The Impact of Saturation on Usability and UX for West-Europeans and Asians

A cross-cultural study with tasks, interviews and eye tracking

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Abstract

Introduction: Nowadays, the Web is an essential part of many people's lives, and it became apparent that the emergence of the Web resulted in the need for web localization. This means that a website should be adapted to the needs and wants of a specific culture. Until now, little research on the influence of web design factors is done with cultural groups or countries localized close to each other, but rather with specific nationalities. Additionally, little research is performed on the effects of saturation on usability and user experience. **Aim:** Hence, the aim of this study was to find the differences in usability and user experience between Asian and West-European users on websites that differ in saturation of colour. **Method:** This was examined by a cross-cultural task-based study, including interviews and the use of an eye tracker. The sample consisted of 10 West-European and 10 Asian participants, and the test was performed on self-made university websites which differed solely in saturation of the colour blue. **Results:** The results of this study showed that there is no effect of saturation on usability and user experience. However, the results did suggest there is a positive relationship between perceived navigation on the perceived easiness of a task for both cultures. Additionally, it was found that, for Asian participants, colour, visual design and layout style might influence the preference for a website, as well as the usability of it in a positive way. **Conclusion:** These results show that it is not necessary to adapt an information provision website according to different cultures with regards to the saturation of colour. Still, this study shed light on multiple other findings, which can be further investigated in future research. **Recommendations:** Therefore, this research suggests that it is important for a web designer to take colour, visual design, navigation style and layout into account when designing a website, especially for Asian participants. Furthermore, when considering localizing an information provision website, the saturation of colours does not necessarily have to be taken into account.

Keywords: cultures, usability, user experience, web design, eye tracking, saturation, colour

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1. Introduction

In the current society we are living in, web-based applications have become an integral part of our lives. They are widely used around the world for, e.g., educating people, conducting business, receiving information and communicating. In addition, people use websites more and more for the exchange of information or for knowledge sharing (Nawaz, 2013). Besides that, Nawaz also mentions that organizations utilize website technologies for multiple goals, such as promotions and connecting with stakeholders. In general, the Web is nowadays an essential part of many people's lives around the world.

Since web-based applications are used all over the world, it is obvious that different cultures are involved as well. It is already shown that users from different cultures often have different associations with design elements used in web design (e.g., colour, symmetry, information architecture), therefore, they usually have different ways in understanding, thinking and responding to websites (Alexander, 2019). Those differences are important to recognize in web design, since they lead to different requirements needed for the design of a website to fit the cultural background of the users. This is also shown by Al-Badi (2009), who mentioned that the culture and the environment of the target group should be fully understood for a website design to be successful. In addition, cultural website adaptation can help in offering clear and effective communication towards the user of the webpage (Mushtaha & Troyer, 2016).

A process already engaged in tailoring websites to different cultures is website localization. In general, "localization revolves around combining language and technology to produce a product that can cross cultural and language barriers" (Esselink, 2013, p.21). The need for localization started when there was an expansion on international level of software and hardware around the 1980s. Nowadays, localization is often seen as much more than just translating text, and it can involve the making of large-scale applications, web-based content like support information or personal consumer-type content whereby text, graphics, audio and video is adapted to the target group (Schäler, 2010). In addition, there are many ways of localizing software and hardware, however, the focus for this research will be on website localization.

Website localization is a specialized process where web content and applications are adapted for regional or local use (Alexander, Murray, & Thompson, 2017). In other words, a successfully localized website is one of which it seems like it is developed within the country or culture itself, and thereby fits the needs of this cultural group (almost) perfectly. According to Alexander, Murray and Thompson (2017), the adaptations on the website should go further

than just simple language translations, thereby tailoring aesthetics, as well as the look and feel of the page. The full website, including all its details, should be made fitting for the culture it is targeted at. As already mentioned, web designers must take website localization into account since it is expected that there will be an increase in access to content and enhanced user experience when a website is suitable and culturally sensitive (Cyr & Trevor-Smith, 2004). Reinecke and Bernstein (2013) also showed that web pages accommodated to specific cultural values can positively affect user experience, as well as enhances the performance and perception of the user. Furthermore, it can help in increasing usability, thereby making the website easier to use for the target group (Riipa, 2016; Sears & Jacko, 2009). For culturally diverse users, ambiguity in, for example, links, aesthetics, navigation or context can cause frustrations. A website fully tailored to the needs and preferred style of the user can minimize those frustrations and also increase acceptance (Chakraborty, 2009).

Developments in web localization apply to multiple interfaces, including e-government and e-commerce sites, but also online banking and travel agencies (Nawaz, 2013). As can be seen, some of these interfaces include information provision websites, which are not necessarily targeted at a specific culture. Specifically, a university website is often used by several different cultures as students can come from all over the world to study at a specific university. In the Netherlands, for example, it can be seen that 40 per cent of students at Dutch universities are international (CBS, 2022). The majority of those international students are originating from Germany or other European countries; however, the third biggest group of students originates from Asia (CBS, 2022). Here, the problem arises that within those information provision interfaces, specifically a university website, the target group consists of multiple cultures, therefore it is almost impossible to tailor the website to the whole target group.

Moreover, there is already various research done to investigate the differences between Chinese and Western web designs (Liljenberg, Tian & Yao, 2019; Liljenberg, 2018; Zahed, Van Pelt & Song, 2001), and it is often shown that there are multiple differences between those designs. The designs vary, for example, with regard to visuals, icons/symbols, colours, functionality and navigation tools. It is also shown that the differences in those design elements are often rather broad and there are many differences between countries (Nordhoff, August, Oliveira & Reinecke, 2018). However, they also show that the differences between countries with similar cultures, or countries close to each other, are smaller (Nordhoff et al., 2018). By further investigating these findings, it became apparent that even though much research is already done tailored to specific countries, such as China or

America, little research is done with broader cultural groups, such as Asians or Western-Europeans, where multiple countries share similar cultures and/or are localized close to each other.

Furthermore, previous research shows that there are significant differences between countries with regards to the design element colour (Reinecke & Bernstein, 2013; Marcus & Gould, 2000; Russo & Boor, 1993). Different countries, for example, prefer other colours and have different associations with colours (Russo & Boor, 1993). Therefore, national websites often differ in which colour is used, how many colours are used and the saturation of the colours (Reinecke & Bernstein, 2013). Cyr, Head and Larios (2010) also show that appeal of the website colour, which can differ for different countries, is a significant indicator for website trust, as well as satisfaction. Since not much research is done yet with broader cultural groups, but rather with specific nationalities, this research will investigate whether web design can also be tailored to cultural groups, such as Asians and West-Europeans, with regard to the key antecedent colour. This because, especially for web designers for information provision websites with a broad target audience, it is often hard to adjust the website to all the needs of the specific nationalities, however for broader target groups there might be more options. In order to do this, the following research question will be answered: *What are the differences in usability and user experience between Asian and West-European users on websites that differ in saturation of colour?*

To answer this question, a cross-cultural task-based user test will be performed. In addition, interviews will be conducted and an eye tracker will be used. Within this task-based test, the usability of two websites will be tested, both for Asian and Western-European users. One website is designed in accordance with the preferred saturation of colours for Asian cultures, whereas the other one will be designed in accordance with the preferred saturation of colours for Western-European cultures. In addition, the interviews will be conducted to get a better insight into the user experience of both groups for the two websites. Lastly, the eye tracker will be used to potentially support the findings of the other methods used.

Before further details on the study will be given, the key constructs involved will be elaborated on. After that, the methods and results of the conducted experiment will be described and the most important findings will be discussed, as well as the research question answered in the conclusion. Lastly, in the discussion, the study's limitations and recommendations for future research will be given.

2. Theoretical framework

For this research, several concepts play a crucial role. Hence, in this section, the concepts of usability, user experience, differences in cultures and colours will be introduced and further elaborated upon.

2.1 Usability

In general, usability testing is helpful for ease-of-use improvements of several products. Usability can be defined as "the degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (ISO, 2021). Frokjaer, Hertzum and Hornbaek (2000) mention that the effectiveness relates to the correctness and completeness of achieving certain aims and the efficiency is a relation between the expended resources in achieving the aims and the effectiveness. They also mention that satisfaction relates to whether the attitude towards the product is positive and how comfortable in use it is. Moreover, usability testing can be done in multiple domains and is most often used in technical product and manual or document design, as well as in human-computer interaction (Corry, Frick & Hansen, 1997).

According to Flavian, Gurrea and Orús (2009), it is undeniable that there is a high correlation between usability and web design. Usability testing in web design can, for example, be used to ensure that the website is adapted to its users and their usage does not result in negative outcomes (Bastien, 2010). Flavián, Guinalíu & Gurrea (2005) also found that if a website has great usability, it is more likely that the user is satisfied, which on its turn results in greater website loyalty. It can thus be said that, when designing a website, usability testing is necessary. Usability on an information provision website specifically is of great importance since it can increase the accuracy and acceptability of the system, and decrease the task time (Durucu, Isik, & Calisir, 2019).

Overall, there are plentiful measures of usability testing in web design, such as task completion time, error rates, perceived workload and questionnaires on ease-of-use (Hornbaek & Law, 2007). In this research, task completion time and interview questions are chosen in order to test the usability of two different websites. Additionally, eye tracking will be used to possibly support the findings of the task completion time and interview questions. Subsequently, those results will be compared to each other to find possible differences.

2.2 User Experience

User experience (UX) is very quickly adopted by the community of human-computer interaction (HCI), but it is often described in different ways (Hassenzahl & Tractinsky, 2006). Very global, it can be said that user experience is the experience the product creates for the users of it. Garret (2011) explains it as something that can make the difference between a successful product and a failure, and mentions it is not about the inner working of the product, but rather about the working on the outside, where someone comes in touch with it. Furthermore, Battarbee and Koskinen (2010) mention that, in general, there are three approaches for the appliance and interpretation of UX, namely the measuring, empathic and pragmatist approach. The measuring approach is developed from the belief that emotional reactions can be used to quantify experiences (Battarbee & Koskinen, 2010), the empathic approach adds to this by emphasizing the need of connecting experiences to people's needs and motivations (Black, as cited in Battarbee & Koskinen, 2010), and the pragmatist approach focuses more on the experiences based on interactions (Forlizzi & Ford, 2000).

With regards to web design, it has been found that for a web page, the visual impact significantly influences the user experience (Hoffmann & Krauss, 2004). In other words, the user experience on a website which is positively perceived with regards to visuals is often higher than on a website where the visuals are negatively perceived. Ben-Bassat, Meyer and Tractinsky (2006) mentioned that users easily turn down a website when it is poorly designed, which shows that when the user experience is low, people are less likely to re-visit a website. On the other hand, Karvonen (2000) found that when a website is appealing to the eye, it has a positive effect on trust, which on its turn shows that a positive user experience can result in beneficial outcomes with regards to, for example, trust. Specifically for information provision websites, it has been noted that a good UX can enhance the relationship between the visitor and the organisation, as well as encourage use of the service (Kamau, Njihia, & Wausi, 2016). The user experience related to the websites in this research, specifically, whether the website is appealing to the eye and the visuals are perceived in a positive way, will be tested by means of interview questions and the data of the eye tracker.

2.3 Differences in cultures

One way of seeing cultures is as a term to summarize the way people in a society are thinking, acting or feeling and it is a combination of learned and inherited behaviour (Kyriakoullis & Zaphiris, 2015). An often-used framework on differences between cultures is the one of Hofstede (1983), where he proposed that cultures differ on four dimensions, which

are power distance, uncertainty avoidance, individualism/collectivism and masculinity/femininity. Later, a fifth and sixth dimension were added called long/short term orientation and indulgence/restraint. In short, power distance can be seen as inequality in power between superiors and their minorities, uncertainty avoidance relates to the tolerance for ambivalence or vagueness, individualism-collectivism on its turn can be seen as how people see their own worth or value, but also that of their organizations or groups and masculinity-femininity relates to the gender roles (Wu, 2006). In addition, long/short term orientation is related to the efforts of people and whether the focus of these efforts is on the future, the present or the past (Hofstede, 2011). Lastly, Hofstede explained the indulgence/restraint as the gratification or control related to human aspirations for enjoying life. Signorini, Wiesemes and Murphy (2009) found several limitations on this model, including a too simple approach towards cultural differences and a static model of culture rather than a dynamic structure. Therefore, it is decided to not make use of the Hofstede dimensions in this research.

Regarding web design, it can be seen that the websites of different regions are often significantly different (Eristi, 2009). This is not a surprising finding since Collazos and Gil (2011) showed that people from different countries have different social and psychological associations. The different associations result in different web design needed for different countries, where it can differ on, for example, translation, colour, directions and symmetry, contextualization and information architecture (Collazos & Gill, 2011). Further, Thompson and McGill (2012) have found that it is better to let users of a webpage interact in, which are for them natural ways, rather than new ones which they have to learn to use the website properly. Those natural ways of interaction often differ across cultures; therefore, websites are often adjusted to the users in specific countries.

