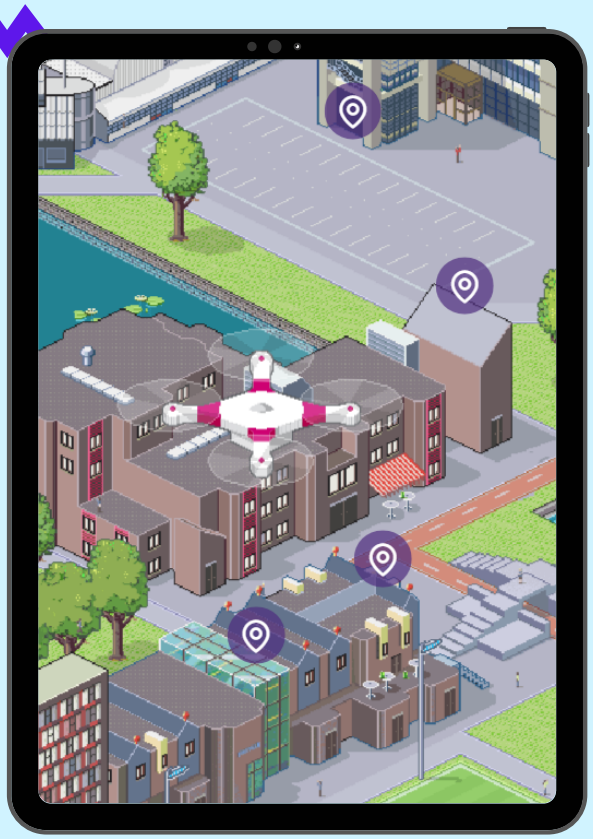
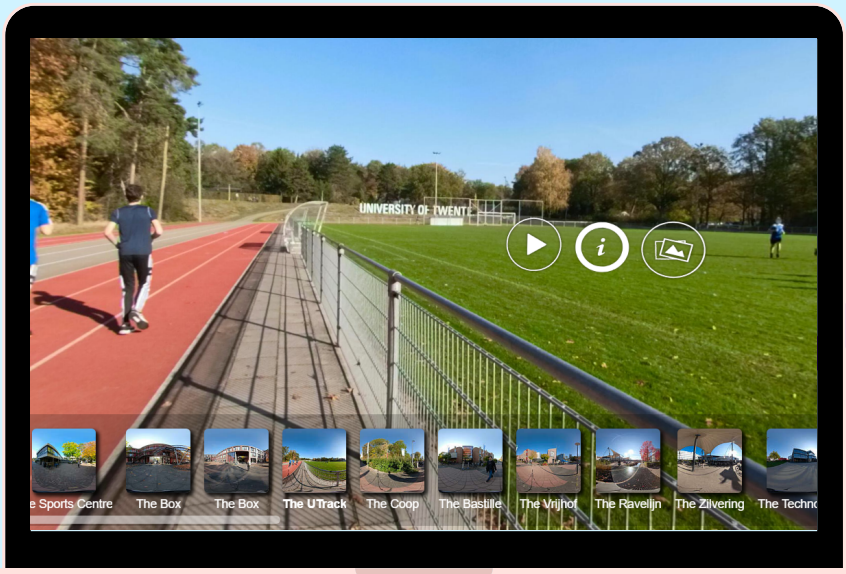
MASTER THESIS

EFFECTS OF A VIDEO TOUR, INTERACTIVE MAP, AND 360-DEGREE VIRTUAL TOUR ON ENGAGEMENT AND INTEREST





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Since I was 16 years old, I dreamt of having a degree abroad in a recognizable world university. This dream brought me to the Netherlands, to the city of Enschede, to the University of Twente. And this master's thesis represents achieving this goal and the end of my student life.

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‘The technology you use impresses no one. The experience you create with it is everything’.

Sean Gerety

Abstract

As the number of interactive technologies increases, various organizations have started using them to improve users' engagement and trigger their interest in purchasing goods or services. For example, in the educational setting, universities around the globe provide campus experience in the form of online campus tours to attract prospective students. This research aims to explore three online campus tours: a not controllable 360-degree video tour, an interactive map, and a 360-degree virtual tour, and their effect on interest to be a student at the University of Twente and three types of engagement (emotional, cognitive, and behavioral) among potential students. The hypotheses have been tested by a single factor experimental design with three conditions (video tour, interactive map, 360-degree virtual tour) among 129 participants. The results indicate that a 360-degree tour, with a high level of perceived control (interactivity) and image quality (vividness), leads to higher excitement (emotional engagement) and concentration on the experience (cognitive engagement) than a video tour. In addition, these relationships are mediated by presence, which provides a feeling of 'being absorbed in a virtual experience'. Further, an interactive map, with a medium level of interactivity and vividness, leads to higher emotional and cognitive engagement than a video tour, without mediational effect.

Keywords: not controllable 360-degree video tour, interactive map, 360-degree virtual tour, interactivity, vividness, immersion, presence, emotional engagement, cognitive engagement, behavioural engagement, interest

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1. Introduction

Rapidly progressing interactive technologies have advanced from simple simulations to fully immersive experiences over the last decade (Bucur et al., 2017). Nowadays, different interactive technologies are applied in tourism (M. J. Kim et al., 2020), e-commerce (Yim et al., 2017), education (Rohizan et al., 2019), and other spheres.

In the educational context, with increasing technology affordance like computers and phones, universities all across the globe embrace interactive technologies to improve student engagement (Bucur et al., 2017). Usually, universities employ them for a few purposes: presentational (providing online campus tours for prospective students), social (as an online communication platform where students can exchange information), and educational (e-learning, for example, 3D interactive platforms) (Bucur et al., 2017). In this research, we will focus on the presentational purpose of employing interactive technologies like embracing online campus tours to attract potential students.

An online campus tour (presentational purpose) is one of the alternatives for prospective students and their parents to ‘walk’ on campus without physically being there (Suwarno & Murnaka, 2020). This kind of experience might significantly influence their ultimate decision on which campus to choose to continue their studies (interest towards a university) (Suwarno & Murnaka, 2020). Moreover, such tours increase users’ engagement during a campus exploration (Rohizan et al., 2019).

Some universities have already employed online tours for prospective students to experience campuses. For example, Radboud University provides a 360-degree controllable

video tour[1]; Rice University uses an interactive map[2]; and Harvard College has a 360-degree tour[3] to show the interior and outside areas of their campuses.

In this research, we will compare the effects of online tours, such as not-controllable 360-degree video tour[4] with a background narrative, an interactive campus map[5], and a 360-degree virtual tour[6] of the University of Twente, on users' engagement and interest towards the University of Twente.

Various interactive technologies have different levels of control (interactivity) and image clarity (vividness) of an environment. For this research, we have considered that a video tour has a low level of interactivity and vividness, an interactive map medium and a 360-degree virtual tour high (Algharabat & Dennis, 2010; Flavián et al., 2018).

Moreover, with an increasing level of control (interactivity) and image sharpness (vividness), the feeling of 'being in a virtual experience' (presence) also increases. In this study, an interactive map leads to a higher presence than a video tour. At the same time, a 360-degree virtual tour provides a higher level of presence than an interactive map and video tour.

According to Flavián et al. (2020), Khalifa and Shen (2004), and Li et al. (2013), a higher level of interactivity and vividness, mediated by a higher level of presence, lead to a higher level of excitement and pleasure (emotional engagement); concentration on the experience (cognitive engagement); sharing and searching for information about an experienced online place (behavioural engagement); and interest towards an experienced online area.

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[1] https://www.youtube.com/watch?v=GEI7n3HRPPw&t=74s&ab_channel=RadboudUniversity
[2] https://experience.rice.edu/explore-map
[3] https://college.harvard.edu/admissions/explore-harvard/virtual-tour
[4] https://www.youtube.com/watch?v=Ds3ymZU3-dc&ab_channel=MarcioLimadeOliveira
[5] https://www.utwente.nl/en/campus/campus-experiment/
[6] https://merijnreerink.com/360-virtual-tour/

As a primary objective, this research aims to investigate if interactive technologies corresponding to low, medium, and high levels of interactivity and vividness, mediated by low, medium, and high levels of presence, lead to low, medium, and high interest, emotional, cognitive, and behavioral engagement levels, respectively. Therefore, the research question is:

'To what extent do online tours (a video tour, an interactive map, and a 360-degree virtual tour), with increasing levels of interactivity and vividness, have an effect on interest and engagement (cognitive, emotional, and behavioural), mediated by presence?'

2. Theoretical Framework

In the following sections, we define concepts such as interactivity (control) and vividness (levels of clarity, details, and sharpness). Then, by defining immersion (technological quality), presence ('being here' or 'being there'), interest, emotional, cognitive, and behavioural engagement, we show how interactivity and vividness affect them. Further, we describe how interactivity and vividness are related to a video tour, interactive map, and 360-degree virtual tour. Finally, we explain the impact of online tours on presence, interest, and engagement.

2.1 Interactivity

The research of Cheung et al. (2020) showed that one of the key elements of interactive technologies for increasing engagement is interactivity. Interactivity is the user's ability to control and manipulate an object or an environment (Flavián et al., 2018). It includes some key elements like speed, mapping, and range. The speed element refers to how fast an object can be controlled. Mapping refers to the similarity between virtual and real environments. Finally, range refers to how broadly an object can be operated (Yim et al., 2017). According to the EPI (The Embodiment, Presence, Interactivity) Cube (Flavián et al., 2018), there is a continuum from low interactivity (just 'navigation control' or 'navigability in the media') to high interactivity (ability to control and modify object/environment) of technologies. 'Navigation control' is the ability to change presented content; 'navigability in the media' is the act of clicking on clues and observing the follow-up activities on the screen. At the same time, manipulation is the ability to change characteristics - like shape, position, form, and state of an object (Flavián et al., 2018).

