

# **User-centred Mobile Augmented Reality application's concept evaluation**

## **Case: Freshman App**

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<b>Degree programme</b> BITe – Business Information Technology Programme	
<b>Report/thesis title</b> User-centred Mobile Augmented Reality application's concept evaluation. Case: Freshman App.	<b>Number of pages and appendix pages</b> 52 + 7
<p>Mobile Augmented Reality applications have been making its impact on how people interact with the virtual and real worlds using their smartphones. Some of the most famous examples of good design MAR applications are entertaining applications such as Pokémon Go or Snapchat. However, the technology's potential can go beyond entertainment to create impact in different areas, such as education and training. In order to design a good MAR application for users, the application should be user-centric; hence, the need for the study of how to apply User-Centric Design approach to a MAR application for positive user emotional engaging.</p> <p>In this thesis, the case subject is a MAR application called Freshman app which was commissioned by Haaga-Helia's BITe programme. The objective is to collect new and useful information for the thesis's research topic and research questions about the practise of user-centred design approach, emotional design and concept evaluation when developing Freshman App. The thesis author studied and applied a combination of the two methods: literature review and qualitative research. The literature review is the research method that researchers used for scanning existing knowledge about the research topic area. The literature review about the thesis topic area helps the thesis author in the process of finding answers for the main research question: "<i>How can the user-centred design (UCD) methodologies help to design an emotional MAR application?</i>" The qualitative research is the primary research of the thesis project, which is the implementation of qualitative data collection and analysis during the case project. The qualitative data will provide the answers for the thesis author's sub question: "<i>What are the students' emotional engagement and feedback about the Freshman app's concept that was created using the UCD approach?</i>" The thesis research will act as an example case study and future references of how to apply UCD methodologies and emotional design study to the designing and evaluating of a MAR application concept. The final discussion about the thesis topic, which is UCD approach in a specific MAR application's concept development and evaluation, is that based on the users' feedback, the approach indeed has practical benefit and usefulness to the Freshman application development.</p> <p>The product-based thesis contains the introduction of the thesis, the case project in chapter 2, the thesis's research methods in chapter 3, the thesis author's literature review in chapter 4 and the results of the thesis author's implementation of studied knowledge and professional skills in chapter 5. Chapter 6 includes the user tests' data collation and the thesis author's data analysis as the findings for the research questions. Chapter 7 contains the thesis author's further discussion about the future development of the Freshman app for BITe programme using the practice of UCD approach in MAR design.</p>	
<b>Keywords</b> Mobile Augmented Reality, User-Centred Design, Mobile Application, Concept Evaluation, Freshman App	

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## **SYMBOLS AND ABBREVIATIONS**

App	Mobile Application
AR	Augmented Reality
BITe	Business Information Technology
EEA	Emotional Engagement Analysis
ISO	International Organization for Standardization
MAR	Mobile Augmented Reality
UAS	University of Applied Sciences
UCD	User-Centred Design
UX	User Experience
UI	User Interface

## 1. Introduction

Augmented reality or AR is an “interactive user experience with computer-generated objects that are displayed in the actual space via computing devices”, such as smart phones and tablets (Aukstakalnis, 2017, 2). Through the camera of a smart device, users can see visually constructed information that have been immersed in “the users’ spatial awareness” of the real environment (Dünser *et al.*, 2006a, 1). Some of the most notable examples of the successful usage of augmented reality in the modern tech-consumer era are Snapchat, L’Oreal, and Ikea Place. These successful examples are also well-designed mobile apps with a user-centred approach that enhance users’ positive feelings and experiences. Since then, many organizations realized the benefits of implementing AR into their services that can boost customers’ engagements with them, leading to positive emotions and ultimately, the loyalty of their customers. (Dünser *et al.*, 2006b; Aukstakalnis, 2017; Recchia, 2018)

Mobile Augmented Reality or MAR is the mobility version of augmented reality, which has attracted a significant amount of attention and shown a rapid growth of usage across many areas. Instead of having traditional wearable AR devices, such as Google Glass, users can experience AR features with their pocket devices like smartphones and tablets. The potential of MAR can go beyond entertainment and retail marketing, to create impact in different areas, such as education and training. (Craig, 2013).