Next to the differences in associations, there are also differences in preferences across cultures (Barber & Badre, 2006; Cyr & Trevor-Smith, 2004). As shown by Cyr, Bonanni, Bowes and Ilsever (2005), the results of research done on this topic differ quite much. Design characteristics such as colour often result in smaller cultural differences, while for navigation tools, symbols and graphics, there is proof that preferences differ across cultures. Knight, Gunawardena & Aydin (2009), for example, found that participants from Sri Lanka and Morocco perceived icons quite differently from participants from the USA. Also, in cultures such as Chinese or Japanese, internet users often need symbolic expressions, including icons, in their information provisions, while in cultures such as German or American the users often are more drawn to detailed texts over icons (Marcus & Hamoodi, as cited in Khan &

Alhusseini, 2015). In addition, Barber and Badre (2006) found that there are also differences in the side of the webpage where people focus first, showing that American participants had a first focus of attention on the left side of a webpage, while Middle Easterners had this on the right side. In the design of a website, it is therefore important to look at the culture of your target group and adjust such details to their needs. As mentioned earlier, while designing a university website, multiple cultures have to be taken into account, which makes it hard to adjust the website completely to the target group. However, it is possible to, for example, make multiple versions of the website in order to make it fitting for multiple cultures.

Moreover, even though there is significant proof for differences in associations and preferences between countries, it is also shown that countries located close to each other often differ less in associations and preferences than countries located far away from each other. Nordhoff et al. (2018), show that websites from Japan, South Korea and China usually rank not far from each other in, for example, the average saturation of colours and the number of text areas, and Reinecke and Gajos (2014) show that mainly for the differences in colour perception, neighbouring countries share similar preferences. However, it is still rather unknown whether those findings also apply to information provision websites. Therefore, this research will investigate further whether preferences and needs on an information provision website differ between broader cultural groups, thereby affecting the usability and UX of the websites.

2.3.1 Colours

Over the past years, colour is an often-researched variable within cross-cultural website research. Bonnardel, Piolat and Le Bigot (2011) showed that the use of both background and foreground colours can affect emotional reactions and the perception of the user, as well as behavioural intentions. In addition, multiple researchers have shown that it also influences perceived trustworthiness and the loyalty of the user (Cyr et al., 2010), as well as satisfaction and the work efficiency (Alexander, 2019; Reinecke & Bernstein, 2013).

Apart from those findings, it is also often investigated whether cultures have different associations with colours. The Color-Culture Chart of Russo and Boor (1993) gives a preview of the different colour associations in some countries and shows that they can vary hugely (Figure 1). Where white can be perceived as a positive colour for French people, it will most likely be perceived as negative in Japan or China for example. This is because white is associated with neutrality in France, while it is associated with death in Japan or China. Next to this, differences can be seen when using the colour yellow, as it is positively perceived in

Japan or China (associated with grace, wealth and power), while it is more negatively perceived in France and the United States (associated with cowardice and temporary).

Figure 1

Color-Culture Chart of Russo & Boor (1993)

Culture	Red	Blue	Green	Yellow	White
United States	Danger	Masculinity	Safety	Cowardice	Purity
France	Aristocracy	Freedom Peace	Criminality	Temporary	Neutrality
Egypt	Death	Virtue Faith Truth	Fertility Strength	Happiness Prosperity	Joy
India	Life Creativity		Prosperity Fertility	Success	Death Purity
Japan	Anger Danger	Villainy	Future Youth Energy	Grace Nobility	Death
China	Happiness	Heavens Clouds	Ming Dynasty Heavens Clouds	Birth Wealth Power	Death Purity

In addition, a study by Kreitler and Kreitler (as cited in Grossman & Wisenblit, 1999) showed that there are indeed cultural differences in associations with colours. Here, it became apparent that for Western countries, black is associated with grief, while in Indian cultures it is associated with dullness and/or stupidity. In accordance with the findings of Russo and Boor, Kreitler and Kreitler also found that yellow is more positively perceived in China since it is associated with trustworthiness, while it is more negatively perceived in Western countries, as it is associated with hatred there.

In general, Camgöz, Yener and Güvenc (2001) found out that it seems like there is a general preference across different cultures toward the colour blue. This became visible since, in their research, the colour blue was most preferred regardless of the background colour. In addition, most participants mentioned the colour blue when they were asked what their favourite colour was. Moreover, the outcome of a survey by Maguire (2011) also showed that blue was the most preferred colour across cultures and Broeder and Scherp (2018), on its turn, showed most cultures prefer the colour blue with a factor evaluation.

Next to this, saturation is an important aspect of colours and refers to the richness or intensity of the colour. It is found that emotional responses to colour are not the highest when looking at different colours, or in other words, the hue of the colour, but rather when looking at lightness and chroma (Gao & Xin, 2006). In accordance with those findings, Reinecke et al. (2013) showed that for the overall colourfulness, saturation is of significant importance. Furthermore, Nordhoff et al. (2018) found that culturally similar countries are often similar in

colourfulness and saturation. Countries like Japan, China and South Korea often scored low on the saturation of the colours, whereas countries like the United States or Argentina scored rather high. In addition, Palmer and Schloss (as cited in Seckler, Opwis & Touch, 2010), found that Western adults often prefer high saturated colours over low saturated colours. Apart from those studies, the effects of differences in saturation are not often researched within cross-cultural web design. With the previous findings in mind, it is decided to test the effects of two websites, which differ in saturation of the colour blue in order to investigate differences in usability and user experience between cultural groups in this research.

3. Method

3.1 Research design and stimuli

To be able to answer the research question, the differences in user experience and usability of Asian and European users have been investigated by cross-cultural, task-based user testing, combined with an interview. In addition, eye tracking was used. Ethical approval for the study was given by the Ethics Committee of the University of Twente. For this study, based on the literature review the variable colour was selected to be manipulated as the independent variable on the website. Literature suggested that blue was generally perceived as the most preferred colour across different cultures (Broeder & Schermp, 2018; Maguire, 2011, Camgöz et al., 2001), therefore, it was chosen to use the colour blue. In addition, it was found that high saturated colours are preferred more by West-European users, whereas low saturated colours are preferred more by Asian users (Nordhoff et al., 2018; Palmer & Schloss, as cited in Seckler et al., 2010), so in this research it was chosen to manipulate the saturation of the colour. Moreover, usability and user experience were identified as the dependent variables.

Furthermore, the stimuli consisted of two different websites, made with Wix.com. One website was made with a 100% saturated blue colour (hex color code: #538AFF), whereas the other one was made with the same blue color at a 30% saturation. A few objects on the website could not be changed in saturation, therefore, another hex color code (#A4BDF0) was used which is very similar to the 30% saturated blue color. The website consisted of seven different pages: home, education, master's programmes, organisation, events, news and route. In addition, a chat function was added. The websites can be visited via the following links; https://brittven.wixsite.com/bscthesis1 (low saturation) and https://brittven.wixsite.com/bscthesis2 (high saturation). In addition, a screenshot of the two home pages can be found in Figure 2 and 3 and all screenshots of the website can be found in

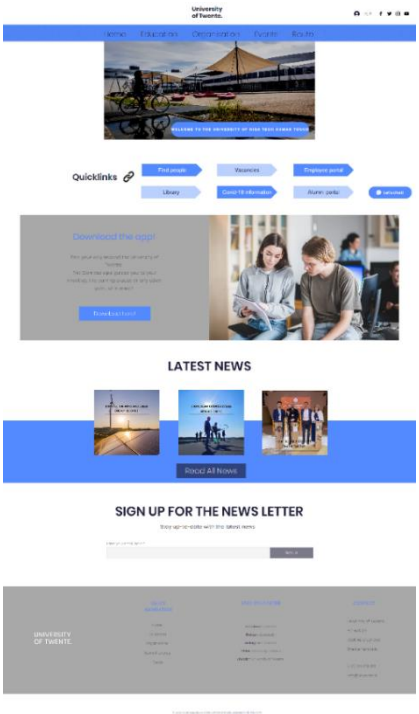
Appendix A. It has to be noted that scrolling was necessary to see all information on the pages. The chat function was always visible in the right corner at the bottom of the page.

Figure 2

Homepage low saturated website

Figure 3

Homepage high saturated website



Next to the websites, the stimuli also included an eye tracker. It was decided to use an eye tracker in this study since it offers another way of learning about and approaching usability issues (Elling, Lentz & de Jong, 2011; Cooke, 2005). Additionally, Cowen (2001) mentioned that fixation duration or the number of fixations measured with the eye tracker did causally relate to rated usability or completion time for tasks, thereby indicating that it might be a beneficial addition to research on web usability. Over the last years, most eye trackers make use of Pupil Center Corneal Reflection (PCCR), which means that they use infrared cameras or optical sensors for tracking eye movements (Punde, Jadhav & Manza, 2017). Screen-based eye tracking also often uses PCCR and is the most common type of eye tracking to use with web usability testing. With screen-based eye tracking, the eye movements are measured from a distance, and as mentioned, it is recommended to use it with websites, magazines or other small settings (iMotions, 2017).

Therefore, for this research, Tobii Pro Fusion was used, which is a screen-based eye tracker. The eye tracker was attached to a computer screen (27 inch) and connected to a laptop

with an USB-c cable. The computer screen was also attached to the laptop with an HDMI-cable and the screen of the laptop was duplicated on the computer screen. In addition, a mouse was attached to the laptop. The laptop was used by the researcher, while the computer screen and mouse were used by the participant. To use the eye tracker, both the Eye Tracker Manager and Tobii Pro Lab (x64) had to be installed. The program Tobii Pro Lab (x64) was used for the data collection as well. In this program, two so-called timelines were made, one with the low saturated website included and one with the high saturated website included. Lastly, a smartphone was used to record the interview.

During this study, the participants performed tasks on only one of the two websites. After the tasks were finished and specific interview questions were asked, the participants saw the other website, for which they only had to answer questions. A task and interview scheme was made in order to guide the experiment (see Appendix B). Participants were randomly assigned to one of the websites on which they would perform the tasks, and half of the West-European participants performed the tasks on the low saturated website and the other half on the high saturated one. The same applied to the Asian participants group. Afterwards, the data from the interviews, tasks and eye tracker were all compared to see for which design the usability and user experience was perceived the highest amongst the four conditions (West-European & high saturation; West-European & low saturation; Asian & high saturation; Asian & low saturation).

3.2 Procedure

The experiment consisted of tasks the participants had to perform, interviews and eye tracking. The experiments were performed by one researcher, and all were performed face to face, since this was necessary for the use of the eye tracker. Therefore, all experiments took place at the same location. In total, the experiment lasted 15 to 30 minutes for every participant. The interviews were structured; however, follow-up questions could be added during the interview.

At the start of the experiment, a short introduction was given by the researcher, which explained the purpose of the study and the course of the experiment. In addition, it was mentioned that the participant had the right to stop the interview at any time, to refuse to answer a question or perform a task, as well as that the participant could withdraw from the study at any time. Moreover, it was assured that the data would be kept anonymously. After the introduction, an informed consent form (see Appendix C) was given, which had to be signed before the experiment could continue. After the informed consent form was signed,

thereby indicated that the participant agreed on performing the experiment, the participant had to calibrate the eye tracker, which was done automatically by the program Tobii Pro Lab (x64) as soon as a new recording was started. Before it was indicated whether the calibration was performed properly, demographic questions about age, nationality, gender and occupation were asked. After it was indicated that the calibration was performed properly in the program, either the low saturated or the high saturated website would automatically open. From this point on, the tasks were given, as well as the interview questions asked.

The tasks were designed in a way that the participants were forced to go to at least four of the seven different pages, namely home, education, master's programs, and news. The tasks given can be found in Appendix B. During the interview, questions were asked at different moments during the experiment: after every task was completed, after all the tasks were completed and after showing the second website (see Appendix B). After a task was completed, questions about the difficulty of the task and the starting point of their search were asked. Next, after all the tasks were finished, questions about their overall experience, the overall difficulty of the tasks (on a Likert scale from 1 to 5) and the design of the website were asked. In addition, it was asked what they liked the most about the website, if there was anything that frustrated or surprised them and how likely they were to recommend the website to others (on a Likert scale from 1 to 5). Lastly, after showing the second website, their opinion about the design of that website was asked, as well as questions about which website they would prefer to visit and to which website they were more drawn. Their opinion on the main differences between the two websites was also asked. In addition, the recording with the eye tracker was stopped as soon as the second website was shown. Therefore, it was decided to record the whole interview with a smartphone as well. The recording with the smartphone was started after the consent was given, ended after the last questions was answered, and was later used for the transcription.

After both the tasks and the interview were completed, participants were thanked once more for their participation in the study, and it was mentioned again that the interview was recorded and will be used for research purposes only. Lastly, in order for the participant to be able to contact the researcher for later comments and/or further questions, the contact details of the researcher were provided again.

3.3 Sample

In total, twenty participants participated in the user test as well as the interviews. For the recruitment of the participants, convenience sampling was used, meaning that it was tried

to find suitable participants within the personal network of the researcher. In addition to this, snowball sampling was used, where participants were asked if they would know others who were likely to be willing to participate. The participants were asked first if they would be willing to participate in the research by sending a text with general information about the research, including the aim of the research and the methods of data collection used. As soon as the participants indicated they were willing to participate, more detailed information, like the location, day and time, were sent to them. There were multiple restrictions for the participants, the first one being that they should read from left to right in their native language. Secondly, all participants had to be above 18, so no specific consent of parents is required.