2.2 Vividness

Vividness is strongly related to interactivity. Researchers like Algharabat and Dennis (2010), Li and Meshkova (2013), and Yim et al. (2017) use interactivity and vividness as essential and inseparable parts of virtual experience. Vividness (media richness) is the technology's capacity to provide a rich computer-mediated environment. Vividness includes two essential elements: depth and breadth. Depth refers to the quality of the information provided in the perception of media users. Breadth refers to the number of sensory dimensions that the communication environment can deliver. For example, having poor quality computer graphics might lead to a low level of vividness (Yim et al., 2017).

2.3 Immersion and Presence

Interactivity (control/navigation) and vividness (media richness) are the antecedents of the presence and immersion (Algharabat et al., 2017; H. Li et al., 2013). Presence can be increased through movement control or the ability to change the environment (interactivity) and media richness (vividness) (Khalifa & Shen, 2004). The sense of presence is higher for active users who are in control of their movements rather than passive observers (Khalifa & Shen, 2004).

Immersion, which is an antecedent of presence (Flavián et al., 2018), helps users to better concentrate on what is in front of them, potentially improving the enjoyment of the experience (Flavián et al., 2018). Different types of devices can provide different levels of immersion which can be ranked from external devices, like desktop computers, to internal devices as embeddable technologies. More sophisticated technologies that provide a greater sense of embodiment provide a more immersive experience by creating a sense of proximity between a technology and a user (Flavián et al., 2018).

During an immersive experience, a user can feel the sensation of presence. The psychological state of being transferred to a different place outside of the real human body is known as presence. Presence is linked to transportation, which means that human awareness is moved to a new location, entirely different from where this person is now (‘being there’). For example, reading a book, watching a movie, listening to music may generate a sense of presence (Flavián et al., 2018; Wu & Lai, 2021).

In other words, immersion, being an antecedent of presence, represents the technological quality, which relies on the capabilities of the technology, while presence is a psychological state of the user’s consciousness (Flavián et al., 2018).

2.4 Engagement and Interest

Interactive technologies that provide vivid object visualization with navigation control for users lead to positive affective evaluations (McLean & Wilson, 2019). Engagement is characterized by the *‘user’s cognitive, temporal, affective, and behavioral investment when interacting with technologies’* (Flavián et al., 2020). In addition, there are three types of user engagement: cognitive, emotional, and behavioral.

Cognitive engagement is related to the mental states of attention and absorption. Attention defines the availability and quantity of time being focused, while absorption is the amount of user’s attentiveness and immersion.

Emotional (affective) engagement refers to the user’s overall emotional response to a particular experience. Emotional engagement consists of enthusiasm and enjoyment. Consumer enthusiasm demonstrates the level of the user’s excitement and interest, while enjoyment is associated with pleasure.

And finally, behavioral engagement defines the understanding of consumer's actions, forced by motivational drivers. In essence, these actions shape social behaviors such as sharing, learning, and endorsing. Sharing and learning are about searching for information, experiences, and thoughts while endorsing is about approving and supporting. One of the outcomes of behavioral engagement is the user's recommendations and word of mouth. The study by McLean and Wilson (2019) suggests that when interactivity and vividness increases, engagement also increases.

In e-commerce, after a virtual experience, users may exhibit a higher level of purchase intention. Purchase intention is a consumer reaction to a marketing stimulus or product evaluation (T. Li & Meshkova, 2013). In this research, the term 'interest' will be used instead of 'purchase intention', which defines student reaction characterized by applying and paying tuition fees for a desired university. According to Flavián et al. (2020), interest (or purchase behavior) is related to engagement, and a higher level of interactivity and vividness (therefore presence and immersion) leads to an increased level of purchase intention and engagement (H. Li et al., 2013).

2.5 Online Campus Tours

Information about a place can be transferred by means of an online tour. An online tour can have various interactive elements like storytelling, navigation, virtual scenes, gamified aspects, and other features (Argyriou et al., 2020).

This section will explain how online campus tours (a video tour, an interactive map, and a 360-degree virtual tour) have different levels of interactivity and vividness, mediated by presence, affect the users' engagement and interest.

2.5.1 Video Tour

According to the research of Yadav et al. (2011), video-based information outperforms text-based information by triggering higher levels of users' engagement. One of the popular types of online tours is a panoramic video, which provides users with 360-degree images of a selected area. In addition to 360-degree pictures, a video tour can have background narration, which helps users learn more about a place during their online journey (Feng et al., 2019).

For this research, a video tour, when compared to other media technologies, represents a low navigation control as the users can only play, pause, or fast forward. Users have a 'passive observer' experience, perceiving information by simply watching 360-degree shots and listening to a narrative without any control of the environment (Spielmann & Mantonakis, 2018). According to the research by Flavián et al. (2018), such video tour leads to a low interactivity and, therefore, low level of presence.

2.5.2 Interactive Map

An interactive map is another type of online tour. It can include gamified elements to better engage users in exploring the desired location (Fitz-Walter et al., 2011). The idea of enriching tours with gamification elements is not novel and is already actively used in tourism (Gordillo et al., 2013) and educational settings (Argyriou et al., 2020). Gamification is 'the use of game design elements in non-game contexts' (Gordillo et al., 2013). Gamified-like features can help build a greater engagement between users (Argyriou et al., 2020; Pettit et al., 2015). Such a setting challenges the mindset of users and encourages them to explore more of the storyline (Argyriou et al., 2020).

According to the study of Minhas-Taneja (2017), one of the most significant successes for the University of Auckland was the introduction of an interactive map with gamification

aspects that helped students to understand better various services on campus. In addition, the developers included several interactive games and quizzes to the map, which also helped increase student engagement. However, since gamification does not directly provide information about a location, the creators balanced the quizzes with informational text.

For this research, an interactive map has a 'pixelated' appearance and provides information about the campus with clickable hotspots. Hotspots are the spots that provide user interaction, such as navigation or informational buttons (Osman et al., 2009). Our interactive map allows the user to navigate the UT campus area by flying a drone (as a game), clicking on hotspots consisting of descriptions, pictures, and videos. Since such an interactive map provides more navigation options than a video tour, it has a higher level of interactivity than our video tour.

Regarding vividness, even though the scheme of our map has a 'pixelated' image inspired by old 90's games, a great portion of the experience has a high-quality appearance due to the included hotspots. In addition, since an interactive map can be more controlled than a video tour, this type of interactive technology leads to higher interactivity and vividness, therefore higher immersion and presence, than a video tour when using an external device (such as laptops or phones). As mentioned before, higher levels of interactivity and vividness, mediated by presence, lead to higher levels of interest, emotional, cognitive, and behavioral engagement. Thus, our hypothesis is:

H1*: An interactive map (with medium level of interactivity and vividness), mediated by higher presence, leads to higher a) emotional, b) cognitive, c) behavioral engagement and d) interest toward UT than a video tour (with low level of interactivity and vividness).*

2.5.3 360-degree Virtual Tour

The last type of online tour used in our research is a 360-degree virtual tour. A 360-degree virtual tour can help visitors experience a place by immersing themselves in the virtual surroundings (Wu & Lai, 2021). It can be created by stitching overlapping photos (Wu & Lai, 2021) or automated 360-degree photography (Sheppard et al., 2017). Various universities have 360-degree pictures of campus areas, such as lecture rooms, study areas, sports locations, laboratories, and other facilities, to provide potential students with an extensive campus experience (Suwarno & Murnaka, 2020).

For this research, our 360-degree virtual tour provides users with a large range of navigation options such as 'walking' through arrow signs, menu buttons, and by clicking on the map. In addition, there are clickable hotspots containing text, videos, and pictures. This tour allows environment manipulation by rotating and zooming in or out of 360-degree images (Spielmann & Mantonakis, 2018). Since 360-degree tours have high levels of environment control (interactivity), they also have a high level of presence.

According to Yim et al. (2017), 360-degree virtual tours are more vivid than interactive maps due to the difference between the 'real world' (360-degree controllable pictures) and a 'gamified' map with real pictures and videos.

In addition, higher levels of interactivity, and vividness, mediated by a higher level of presence, lead to higher levels of interest, emotional, cognitive, and behavioral engagement. Thus, the following hypotheses are:

H2*: A 360-degree virtual tour (with high level of interactivity and vividness), mediated by higher presence, leads to higher a) emotional, b) cognitive, c) behavioral engagement and d) interest toward UT than a video tour (with low level of interactivity and vividness).*

H3: *A 360-degree virtual tour (with high level of interactivity and vividness), mediated by higher presence, leads to higher a) emotional, b) cognitive, c) behavioral engagement and d) interest toward UT than an interactive map (with medium level of interactivity and vividness).*

In addition, Figure 1 represents the research model of this study, while Figure 2 represents a continuum of conditions with manipulations and mediator.