Because the knowledge about MAR applications are still in early-discovery stage, there are many questions arisen for organizations who want to design and developing a MAR app. What are the user-centred design (UCD) methodologies that are applicable for the MAR concept design process? How to tailor the content to users’ needs and wants? How can the app’s design enhance users’ positive emotions? How to evaluate the app’s performance and its effects on the users’ thoughts and feelings? To answer these questions, the thesis author discusses a specific case of an organization in higher education context.

In this thesis, the subject is an educational organization known as Haaga- Helia University of Applied Sciences (UAS) and the thesis’s commissioner is the Bachelor degree programme called Business Information Technology or BITe. The organization were interested in developing a MAR application that would help BITe’s freshman students to have a better orientation experience at their own home, before they arrive to the University for their first semester. The objective is to collect new and useful information for the thesis’s research topic and research questions about the practise of user-centred

design approach, emotional design and concept evaluation when developing a MAR application called Freshman for the commissioner.

The project were initially a student project that later on were supported by BITE programme to continue researching and building a real MAR application that were tested and introduced to the freshman students who came during the following academic year. The thesis author had worked in the case project from beginning to end, therefore, has an insider's experiences and information about the project process. Moreover, the thesis author's professional path is Digital Services and User Experience Design, therefore, the thesis topic is well within the thesis author's scope of knowledge. College students, academic researchers, individuals and organisations that are interested in the newly explored area of AR and MAR will be the target readers of this thesis research. The thesis research will contribute to the empirical research and practical application of AR and MAR for higher education purpose, in this case, is BITE programme of Haaga-Helia UAS. The thesis research will act as an example case study and future references of how to apply UCD methodologies and emotional design study to the designing and evaluating of a MAR application concept.

The product-based thesis contains the introduction of the thesis, the case project in chapter 2, the thesis's research methods in chapter 3, the thesis author's literature review in chapter 4 and the results of the thesis author's implementation of studied knowledge and professional skills in chapter 5. In Chapter 5, the thesis author explained in detail about the process of the UCD approach during the application development time. The process consisted of four phases: Feasibility and User Study, Data Collection and Analysis, Ideation and Prototyping, and Usability Assessment. The thesis focuses on the UCD area of the Freshman app and its impact on the usability and the emotional engagement of application. The thesis author conducted user data collection by user study method, usability testing method, pop-up feedback inside the app and emotional engagement evaluation for the Freshman app. Chapter 6 includes the tests' data collation and the thesis author's data analysis as the findings for the research questions. Chapter 7 contains the thesis author's further discussion about the future development of the Freshman app for BITE programme of which the initial concept and earlier prototypes were published in a co-written journal by the thesis author and members of the Freshman app's development team. Note that the thesis is written using the Harvard reference style. (Nguyen *et al.*, 2018) (Nguyen *et al.*, 2018)

## 2. Research method and Research methodology

### 2.1 Research question

The thesis author upon studying about research and academic writing has chosen the research methods for this thesis project. The thesis author studied and applied a combination of the two methods: literature review and qualitative research. The literature review is the research method that researchers used for scanning existing knowledge about the research topic area. The researchers examine and review related theories, frameworks and their applications on real-life cases. This research method is extremely helpful in the beginning stage of the thesis research because it helps the thesis author to gather useful and necessary information for the project's implementation. The qualitative research is the primary research of the thesis project, which is the implementation of qualitative data collection and analysis during the case project. The purpose of the qualitative research in this thesis project is to collect information from real students when they are using the Freshman app. The qualitative research method allows the thesis author to collect new information regarding the thoughts and feelings of the students. The literature review about the thesis topic area helps the thesis author in the process of finding answers for the main research question: *"How can the user-centred design (UCD) methodologies help to design an emotional MAR application?"* The qualitative data will provide the answers for the thesis author's sub question: *"What are the students' emotional engagement and feedback about the Freshman app's concept that was created using the UCD approach?"* To answer the main research question, the thesis author used the reviewed UCD methodologies and applied in particular, the mLUX method, to implement in the process of designing the Freshman app. The process consisted of four phases: Feasibility and User Study, Data Collection and Analysis, Ideation and Prototyping, and Usability Assessment. The thesis author learnt about the mLux framework and the implementation in concept development when studying in school's courses taught by Amir Dirin. The thesis author started by learning about the needs and expectations of the students. Afterward, the students' needs and expectations are translated into performing tasks that can be potential features and functions for the application. The prototypes and final version include primary features and functions with UCD approach at the core of the application's user interface (UI) and user-experience (UX). The thesis author describes and elaborates the studied, selected and implemented theoretical background for the case project in chapter 4 of the thesis. To answer the research questions, the thesis author conducted questionnaires and in-depth 1-on-1 interview with Haaga-Helia's students. The students' feedback are the new information that the author used to evaluate and discuss the Freshman app's future development. Chapter 5 and 6 contains the detailed information and results of the qualitative data

