYSIS

The qualitative analysis identified various issues with website design and revealed a number of ways in which website design can be improved that affects impression. The responses from participants were analyzed, coded and categorized with reference to design factors identified by various researchers [38], [28], [36], [19]. Participants were shown gaze plots and asked questions regarding the pattern of their fixation. They were also asked to provide recommendation on the design of the websites. The responses were coded and categorized as below:

4.2.1. Colors. The first design factor identified by participants was use of color. Pacifying and relaxing use of background colors like light green, light blue, and yellow were preferred and use of colors like bright red, dark blue, and black were not preferred by participants. Colors also related to the statements pertaining to main color (color of navigation menu, banner, sidebar etc.), background color, and text color. Participants recommended the main color and background color be pleasant,

Table 4.15. Independent samples test for valence between favorable and unfavorable websites

		Leven's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2 tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
valence	Equal variances assumed	.358	.555	8.478	23	.000	.80660	.09514	.60979	1.00341
	Equal variances not assumed			8.876	19.062	.000	.80660	.09088	.61643	.99677

Table 4.16. Correlation between impression factors and arousal

		Impression Factors	Arousal
Impression Factors	Pearson Correlation	1	-.886**
	Sig. (2-tailed)		.000
	N	25	25
Arousal	Pearson Correlation	-.886**	1
	Sig. (2-tailed)	.000	
	N	25	25

**.Correlation is significant at the 0.01 level (2-tailed).

Table 4.17. Correlation between impression factors and valence

		Impression Factors	Arousal
Impression Factors	Pearson Correlation	1	-.956**
	Sig. (2-tailed)		.000
	N	25	25
Valence	Pearson Correlation	-.956**	1
	Sig. (2-tailed)	.000	
	N	25	25

**.Correlation is significant at the 0.01 level (2-tailed).

Table 4.18. Correlation between arousal and valence

		Arousal	Valence
Arousal	Pearson Correlation	1	.883**
	Sig. (2-tailed)		.000
	N	25	25
Valence	Pearson Correlation	.883**	1
	Sig. (2-tailed)	.000	
	N	25	25

**.Correlation is significant at the 0.01 level (2-tailed).

and attractive and the contrast of the text color should be such that it is easier to read. One of the participants stated, "The use of three colors like blue, red and white reminds me of an airline website rather than a university." Other participant stated, "The use of background color as light blue and text color as white makes it harder to read the text."

4.2.2. Images. The other design factor identified by participants was use of images. Participants suggested that use of meaningless and irrelevant pictures used by some of the websites led to negative impression on those websites. Participants recommended that the main image has to be related to professional and related to the university. The website should also not be cluttered with too many images. One of the participants stated, "Too many images have made the website cluttered. They could have used a flash player for all the images and animated them." Other participant stated, "Big image on the home page gives me good impression."

4.2.3. Navigation. One of the most common design factors identified by participants was navigation. Navigation can further be classified into navigation in main menu, left navigation, right navigation, top navigation and bottom navigation. Majority of participants suggested that the main menu located on the top or left of the website drew more attention to the website since they know where to navigate the website from. Too many navigation links on the bottom and right of the website led to confusion and negative impression towards the website. One of the participants stated, "Menus on menus does not look attractive. The sub menus should be hidden within the main menus."

4.2.4. Text. The other design factor identified by the participants was text which include text size and use of different fonts. Use of irregular text size and fonts were an issue to only few participants. Most of the participants suggested that the font type and size used on the websites were clear and readable. Some of the websites that used too much text on an image or unreadable text due to bad contrast of the color with the background led to negative impression towards the website.

4.2.5. Position. Sequential position of images and text on the website were identified as other design factors that led to the formation of impression towards that website. Participants suggested that use of a large and meaningful image on the area where eyes hit the website leads to the formation of positive impression. Websites that are cluttered with too many images, links and texts do not capture the attention towards the website. One of the participants stated, "This website is complete pain to navigate because of the weird position of images and texts. It looks like an advertisement of a product rather than a website of a university."

4.2.6. Space. Proper use of white space is also one of the design factors identified by participants. One of the issues with the unfavorable websites was an

improper use of white space. Participants recommended that the websites need to make a good use of white space by providing the right content. The websites with too much white space are repulsive since they provide very little content.