Figure 1

Research Model

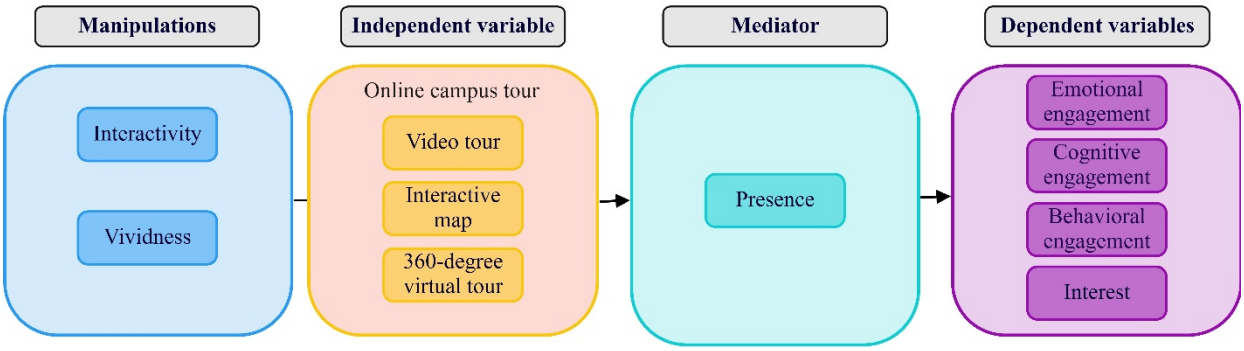
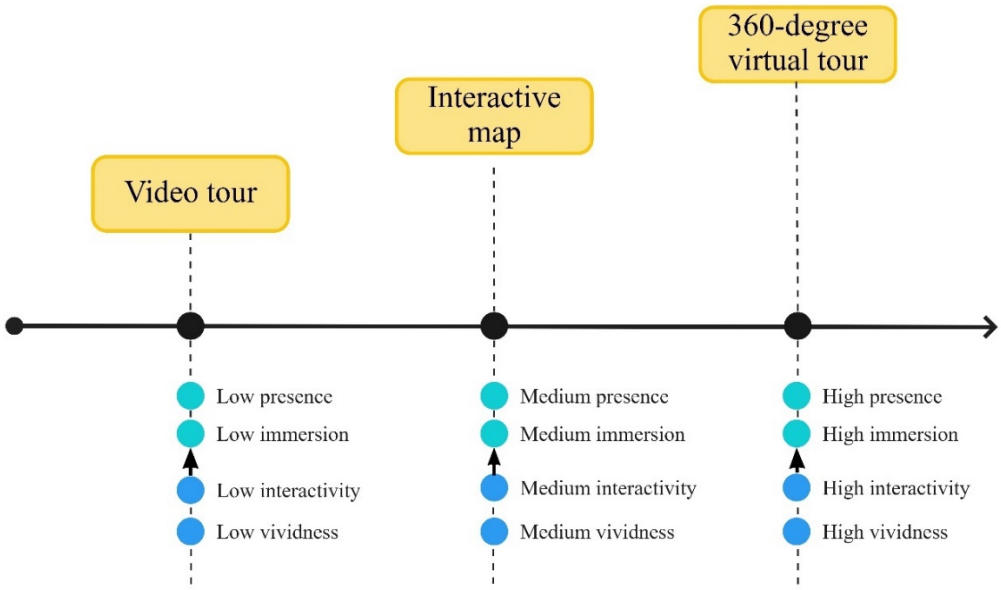


Figure 2

Continuum of Interactivity, Vividness, Immersion, and Presence



3. Methods

This section presents the outline, justification, and elaboration of research methods and instruments. The structure of this chapter follows the sequential order: Experimental Design and Stimuli, Pre-test, Data Collection Procedure, Sample, and Measurements.

3.1 Experimental Design and Stimuli

For hypothesis testing, this research applied an experimental between-subjects design. The independent variable of this study was 'online campus tour' and consisted of three conditions: a video tour, an interactive map, and a 360-degree virtual tour.

We created the video tour and the 360-degree tour from scratch while the interactive map already existed as a part of the 'Suitability Walk'[7] project. The first step of producing all three conditions was writing down a script containing different campus areas. Our video tour had the least number of places as, otherwise, it would be too long, while the interactive map and the 360-degree tour had an equal number of campus areas that could be visited. The video tour had an audio description of the facilities, while the interactive map and the 360-degree tour had texts, 2D images, and 2D videos. In addition, the 360-degree tour also included controllable 360-degree videos. For the video tour, the audio description of the facilities was retrieved from the YouTube channel 'Student Report'[8]. For the interactive map and the 360-degree tour, we extracted the descriptions of the buildings and open areas from two existing tours: 'A walking tour of the campus: architecture & art'[9] and 'De Campus van A tot Z'[10]. The 2D pictures were found on Google, while 2D videos were retrieved from various websites.

[7] https://www.utwente.nl/en/sustainability/sustainability-walk/
[8] https://www.youtube.com/watch?v=asd0qX9I5Rk&ab_channel=StudentReport
[9] https://www.utwente.nl/en/campus/buildings-rules/architecture-en-art-walking-tour.pdf
[10] https://issuu.com/utwente/docs/2010313_ut_driveuthrough_vervolg_feitenboekje_a5_v

A colleague from the Marketing Department provided the controllable 360-degree videos for the 360-degree tour.

In the following subsections, we will explain the creation of the three online campus tours.

3.1.1 Interactive Map

Our interactive map[11] had a gamified look where all the buildings had a 'pixelated' appearance (Figure 3). The map's navigation could be achieved by controlling a flying drone through a mouse or keyboard.

Figure 3

The Main Page of the Interactive Map

The original map, extracted from the 'Suitability Walk' project, consisted of information about sustainability on the campus. To change the content from sustainability information to an informational tour about the campus for potential students, we had to use WebHare. Using

[11] https://www.utwente.nl/en/campus/campus-experiment/

WebHare, the sustainability content was substituted with the new hotspots, which contained new 2D pictures, 2D videos, and relevant text pieces (see Figures 4 and 5).

Figure 4

Image and Text Hotspot of the Interactive Map

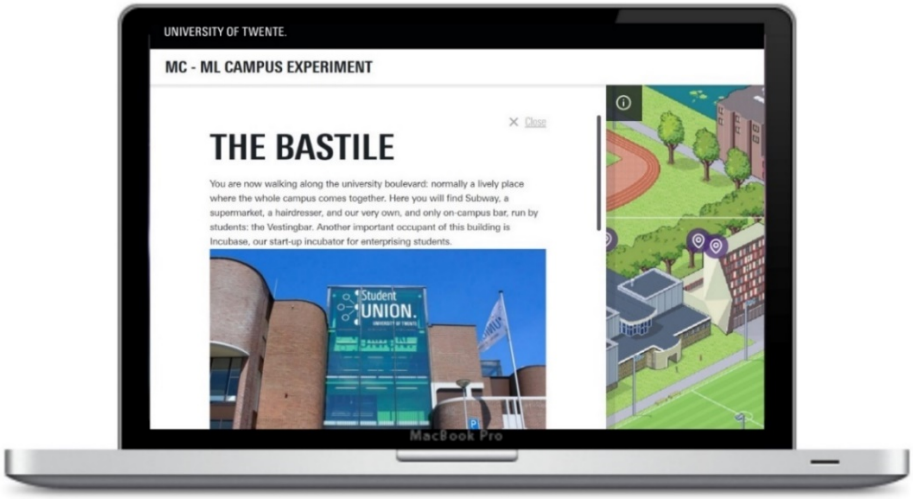
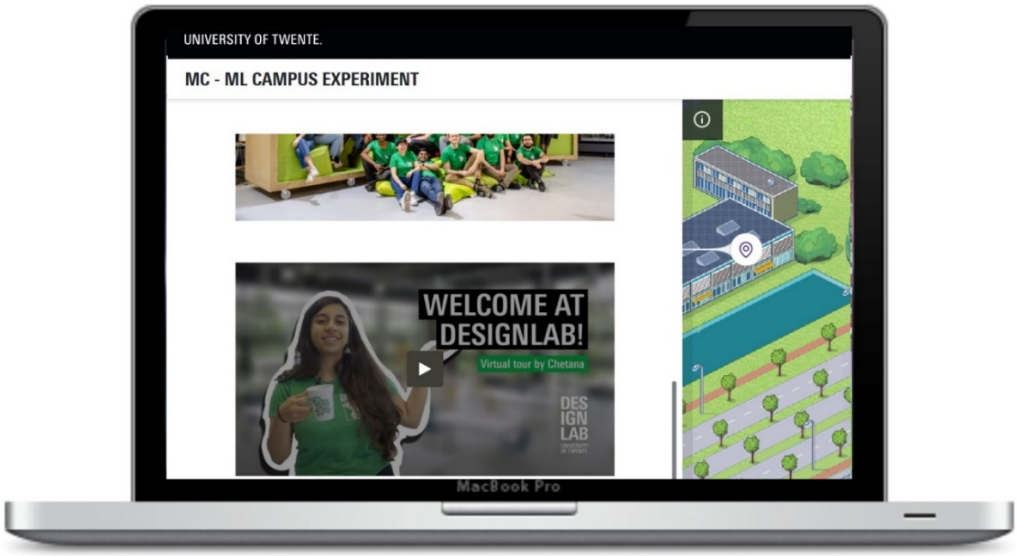


Figure 5

Video Hotspot of the Interactive Map



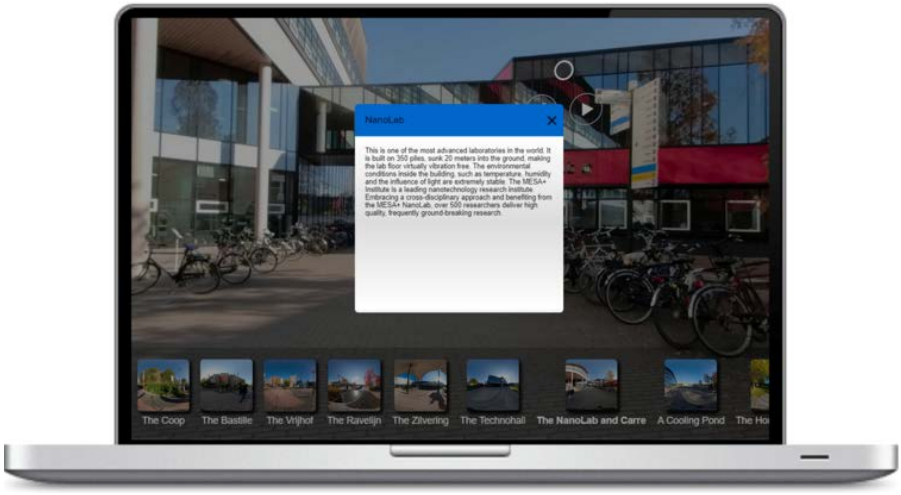
3.1.2 360-degree Virtual Tour

Since the University of Twente did not have existing 360-degree pictures, we had to record them by ourselves. In addition, the sunny weather had to be considered for a better visual appearance of the pictures. In total, we spent three days taking pictures with the 360-degree camera (a GoPro Fusion 360 Degree Camera) borrowed from the Marketing Department. Due to the time limitation with the upcoming Open Days, one day of work was delegated to the student assistant from the Marketing Department.