collection process during the case project. (MacDonald, S., & Headlam, 2009,35; Fink, 2014, 3; Dirin, A., & Nieminen, 2015)

## **2.2 Questionnaires and Interview**

The thesis author used small-scale qualitative survey for the thesis project to explore in-depth information and the detailed findings of the thesis's research topic. The thesis author conducted cross-sectional survey using different set of questions to gather opinions, thoughts and feedback of the targeted individuals during different points of time of the case project. One must choose questions carefully in order to be as neutral as possible about the questionnaire's topic. The neutral and unbiased questionnaire will help to gather rich and quality information. The collected data is helpful to the thesis project because it can provide the detailed story of how the case project can be implemented, and the impact it would have on its targeted users. (MacDonald, S., & Headlam, 2009, 35-37.)

The interview is usually between an interviewer and an interviewee in a private setting, which enhances the chance to acquire information that would not show during a group setting. The thesis project was using a combination of structured and semi-structured interview styles to find fact-related information and to explore the interviewees' feelings and emotions on a personal level. Structured interview has a set of specific questions, which are asked in certain order to obtain insightful fact-related information from an interviewee beside the already-known information. (MacDonald, S., & Headlam, 2009, 39-42.)



### 3. Literature review

The literature review chapter includes the researches about UCD methods and UI design principles that are well-known studies. These UCD methods, emotional design and UI design principles are implemented in the case project. The chapter also includes MAR definition and its potential for educational purpose.

#### 3.1 User-Centred Design (UCD)

The International Organization of Standardization or ISO is an organization whom has certified and authorized standards that are call ISO, which are accepted and applicable by global governments and international organizations when it comes to producing systems for human. According to ISO 9241 (2004) - Ergonomics of human-system interaction, human-centred design approach in a system development process will help the system to be more useful, friendly, usable and effective for users. By studying users' needs and expectation and by implementing knowledge and techniques about User-centred Design Methods, organizations can improve not only the system's performance quality, but also the well-being, the satisfaction, the trust and sustainability for the people. For application development, ISO 9241's series of standard provide guidelines about how to plan, identify, manage and corporate the UCD approach within different types of application development such as object-oriented, waterfall or lean. Moreover, the standard is constantly updated throughout the years to provide accurate guidelines that are suitable for the current industrial requirements.(Standard *et al.*, 2004, 1-2.; Travis, 2014, 1-4.)

The latest updated version is called ISO 9241- part 210: Human-centred design for interactive systems, provides six key principles for organizations to apply when designing a system to be user-centric. The standard emphasized the role and level of co-creation and involvement of the users during the system development process. The first principle is to understand who the users are, including their backgrounds, environment, problems, needs, emotions, and effectiveness expectation regarding a potential interactive system. It is only when developers and project manager communicate and truly understand users that the requirements for the system design will be explicitly clear. For example, different users with different age groups and genders will use the system to help them for different purpose that only that group of users can provide information about the system's design requirements. The second principle advices organization to include users to the co-creation process of the development and design so that the system brings real value and meaning to users. This action lead to the third principle that is about design, which is driven and defined by user-centric evaluation. The principle suggests development team

to constantly test and evaluate preliminary idea, prototypes, and alternative design versions with real users throughout the design process. As a result, the system design, quality and usability are evaluated and improved by users for users. The fourth principle describes the idea of doing iteration of design rounds starting from the first idea and design and continue to improve, change, innovate it during the design process. In order to be user-centric, it is crucial that the development and design team show users visualized ideas and ask for users' reaction, feedback, thoughts and feelings about these design features. The ones that users want and choose based on their liking and helpfulness to their tasks will then continue to make into the next round of design process. The fifth principle is about user experience as the system's core value. The design team needs to ask questions such as how to make users feel easy, good, positive, happy, fun, helpful, effective, supportive using the interactive system as part of their life. For example, the design team can imagine a scenario or user journey and the interactive system in a relationship every day and find out how to make the relationship a good and enjoyable one. The sixth and final principle is how a design team should work together. The design team should include different multidisciplinary skilled and characteristic people. The team should not be a soloist or following a leader but a collaborative effort between different background members. All the roles that are necessary for the interactive system development project have to be allocated to the right human, and the responsibilities are shared among the group, that is including also the end users. (Travis, 2011, 2014, 57-59.)