4.2.7. Design. The overall design of a website is another design factor to be considered. Grouping and displaying the contents for easier navigation is one of the recommendations of participants. Meaningless contents on a website detract users although the contents are smoothly laid. Hence, the participants recommend the use of images and texts that actually signify what the university is for. One of the participant stated, "The content of the website is smoothly laid out, but I had no idea what the university actually is. Pictures of screaming girls on homepage does not tell me what the website is about. The content of the website is also not relevant to what the students would look for."

5. DISCUSSIONS

5.1. FIXATIONS

Human eyes are constantly moving until they stop and focus on a point. When the eyes stop to focus, it is called a fixation [55]. The length of the stops, when the eyes fixates, varies from about 100 to 600 milliseconds depending on what eyes are looking at. During this stop, the brain starts to process the visual information received from the eyes [56]. Fixations are important because they locate the foveal vision. It is easier for the brain to interpret foveal vision than peripheral vision because the brain requires more effort to process blurry visual information received from peripheral vision than foveal vision. In other words, users cannot interpret what they have seen until they pay attention to it or fixate their eyes on it [57]. Hence, the length of fixation is the indication of information processing and cognitive activities as this is when the brain interprets the visual information from the eyes.

Time to first fixation is the time in seconds from when the stimulus was shown until the start of the first fixation within a page. It is a metric that provides insight regarding which AOI or element in a design attracts attention first. It can help measure how long it takes before a user finds a specific link, text or image [58]. Eye movements usually indicate one's spatial focus of attention on a display and it is evident that eyes move towards the informative area of a screen and fixate upon areas that are surprising, salient, or important through experience [30]. Hence, first fixations are important. The result indicated that users take at least 2.66 seconds to scan the website and fixate their eyes on an element of the website. In other words, the web pages managed to attract attention of the participants in 2.66 seconds.

Our analysis shows that first fixation duration lasted for 180 milliseconds. This indicates that after allocating attention to a specific area on a home page, the eyes stopped to focus and this length was 180 milliseconds during which the brain actually starts to process the visual information received from the eyes, organize the information and finally form a cognitive representation of that information which is first impressions. Hence, first impressions was formed within 180 milliseconds. Various other authors have suggested that first impression is formed within 50 milliseconds [3],

five minutes [59], [18], 100 milliseconds [19] of exposure to an interface or facial appearances. But the authors have failed to recognize the process of impression formation which involves allocation of attention and integration of the available information into an organized cognitive representation of information [24], [2]. Continuum theory of impression formation also explains the fact that perceivers give priority to categorization over individuation. Information about the attention to attributes mediates the process of impression formation [24]. Impression formation in this study is a conscious thought process. Conscious thought is object-relevant or task-relevant cognitive or affective thought processes that occur while the object or task is the focus of one's conscious attention. Attention is the key to distinguish between unconscious thought and conscious thought. Conscious thought is thought with attention; unconscious thought is thought without attention and attention is key to impression formation [60].

5.2. USER-CENTERED DESIGN

Our result shows that fixation duration was higher for main menu followed by body of the website, and the least fixation duration was on the main image of the website. Thus, our study provides an evidence that users care for how and where the website can be navigated followed by body of the homepage. The quantitative results from interview also indicate that users' first impressions are highly affected by several design factors like use of colors, font types and size, use of images, easier navigation and so on. Hence, in order for the users to form positive impression and stay longer on the website, it becomes imperative for a designer to follow a user-centered design. Beside our quantitative and qualitative data analysis, this section describes Veen's design principles and how this principle can be utilized for a better design of a website.

It is evident that design of the website needs to meet the needs of potential users. There are various design principles that designers can focus on while designing a website. Veen's design principle answers three different questions: 1) Where am I? 2) What's here? 3) Where can I go? These three principles can be utilized to provide a further explanation on how user-centered design can be followed [61].

5.2.1. Clear Navigation. Veen's design principle states that users don't follow designers traffic patterns. A website must provide localization. Hence, the main interface of a website should provide users a sense of where they are within the

website. This can be achieved by providing clear, consistent icons, graphic identity schemes, and graphic or text-based overview and summary screens that provide user the confidence that they can find what they are looking for without wasting time.

5.2.2. Direct Access. According to Veen's design principle, users want to know where they can go next on a website, but users want to get information in the fewest possible steps. This means that an efficient hierarchy needs to be designed to minimize the steps through menu pages. Menus with at least five to seven links are preferable by users. The site hierarchy needs to be designed in such a way that the real content is only a click away from the main menu pages of the website.