The mean age of the complete sample was 21,9 and 12 women and 8 men were included. In total, 16 participants were bachelor or master students from the University of Twente, one was a PDEng student from the University of Twente, one was a PhD student from the University of Twente and two participants just started working, therefore, they are considered post-graduated (both used to study at the University of Twente). The study or working fields varied and included Creative Technology, Communication Science, International Business Administration, Industrial Design Engineering and Management, Industrial Design Engineering, Applied Mathematics, Graphic Design, Robotics, Technical Computer Science, Biomechanics and Mechanical Engineering.

More specific, the mean age of the West-European participants was 21,3, this sample consisted of 7 women and 3 men, and they were all students. The mean age of the Asian participants was 22,4 and this sample consisted of 5 women and 5 men. For the West-European participants, the following nationalities were included: English, German, Dutch, Austrian, French, and Italian. The Asian participants had the following nationalities: Chinese, Indian, Indonesian, Kazakh and Russian. A detailed overview of the demographic per condition can be seen in Table I.

Table I

Demographics per condition

Condition	**Mean age**	**Gender**	**Nationalities**	**Occupations**
West-European & low saturation	20,6	4 women 1 man	English Dutch Italian French German	5 Bachelor students

West-European & high saturation	22,0	3 women 2 men	English Dutch Italian Austrian German	4 Bachelor students 1 Master student
Asian & low saturation	23,0	2 women 3 men	Chinese (1) Kazakh (1) Indian (3)	3 Bachelor students 1 PDEng student 1 post-graduate
Asian & high saturation	21,8	3 women 2 men	Russian (1) Indonesian (1) Indian (2) Kazakh (1)	3 Bachelor students 1 PhD student 1 post-graduate

3.4 Data analysis

To analyse the data, several steps were taken. First, the interviews were transcribed by making use of intelligent transcription, meaning that the 'uhms' were excluded in the transcription, as well as laughter and pauses were ignored. Apart from that, the transcription was done as exact as possible. The transcriptions took all place in the week after the data collection. In addition, the transcribed interviews were anonymised in order to make sure the participants could not be identified. To test the user experience and usability, a coding process was used for the transcribed interviews. For this, deductive coding was used, therefore, a coding scheme was made beforehand. However, during the first stage of the coding process, codes were still deleted or added. The complete coding scheme can be seen in Table 2.

Table 2

Coding scheme

Main code	Sub code	Explanation
1. Task performance	a. LOW Easy b. LOW Difficult c. LOW Moderate d. HIGH Easy e. HIGH Difficult f. HIGH Moderate	Refers to the difficulty of the tasks the participant performed.
2. Navigation	a. LOW Positive b. LOW Negative c. HIGH Positive	Refers to the participant's navigation on the website when he/she was searching.

	d. HIGH Negative	
3. Colour	a. LOW Positive b. LOW Negative c. HIGH Positive d. HIGH Negative	Refers to the attitude towards the colours used on the website.
4. Visual design	a. LOW Positive b. LOW Negative c. HIGH Positive d. HIGH Negative	Refers to the general appearance and design features of the website
5. Overall satisfaction	a. LOW Satisfied b. LOW Not satisfied c. HIGH Satisfied d. HIGH Not satisfied	Refers to the overall satisfaction of the participant towards the (usability of the) website.
6. Improvements		Refers to improvements for the website
7. Differences		Refers to differences between the two websites shown
8. Features	a. LOW Positive b. LOW Negative c. HIGH Positive d. HIGH Negative	Refers to the attitude towards specific elements/features on the website (such as the quick links or the news page)
9. Structure	a. LOW Positive b. LOW Negative c. HIGH Positive d. HIGH Negative	Refers to the general structure and organization (layout) of the website

In total, nine main codes were used, which almost all have subcodes. All subcodes are duplicated, so they once can be applied for the tasks and questions about the low saturated website, and once for the tasks and questions about the high saturated website. Further, ‘task performance’ and ‘navigation’ are chosen to analyse the usability of the websites. Then, ‘colour’ and ‘visual design’ are chosen in order to analyse the attitudes towards the colours and other design elements such as the pictures used, and ‘overall satisfaction’ is chosen to analyse the general attitude towards the complete website, which all might relate to the user experiences of the participants. In addition, ‘improvements’ is chosen to analyse mentioned improvements and ‘differences’ is chosen to get an understanding of what the participants saw

as the main differences between both websites. Lastly, 'features' was added to the codebook in order to analyse the attitudes towards specific elements on the websites, such as the quick links or the news page, which might relate to the user experience of the participants, and 'structure' was added to analyse the opinions on the general layout and/or organization of the website, which, on its turn, relates to the usability of the website.

After the coding scheme was completed, and before the whole data set was coded, the Cohen's Kappa was calculated. Cohen's Kappa coefficient (k) relates the number of congruent codes to the number of incongruent codes while also taking into account a factor for chance (Burla et al., 2008). This was done by cross coding three interviews in the program Atlas.it. The second coder received the three interviews, in which the parts were a code was added by the first coder were highlighted, and the second coder coded those highlighted parts with the use of the coding scheme. The overall Cohen's Kappa resulting from this is 0.838, and as this is higher than 0.7, the coding scheme was used further without changes. This because a Cohen's Kappa of over 0.8 shows an almost perfect agreement between the coders (Everitt, 1996). However, as it became visible that mainly the first two codes where somewhat unclear, it was discussed with the second coder what the reasons where for giving either one of those codes and compared with the reasons of the researcher. This was then taken into account during the rest of the coding process. When all interviews were coded, the results were analysed.

Furthermore, an additional way used for testing usability is time to completion (TTC). For this, the time it took a participant to complete a task was measured, which was done for all twenty participants and all four tasks. In case a participant did not complete a task, no time for the task was calculated. This was only the case for task four, where one participant (West-European, low saturation) did not complete the task. Afterwards, an average for every condition was calculated per task and those were compared amongst each other in a two-way univariate analysis of variance (ANOVA) in the program SPSS.

Lastly, the data from the eye tracker was analysed by making heatmaps of it. Heat maps are collections of the fixations and gaze points of one or multiple persons, and therefore show the distribution of where people have looked at and which parts drew attention (iMotions, 2017). It has been found that there is around 85% correlation between the mouse movements of people and their eye movements (Lettner & Holzmann, 2012), so it is decided to make heatmaps in order to possibly provide information not visible with the mouse movements. For this research, only the data points of the time period in which the participants performed the tasks were used, meaning that the data points of the eye movements in the time

period when the general questions were asked, after the tasks were completed, were excluded. In addition, the data points for the event, organisation and route page were not used since it was not necessary for the participants to visit those pages during the tasks, therefore, there were too little data points for those pages. This resulted in heatmaps for the home, education, master and news page. The heat maps were made in the program Tobii Pro Lab (x64), first by mapping the data points with assisted mapping, and second by letting the program create heatmaps of those mapped data points. For the creating of the heatmaps, the relative count of data points was used, since not all participants did spend the same amount of time at a page.

4. Results

In this section, the results of the performed analyses will be introduced. First of all, the results of the coded interviews will be elaborated upon, after which the results of the two-way univariate analysis of variance (ANOVA) on the times to complete a task will be shown. Lastly, the heatmaps will be presented.

4.1 Interviews

In this subsection, the results of the interviews will be discussed. First, the preferences the participants mentioned for one of the two websites will be discussed. Next, the results of all codes visible in the coding scheme will be elaborated upon. This will be done by analysing how much a code is mentioned for both websites and both participant groups, as well as the reasons mentioned by the participants.

4.1.1. Preferences

Out of the 10 West-European participants, 6 preferred the high saturated website over the low saturated one, and 4 preferred the low saturated website more. From the 6 participants who preferred the high saturated website, 2 participants first saw the low saturated website and performed the tasks on this website, while 4 participants first saw the high saturated one and performed the tasks on that website. For the low saturated website, 3 out of the 4 participants first saw the low saturated website and performed the tasks on that website. In addition, there were 4 woman and 2 men who preferred the high saturated website over the low saturated one, and 3 woman and 1 man who preferred the low saturated website more. On the other hand, all Asian participants preferred the high saturated website over the low saturated website.

4.1.2. Task performance

The code ‘task performance’ consisted of six subcodes, namely ‘low easy’, ‘low hard’, 'low moderate’, ‘high easy’, ‘high hard’, and ‘high moderate’, indicating the difficulty of the tasks given on both the low saturated website and the high saturated website. An overview of the amount of subcodes used for both groups of participants can be seen in Table 3.

Table 3

Number of mentioned codes for ‘task performance’

	West-European participant	**Asian participant**
Low easy	19	23
Low hard	7	1
Low moderate	7	7
High easy	20	20
High hard	8	4
High moderate	11	9

What became visible from the displayed results is that generally, the tasks were perceived as easy by both participant groups and for both conditions, since the codes ‘low easy’ and ‘high easy’ are used the most. However, it also became visible that the West-European participants more often mentioned they had difficulties with a task compared to the Asian participants, regardless of the low or high saturated website.

The most indicated reason why a task was considered easy was for both websites and both participant groups the same, namely that they could use their pre-knowledge about websites to find the information needed, since it was placed at common locations. An Asian participant (low saturated), for example, mentioned that it was very straightforward, and someone from West-Europe (high saturated) said: “Not difficult, because I already know like in nearly all websites it is in the same spot”. Next, for both websites, it was most often mentioned that the counting of the study programmes was considered the hardest, both by the West-European and Asian participants. Further, for the high saturated website, it was twice mentioned that the news was hard to find since it was not clear that it was possible to scroll on the homepage, once by someone from West-Europe and once by someone from Asia. Additionally, two West-European participants mentioned it was rather hard to find the phone number to contact the University of Twente, one who performed the tasks on the low saturated website and one who performed them on the high saturated website. Lastly, with

regards to the indication that a task was moderate in difficulty, it was most often mentioned in combination with the task where the number of studies had to be counted, however, it was also mentioned about the tasks to find the news article or the phone number. For all those tasks, it is mentioned almost equally between the four conditions. So, little to no differences are found between Asian and West-European participants with regard to task performance on either the low or high saturated website. Additionally, it seems like pre-knowledge about a website is of greater influence when performing a task than the saturation of colour is, regardless of the nationality.

4.1.3. Navigation

The code 'navigation' was sub coded into 'low positive', 'low negative', 'low neutral', 'high positive', 'high negative', and 'high neutral', indicating whether the navigation options on the websites were considered positive or not. An overview of the amount of subcodes used can be seen in Table 4.

Table 4

Number of mentioned codes for 'navigation'

	West-European participant	**Asian participant**
Low positive	9	18
Low negative	1	2
Low neutral	17	9
High positive	13	15
High negative	5	6
High neutral	20	17

The table shows that Asian participants more often mentioned they perceived the navigation as positive on the low saturated website than the West-European participants did. However, for the high saturated website this difference is not noticeable. Furthermore, the West-European participants mentioned more frequently a neutral comment about the navigation on the low saturated website than the Asian participants did. Again, for the high saturated website, this difference is not noticeable.

For all four conditions, the two reasons mentioned why the navigation was perceived positive are that everything they needed to find was in familiar places and that the main topics

were easy to find. In general, it is also often mentioned that the websites were just easy to navigate on. However, there was one Asian participant who said that it felt like he could navigate easier on the high saturated website than on the low saturated one: “I guess this one [high saturated website] is just a little bit easier to navigate, to find some things”. Next, the only reason mentioned why the navigation on the low saturated website was perceived negatively was that the news was rather hard to find. On the other hand, for the high saturated website, it was, next to the news being somewhat hard to find, also mentioned that the phone number was hard to find. In addition, an Asian participant (high saturated) mentioned: “I didn’t notice these options”, indicating she had difficulty with finding the general navigation bar on the website. Lastly, the comments which were coded with the neutral codes consisted of general information where the participant started their search, and no differences were visible between the four conditions in those comments. All participants mainly started their searches in the navigation bar at the top of the page or, for the task to find the phone number, at the bottom of a page. Again, little to no differences are found between the two participants groups with regard to navigation on either the low or high saturated website and pre-knowledge of a website was also here of great importance to the participants.

4.1.4. Colour

In total, there were four subcodes of the code ‘colour’, namely ‘low positive’, ‘low negative’, ‘high positive’ and ‘high negative’, indicating whether the colours used on both websites were perceived in a positive or negative way. An overview of the number of codes used can be found in Table 5.

Table 5

Number of mentioned codes for ‘colour’

	West-European participant	**Asian participant**
Low positive	16	10
Low negative	13	16
High positive	12	22
High negative	6	0

As shown above, the West-European participants mentioned slightly more that the colour on the low saturated website was perceived positively compared to the Asian

participants. However, for the high saturated website, the Asian participants more often mentioned they perceived the colour positively compared to the West-European participants. Besides, the Asian participants did not mention any negative comment about the colour on the high saturated website, while the West-Europeans did.