### **3.2 Emotional design**

As human, emotions are what make experiencing the world different from other species. According to Damasio (1994), emotion is an overriding influence in human's daily lives. What people feel about something determines their actions, decision-makings and later memories about it. When a person experience an encounter and interaction with other people and things, the way they feel during the experience will be their impression about it and will be stored in their memories as things with meanings and values linking to the expressed emotions. Consequently, the emotional impressions that people has when using a product, service, software and system reflects on how well it is designed for its users. (Damasio, 1994; van Gorp and Adams, 2012.)

Since emotional information is, a type of perceptive information that human can process, learn and react; Norman (2004) suggests that there are three different levels of processing human's emotions as information, which are visceral, behavioural, and reflective. For example, when using a device or system, if user is feeling good and positive, they are more likely to ignored minor faults. However, if they become anxious and frustrated, they pay more attention in the little things and react to situations stressfully. Therefore, the

product should appeal to users as a mean of delivering good feelings and positive emotions. On the other hands, when there are tasks that require users' attention, being anxious and stressed may help users to complete the tasks. For example, when students know that a deadline is approaching quickly, they push through their homework with motivation but also by the stress and pressure that they might not make the deadline and have bad results if they are slacking off. Norman's ideas about three levels of emotion processing translate well into emotional design as not only designers have to think about positive aspect of emotions but the negative feelings' impact that a system can have on its users' experience.(Norman, 2004, 22, 26.)

In recent years, researchers and educators have found that engaging human's five-senses in training and learning, or multisensory learning, is making learning more "effective" (Shams and Seitz, 2008, 7). Multisensory learning usually involved the body senses such as visual, auditory, kinaesthetic, and tactile. Many educational organizations have already used multisensory learning method to the extent of technology advancement with visualized information on touch screens, learning by doing, and audio learning with musical or natural background noises. How does the sensory information affect a person upon receiving external stimulation? The person perceives this gathered information by assigning first reactional, then emotional and finally meaningful values to them. By being aware of the educed feelings that stems from body interaction during learning process, designers can understand users better so that they can design and transform the experiences into engaging and positive effect via the utilization of multisensory learning. (Stein, 2011, 824.; Austin, 2016,19, 21.)

According to Goya-Martinez (2016)'s journal about emotions in computing and robotics, emotional design in machines and systems were not always considered a feature during the 1970s as Newell (1982)'s research recalls it. However, as Goya-Martinez mentioned Minsky (2004)'s research, he argued that emotional mental is also a way of thinking and as much as the human intelligence, it is the information and data that can be stored and learned by other human and computing systems. Goya-Martinez reviewed a project that involving creating software agents as virtual humans with imitation of bodily gestures, verbal interaction and emotional expression. The project belongs to Cassell and colleagues (2006), in which a virtual child agent was made to interact with children and try to motivate and elevate the children's learning abilities and social skills. Researches have shown that when there are emotional behaviours involved in a virtual agent, human learn better and feel more motivated because their educational experience is enhance by positive emotions such as trustworthy, reliability, persuasiveness and being natural. (Goya-Martinez, 2016, 171-186.)

An interactive system is designed with the mean to deliver a technical solution for its users who happen to be easily impressed by beauty and styles. What this means is that users rely on visual clues to navigate themselves through their surroundings and process new information quickly. Researchers have been applying psychology findings about human's nature into graphic and interface designing for every-day-use products. There are certain principles and guidelines that are universal in designing interfaces that are compatible to the human's psychology and brain processing. A computing system is bound by these guidelines in order to serve human better, and thereby, a user-centric product of design. (Constantine and Lockwood, 1999.)