5.2.3. Simplicity and Consistency. Users avoid complexity. Hence, the interface metaphors need to be simple, familiar and logical. Veen's design principle also states that the site content need to be organized by principles of layout. Thus, the user interface of the website should follow the general navigation and layout conventions since users will already be used to those conventions.

5.2.4. Design Integrity and Stability. Websites need to be designed carefully and professionally by using high design standards. Websites that look sloppily built with poor visual designs lowers the confidence of users towards the website. A good web design should also offer visual and functional components by adding attractive images, videos, navigation button, or uniformly placed hypertext links.

5.3. RELATIONSHIP BETWEEN FIRST IMPRESSIONS AND EYE MOVEMENT

Psychological, psychophysical and physiological research indicates that people switch between two visual attention states, local and global attention, while exploring complex scenes which leads to distinct scan paths of eye-movements [62]. The focus on the local attention state is on specific aspects and details of the scene, and on examining its content with greater visual detail. The focus in the global attention state is on exploring the informative and perceptually salient areas of the scene.

The following gaze plots show that users' fixation are distributed on specific areas like logos, main menu, search box, text images and links (Figure 5.1 and Figure 5.2). There are more global scan paths than local scan paths. Local scan paths have occurred on the areas where participants have to explore the specific aspects
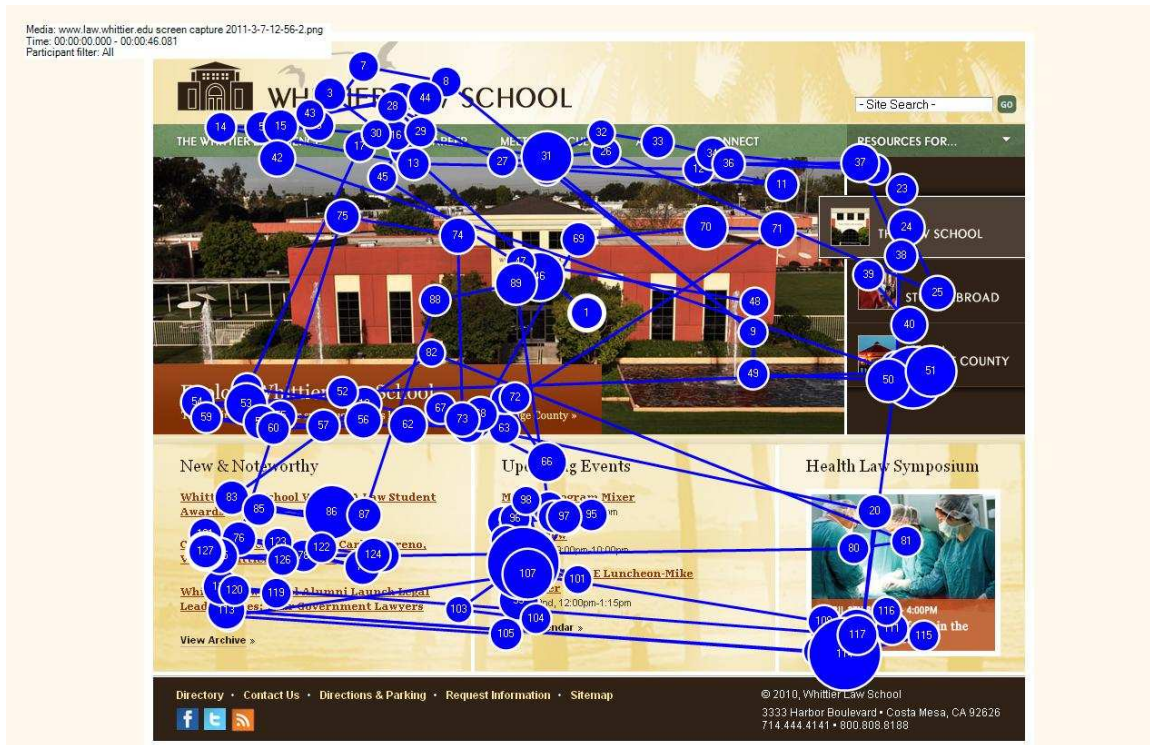
Figure 5.1. Gaze plot 1