Further, the Marketing Department purchased access to the professional virtual tour software – 3D Vista. After receiving the pass, we could create the hotspots on the 360-degree pictures and fill them with the content. There were four types of hotspots: texts, 2D images, 2D videos, and controllable 360-degree videos (see Figures 6, 7, 8, and 9). Each area of our 360-degree virtual tour[12] could have a minimum of one and a maximum of four hotspots (Figure 10).

Figure 6

An Example of a Text Hotspot in the 360-degree Tour



[12] https://merijnreerink.com/360-virtual-tour/

Figure 7

An Example of a 2D Image Hotspot in the 360-degree Tour

Figure 8

An Example of a 2D Video Hotspot in the 360-degree Virtual Tour

Figure 9

An Example of a Controllable 360-degree Video Hotspot in the 360-degree Tour

Figure 10

An Example of a 360-degree Picture with Three Hotspots in the 360-degree Tour

Besides the hotspots, the 360-degree tour had a main menu (consisting of two lists of the campus places), a general information button, a welcome information button, and the campus map. Therefore, the users could navigate between the areas in a few ways, such as using the top screen list with categories like ‘Study places’, ‘Educational buildings’, ‘Sports’, ‘Accommodation’, and ‘Campus facilities’; the bottom screen list of all the locations; and the top right corner map that showed the user's current location with a red semi-circle around the spot (Figure 11).

Additionally, nearby areas were connected by the arrow signs, which were placed on the ground of some 360-degree pictures. Moreover, entering or exiting a building was possible by clicking on animated door signs.

Figure 11

The Campus Map of the 360-degree Virtual Tour Showing User’s Current Location

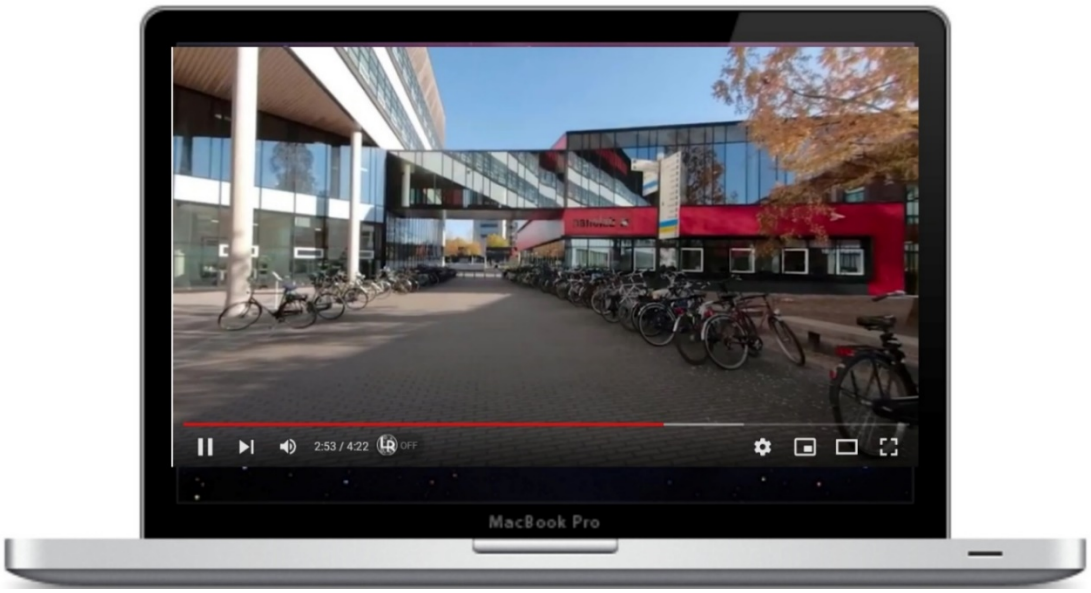
3.1.3 Video Tour

360-degree video tours over five minutes might cause physical discomfort like dizziness, being the optimal length between three and five minutes (Shadiev et al., 2021). Therefore, our video tour[13] had four minutes and twenty two seconds. In order to produce the video tour, we used the same 360-degree pictures as in the 360-degree tour, but in a smaller quantity, with only the essential information about the campus.

Our video tour was composed of rotating 360-degrees pictures. Additionally, we synchronized the visuals with a background narration. This type of 360-degree video (Figure 12) was not controllable by the user. Users could only watch the rotation scenes of the areas and listen to their descriptions. The only possibility to navigate through the video was to play, pause, fast forward, and stop.

Figure 12

The Not Controllable 360-degree Video Tour



[13] https://www.youtube.com/watch?v=Ds3ymZU3-dc&ab_channel=MarcioLimadeOliveira

3.2 Pre-test

Before the experiment, it was necessary to conduct a pre-test to evaluate the levels of interactivity and vividness of the online campus tours. Moreover, each participant experienced the three tours using a think-aloud method and answered questions regarding their perception of interactivity and vividness.

All five selected candidates were already familiar with the campus prior to this research. The sessions were carried through Google Meets. After connecting to the meeting, the candidates read the consent form. Then, they listened to the aim and instruction of this study. Each participant experienced all three online campus tours. They started by watching the video tour, commenting on it, and answering questions on a scale from one to seven (1 = strongly disagree, 7 = strongly agree) about the interactivity and vividness of the video tour. In the sequence, the respondents experienced the interactive map commenting on each step of their journey and answering the questions about the interactivity and vividness of the map. Lastly, they explored the 360-degree virtual tour by commenting and answering the same questions. Afterwards, the respondents received the whole questionnaire via WhatsApp to check for general mistakes.

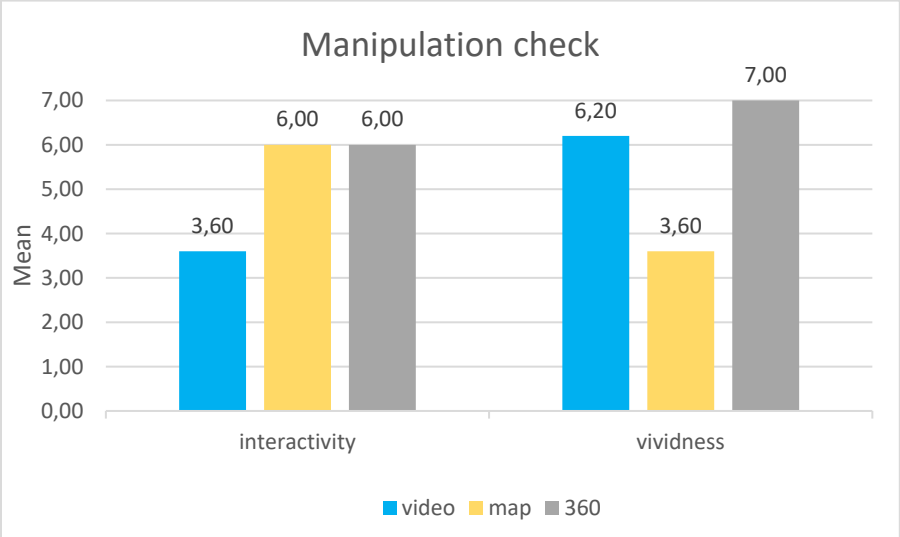
The pre-test results correlated partially with the established levels of interactivity and vividness in the theoretical framework (Figure 2). Firstly, the between-subject test indicated the statistical significance for interactivity F (2,12) = 3.94, p = .48, and for vividness F (2, 12) =5.57, p = .019.

The video tour had the lowest interactivity level (M = 3.6; SD = 2.2), while the interactive map (M = 6; SD = 1) and the 360-degree tour (M = 6; SD = 1.22) had the same level of interactivity (Figure 13). This can be explained by using the participants' comments. First of

all, each of the five participants saw the campus physically. Moreover, three out of five participants were university students going to the UT campus periodically. Based on their comments, the 360-degree tour was very detailed redundant as they were familiar with most of the places. The interactive map introduced novelty for them, as they had never seen a gamified version of the campus before. That might be a reason why the 360-degree tour was not more interactive than the interactive map. At the same time, some of them commented that the 360-degree virtual tour would be a great experience for potential students, especially those who have never seen the campus physically. In addition, the participants underlined that the interactive map was a fun and interesting experience that gave them a short overview of the campus from an aerial view, although it did not provide a full realistic view of the campus (thus the lowest level of vividness).

Figure 13

The Level of Interactivity and Vividness per Condition



Regarding the vividness of the online tours (Figure 13), the interactive map had the lowest level of vividness (M = 3.6; SD = 2.8), followed by the video tour (M = 6.2; SD = 0.83) and 360-degree tour (M = 7; SD = 0.0). The reason could be that they already knew the campus,

and a more detailed version of it would look more vivid to what they recalled as being the campus.

Based on the respondents' comments, some adjustments were made. Before the data collection, firstly, we remade the video tour due to complaints about the fast-speeding shots and lag. Thus, we rerecorded 360-degree at a slower pace. Additionally, we embedded the campus map in the 360-degree tour, where users could see their current location.

3.3 Data Collection Procedure

The research was conducted by means of an online experiment. The questionnaire and embedded links for the three conditions were stored in Qualtrics.

The participants were reached through various events at the University of Twente and different social media channels. Non-probability sampling method, called convivence sampling, was used to conduct this experiment.

The data collection started on the Open Days of the University of Twente: 19th of November (for master's students) and 20th of November (for bachelor's students). Throughout these two days of events, our experiment was introduced four times in live sessions of Communication Science and two live sessions of 'Life as a student'.

Furthermore, we presented our research during: 'Taster Day' for bachelor's in Psychology, where participants could follow the experiment by scanning a QR code; International Webinar for potential Computer Science students, through a pre-recorded video; and for participants of the 'Student for a Day' program, where the survey link was distributed among potential students. In addition to official university events, prospective students were attained through Facebook, Telegram, and WhatsApp groups.