As the ISO 9421 suggests an interactive system needs users to contribute in every step of the designing and developing process. Users' feedback, opinions, thoughts and feelings are crucial information that will evaluate the system's idea and concept as well as its usability. Therefore, designers need to apply thoroughly user-testing methods to make sure users are satisfied and happy with the technical solutions they are using. The notable method that is very helpful in evaluating a system's usability is Nielsen's Heuristic Evaluation that focuses on what users see and think during the usage time. Another method that is also a UCD approach about usability evaluation is the Emotional Engagement Analysis, which focuses on what users feel before, during and after their usage experience. This chapter includes researches that related to these UCD evaluation methods, as well as the aforementioned research summaries of existing UCD and emotional design findings. (Nielsen, 2001; Dirin, Laine and Nieminen, 2017.)

### **3.2.1 Three levels of design**

According to Norman (2004), designers may often think that emotion comes with beautiful, cute, and colourful things. However, Norman argues that the way an object makes people feels is the actual reason a person is emotionally attached to it. A memorable thing becomes a favourite item to someone, even if it is ugly or disliked by others. Emotion and memories can go hand in hand when it comes to loving something. For example, a childhood toy which has worn out by time can become the source of soothing calm and happiness to a person because they associate their toy memories with the happy emotion, or the happy old time. Apart from sentimental reasons, human's desire is related to their sense of self-image and pride. The desire of being noticed, approved, respected and admired leads to people seeking materialistic solutions to appeal fashionable, beautiful, successful and accomplishing. For example, a student will purchase new computer and new clothes coming to a new school to feel confident. A good product can also contribute to the creation and development of a person's personality and behaviours. For example, the

newly bought computer provides a smooth experience to use and helps the student to study better, which results in good grades and thus, contributes in the image of the students as being the smart one in the class. Emotional design is the reason behind the creation of these memorable, desirable and personal experiences for users when they use the products. Norman has connected the dots between human behaviours and emotional design to create not just a guideline but also a practice for designers to think and approach their design with the Three Levels of Design. (Norman, 2004, 53-60.)

The first level is Visceral design. How can the products feel good and attractive right away? The answer is that the appearance and visualized interface of the products have to immediately catch the attention and create emotional impact like “wow I like it” at the first eye sighting. The use of colours, curves, and shapes, the cover of a juice bottle in the super market is a good example. Among several different branding juice bottles, what makes one brand’s juice bottle stands out is its packaging that forges an emotional link between the people and the brand. If the cover is unique, strange, and yet giving out signals that it can make people feels good if they pick it up, that means the visceral design is successfully applied. To find out which visceral designs are best, designers can invite users to give a visceral, quick reaction to the appearances of different designs and record users respond with their emotional expression and verbal confirmation. If the respond is smiling and saying, “I love this!” then the design has catch their immediate attention and if it is pouting and saying, “hmm...” then it might have not created a momentum to users.(Norman, 2004, 66-69.)

The second level is Behavioural design. How can the products contribute to users’ life effectively? The answer is four components, which are function, understand-ability, usability, and physical feel. The first answer is the products should be functional, a solution to solve users’ problems in their context of use, even the ones that users are not aware of. For example, the computer has to be able to replace physical notebook, physical copies of books, and other physical tools so that a student can make things happened, done faster by using it. Norman advices that designers should observe users’ life and look for the problems proactively where the potential of a functional solution can change users’ life significantly. Users should be able to understand the mean of the products and theirs added value to users’ life. It is also through observation when the product is being used naturally by users that designers can find out which aspect of the product the users feel confused and frustrated about. For example, designers can create quickly a paper prototype and test it with users. Even after users have fully understood the products, some may still not be able to use the products effectively because the products seem to forget the characteristics of the users. For example, young users can understand slangs but to use

slangs in a product for both young and old users will make the older ones feel like they are not welcomed to use. Therefore, usability should be of universal standards so that everybody can use them. Universal design for universal usability can be a big challenge however it is an idealistic concept that designers can strive for the best possible outcome. Nowadays, physical feel of a product has become different due to the use of many technological devices, such as mobile phones and computers. Because of that, designers have to look at the convenience and comfortability of physical components' positions, sizes, and materials to enhance users' experience. For example, the keyboard of the computer should include buttons in an easy-to-reach position for users' fingers; the grouping of functional buttons with the same meanings can also help users to learn how to use the device faster. These components of a good behavioural design can be applied in every step of the design process. By doing iterative design process and continuously testing with users to look for mistakes and improvement, the final design and product can truly become user-centric. (Norman, 2004, 70-83.)