of the website. Hence, this indicates that users start global and end local during the formation of first impressions while visiting home pages of universities. This also provides an evidence that designers have to follow a specific design convention while designing websites.
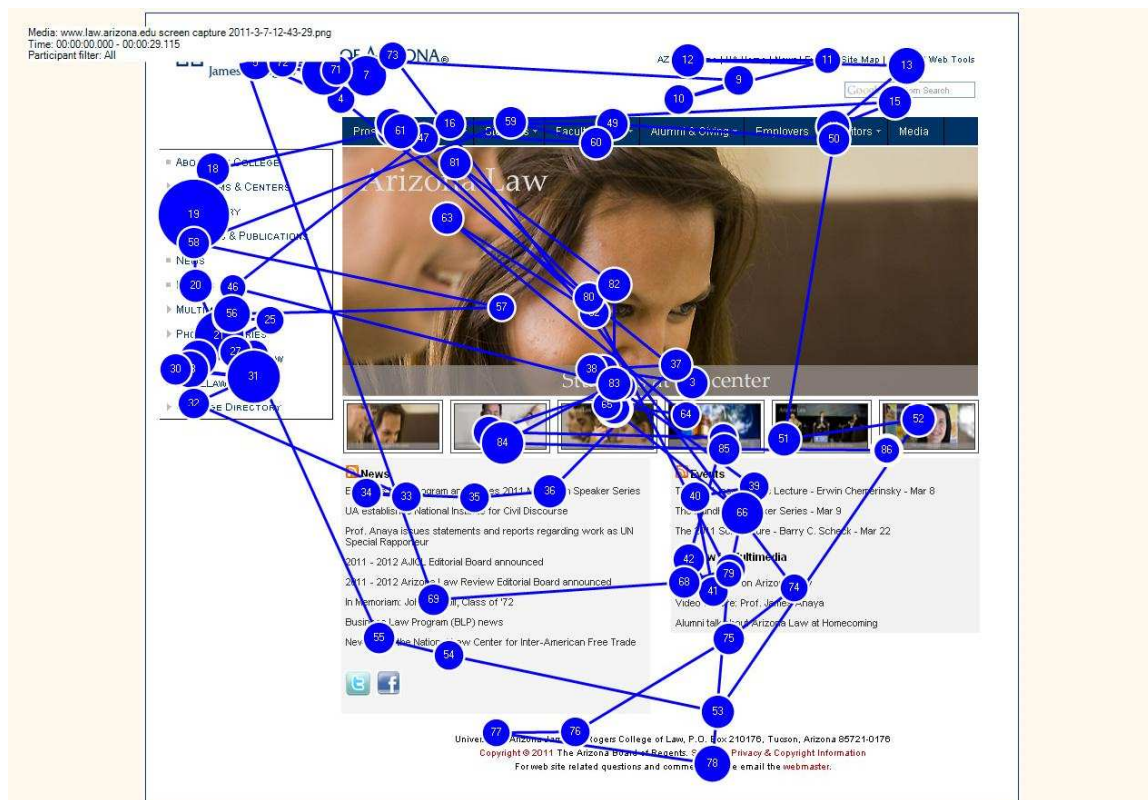
Figure 5.2. Gaze plot 2

6. IMPLICATIONS

Due to an increasing use of the World Wide Web as both an information-seeking and an electronic commerce tool, the significance of web-user interfaces increases to grow. Poor interface functionality is one potential cause for web usability meltdown [63]. The most challenging factors faced by designers is to identify and develop design factors that can (1) make website usable and serviceable, avoiding users frustration or dissatisfaction; (2) create more stimulating, and visually pleasing websites; and (3) maintain their interest in the website and encourage them to return to the Website again [64]. Before these challenges are addressed, it is important to know how users focus their attention on the websites, and form first impressions and the effects of users' first impressions on Website design.

The results from this study have further strengthened the importance of first impressions on website design. Results from this study show that users form first impressions within few milliseconds. Users also express their liking and disliking about the websites after the formation of impressions. Thus we can conclude that employing better designs helps to form positive impressions on the websites leading the users to stay longer. Therefore, this study helps designers better design the websites.

In addition, emotional responses indicated that users have a pleasant and exciting experience with websites that convey positive impression than negative impression. The qualitative analysis on the other hand, provides design factors that needs to be considered while designing websites.

7. LIMITATIONS AND FUTURE RESEARCH

In this study, stimuli was used as university websites and students were used as participants. Students were appropriate subjects since the stimuli consisted of university websites. But, for future research, stimuli can be mix of university websites, e-commerce websites, government websites and other various service websites. This way participants with more diverse background can be recruited.