Some West-European participant mentioned that the low saturated website was nice/comfortable, sophisticated, not too distracting, easier on the eye and that it popped out more since the contrast between the background and the text was perceived higher. One West-European participant (low saturated) for example mentioned: "I just like the pastel colours more, I think that has a more sophisticated look even". The Asian participants who made a positive comment about the low saturated colour only mentioned that this website was comfortable and that it popped out more. Moreover, for the high saturated website, some West-European participants also mentioned that this website popped out more and had more contrast, therefore the text was easier to read. For the Asian participants who commented on the colour of this website, the same reasons were mentioned, and additionally, they mentioned that it was an attractive colour. An Asian participant who performed tasks on the high saturated website for example mentioned: "It's a little brighter so I automatically am attracted to it compared to the more duller one". With regards to the negative comments, however, some West-European participants mentioned that, for the low saturated website, there was not that much contrast, it was not standing out, or that the information was hard to read due to the used colours. Some Asian participants agreed on those reasons and added that it was not that attractive for them. Then, for the high saturated website, some West-European participants mentioned that it was quite harsh on the eye and not attractive. Generally, those results are in line with the preferences mentioned for either one of the websites since West-European participants slightly preferred the low saturated website over the high saturated one, while the Asians clearly preferred the high saturated website over the low saturated one. However, the reasons why a colour was perceived positive or negative do not show many differences between the two nationalities or the two websites.

4.1.5. Visual design

The code 'visual design' was sub coded in four codes, namely 'low positive', 'low negative', 'high positive' and 'high negative', indicating whether the design on both websites was perceived positive or negative. An overview of the number of codes mentioned by both participant groups can be found in Table 6.

Table 6

Number of mentioned codes for 'visual design'

	West-European participant	**Asian participant**
Low positive	13	14
Low negative	4	2
High positive	12	19
High negative	10	12

Here, it became visible that there were not many differences in codes mentioned when comparing the West-European and Asian participants. The biggest difference visible is with the subcode 'high positive', where the Asian participants more often mentioned they perceived the visuals on the high saturated website as positive compared to the West-European participants.

For the low saturated website, some West-European participants mentioned that the design was easy on the eyes, they liked the images and the fonts used, or they just liked the design. Some Asian participants also mentioned that it was easy on the eyes, and additionally, they mentioned that it was simple and minimalistic, which they perceived as positive. Then, for the high saturated website, almost the same reasons where mentioned, meaning that some West-European participants thought the design was simple in a positive way, they liked the images and fonds used or just thought it was a good design. Some Asian participants also mentioned it was simple in a positive manner and liked the fonds. Additionally, they thought the design of this website was eye catching and easy on the eyes. On the other hand, some West-European participants thought that, on the low saturated website, the images where too much the same as the textual elements next to it, which made it hard to read the information, and some Asian participants found the design of this website unattractive. One Asian participant (low saturation) for example mentioned: "For the look, the website looks really bland, like not that attractive". For the high saturated website, it was mainly mentioned that it was too simple or empty by both participant groups, and some Asian participants added that they thought there were different fonds used, which they disliked. So, the visual design was mostly perceived the same on both websites by both groups, however, the Asian participants seem to prefer the visual design on the high saturated website over the low saturated website.

4.1.6. Overall satisfaction

Regarding the code ‘overall satisfaction’, four subcodes were made, consisting of ‘low satisfied’, ‘low not satisfied’, ‘high satisfied’, and ‘high not satisfied’. The numbers per participant group for this code can be found in Table 7.

Table 7

Number of mentioned codes for ‘overall satisfaction’

	West-European participant	**Asian participant**
Low satisfied	10	13
Low not satisfied	3	0
High satisfied	10	10
High not satisfied	1	3

Here, it became visible that both the West-European and Asian participants are almost equally satisfied with both websites. However, it is noticeable that the Asian participants did not mention any comment that indicated they were not satisfied with the low saturated website, while the West-European participants did.

Reasons why West-European participants were satisfied with the low saturated website included that it was easily usable, it felt calming, and it was just a good overall experience. The Asian participant also mentioned it was easily usable, and they had a good overall experience, and added that it felt comfortable to use the website. One Asian participant (low saturation) for example mentioned: “I feel pretty content with this website”. For the high saturated website, the West-European participants mostly mentioned that it was easy to use, and they had a good experience, whereas the Asian participants also mentioned that the information they found was good in addition to that it was easy to use. Reasons why participants were not satisfied where for the low saturated website that the part about the bachelor studies was not easily understandable, whereas for the high saturated website this was mostly because participants felt like some information was not easy findable. A West-European participant (high saturation) for example mentioned: “Some things could be easier to find”. The comments were mentioned by both the West-European participant and the Asian participants. In general, since the satisfaction did not differ much for both websites, it seems like the saturation of colour does not influence the satisfaction for both nationalities.

4.1.7. Improvements

A code 'improvements' was made to indicate mentioned approvements by the participants. The number of improvements mentioned per participant group can be found in Table 8.

Table 8

Number of mentioned codes for 'improvements'

	West-European participant	**Asian participant**
Low saturated website	8	13
High saturated website	6	4

It can be seen in the table above that Asian participants generally gave slightly more recommendations for improvement than the West-European participants did. Further, there were more comments made about improvements for the low saturated website than for the high saturated one.

Improvements for the low saturated website mentioned by West-European participants were that it would be easier to have numbers indicated for the bachelor studies, the news could be easier visible, the footer could be placed on every page instead of only on the home page, the navigation bar could be a drop-down menu and more diverse colours could be used. One West-European participant (high saturation) for example mentioned: "But I think to the use of numbers and more diverse colours, it might be clearer as to what is what". This group mentioned improvements such as the footer on every page, the numbers before the bachelor studies and the drop-down menu also for the high saturated website. Additionally, they mentioned that for the high saturated website the white spaces could be filled with pictures, and it could be made more playful. Further, the Asian participants also mentioned that the numbers could be added before the bachelor studies and the news could be easier visible, In addition, they mentioned that the bachelor studies page could be clearer in general. With regards to the high saturated website, they, again, mentioned that the news could be more visible, as well as that the white spaces could be filled, and furthermore, it was mentioned that a search bar would be a useful addition to the website. So, little to no differences were found in mentioned improvements for the two websites, also not when comparing the comments made by the two nationalities.

4.1.8. Differences

In total, there were 35 comments made about the differences between the two websites. 17 of those comments were made by a West-European participant, and the other 18 were made by an Asian participant. The most mentioned difference the participants saw was colour. West-European participants mostly mentioned that the colours differed with regard to their intensity or brightness, while Asian participants mentioned they differed in, saturation, hue or brightness. To show this, a West-European participant, who first saw the high saturated website, mentioned: "The colour scheme is the biggest difference, but it makes a huge difference". In addition, the West-European participants also mentioned that the low saturated website looked more faded, and it seemed like there was an overlay on the pictures on this website. The Asian participants mentioned that the contrast between the background colours and the text on the websites differed. Lastly, it was mentioned by both participant groups that they thought the font was different on the two websites. In general, the colour was the most mentioned difference for both participant groups, however, some participants of both cultures also thought that the fond differed between the two websites.

4.1.9. Features

The code 'features' was sub coded into four different codes: 'low positive', 'low negative', 'high positive', and 'high negative'. Those codes indicated whether a specific feature of the websites was perceived in a positive or negative way. The number of codes used can be found in Table 9.

Table 9

Number of mentioned codes for 'features'

	West-European participant	**Asian participant**
Low positive	5	6
Low negative	2	0
High positive	11	1
High negative	3	2

It is most noticeable that the West-European participants made more positive comments about the features on the high saturated website compared to the low saturated

website, as well as compared to the Asian participants. Furthermore, no Asian participant mentioned a negative comment about features on the low saturated website.

For the low saturated website, both group of participants mentioned that the features they liked the most were the quick links, the navigation bar and the layout of the news. Additionally, a West-European participant mentioned that the clickable logo was a positive feature and an Asian participant mentioned this about the route page. Regarding the high saturated website, the West-European participants mentioned that the education, master, events, and news page were all considered positive features, as well as the navigation bar. The Asian participant mentioned here that the chat was a positive feature. On the other hand, for the low saturated website, the footer not being visible on all pages was considered a negative feature. One West-European participant (low saturated) for example mentioned: "However, I did try to find this footer on other pages, which there was not". For the high saturated website, it was mentioned that the organisation page was perceives as a rather negative feature by the West-European participants, while the Asian participants mentioned no footer on every page and no search bar as negative features. So, Asian participants were generally more positive about features on the low saturated website, while West-European participants were more positive about features on the high saturated website. Especially for the Asian participants, this is in line with their mentioned preferences.

4.1.10. Structure

There were four subcodes for the code 'structure', namely 'low positive', 'low negative', 'high positive' and 'low positive', which indicated whether the general layout of the websites was perceived positively or negatively. The number of codes used per participant group can be found in Table 10.

Table 10

Number of mentioned codes for 'structure'

	West-European participant	**Asian participant**
Low positive	11	5
Low negative	9	10
High positive	6	2
High negative	8	10

What became visible for this code is that West-European participants generally mentioned more positive comments about the structure of the website than the Asian participants did, regardless of the saturation of the colour. Additionally, the Asian participants more often mentioned negative comments about the structure than positive ones, also regardless of the saturation of the colour.

There were three reasons mentioned to indicate that the structure of the low saturated website was perceived positively by both the West-European and Asian participant, namely that the website was structured, organized and that it had a clear layout. For the high saturated website, it was mentioned that the website was organized and did have a clear layout by both participant groups. Moreover, negative comments about the structure where also the same for all four conditions and were mainly that the bachelor programme page was chaotic, there was no consistency in the layout (mainly related to the footer which is visible on the homepage), and lastly, that it is not always visible that it is possible to scroll down on a page. Generally, West-Europeans were more positive about the structure of the website than the Asians were, however, this was regardless of the saturation of the colour. Further, no differences in reasons for a positive or negative perceived structure were found between the two participant groups.

4.2 Time to completion

For the time to completion, first, the times it took each participant to complete a task and the averages per condition were measured (see Appendix D), and subsequently, a two-way ANOVA was conducted for every task, with time as dependent variable and saturation and culture both as independent variables. In total, four analyses were done, in which the effect of saturation and culture on the time to complete a task was examined. The analyses were performed in order to test the usability of the websites. For all four tasks, no statistically significant interaction between the effects of saturation and culture was found, as well as no statistically significant effect of saturation or culture on the time to complete a task. The exact results of the two-way ANOVA can be found in Appendix E. ‘

4.2 Eye tracking

With the data from the eye tracker, heatmaps were created using the program Tobii Pro Lab (x64). The heatmaps consist of only the data points of the time period in which the participants performed the tasks and were made to possibly support the findings from the coded interviews and/or the time to complete a task. The differences in heat maps could be seen the most at the education page (see Figure 4, Figure 5, Figure 6 and Figure 7).

In those heatmaps, it is visible that on the low saturated website, participant seemed to look more at different places than on the high saturated website. This is especially visible in the part where the different bachelor programmes are displayed, since the low saturated websites are both more covered in green areas than the high saturated websites, indicating that the participants on this webpage looked at more places. In addition, it is visible that the West-European participants looked more at the text displayed at the top of the page than the Asian participants did, especially for the high-saturated website.

Figure 4

Heatmap of low saturated education page with West-European participants

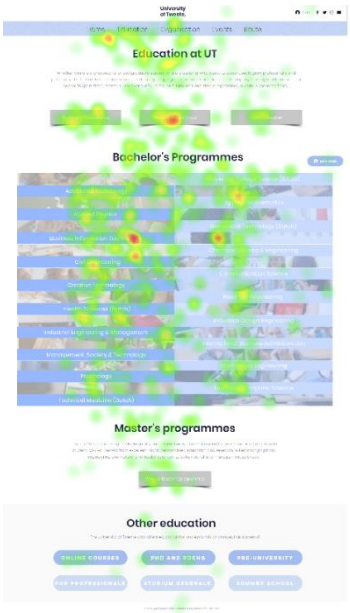


Figure 5

Heatmap of high saturated education page with West-European participants.

Figure 6

Heatmap of low saturated education page with Asian participants

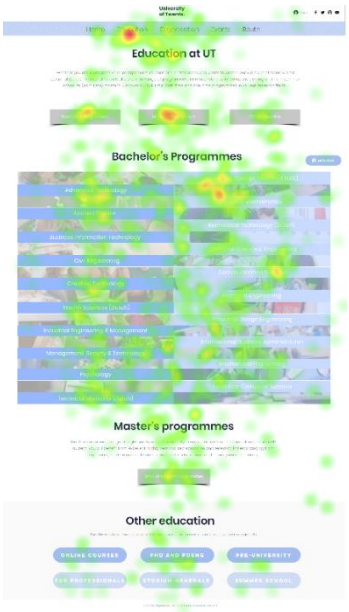


Figure 7

Heatmap of high saturated education page with Asian participants

Further, the heatmaps of the home, master and event page can be found in Appendix F. At the home page, it can be seen that the Asian participants looked more at the quick links and the social media icons in the upper right corner at the low saturated website when comparing to the high saturated website, as well as to the West-European participants. Additionally, the Asian participants looked less at the navigation bar at the high saturated website than the West-European participant did at the same website. Next, at the master page, it is visible that the participants at the low saturated website looked at more different places than the participants at the high saturated website. Moreover, at the low saturated website, the Asian participants looked more at the actual master programmes than the West-European participants did. Lastly, for the news page, it became visible that the West-European participants looked more at the pictures displayed than the Asian participants did. Also, at the high saturated website, both groups of participants looked more at the different news articles than they did at the low saturated website.