3.4 Sample

A total of 231 people entered the link, but only 129 people experienced one of the online tours and finished the survey. Moreover, 45 people dropped the questionnaire right after experiencing the campus online. The sample of respondents who completed the whole questionnaire consisted of 73 men (56.6%), 54 women (41.9%), and two non-binary people (1.6%), with the mean age being 23.8 (*SD* = 7.1) years old. In Table 1, it is possible to see the distribution of gender and age per condition. The majority of the participants were born outside of the European Union (EU) (46.5%), followed by EU students (34.9%) and Dutch (18.6%).

Table 1

Distribution of Sample Characteristics

	Video		*Map*		360 tour	
Age [a]	*M* =24/*SD* =9.01		*M* =22.3/*SD* =4.42		*M* =24.8/*SD* =7.04	
Gender [b]	Male	56.80%	Male	48.80%	Male	63.60%
	Female	40.90%	Female	48.80%	Female	36.40%
	Non-binary	2.30%	Non-binary	2.40%	Non-binary	

a) Mean + SD of self reported age

b) Percentage division Male / Female

Furthermore, 124 respondents (96.1%) participating in the experiment were potential students, and five respondents were parents of prospective students (3.9%). The majority of participants, 96 people (74.4%), used a laptop or desktop computer for campus experience, and only 30 respondents (23.3%) used a mobile phone. The mean time of the participants watching the video tour was 3.6 minutes, while for the interactive map and 360-degree tour the difference in time was small: 4.03 minutes and 4.04 minutes, respectively.

3.5 Measurements

The survey consisted of 12 parts: consent, demographics questions, questions regarding future study, a link to one of the tours, navigation, interactivity, vividness, cognitive, emotional, behavioural engagement, immersion, presence, and interest blocks. In the end, the participants could leave their comments and access all of the other online campus experiences. Each participant received the same questionnaire although experiencing different online tours.

3.5.1 Validity and Reliability

A factor analysis was used to ensure that the five constructs were recognized as separate constructs in this study (see Table 2). All scales were evaluated using the commands like a fixed number of factors, varimax method with rotated solution, sorted by size, and suppressed small coefficients below 0.55. The rotated component matrix result revealed the need to eliminate six items.

The engagement part consisted of the three cognitive, emotional, and behavioral dimensions. The items of cognitive engagement were based on the research of Wu & Lai (2021), while emotional and behavioral types were created based on the research of Flavián et al. (2020). The reliability test was carried out, and Cronbach's alpha showed the acceptable level of three types of engagement (α = .92; α =.92; α =.82 respectively).

The interest construct was reworked and created based on the Kim & Forsythe (2007) research. The Cronbach's alpha illustrated a sufficient level of reliability (α = .79). The constructs of immersion and presence were based on the research of Wu & Lai (2021). The Cronbach's alphas showed a high level of reliability (α = .82; α = .90). The 7-point Likert scale (from 1 'Strongly disagree' to 7 'Strongly agree') was used for all of the constructs.

Table 2

Factor analysis

	Factor				
Statements	**1**	**2**	**3**	**4**	**5**
Emotional 1 - The online campus tour was a positive experience for me.	.80				
Emotional 2 - The online campus tour was interesting.	.79				
Emotional 3 - The online campus tour was fun.	.77				
Emotional 4 - The online campus tour was exciting.	.73				
Presence 1 - While I was experiencing the online campus tour, I felt I was at the campus of the University of Twente.		.79			
Presence 2 - The world generated by the online campus tour seemed to me like 'somewhere I visited' rather than 'something I saw.'		.78			
Presence 3 - While I was experiencing the online campus tour, my body was in a place, but my mind was inside the world created by the tour.		.64			
Presence 4 - When I finished the online campus tour, I felt like I came back to the 'real world' after a journey.		.57			
Cognitive 1 - While I was experiencing the online campus tour, my attention was focused on the online campus tour.			.82		
Cognitive 2 - While I was experiencing the online campus tour, I concentrated entirely on the online campus tour.			.81		
Cognitive 3- While I was experiencing the online campus tour, I felt deeply absorbed by the online campus tour.			.61		
Behavioral 1 - After the online campus tour experience, I will follow the social media accounts of the University of Twente.				.89	
Behavioral 2 - After the online campus tour experience if I would see a post about the University of Twente, I would click a 'like' there.				.75	
Interest 1 - After the Open Days and my online campus experience, I feel more likely to physically visit the campus when I can.					.79
Interest 2 - After the Open Days and my online campus experience, I feel more likely to apply to for a program at the University of Twente.					.78
Explained variance:	21%	15.35%	13.35%	11.11%	9.96%
Eigenvalue:	8.97	1.62	1.29	0.78	0.70
Cronbach alpha:	.91	.90	.92	.82	.75

4. Results

In this chapter, we provide the outcome of the research analyses. The following sections consist of the Manipulation Checks, Descriptive Statistics, Analysis of Variance with Tukey Test, and Mediation Analysis.

4.1 Manipulation Checks

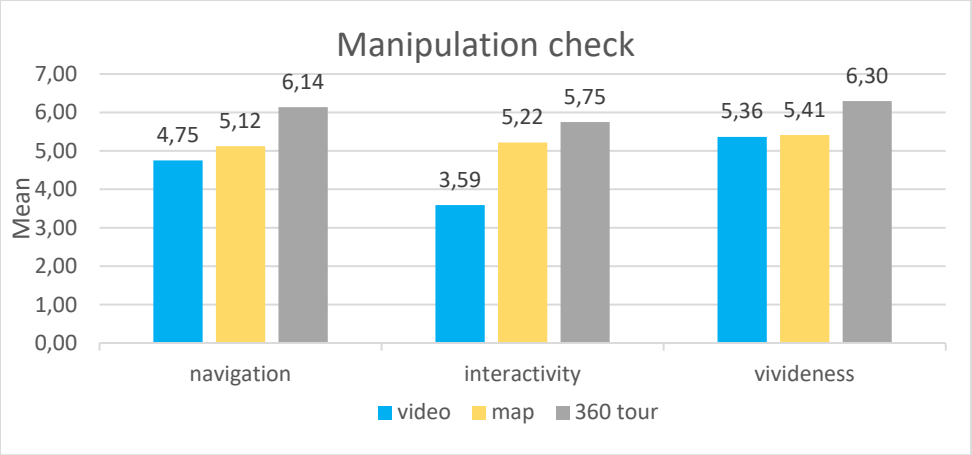
Before evaluating the collected data, the manipulation checks were performed to verify whether navigation, interactivity, and vividness corresponded to our theoretical framework.

Firstly, the between-subject test indicated significant differences for navigation (a part of interactivity) F (2,126) = 11.3, $p < .001$; for interactivity F (2,126) = 27.5, $p < .001$; and for vividness F (2, 126) = 6.09, $p < .05$.

Based on the one-way ANOVA analysis, as seen in Figure 14, it was clear that levels of navigation gradually grew, starting from the video tour (M = 4.75, SD = 1.61), passing through the interactive map (M = 5.12, SD = 1.64), and ending in 360-degree tour (M = 6.14, SD = 0.82). Interactivity levels also grew from the video tour (M = 3.59, SD = 1.76), passing through the interactive map (M = 5.22, SD = 1.37), and arriving at the 360-degree tour (M = 5.75, SD = 1.01). Although the vividness level showed growth from the video (M = 5.36, SD = 1.64), passing through the interactive map (M = 5.41, SD = 1.54), and ending in the 360-degree tour (M = 6.30, SD = 0.90), the results between video tour and map were similar. Therefore, according to Figure 14, the results correlate to the theoretical framework (Figure 2).

Figure 14

Navigation, Interactivity, and Vividness per Condition



4.2 Descriptive Statistics

Table 3 illustrates the means and standard deviations of the five constructs of the dependent variables and the mediator per condition. These mean scores will contribute as a base for a more extensive and directed evaluation during the hypothesis testing.

Table 3

Descriptive Statistics of the Dependent and Mediator Variables per Condition

	Video tour		Map		360 tour	
	M	*SD*	*M*	*SD*	*M*	*SD*
Emotional engagement [a)]	4.94	1.3	5.89	0.9	6.09	0.87
Cognitive engagement [a)]	4.46	1.50	5.51	1.11	5.54	1.04
Behavioural engagement [a)]	4.45	1.59	4.96	1.57	5.26	1.36
Interest [a)]	5.32	1.15	5.71	0.96	5.70	1.02
Presence [a)]	3.79	1.46	4.34	1.43	4.83	1.22

[a)] *7-point likert scale (1=strongly disagree / 7=strongly agree)*

4.3 Analysis of Variance and Tukey Test

A one-way ANOVA with a follow-up Tukey Test was conducted to determine if the online tours affected presence, cognitive, emotional, behavioural engagement and interest toward the University of Twente. Thus, we analysed one independent variable with three groups (a video

tour, a map, a 360-degree tour), four dependent variables (interest and three types of engagement), and a mediator (presence).

Firstly, the between-subject test indicated the statistical significance for cognitive engagement F (2, 126) = 10.6, $p < .001$; for emotional engagement F (2, 126) = 14.8, $p < .001$; for presence F (2, 126) = 6.27, $p = .003$; further, statistically non-significant results for behavioural engagement F (2, 126) = 3.2, $p = .044$; and for interest toward the university F (2, 123) = 1.9, $p = .155$.

According to Tukey Test (Table 4), the interactive map resulted in higher levels of cognitive engagement than the video tour (-1.05, 95% CI [-1.7, -0.4], $p < .001$). Further, the 360-degree tour resulted in higher levels of cognitive engagement than the video (-1.08, 95% CI [-1.71, -0.45], $p = .001$). In contrast, the 360-degree virtual tour had a slightly bigger effect on cognitive engagement than the interactive map (-0.03, 95% CI [-0.67, 0.61]), but it was not statistically significant ($p = .992$).