This study only uses SAM as means for collecting emotional responses of users towards website design. The future research can focus on utilizing physiological devices and measuring users GSR, pupil dilation, HRV, heart rate, respiration etc to assess users' emotional states and responses.

8. CONCLUSIONS

This study used twenty-five different university websites that offered Law as undergraduate or graduate degree as stimuli. Participants were asked to view each website with no exposure time limitation and rate their impression and also their emotional response to the website. The quantitative analysis showed that first impressions is formed within few milliseconds of exposure to a stimuli. Websites were further categorized into favorable and unfavorable websites based on users' rating of impression factors. The results also showed that users have positive impression towards favorable websites and negative impression towards unfavorable websites. Participants also spend more time on favorable websites than unfavorable websites. Furthermore, emotional responses of participants on both favorable and unfavorable websites indicated that participants get more excited and also have a pleasant experience with favorable websites than unfavorable websites.

The qualitative analysis identified various issues with the website design and also revealed a number of ways in which the website design can be improved that affects impression.

APPENDIX A

Impression Factors Ratings

Q1 **Please rate your impression on the website based on your observation.**

Interesting	☐	☐	☐	☐	☐	Boring
Charming	☐	☐	☐	☐	☐	Irritating
Vibrant	☐	☐	☐	☐	☐	Pale
Simple	☐	☐	☐	☐	☐	Complex
Consistent	☐	☐	☐	☐	☐	Inconsistent
Straightforward	☐	☐	☐	☐	☐	Awkward
Clear	☐	☐	☐	☐	☐	Cluttered
Reliable	☐	☐	☐	☐	☐	Unreliable
Attractive	☐	☐	☐	☐	☐	Unattractive
Appealing	☐	☐	☐	☐	☐	Unappealing
Lasting	☐	☐	☐	☐	☐	Brief
Soulful	☐	☐	☐	☐	☐	Emotionless
Pleasant	☐	☐	☐	☐	☐	Unpleasant
Significant	☐	☐	☐	☐	☐	Insignificant
Exciting	☐	☐	☐	☐	☐	Pacifying
Likable	☐	☐	☐	☐	☐	Abonimable
Rich	☐	☐	☐	☐	☐	Poor
Progressive	☐	☐	☐	☐	☐	Conservative
WItty	☐	☐	☐	☐	☐	Dull

Figure A.1. Impression Factors Ratings

APPENDIX B

Scales to Measure Arousal and Valence

Q2☐ **Based on the scale of Calm to Excited, please select and circle the picture which matches most closely to your current feeling.**
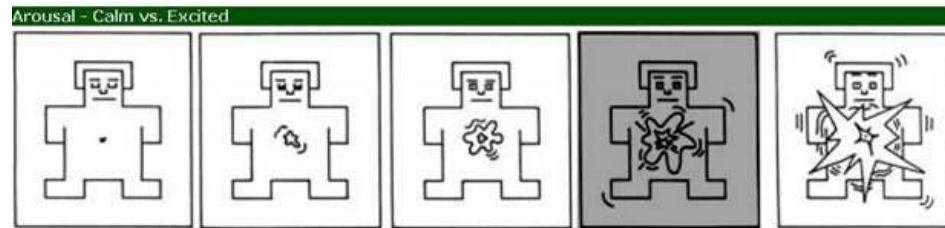

Figure B.1. Scales to Measure Arousal

Q3☐ **Based on the scale of Unhappy to Happy, please select and circle the picture which matches most closely to your current feeling.**

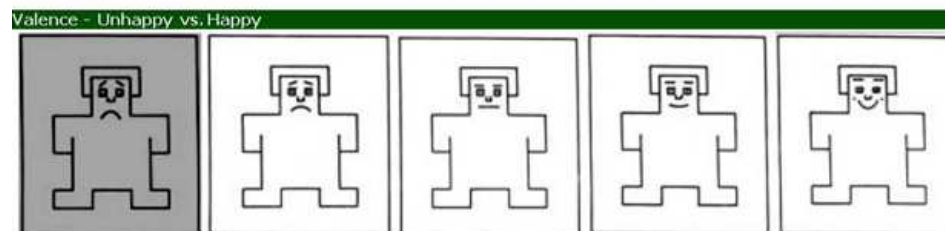Figure B.2. Scales to Measure Valence

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