5. Discussion

First of all, this study is one of the first studies looking at differences between cultures instead of countries. Additionally, it is one of the first studies investigating solely the effect of colour, especially the saturation of the colour, on usability and user experience. However, it has to be noted that the results found in this research apply mostly to young adults (18-25 years), as the majority of the sample was a young adult, as well as to information provision websites such as a university website. Next, the main findings will be discussed and subsequently, limitations, practical uses and future recommendations will be elaborated upon.

5.1 Main findings

This study aimed at answering the following research question: *What are the differences in usability and user experience between Asian and West-European users on websites that differ in saturation of colour?* This was done by performing a cross-cultural task-based user test, combined with interviews and the use of an eye-tracker. In this section, first, some general findings will be discussed, after which the results for usability and user experience specifically will be discussed.

To begin with, when asking for the perceived differences on the websites, all participants mentioned the colour, indicating that the difference in colour saturation was noticeable. However, it also became clear that some of the participants thought that, next to

the colours, the font on both websites was different. Aladwani (2012) found that British people value a proper use of fonts on website more than Kuwaiti people, indicating that the West-European participants might have paid more attention to the font than the Asian participant did. However, both the Asian and West-European participants mentioned equally that they thought the fonts differed. Apparently, a change in saturation of the colour used on a website might change the perception of a font used.

Then, the participants indicated their preferred website during the interview, which resulted in all Asian participants and six West-European participants who preferred the high saturated website, and four West-European participants who preferred the low saturated website. The eye tracker data did not support those findings, as no differences were found in viewing behaviour for both the Asian and West-European participants. Those results were not expected, since previous studies found that Asian countries often use low saturated colours in web design (Nordhoff et al., 2018), and West-European adults generally have a preference for high saturated colours over low saturated ones (Palmer & Schloss, as cited in Seckler et al., 2010). However, Fushikida, Schloss, Yokosawa and Palmer (2009) found that for cool colours, such as green and blue, there was no difference in preferences for low or high saturation between Japanese and American participants. According to them, the difference in preference is only visible for warmer colours. Additionally, Yokosawa, Schloss, Asano and Palmer (2016) also found that there is little to no difference in preferences across Japanese and American people when the saturation of the colour blue differs. As this current research focused on West-European participants instead of Americans, it adds to those findings that also for West-European participants, no differences are found when the saturation of the colour blue differs. Furthermore, it thereby also suggests that the saturation levels do not influence preferences across different countries, rather it seems like it is an individual preference.

What is remarkable is that the overall satisfaction of the participants, mainly the Asians, towards the websites does not correlate with their preferences for a specific website. The West-European participants commented an equal number of times that they were satisfied with either one of the websites, which is expected with regards to their mentioned preferences. However, the Asian participants did mention more often that they were satisfied with the low saturated website, while they all preferred the high saturated one. Those differences might be visible since the preference was asked after seeing both of the websites, while most comments about their satisfaction were made after only seeing one of the two websites. Therefore, they did not have a chance to compare yet.

5.1.1. Usability

To test the differences in usability on the websites, both the interview questions and the time to completion for the tasks were used. With regards to the coded interviews, the codes 'task performance', 'navigation' and 'structure' referred to usability. First of all, there seems to be a small relation between positive perceived navigation and the ease of a task regardless of the preferred colour, since Asian participants were generally more positive about the navigation of the low saturated website, and also more often mentioned that the tasks on the low saturated website were easy compared to the high saturated website, whereas this was the other way around for the West-European participants. Those results support findings of Alexander (2019) and Cui, Wang and Teo (2015), who found that a high ease of navigation often leads to an increase in usability. However, since the Asian participants all mentioned to prefer the high saturated website, while the West-European participant only partially mentioned this, this finding is not in line with most previous research, such as Vitols, Arhipova, Hirata and Ikarts (2015) or Nathan and Yeow (2009), who indicated that using a preferred colour could positively impact cross-cultural web usability. A possible reason for this difference in results might be that this research made use of an information website, while the other studies did not.

Additionally, Yakunin, Bodrunova and Gourieva (2018) have shown that for Chinese people, perfection of the page layout did influence their performance. This is supported in this current research, since the Asian participants slightly mentioned to prefer the structure of the low saturated website and mentioned more often that the tasks were easy on this website compared to the high saturated website. Furthermore, for the code 'structure', the West-European participants more often mentioned they had a negative attitude towards the structure of the high saturated website compared to the low saturated one, while they generally found the tasks on the high saturated website easier. Therefore, this research adds that for West-European participants, it seems like the structure of the website and the task performance do not correlate such as for Asian participants. Nevertheless, it has to be noted that the differences found in coded interviews with regard to usability are rather small and generally, all participants perceived the website they performed tasks on as rather usable. A possible explanation is that this can be due to the colour blue used, as cooler colours are in general positively correlated with perceived usefulness, while for warmer colours, this is a negative correlation (Oyibo & Vassileva, 2020).

In line with the findings of Oyibo and Vassileva (2020), no statistically significant differences were found for all four tasks with regards to the time to completion for a task.

This indicates that using a low or high saturated website does not influence the usability of either West-European or Asian people in this regard. Not much research is previously done on the effects of saturation on usability, however, a somewhat similar research found that there was no significant effect of general preferred colour count on the response time for tasks on that website (Bhatia, Samal, Rajan & Kiviniemi, 2011). On the other hand, contrary to this finding, Sauer and Sonderegger (2011) found in their study that an aesthetically pleased website (including an appealing colour) did significantly influence the task completion time. It has to be noted here that this was no cross-cultural study and more visual design elements than only colour were changed. Therefore, this research adds to those findings that it seems like solely changing an aspect of colour, in this case saturation, does not have an influence on the usability of the website for Asian and West-European people.

5.1.2. User Experience

The differences in user experience (UX) were analysed by the codes 'colour', 'visual design' and 'features'. West-European participants mentioned more frequently that they found the colour and the visual design of the low saturated website positive compared to the high saturated website. For Asian participants this was the other way around. These findings are contradictory to earlier findings of Nordhoff et al. (2018) and Palmer & Schloss (as cited in Seckler et al., 2010), as mentioned before. More in accordance with the findings of this study, Yokosawa, Yano, Schloss, Prado-Leon and Palmer (2010) found that Japanese people preferred high saturated colours, however, they also found that pastel or light colours were even more preferred than high saturated colours by them. The low saturated colour used in this research can, to a greater extend, be compared with a pastel or light colour than the high saturated colour, therefore, the findings of this research also contradict the findings of Yokosawa et al.

Additionally, Asian participants were generally more satisfied with the low saturated website, which indicates that the attitude towards the saturation of the colour and the visual design does not influence UX in this study. Cyr et al. (2010), however, did found that colour appeal does significantly influence satisfaction of a website, and Cyr (2008) found this same effect for visual design. Although the Asian participants more often mentioned they were satisfied with the low saturated website, they still preferred the high saturated website, which is on its turn in line with the findings of Cyr et al. (2010). Since the reasons mentioned to indicate a positive or negative attitude towards the colours used were more or less the same for both the websites and both the participant groups, it remains rather unclear what is causing

these contradictory results with regard to the satisfaction of the website. However, a possible explanation might be visible in the findings of Fushikidi (2009) and Yokosawa et al. (2016) as mentioned before, since they found that the preferences in saturation of the colour blue are not different across different countries, but rather are individual preferences regardless of nationality.

On the other hand, for the code 'features', Asian participants more often mentioned they perceived a feature as positive on the low saturated website than on the high saturated website, while this is the other way around for the West-European participants. However, in this study, the most mentioned features that were liked or disliked where the quick links, the navigation bar or (parts of) specific pages. The eye tracker data supports this, since it became visible that the users took foveal snapshots of the navigation features (the top bar and the quick links), meaning that they focused on these areas (Djamasbi, 2014). Nevertheless, it is impossible to compare those findings to previous research, as no research design consisted of those exact features. Generally, it can be indicated that the features mentioned on this website do not have a relationship with UX.

5.2 Limitations and future recommendations

As with most research, some limitations can be noted, which can be used as a springboard for further research. First of all, the sample of participants (N=20) is rather small, which allowed the researcher to thoroughly investigate this sample, however, the research can therefore not be interpreted with high confidence. Therefore, a recommendation for future research would be to increase the sample size to at least thirty, but preferably even higher (Lewis, 2014). Moreover, with regards to the sample size, it has to be noted that most Asian participants already lived in the Netherlands for at least one year, therefore, their preferences might have already been slightly adapted to the Western standards. However, Li, de Jong and Karreman (2021) performed their study with Chinese participants living in China and Chinese participants living in the Netherlands and did not find significant differences in preferences for pictures. Still, since this research is about colours rather than pictures it would be recommended for future research to sample participants that were not possibly influenced by other standards than those of their origin country.

Furthermore, when looking at the design of the study, multiple limitations can be noted. To start with, the tasks given were in general quite leading, therefore, they might have been too easy for the participants to perform. Also, because of this, they were performed rather quick, which might have resulted in no statistically significant results. Therefore, it is

recommended for future research to let the participants perform longer tasks, which are not necessarily leading when given to them. Furthermore, for the third and fourth task, they were not always started from the same page since not all participants ended at the same page after the second task. Therefore, it is recommended to always let the participants start a task from, for example, the home screen.

With regards to the eye tracker, a limitation of this research is that the data points used for the heatmaps also consisted of the times in which the participants explained their search behaviour and the difficulty of the tasks. As mentioned before, it is therefore recommended to give tasks which will take the participants a longer amount of time to complete, so the parts where explanations are given can be kept out of the analysed data. Besides, assisted mapping in the program Tobii Pro lab (x64) was used, which is prone to error. In order to reduce the errors as much as possible, it is advised to have all objects in the so-called snapshot at the same size as in the recorded video (Tobii, 2022). Since a snapshot was created from a complete page (including the parts that are only visible after scrolling), the objects on the snapshots did not have the same size as in the recorded video. Therefore, the mapping of the data might have been not completely accurate. To prevent this in future research, it is advised to either have the objects in the snapshots at the same size as in the recorded video, or to use manual mapping. However, this last option is rather time consuming.

Moreover, the website was designed by a researcher from the Netherlands, therefore, the design, apart from the saturation in colour, might be made more according to Western standards although it was tried to keep the design as general as possible. This might have influenced the results on both usability and user experience, as the West-European participants might have been more familiar with the design.

Besides the previous mentioned recommendations, the results shown in this research also allow for future recommendations for research. Firstly, it seems like there are other aesthetics that influence the usability and user experience of the participants, even though the only dependent variable in this research was the saturation of colour. For example, the results suggest that there might be an influence of navigation and structure on usability, however, regardless of nationality. Although no main differences were found between Asian and West-European participants with regards to other aesthetics in this research, it is recommended to perform studies with those participant groups and other dependent variables, such as navigation tools or layout. This is also in line with the findings of Ilmberger, Schrepp and Held (2008), as they assumed that colour is not solely able to influence usability, rather other aesthetic dimensions should be investigated. Furthermore, since it became apparent that a

change in saturation of colour used might change the perception of a font used, it is recommended to further investigate this possible relationship.

5.3 Practical implications

With regards to the findings of this research, practical implications can be proposed. This research suggests that it is important for web designers to keep the colour, visual design and layout in mind when designing a website for especially Asian participants, as it seems like a preferred colour and visual design influence the preference for a website by Asian participants. Also, a positive perceived layout of a website seems to influence the usability of the website in a positive way. However, since it did not influence the satisfaction, the effects are expected to be rather small. Additionally, it is important for web designers to take the navigation of a website into account, as it is found that this positively influences the usability of the website for both Asian participants and West-European participants. Hereby, it is advised to look at preferred navigation styles and implement those in the design. Lastly, in the consideration to localize an information provision website, especially a university website, in a way that it is possible to choose for the visitor if they want a website based on, for example, Asian or West-European standards, it should be taken into account that the saturation of the colours used will probably not influence the usability and or UX to such an extent that it will average the costs out. However, to advise this with more certainty, more research is needed.

6. Conclusion

To answer the research question, little to no differences in usability and user experience are found between Asian and West-European users on websites that differ in saturation of colour. Therefore, it is proposed that it is not necessary to adapt an information provision website, specifically a university website, to different cultures with regards to the saturation of the colour. However, this study shed light on multiple other findings, which can be further investigated in future research.

First of all, opposed to previous research, it was found that Asian participants preferred a high saturated information provision website over a low saturated one. West-European participants preferred both websites almost equally, suggesting that the preferences for a high or low saturated website might differ per individual rather than per culture. Secondly, it was found that the saturation of the colour does not influence the usability or user experience of an information provision website for both Asian and West-European people.