Further, the interactive map had a bigger effect on emotional engagement than the video tour (-0.95, 95% CI [-1.5, -0.4]), which was a statistically significant result ($p < .005$). Sequentially, the 360-degree tour had a statistically significant ($p < .001$) and bigger effect on emotional engagement than the video tour (-1.15, 95% CI [-1.68, 0.61]). While the 360-degree virtual tour had a slightly bigger effect on emotional engagement than the interactive map (-0.2, 95% CI [-0.74, 0.34]), the result was not statistically significant ($p = .660$). Furthermore, the rest of the results on the other dependent variables (behavioural engagement and interest) was not statistically significant.

Lastly, only the 360-degree virtual tour had a statistically significant (p = .002) and bigger effect on presence than a video tour (-1.03, 95% CI [-1.73, -0.34]). The rest of the results for presence were not statistically significant (see Table 4).

Table 4

Tukey Test

Dependent variable	Comparison conditions	*M* difference	*SE*	*p*	95% CI
Cognitive engagement	Video vs Map	-1.05	0.28	<.001	[-1.7, -0.4]
	Video vs 360 tour	-1.08	0.26	<.001	[-1.71, -0.45]
	Map vs 360 tour	-0.03	0.27	.992	[-0.68, 0.61]
Emotional engagement	Video vs Map	-0.95	0.23	<.001	[-1.5, -0.4]
	Video vs 360 tour	-1.15	0.22	<.001	[-1.68, 0.61]
	Map vs 360 tour	-0.20	0.23	.666	[-0.75, 0.35]
Behavioral engagement	Video vs Map	-0.50	0.32	.271	[-1.28, 0.27]
	Video vs 360 tour	-0.80	0.32	.036	[-1.57, -0.04]
	Map vs 360 tour	-0.30	0.32	.636	[-1.07, 0.48]
Interest	Video vs Map	-0.40	0.23	.216	[-0.94, 0.16]
	Video vs 360 tour	-0.38	0.22	.214	[-0.92, 0.15]
	Map vs 360 tour	0.007	0.22	.999	[-0.54, 0.55]
Presence	Video vs Map	-0.55	0.29	.159	[-1.26, 0.15]
	Video vs 360 tour	-1.03	0.29	.002	[-1.73, -0.34]
	Map vs 360 tour	-0.48	0.29	.230	[-1.19, 0.22]

Note: CI = confidence interval, SE = standard error, p is adjusted for multiple comparison Tukey

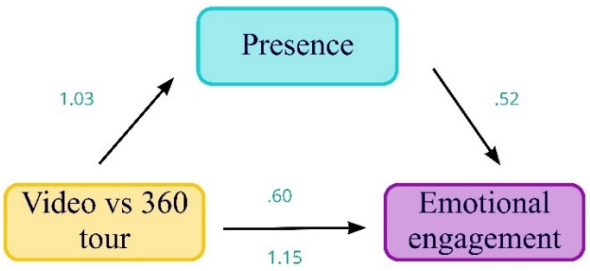
4.4 Mediation Analysis

A regression analysis using the process developed by Hayes (2017) was executed to investigate the relationship between a video tour and the 360-degree virtual tour with different levels of interactivity and vividness on two types of engagement with a mediational effect of presence.

According to Figure 15, the regression analysis revealed the direct effect of the video tour vs 360 tour on emotional engagement, ignoring the mediating variable presence, was significant, $b = .60$, $t\,(85) = 3.02$, $p = .003$. Further, the indirect effect of the video tour vs 360-degree tour on presence was significant, $b = 1.03$, $t\,(86) = 3.60$, $p < .001$. Then, the mediation process showed that presence, controlling for the video tour vs 360 tour, was significant, $b = .52$, $t\,(85) = 7.54$, $p < .001$. The total effect of the video tour vs 360 tour was a significant predictor of emotional engagement, $b = 1.15$, $t\,(86) = 4.80$, $p < .001$. Regarding mediational effect, the effect size was 0.54 with a 95% confidence interval, which did not include zero.

Figure 15

Mediation Analysis



According to Figure 16, the direct effect of the video tour vs 360 tour on cognitive engagement, not considering the mediating variable presence, was not significant, $b = .43$, $t\,(85) = 1.89$, $p = .06$. Then, the mediation process showed that presence, controlling for

the video tour vs 360 tour, was significant, $b = .62$, $t\ (85) = 7.76$, $p < .001$. The total effect indicated that the video tour vs 360 tour on cognitive engagement was significant $b = 1.08$, $t\ (86) = 3.88$, $p < .001$. Regarding the mediational effect, the effect size was 0.64 with a 95% confidence interval, not including zero. Therefore, hypothesis confirmation or rejection can be seen in Table 5.

Figure 16

Mediation Analysis

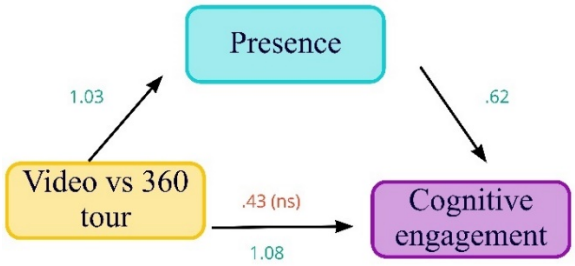


Table 5

Summary of Hypotheses

Hypotheses	Intermediate Result	Result
H1: An interactive map (with medium level of interactivity and vividness), mediated by higher presence, leads to higher a) emotional, b) cognitive, c) behavioral engagement and d) interest toward UT than a video tour (with low level of interactivity and vividness).	An interactive map, without mediation, leads to higher a) emotional, and b) cognitive engagement than a video tour.	Partially confirmed
H2: A 360-degree virtual tour (with high level of interactivity and vividness), mediated by higher presence, leads to higher a) emotional, b) cognitive, c) behavioral engagement and d) interest toward UT than a video tour (with low level of interactivity and vividness).	A 360-degree tour with mediation leads to higher a) emotional, and b) cognititve engagement than a video tour.	Partially confirmed
H3: A 360-degree virtual tour (with high level of interactivity and vividness), mediated by higher presence, leads to higher a) emotional, b) cognitive, c) behavioral engagement and d) interest toward UT than an interactive map (with medium level of interactivity and vividness).	No confirmed associations.	Rejected

5. Discussion

This research aimed to investigate the difference between three types of interactive technologies (i.e., a video tour, an interactive map, and a 360-degree virtual tour), mediated by presence, on cognitive, emotional, behavioral engagement, and interest towards UT. The results indicate that mediation occurs when comparing a video tour and a 360-degree virtual tour, leading to higher emotional and cognitive engagement. In addition, an interactive map without a mediation effect shows a higher emotional and cognitive engagement than a video tour.

In line with our expectations, both an interactive map and a 360-degree virtual tour have higher levels of navigation and interactivity than a video tour. This means that users have more controlling options when experiencing an interactive map than a video tour, while a 360-degree tour provides even more controlling possibilities than an interactive map. This finding aligns with the researches of Flavian et al. (2018) and Spielmann and Mantonakis (2018). However, we found that the vividness level of our interactive map is similar to our video tour. It means that users identified the level of clarity and image quality similarly for an interactive map and a video tour. Nevertheless, the vividness findings go in line with Yim et al. (2017) research since a 360-degree virtual tour is more vivid than a video tour.

The results regarding emotional (a) and cognitive engagement (b) of Hypothesis 1 show that an interactive map leads to a higher emotional and cognitive engagement than a video tour, however, without the mediational effect of presence. It means that users find interactive maps more interesting, fun (emotional engagement), and catching their attention (cognitive engagement) than video tours. This finding adds value to Li and Meshkova (2013) research, claiming that interactive 2D experiences are positively associated with engagement. However,

contrary to the hypothesized association, the mediational presence effect does not occur, which means users feel like ‘being here’, in front of a device and not in a virtual experience. The reason why the mediational effect does not occur when comparing a video tour and an interactive map might be explained by the research of Javidi & Okano (2009). They state that 2D images might not provide a feeling of presence. In contrast, 3D images might give a sense of being in a virtual experience, which can be enhanced even more by increased user control over an experience (interactivity).

Further, in line with Hypothesis 2, regarding emotional (a) and cognitive engagement (b), a 360-degree virtual tour leads to a higher emotional and cognitive engagement than a video tour through the mediational effect of presence. It means users feel like being in a virtual campus experience more during a 360-degree virtual tour than during a video tour. Furthermore, users with a higher sense of presence find a 360-degree virtual tour more interesting, exciting (emotional), and affecting attention (cognitive) than a video tour. This study aligns with the research of Khalifa & Shen (2004), which claims that increasing levels of interactivity and vividness lead to higher presence. Moreover, our findings add value to McLean and Wilson (2019) research, which claims that higher levels of interactivity and vividness, mediated by presence (Flavián et al., 2020), lead to higher emotional and cognitive engagement.

In contrast, for our Hypothesis 3, regarding emotional (a) and cognitive engagement (b), a 360-degree virtual tour does not lead to increase engagement than an interactive map. It means that participants do not find a 360-degree virtual tour more exciting (emotional) and absorbing (cognitive) than an interactive map. This result contradicts our assumption that a 360-degree virtual tour leads to a higher engagement than an interactive map through the mediational

effect of presence. A possible explanation may be drawn based on the Desmet et al. (2005) study, which says the 'wow-effect' might appear when a person experiences a pleasant surprise, fascination, or desire. Experiencing pleasant surprises might happen when we participate in something sudden and unexpected. Fascination occurs when we have an unfamiliar and pleasurable experience. Lastly, desire might appear when we want to possess something. Based on participants' comments from the pre-test and main study, we can guess that users might have felt a pleasant surprise and fascination during the interactive map experience, leading to the 'wow-effect'. Participants from the pre-test expressed their astonishment, saying they had never experienced a gamified campus map. In addition, some participants from the main study commented: 'Cool experience, thank you!' or 'Wow! This campus tour is amazing!' (Appendix C). Further, Kamstrupp (2016) research suggests that the 'wow-effect' might increase engagement level during user experience. According to Alsubhi & Sahari (2020), a cause of increasing engagement can be specific gamified elements that we use in our interactive map. In this study, the 'wow-effect' might have occurred due to elements such as flying a drone over a 'pixelated' campus map. This effect could have caused an increased emotional, and cognitive engagement than a usual interactive map would have.