The third level of design is Reflective design. The reflective design level brings memories and personal value and experiences to the users when using the products. It is closely related to one's self-image, satisfaction, and the emotional memories. How can the products make users feel goods and keep using after their first use? The answer is if the product can help create positive memories for users. An item that is useful, helpful, and beautiful and can induce good memories will be proudly introduced to users' friends and families. When the users reflect on how has the product affect their lives, they assess that the product is actually a pleasant experience; hence, their memory can become the reason that they will continue use, and love the product. For example, a computer allows owners to name the computer to their own liking, and to mark that the computer belongs to them by registering their name in the computer's profile. A good reflective design is a welcome screen with the user's own name that will put a personal touch and warm interaction to indicate the experience is designed just for them. A student feels special because the computer's welcome screen say his name along with a smile and therefore, create a sentimental and emotional attachment to the computer. (Norman, 2004, 84-89.)

### **3.2.2 Multisensory design**

Visual and auditory design are the basic for interactive system. When people is put in a specific environment, they look for sounds and sights in the surrounding that can help them understand where they are, who they are with, what they will do, and so on. Colours can contribute significantly to the emotional transaction between the environment and people. Information and knowledge are visualized with use of colour so that they can stimulate specific thought process that educed from the emotions the colours may carry.

When colours are deemed unnatural and detached from human's knowledge of the world, it can trigger different brain stimulation and create confliction of emotions and reactions. For example, when an apple is associated with blue instead of its natural colours of red, pink or green, people can feel unsettled and uncomfortable by the kind of message that the colour is trying to convey. Users can also associate themes, brands, and entities with certain colours. For example, a famous brand with signature colours in their products are known for the colour and users can recognized the brand by the arrangement of the colours; a notable example is Google logo and its colours palette. The study about colours and emotion relationship helps designers to create elements that involve users' visual attention and emotional arousal that recall their immediate reaction. Similar to Norman's Visceral Design level, the visual design is based on the visceral perception of human when their senses first interact with new information, many messages are exchanged within seconds and thus the design has to be able to deliver the targeted emotions to users. (Norman, 2004; Pierotti, 2016.)

Auditory design focuses on the hearing, listening and the feelings derived from that. A person hears sounds and noises first before their listening skills come in. Whenever a speech is transmitting to the listener's ears, the volume of the speech, the tone of voice, the language and tempo and even the stop in between sentences can contain meanings and its attached emotions. Songs that can create emotional moments that make listeners move to tears or happy to dance, are the examples of how powerful auditory design can easily create emotional moments and experiences with users. Hearing sounds cannot translate to meaning and may only be background noises that do not demand attentions. However, when human starts to pay attention to the sounds and question its original and meaning then that is when human starts to listen. However, there are different levels of listening and some levels do not require emotional processing. As designing auditory is part of the emotional design and user-centric design, designers should strive for the levels of listening that can evoke both thinking and feeling processes in users. Questions about the sounds' volume, pitch, language, and tempo are encouraged during the design process. Like other functions of a system, auditory design should also be tested with real users to gather important feedback to design a pleasantly listening experience. For example, a soothing female voice of a virtual agent that help users fall asleep can contribute to the first impression whether it is a good experience or not. On the other hand, a high-pitch loud alarm ringtone can break the calming of the sleeping users in order to wake them up with a sudden, alerting and uneasy feeling. Thus, audial information can reduce the information load of visual display. Another example is, instead of having all the information displayed on a touch screen that users may not be able to notice them all, information is presented in audio files so that users can continue exploring the system and still be aware of

important information. The example is about auditory display, which is a term to describe how a system can communicate information to the users by sounds, such as audio guidance, notifications, status and progress. The use of speech icon in system as auditory guidance and feedback can help users navigate and learn faster which creates an enjoyable experience. Walker, Nance and Lindsay (2006) created a term and usage called “*spearcons*” combining “*speech*” and “*icon*”, which Austin (2016) has reviewed in his research and find that “*spearcons*” can indeed evoke emotions, especially if a real person voices the speech. In his research, Austin also concludes that sounds in a product can play a crucial role in affirming users that the product is safe to use. Moreover, the auditory design in digital media can articulate to a certain level of users’ self-pride and accomplishment when they are successfully converse and interact with the auditory functions. (Austin, 2016, 25, 28-33.)