However, other design elements such as navigation and structure seemed to have an influence on the perceived easiness of a task. Nonetheless, more research is needed to be able to state this with greater confidence. Thirdly, this study suggests that, for Asians, aesthetics such as colour and visual design do slightly influence the preferences for either the low or high saturated website. However, also more research is needed to investigate the effects on both satisfaction and preference to be able to confidently state this. Lastly, this study found that the use of an eye tracker did not add to the previous mentioned findings. In spite of that, it did suggest that when the colour of a picture is closer to the text(box) next to it, people are more easily distracted by it.

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Appendix A

Screenshots of the websites

Figure 8

Homepage of the low saturated website

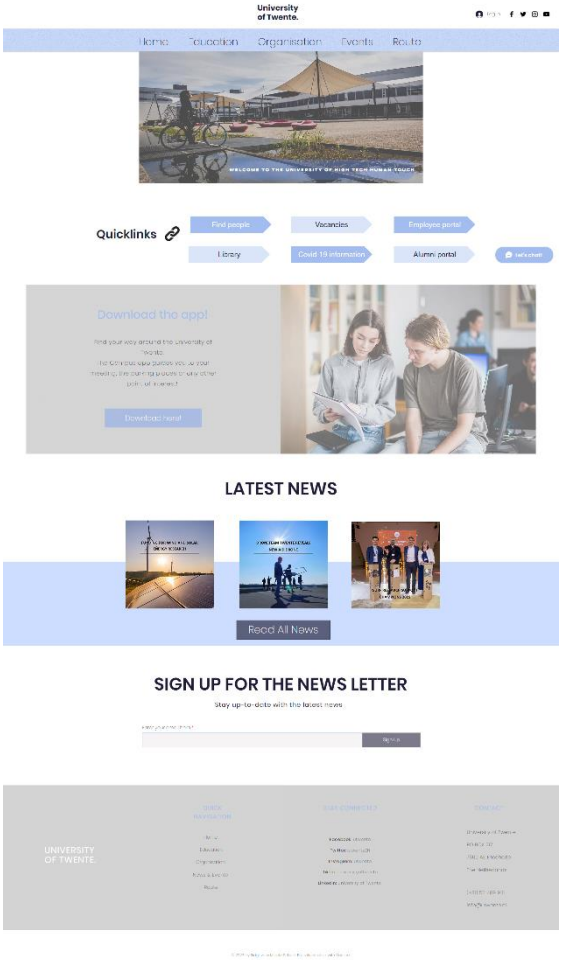


Figure 9

Homepage of the high saturated website

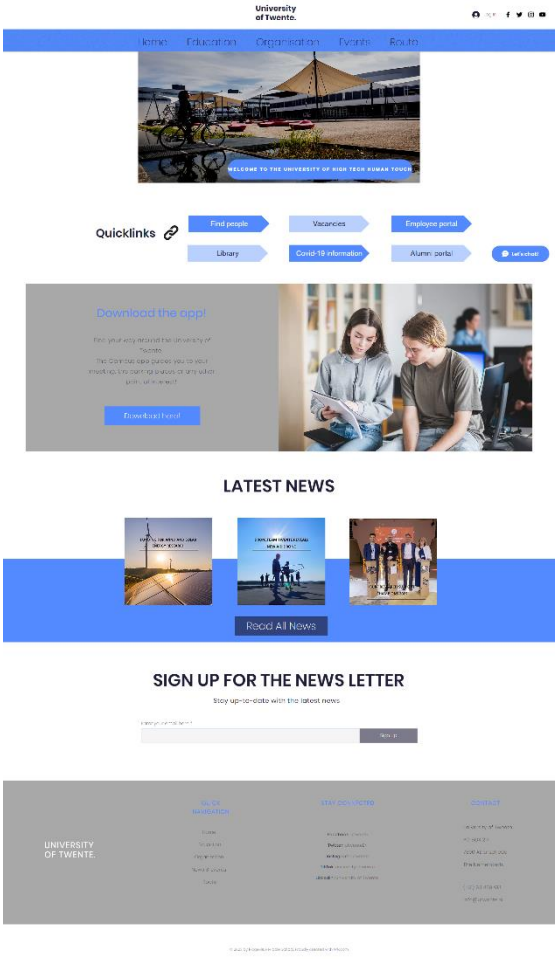


Figure 10

Education page of the low saturated website