In all our three hypotheses, the results regarding behavior engagement (c) contradicted our assumptions, showing that neither online campus tours lead to higher behavioural engagement. It means users were not triggered to follow UT social media or like UT posts (behavioural) after experiencing our campus tours. A possible explanation of this outcome might be that other variables can predict behavioural engagement, in addition to interactivity and vividness. For example, according to Violante et al. (2019), behavioural engagement is predicted by interactivity; hyper textuality (internet links containing extra information about

a product); modality (comparing various contents); connectivity (internet links to social media and blogs); mobility (laptops, mobile phones, or glasses with augmented reality); location specificity (showing the localization of an object inside of an online map).

In neither of our three hypotheses, the online tours were positively associated with interest (d) toward UT. It means that users were not more interested in applying to a UT program (interest) after experiencing our online campus tours. A possible explanation can be drawn based on Li et al. (2002) research. According to this study, product knowledge, as a crucial variable, should be considered when measuring interest (purchase intention). Product knowledge is the knowledge consumers have about an advertised product. In the context of our study, this would mean to what extent prospective students know about UT.

5.1 Limitations

Several limitations of this study can be addressed based on the results, scientific literature, comments from potential students, and comments from the pre-test participants. Due to the time limitation caused by the Open Days, some technical issues could not be improved before the data collection, which could have increased the interactivity, vividness, immersion, and presence of the video tour, interactive map, and 360-degree tour.

One of the major technical problems of the interactive map was drone navigation. Respondents complained that the drone navigation was not explicit, and eventually, it would lag. Participants recommended improving this aspect, which could lead to a better user experience (Appendix B and C).

Another limitation was the lack of a campus overview since there was no zoom-out function (Appendix B and C). In addition, it would be helpful to explicitly define the campus area's borders with the connections to the city centre of Enschede. Lastly, candidates

expressed the inconveniences of the ‘close’ button for the hotspots (the button was hard to notice) (Appendix B and C). Fixing all of these issues may help increase the navigation and interactivity of the interactive map.

Regarding the vividness level of the interactive map being similar to a video tour, a reason might be a ‘pixelated’ image of the map, even though all the picture-based and video-based information of the hotspots were realistic.

The 360-degree virtual tour, likewise, has had several technical issues. For example, the embedded map should have a more visible location on the screen instead of hidden in the top corner button. In addition, features such as map size, and the real-time indicator of the users' current location, should be changed. Another improvement that should be considered is a full-screen mode to give the participants a more immersive experience (Appendix C). The improvement of these technical issues could provide a higher level of navigation, leading to a higher level of interactivity.

Due to upcoming deadlines, the number of interior locations was restricted. Since the 360-degree tour provided an opportunity to ‘walk’ on the campus and enter some buildings, several participants were curious to enter more buildings to explore them in detail (Appendix B and C). Therefore, including a wider variety of places could lead to higher navigation and interactivity, immersion, and presence.

Further, one more limitation was the quality of some of the 360-degree pictures (Appendix B and C). Since the 360-degree camera (a GoPro Fusion 360) did not have an excellent resolution, some fragments of 360-degree photos were blurred, which distracted participants from their campus experience. Better quality for the 360-degree images could lead to a higher level of vividness.

Lastly, due to upcoming Open Days, which did not allow us to optimize the interactive map and 360-degree virtual tour for mobile phones, we suggested participants to use laptops for their campus experience. As a result, 75% of users used a laptop or desktop computer. However, Flavián et al. (2020) claim that using a mobile phone provides a more immersive experience than a laptop, leading to a higher engagement.

By improving these technical issues, perhaps the interactive map and 360-degree virtual tour could have had an even higher level of interactivity, leading to a higher level of presence and engagement.

5.2 Practical & Theoretical Implications

Firstly, based on the Limitations section, future research should consider solving technical issues to increase levels of interactivity and vividness. In addition, based on discussion, more variables such as hyper textuality, connectivity, mobility, and location specificity should be measured to explore dependent variables, especially behavioral engagement and interest (McLean & Wilson, 2019). For example, in this study, hyper textuality could include extra links for campus areas such as contact info (website, location, emails) of medical services, study, culture, and sports associations (Appendix B). Adding social media clickable links would help include connectivity in the campus experiences. Furthermore, inserting a general map for all online campus tours showing campus location within Enschede city or even in the Netherlands (Appendix B and C) would help measure location specificity.

The following implications are based on the research studies of McLean and Wilson (2019) and Flavián et al. (2020). Both state that various devices, from low immersive (as stationary computers) to high immersive (such as wearables devices), lead to increased engagement. For this research, laptops, mobile phones, and VR goggles could be used during the online

experience. To implement this, two main technical issues should be solved. Firstly, optimizing all the online tours for mobile phones. Secondly, embracing all the online tours for a VR mode, which should be relatively easy to implement for the video tour and 360-degree virtual tour, however, might be challenging for the interactive map.

Another variable that can be added to measure better interest towards UT is the knowledge about UT (product knowledge). It could be implemented by including a few questions to what extent prospective students know the University of Twente. According to Nepomuceno et al. (2014), interest (purchase intention) increases with increased product knowledge. In addition, a future research should try to search for a more diverse sample. For example, a sample should perhaps include students who do not know about UT and know the university well. Moreover, besides focusing on prospective students, the selection could also consist of future employees with a different age range.

Lastly, future research could measure the 'wow-effect' to explore the reason for the interactive map's engagement level. It could be done by adding questions right after the interactive map experience about what feelings and thoughts arise during this online tour.

6. Conclusion

This research aimed to explore if a video tour, interactive map, and 360-degree virtual tour, from low to high levels of interactivity and vividness, mediated by presence, lead to higher emotional, cognitive, and behavioral engagement and interest levels toward the University of Twente, respectively.

The first main finding is that a 360-degree virtual tour provides a more powerful feeling of being in a virtual campus environment (presence) than a video tour. Therefore 360-degree tour is perceived as more fun, interesting (emotional engagement), and catching more attention (cognitive engagement) than a video tour. The second main finding indicates that an interactive map is perceived as more fun, exciting and grabbing more attention than a video tour, without the mediational effect of presence. As a result, both interactive map and 360-degree virtual tour, with medium and high control levels, result in higher emotional and cognitive engagement than a video tour. However, the results do not reveal which campus experience (interactive map vs 360-degree virtual tour) leads to higher engagement.

Further, the results of online tours on behavioural engagement and interest toward UT through the mediational effect of presence contradicted our assumptions. Based on scientific literature, a possible reason could be that other variables rather than interactivity and vividness predict behavioural engagement and interest. Therefore, different variables such as hyper textuality, modality, connectivity, mobility, location specificity, and knowledge about UT should be considered for future research. In addition, a more diverse sample is needed, also including prospective employees and students and students with different levels of knowledge about the University of Twente.

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Appendix A – Experiment Survey

Q1 Welcome to this research study!

First of all, thank you very much for having some time to participate in the research study for my master's thesis project. *I created a few different online campus tours by myself that you can explore right now!* But before exploring the beautiful campus, please read the information below, and answer a few questions before and after your campus experience.

Explanation of this research

This research aims to explore which online campus tour version of the University of Twente meets the best potential students' needs. You can dive into one of the campus tours, see the campus in detail, and understand how the campus looks like. I am sure you will have fun!

Please note that you will have an opportunity to explore all the online campus tours after completing the experiment. The links will be provided at the end.

Structure of the experiment

This research is divided into two sections; firstly, you will experience one of the online campus tours of the University of Twente. Please keep in mind that some of you will experience an experimental version of the campus tour.

The second section will include a questionnaire, and it should take approximately 10 minutes to complete. All your responses will be kept confidential and anonymous, and all the data collected will be used only for research purposes.

Your consent

Furthermore, your participation in this study is entirely voluntary. You can withdraw at any point in time and for any reason.

Usage of a laptop

Please remember that the best way to see an online campus tour and survey is on a laptop or desktop computer. Some features may be less compatible with a mobile device.

If you have any questions about the research, don't hesitate to get in touch with me: k.v.matyushina@student.utwente.nl

Q2 Terms By clicking on the 'I consent' button below, you indicate that:
You have read the above information

You voluntarily agree to participate

- O I consent, begin the study (1)
- O I do not consent, I do not wish to participate (2)

Skip To: End of Survey If By clicking on the 'I consent' button below, you indicate that: You have read the above informa... = I do not consent, I do not wish to participate

End of Block: Into

Start of Block: Demographics

Q3 Gender What is your gender?

- O Male (1)
- O Female (2)
- O Non-binary (3)
- O Prefer not to say (4)

*

Q4 Age How old are you?

_____

Q5 Student/parent You are

- O A prospective student (I DID NOT see the campus physically))
- O Parent of a prospective student (I DID NOT see the campus physically))
- O A prospective student (I SAW the campus physically)

Q6 Start of study When are you (or your son/daughter) planning to start your study?

- O 2022(Feb/Sep)
- O 2023(Feb/Sep)
- O 2024(Feb/Sep)
- O None

Q7a Nationality What is your nationality?

- O Dutch
- O EU/EEA
- O non-EU/EEA

Display This Question: If What is your nationality? = non-EU/EEA

- O Q7b Non-EU Country From which country are you from?

_____

Display This Question: If What is your nationality? = EU/EEA

- O Q7c EU Country From which EU/EEA country are you from?
- O ▼ Austria (25) ... Sweden (59)

Q8 Device Which device are you using for exploring the online campus tour?

- O A mobile phone
- O A laptop/desktop computer
- O A tablet

End of Block: Demographics

Start of Block: Condition1 VIDEO

Q9a Timing Video Timing

First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

Q9b In this study, you will be first asked to watch a short 360-degree video about the campus. You will get an overview of the important buildings and some interior areas. Please, after watching this video, fill in the questionnaire. It is crucial for this research. Enjoy!

Q9c
Click here to go to our video tour

Q9d Video Check By checking the box 'I watched the video', you indicate that you watched the video and are ready to continue with the questionnaire.

- O I watched the video (1)

End of Block: Condition1 VIDEO

Start of Block: Condition2 INTERACTIVE MAP

Q10a Map Timing Timing

First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

Q10b-1 In this study, you will be first asked to explore the interactive campus map. You can navigate by moving a drone between various locations. Each location has a hotspot that can consist of an image, text or video of a place.

Take as much time as you need to explore our beautiful campus. But please do not forget to fill the questionnaire afterwards. It is crucial for this research. Enjoy!

Q10c
Click here to go to our interactive campus map

Display This Question: If Which device are you using for exploring the online campus tour? = A mobile phone

Phone users:
To be able to have this experience, you will be required to open our page in **Desktop Mode**. This works for Google Chrome.
If a hotspot can not be closed, click twice on the top part of the map:

Q10d Map Check By checking the box 'I explored the interactive campus map', you indicate that you explored the campus and are ready to continue with the questionnaire.

O I explored the interactive campus map (1)

End of Block: Condition2 INTERACTIVE MAP

Start of Block: Condition3 360_TOUR

Q11a Virtual Timing Timing

First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

Q11b In this study, you will be first asked to explore a 360-degree virtual campus tour. There are some instructions for you.

Navigation

There are a few ways of navigating in this tour that is listed below: you can navigate between the locations by clicking the buttons on the top of your screen with different categories: Study Places, Educational Buildings, Labs, Sports, Accommodation, Campus Facilities.

In addition, there is a line of outside locations on the bottom of the screen.

Another way of navigation is using a map (right top corner button) with clickable hotspots.

Also, when areas are close to each other, the navigation can be done through arrows.

Hotspots

Most of the areas have hotspots which are listed below:

a 2D image(s) button
an info button
a 2D video button
a 360-degree video
a button to enter/exit a building

To close an image/video hotspot, double click on it.

Take as much time as you need to explore our beautiful campus. But please do not forget to fill the questionnaire afterwards. It is crucial for this research.

Phone Users: Some features might work better if the *Desktop Mode* is activated in your browser.

Enjoy!

Q11c
Click here to go to our 360-degree virtual campus tour

Q11d Virtual Check By checking the box 'I explored the 360-degree virtual campus tour', you indicate that you explored the campus and are ready to continue with the questionnaire.

O I explored the 360-degree virtual campus tour (1)

End of Block: Condition3 360_TOUR

Start of Block: Navigation Control Block

Q12 Navigation. To what extent do you disagree or agree with the following statements?

I was able to navigate easily...

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
... the entire environment.	O	O	O	O	O	O	O
... between the campus areas.	O	O	O	O	O	O	O
... through the buttons.	O	O	O	O	O	O	O

End of Block: Navigation Control Block

Start of Block: Interactivity Block

Q13 Interactivity. To what extent do you disagree or agree with the following statements?

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I felt I had a lot of control over my online campus visiting experience.	O	O	O	O	O	O	O
I felt that the content was responding to my actions quickly and efficiently.	O	O	O	O	O	O	O
I felt I could control my movements.	O	O	O	O	O	O	O

End of Block: Interactivity Block

Start of Block: Vividness Block

Q14 Vividness. To what extent do you disagree or agree with the following statements?

I felt that...

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
... the image of the online campus tour was real.	O	O	O	O	O	O	O
... the image of the online campus tour was detailed.	O	O	O	O	O	O	O
... the online campus tour had a good image quality.	O	O	O	O	O	O	O

End of Block: Vividness Block

Start of Block: Engagement Block

Q15 Cognitive. To what extent do you disagree or agree with the following statements?

While I was experiencing the online campus tour...

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
... I felt deeply absorbed by the online campus tour.	O	O	O	O	O	O	O
... my attention was focused on the online campus tour.	O	O	O	O	O	O	O
... I concentrated entirely on the online campus tour.	O	O	O	O	O	O	O
	O	O	O	O	O	O	O

Q16 Emotional. To what extent do you disagree or agree with the following statements?

The online campus tour...

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
... was a positive experience for me.	O	O	O	O	O	O	O
... was fun.	O	O	O	O	O	O	O
... was interesting.	O	O	O	O	O	O	O
... was exciting.	O	O	O	O	O	O	O

Q17 Behavioral. To what extent do you disagree or agree with the following statements?

After the online campus tour experience...

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
... I will follow the social media accounts of the University of Twente.	O	O	O	O	O	O	O
... if I would see a post about the University of Twente, I would click a 'like' there.	O	O	O	O	O	O	O

End of Block: Engagement Block

Start of Block: Immersion Block

Q18 Immersion. To what extent do you disagree or agree with the following statements?

While I was experiencing the online campus tour...

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
... I felt detached from the outside world.	O	O	O	O	O	O	O
... I forgot about my everyday concerns.	O	O	O	O	O	O	O

End of Block: Immersion Block

Start of Block: Presence Block

Q19 Presence. To what extent do you disagree or agree with the following statements?

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
When I finished the online campus tour, I felt like I came back to the 'real world' after a journey. (1)	O	O	O	O	O	O	O
The world generated by the online campus tour seemed to me like 'somewhere I visited' rather than 'something I saw.' (2)	O	O	O	O	O	O	O
While I was experiencing the online campus tour, I felt I was at the campus of the University of Twente. (3)	O	O	O	O	O	O	O

End of Block: Presence Block

Start of Block: Interest Block

Q20 Interest. To what extent do you disagree or agree with the following statements?

After the Open Days and my online campus experience...

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
... I feel more likely to physically visit the campus when I can.	O	O	O	O	O	O	O
... I feel more likely to apply to for a program at the University of Twente.	O	O	O	O	O	O	O

End of Block: Interest Block

Start of Block: Comments

Q23 If you have any comments, please write it down. Leave it blank otherwise.

_____

End of Block: Comments

Appendix B - Pre-test comments

N of comment	Video tour
1	I would like to see a person who shows me the campus, not just a voice over.
2	The video was too dynamic. The transitions were too fast.
3	I would like to have subtitles.
4	The video might be lagging.
5	The quality of the video was quite nice.
6	I would like to see the interior of the buildings, more like walk through instead of just seeing panoramas.
7	I like the background music in the video.
8	The camera is going too fast. The shots are too dynamic.
9	It bothers that some buildings I see in the video they are not introduced for me.
10	I liked that the video was quite diverse, a lot of areas were introduced.
11	The narration of the video was good.
	Interactive map
1	I like the visuals and videos on the map, you can really see the campus.
2	It is nice to walk around the campus like that.
3	Some videos in the hotspots are too long.
4	Close button of informational hotspots could be a bit more visible.
5	I can not move with my mouse, it requires clicking on the map.
6	I do not like that the map is not on the full screen mode.
7	It looks pretty cool and pretty detailed.
8	I like that there is a mix of unrealistic map and realistic pictures.
9	It would be nice to have a small map on the corner, to see the whole campus overview.
10	At first, it was hard to understand how to navigate. I feel like the drone can be optimized.
11	I would like to have the option to zoom in and zoom out. I would like to see the whole overview of the map.
12	I like the design of the map.
13	I like the fact that the hotspots has the diversity of texts, pictures and videos.
	360-degree virtual tour
1	It reminds me of Google Maps.
2	I do not like that it starts moving without me clicking on the panorama. It gives me motion sickness.
3	The quality of some 360-degree videos and pictures is not excellent.
4	I like the virtual tour, it looks nice.
5	I miss the narrative during my experience. I would like to have instructions what to do step by step (reading text, watching a video)
6	I like the fact that people are blurred.
7	I like that I can control it by myself and walk through it. I like that I can zoom it in and out.
8	I like that there are many and different information buttons.
9	I like that in 360-degree videos they do their things and don't look at you. You can just observe them from the side.
10	I would like to have more interior locations with contact and general information.
11	It would be really helpful tour for someone who would like to study at UT.
12	It was not obvious for me that I can rotate myself in 360 video.
13	I like the tour of Vrijhof, it is pretty realistic, it looks like I am walking there.
14	The quality of the pictures can be improved.
15	It is pretty immersive and detailed tour.

Appendix C – Participants' comments from the main study

N of com	Video tour
1	Apparently it is a great opportunity to get initial (visual experience) about this university. Nevertheless it would've looked out much better if there were some quick transitions (accelerated video during a walk between campuses).
	Interactive map
1	Although this was a very unique experience, same could have been made even better if there was an option to go full-screen for the experience to be mesmerizing! I discovered, using the arrow keys was essential to navigate through the beautiful campus!
2	I liked to see the different places and get some information on them. What I missed was the spatial connection between them. And also between them and the city of Enschede.
3	Movement with arrow keys could be more fluent, now it goes really slow for a second and afterwards way to fast.
4	Hi! Wow! The map is amazing, but a zoom in/out button would have been nice, as well as the option to click out instead of clicking "close" on every building description.
5	Cool expereince, thank you! I really enjoyed the tour! But I got distracted by the drone a lot.
6	The layout could be better, it is like a world of a game. It is detailed, but it looks like that game where you build a hotel. It should be more realistic. The speed of the drone is a bit annoying, when I keep pressing the buttons, I want the drone to have a constant speed. Now, I could not fly over the campus and see every detail. But the idea is good, this seems as a sort of concept which has to be improved more.
7	I think the campus map should allow to fly around the campus like flying mode in google earth. A drone is there but is static so you cannot move an see the real extension so it could be misleading.
	360-degree virtual tour
1	Sometimes the image had a little blur on the sides which was a bit distracting, for the rest I liked it a lot.
2	I had no idea of the University's greatness and so the online tour transported me to the site and made me understand how fantastic the university's infrastructure is.
3	I like it, thank you :) Your work is amazing
4	I would like to have a full screen mode
5	I am curious to enter more buildings to see how it looks inside.