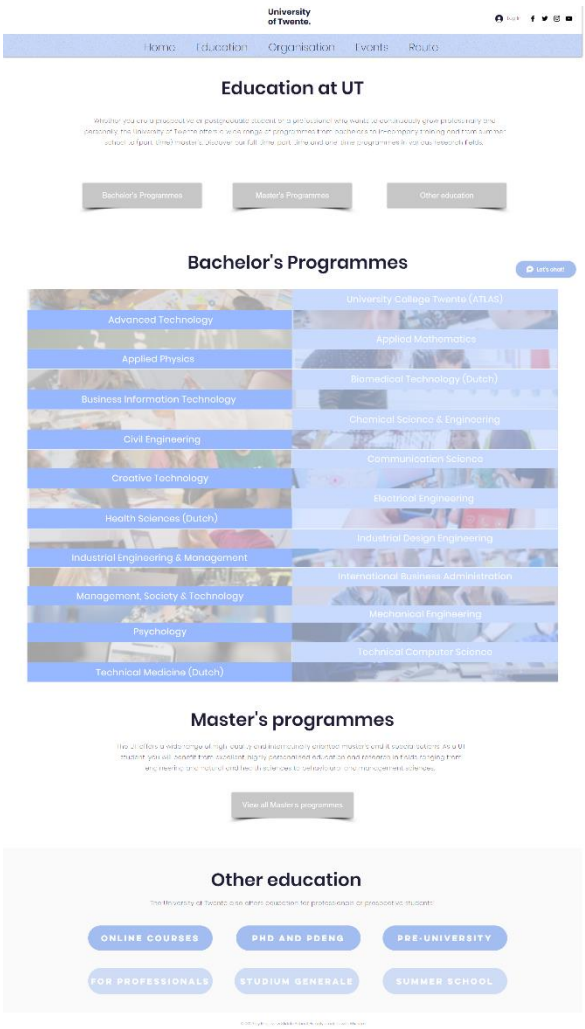


Figure 11

Education page of the high saturated website

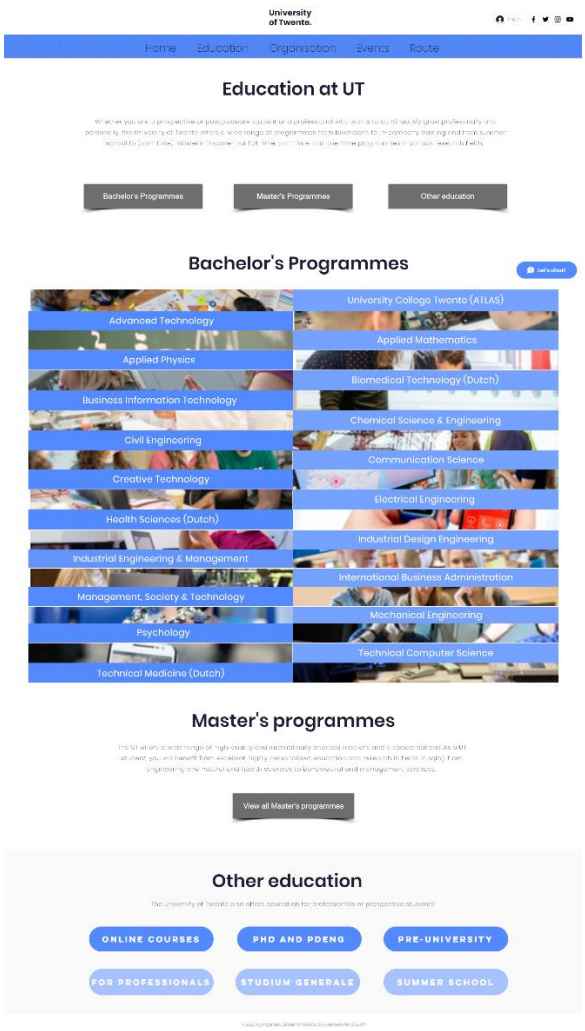


Figure 12

Master's programme page of the low saturated website

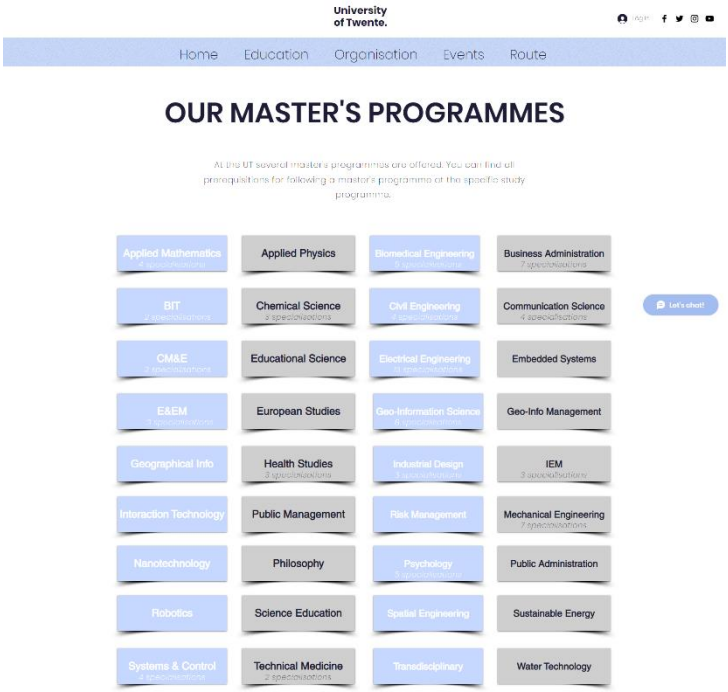


Figure 13

Master's programme page of the high saturated website

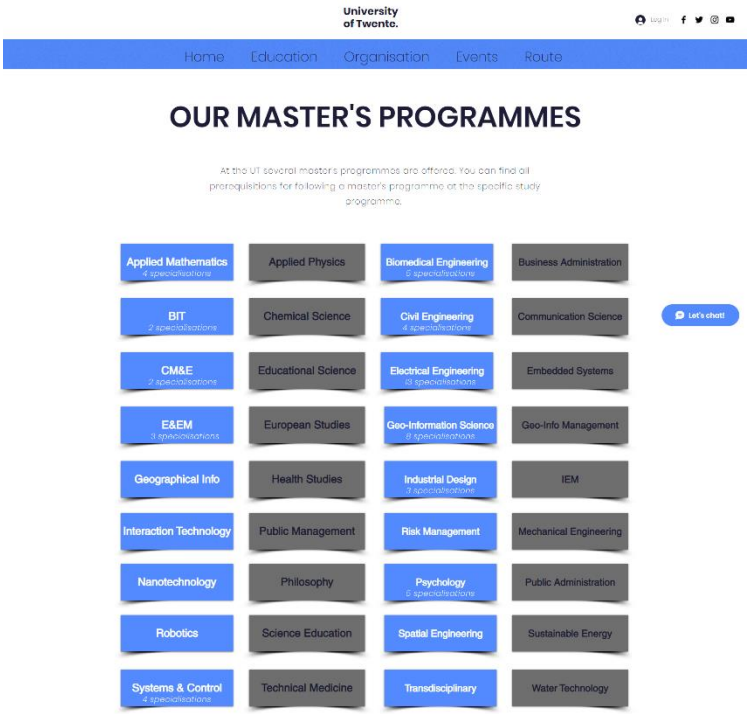


Figure 14

Organisation page of the low saturated website

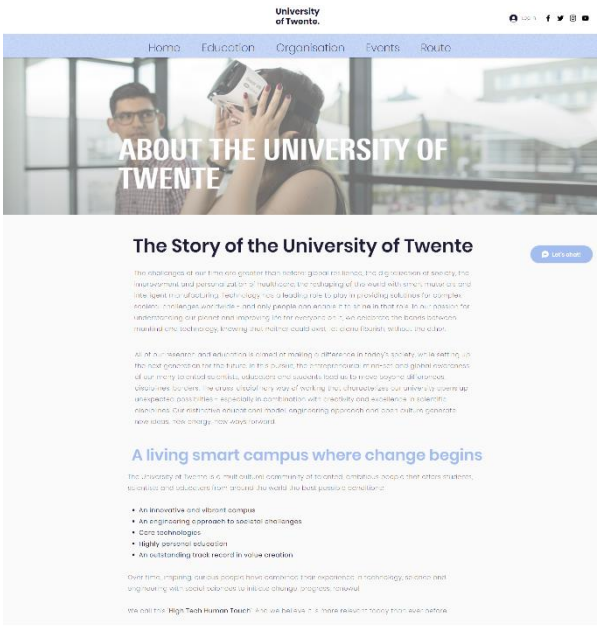


Figure 15

Organisation page of the high saturated website

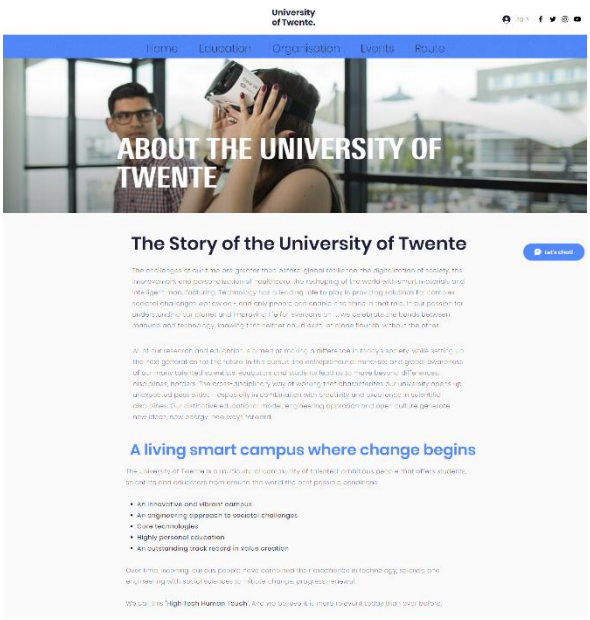


Figure 16

Event page of the low saturated website

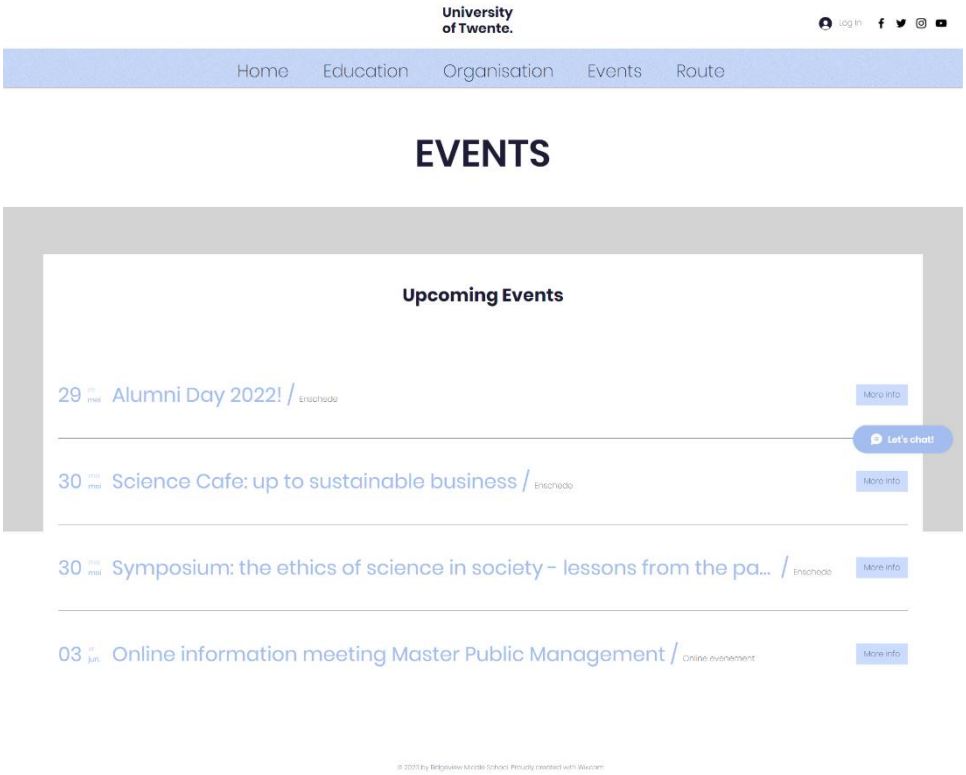


Figure 17

Event page of the high saturated website

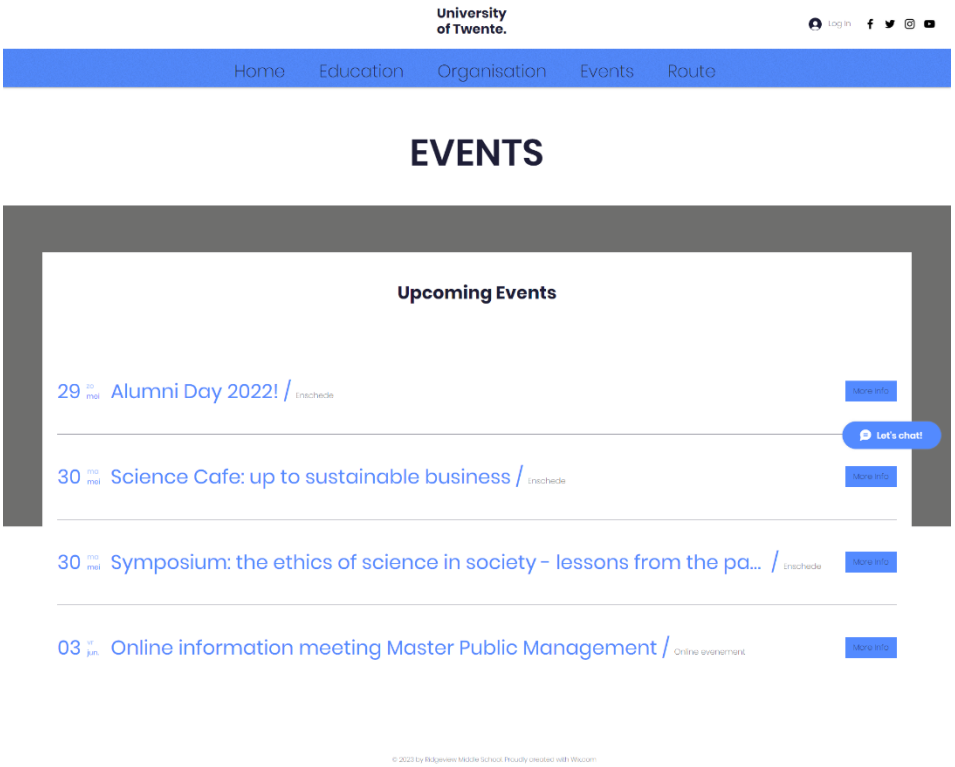


Figure 18

News page of the low saturated website

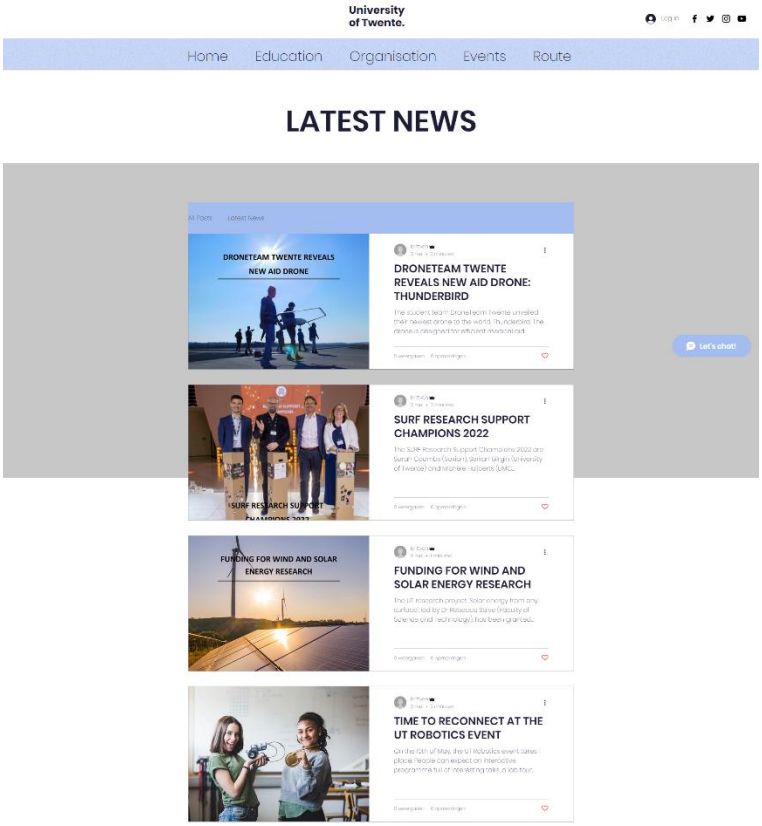


Figure 19

News page of the high saturated website

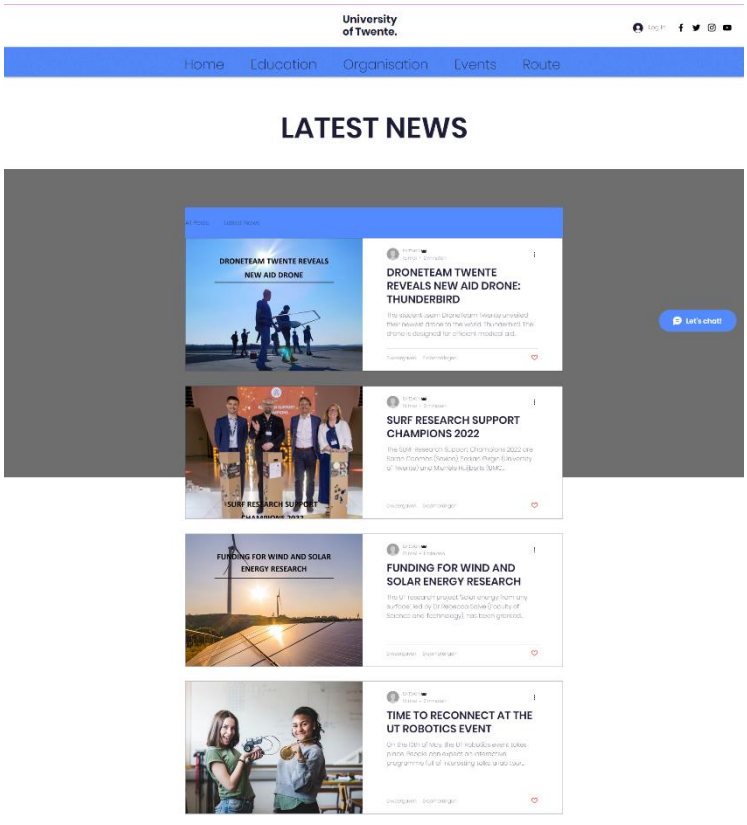


Figure 20

Route page of the low saturated website

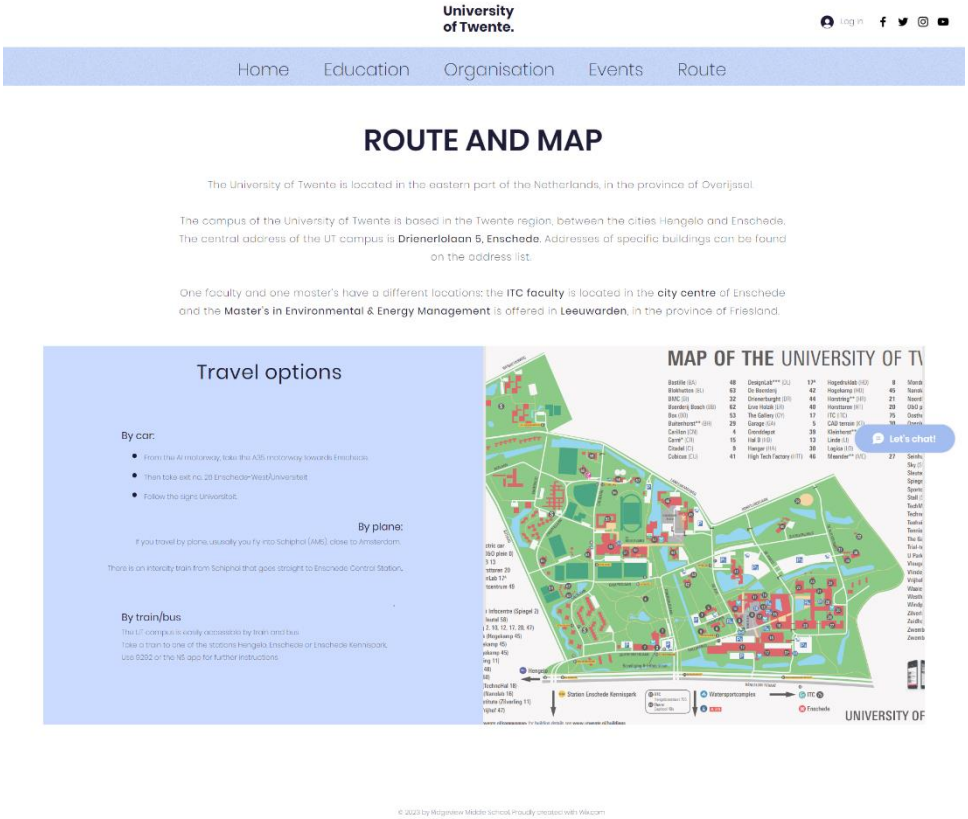
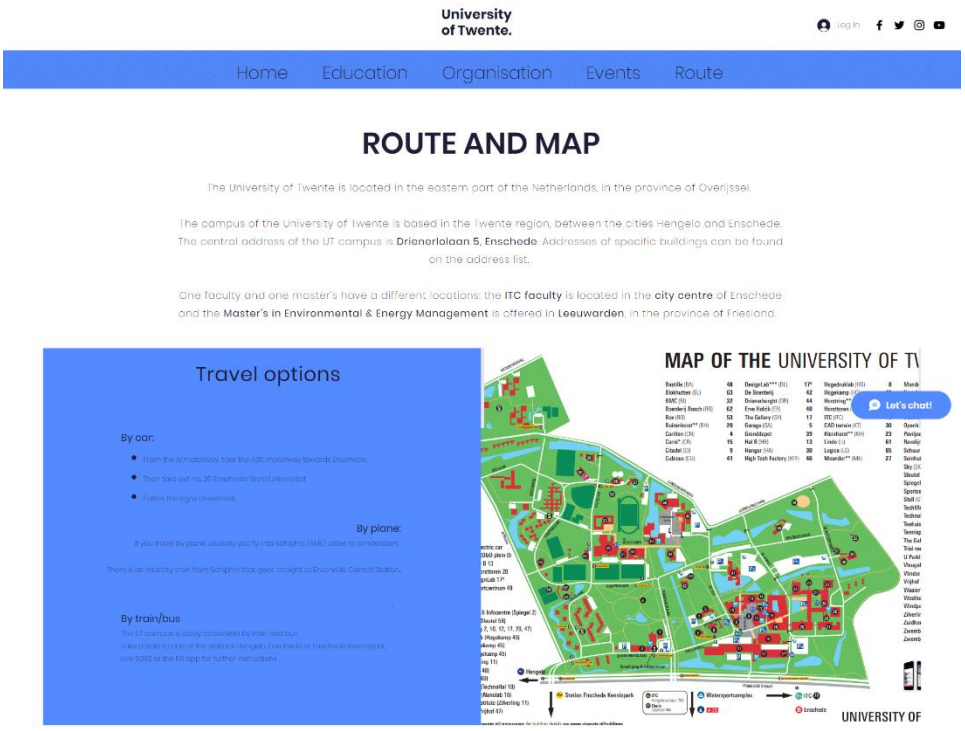


Figure 21

Route page of the high saturated website



Appendix B

Tasks and interview scheme

Introduction

First of all, thank you for participating in this research. This research will investigate differences in usability and user experiences between multiple cultures. After this introduction, you can enter a website and perform tasks on this website. The tasks will be given by me, one after the other. When performing the tasks, it is not allowed to ask for my help, unless it is a practical matter. In between the tasks, I will ask you a few questions. Feel free to answer these questions as detailed as you would like, but please answer these questions with your experiences in mind and as honest as possible. There are no right or wrong answers. I would like to ask you to think-aloud when you are performing a task, so please tell me what you are doing. Please note that you have the right to stop the interview at any time or to refuse to answer any question or perform any task. Moreover, everything you say during the interview will be kept anonymously and you are able to withdraw from the interview at any time. I would now like to ask you for your consent that I will record this interview and use the eye tracker for research purposes only. **Give consent form**.

Tasks to perform on the website

1. Ask 'Where can I find more information on housing?' in the chat.
2. Find out how many study programmes (Bachelor and Master) there are at the University of Twente.
3. Find out what the first news article is on the news page.
4. Find out what the phone number is you need to call when you want to contact the University of Twente.

Interview questions

<u>Demographic questions:</u>

1. What is your age?
2. What is your nationality?
3. Do you identify yourself as men, women, or other?
4. What is your current occupation? If student, which study?

After every task is completed:

1. How would you describe the difficulty of this task?
2. Where did you first start searching when the task was given?
3. [If applicable]: I noticed you did …. Why did you do that?

General questions after completing all tasks:

1) How was your overall experience of the website when completing the tasks?
2) On a scale from 1-5 (1=very easy, 5= very difficult), how difficult were the task assignments? And why?
3) What is your opinion on the design of the website?
4) What did you like the most about the website?
5) What, if anything, caused you frustration or surprised you?
6) On a scale from 1-5 (1 = not at all likely, 5 = very likely), how likely is it that you would recommend using this website to others? And why?

Questions when showing the second website:

1) What is your opinion on the design of the website?
2) Are you more drawn to the first website you saw or to this website shown now?
3) Which website would you prefer to visit? And why?
4) What is the main difference you see between both websites?

Appendix C

Consent form

INFORMATION SHEET

Bachelor Thesis - Communication Science

Britt van de Ven – S2154757

Thank you for agreeing to participate in this study for the Bachelor thesis, conducted by Britt van de Ven.

Purpose of the Study

The purpose of this research is to gain insights into possible differences in usability and user experience of a fictional university website.

Procedures

By participating in this research, you will perform different tasks on a fictional website. This will be done on a computer with an eye tracker. In between, you will answer several questions in an interview.

Potential Risks and Discomforts

There are no physical, legal or economic risks associated participating in this study. You do not have to answer any questions you do not wish to answer.

Confidentiality

Your privacy will be protected to the maximum extent allowable by law. No personally identifiable information will be reported in any research product. Within these restrictions, results of this study will be made available to you upon request. In the report, your name will not be mentioned.

Audio

This research project involves making an audio recording of the interview. This audio recordings will not be used for other purposes than this research. The audio recordings, forms,

and other documents created or collected as part of this study will be stored in a secure location and will be destroyed within ten years of the initiation of the study.

Right to Withdraw and Questions

Your participation in this research is completely voluntary. You may choose not to take part. If you decide to participate in this research, you may stop participating at any time. You will not be penalized or lose any benefits to which you otherwise qualify. If you want to withdraw from the study, you can do this till three days after the interview. The result will not be used anymore after withdrawing from the study.

If you decide to stop taking part in the study, if you have questions, concerns, or complaints, or if you need to report an injury related to the research, please contact Britt van de Ven. This can be done by this email: b.a.a.vandeven@student.utwente.nl

Statement of Consent

I have been given the guarantee that this research project has been reviewed and approved by the BMS Ethics Committee. For research problems or any other questions regarding the research project, the Secretary of the Ethics Commission of the faculty Behavioural, Management and Social Sciences at University Twente may be contacted through ethicscommittee-bms@utwente.nl.

Your signature indicates that you are at least 18 years of age; you have read this consent form; your questions have been answered to your satisfaction and you voluntarily agree that you will participate in this research study. You will receive a copy of this signed consent form.

Consent Form for Research on User Experience and Usability within Website Design

YOU WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I have read and understood the study information or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	□	□
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	□	□
I understand that taking part in the study involves an audio-recorded interview, that will be transcribed as text, and an eye tracker. I am also aware that the data will be destroyed after completing this research.	□	□
Use of the information in the study		
I understand that information I provide will be used for research purposes only, and will be mentioned in the report belonging to this study that might be openly published.	□	□
I understand that personal information collected about me that can identify me, such as [e.g. my name or where I live], will not be shared beyond the study team.	□	□
I agree that my information can be quoted in research outputs	□	□
I agree to both the audio recording and the use of the eye tracker.	□	□

Future use and reuse of the information by others

I give permission for the audio recording and the screen recording of the eye tracker that I provide to be archived in safe possession of the researcher so it can be used for future research and learning. □ □

Signatures

_____	_____	_____
Name of participant [printed]	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Britt van de Ven	Signature	Date

Study contact details for further information:

Britt van de Ven; b.a.a.vandeven@student.utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee/domain Humanities & Social Sciences of the Faculty of Behavioural, Management and Social Sciences at the University of Twente by ethicscommittee-hss@utwente.nl

Appendix D

Times to completion of the tasks

Table 11

Average time to completion for the tasks per condition

Condition	**Task 1**	**Task 2**	**Task 3**	**Task 4**
West-European & low saturation	0,08 sec.	1,04 sec.	0,29 sec.	0,20 sec.
West-European & high saturation	0,12 sec.	1,24 sec.	0,23 sec.	0,26 sec.
Asian & low saturation	0,17 sec.	1,12 sec.	0,39 sec.	0,14 sec.
Asian & high saturation	0,10 sec.	0,80 sec.	0,55 sec.	0,12 sec.

Appendix E

Results two-way ANOVA

A two-way ANOVA was conducted to analyse the effects of saturation and culture on the time to complete task 1. The analyses revealed that there was no statistically significant interaction between the effects of saturation and culture ($F(1,16) = 1.357$, $p = .261$). In addition, a simple main effects analysis showed that saturation did not have a statistically significant effect on the time to complete task 1 ($p = .742$) and culture neither ($p = .500$).

Next, a two-way ANOVA was conducted to analyse the effects of saturation and culture on the time to complete task 2. The analyses revealed that there was no statistically significant interaction between the effects of saturation and culture ($F(1,16) = 1.719$, $p = .208$). In addition, a simple main effects analysis showed that saturation did not have a statistically significant effect on the time to complete task 2 ($p = .777$) and culture did not as well ($p = .383$).

Then, a two-way ANOVA was conducted to analyse the effects of saturation and culture on the time to complete task 3. The analyses revealed that there was no statistically significant interaction between the effects of saturation and culture ($F(1,16) = 0.548$, $p = .470$). In addition, a simple main effects analysis showed that saturation did not have a statistically significant effect on the time to complete task 3 ($p = .817$) and culture neither ($p = .137$).

Lastly, a two-way ANOVA was conducted to analyse the effects of saturation and culture on the time to complete task 4. The analyses revealed that there was no statistically significant interaction between the effects of saturation and culture ($F(1,15) = .645$, $p = .435$). In addition, a simple main effects analysis showed that saturation did not have a statistically significant effect on the time to complete task 4 ($p = .657$) and culture did not as well ($p = .079$).

Appendix F

Heatmaps home, master and news page

Figure 22

Heatmap of low saturated home page with West-European participants

Figure 23

Heatmap of high saturated home page with West-European participants

Figure 24

Heatmap of low saturated home page with Asian participants

Figure 25

Heatmap of high saturated home page with Asian participants

Figure 26

Heatmap of low saturated master page with West-European participants

Figure 27

Heatmap of high saturated master page with West-European participants

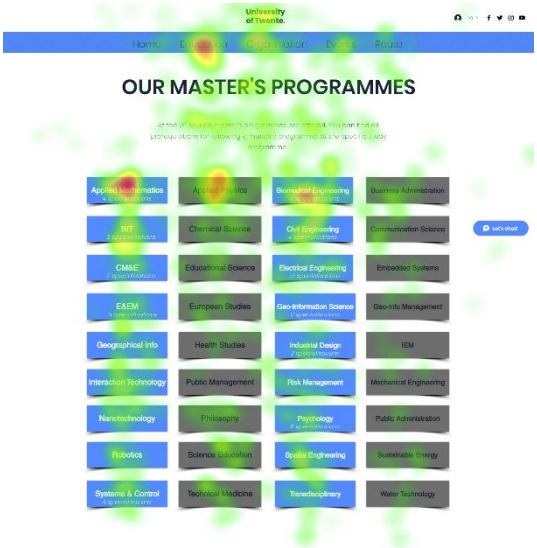


Figure 28

Heatmap of low saturated master page with Asian participants

Figure 29

Heatmap of high saturated master page with Asian participants

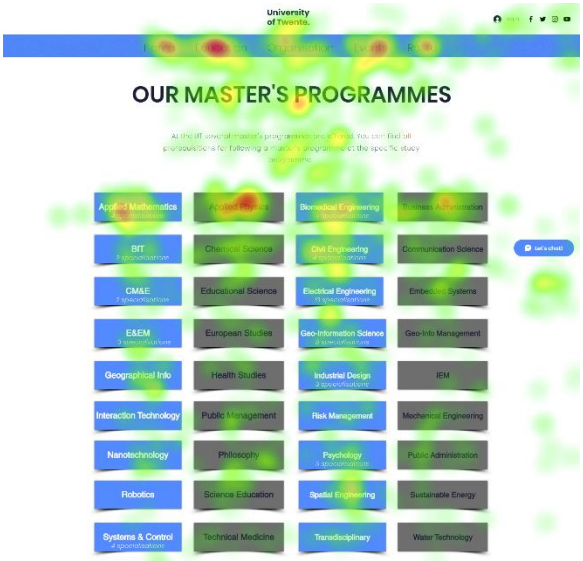


Figure 30

Heatmap of low saturated home page with West-European participants

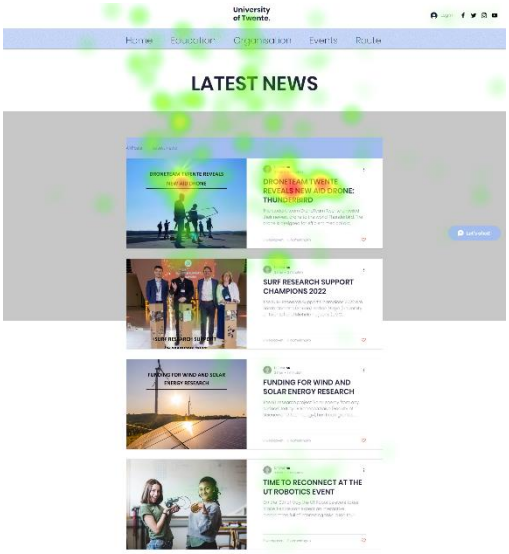


Figure 31

Heatmap of high saturated home page with West-European participants

Figure 32

Heatmap of low saturated home page with Asian participants

Figure 33

Heatmap of high saturated home page with Asian participants