Haptics and tactile design refers to the response and manipulation of a sensory system via users’ touch and proprioception. Reese, Pawluk, and Taylor (2016)’s research about rational design of multisensory effects for engaging learners, emphasizes the need to include haptics and tactile senses as human factor when designing a system and its effect on users’ learning process. In engaging learning system, people learns new topics by relating to the known knowledge and connecting familiarities to the unknown topics that they learn in the system. For example, user plays a game on a screen that has similar rules as a contextual knowledge the user already knows from the real world such as running away from danger. With that knowledge, user reflects on the game rules in the system such as moving forward to avoid being caught and transacting it into reaction by touching (haptics) and interacting (tactile) with the screen. Therefore, by designing an intuitive haptic and tactile interaction for users, designers can enhance and boost the process of transaction of knowledge and reaction to the system faster and thus users feel good because their understanding and usage of knowledge have resulted in a good game experience. (Reese, Pawluk and Taylor, 2016.)

### **3.2.3 Virtual assistant**

The concept of virtual assistant or agents is the pleasing and interactive relationship between a virtual, screen-based characters and user. A virtual assistant needs to establish a certain degree of trust, security, and satisfaction as well as familiarity for users so they can invest their attention and emotion in interacting with the virtual character (Seiler and Craig, 2016, 75.). For learning experience that is supporting the mobility and flexibility of learning everywhere anywhere, the virtual assistant can be valuable as an instructor role for remote learners. Roa-Seiler (2016) has developed a virtual assistant called Samuela, which is designed to be a young female avatar that can interact with children and express



emotional responses with certain conversations. In her research, she studied Samuela and the children during their interactions to come up with an overall process between virtual assistant and user. The framework is called the Affective Channel or AC model, which has three phases: Phase 1 – User Emotional State in Multimodal Sensory Detection systems; Phase 2- Companion Interface and Emotion Interface Process; and Phase 3 – Cognitive Emotional Modelling. First, user interacts with the systems using their body motion, sensory such as hearing, touching, listening, and talking as well as facial expression. The system is a sensory detecting system, therefore, when user touch the screen and speak up, the system takes in the information from users as info input in order to process what the next response is. Depending on what user has interacted and sent info to the system, Samuela – as the system's responsive representative will engage with user by speech and dialogue, emotional expression via stimulating movements, facial expressions and speech tone. Samuela can use the knowledge that the system has to respond to user, thus creating a back-and-forth conversation repeating the interaction process but with new information input from users and information output from Samuela. The loop is completed when Samuela returns information to users with equally humanly knowledge and emotional expression that signal real time talking and interacting with user. The responding time, the verbal and nonverbal signals as well as the conversational behaviours such as ending a dialogue, talking turns, handling interruptions, and listening to feedbacks are designed to stimulate human-human interaction.(Seiler, 2016, 132.; Seiler and Craig, 2016.)

In order to design Samuela with this goal, emotional interaction strategies are applied. The strategies are Sympathetic Strategy, Cheerful Strategy, and Inquisitive Strategy. Like its name, the Sympathetic Strategy is for Samuela to display humanly emotions such as compassion, care, concern, kindness and understand to guide user's emotional state toward a neutral or positive state. The Cheerful Strategy is for Samelua to encourage user's positive emotional state by cheering users when the system detected that they reached a positive state. The Inquisitive Strategy is for Samuela to subtly converse with user in a neutral state of emotion in the case that user is neither in negative or positive state. (Seiler, 2016, 137.)

When user and Samuela are interacting via conversation, there are more strategies to resolve failures to avoid interruptions and misunderstanding in listening to dialogue. The strategies are Conversational Interaction Strategies. The first strategy is Surprised Strategy, to which the system can respond to user's input that is understood but unexpected. For example, Samuela can act or express the feeling of being surprised. The second strategy is Confused Strategy, to which Samuela will respond to user by sharing confusing emotion. The third strategy is Listening and is shown by Samuela's movements and facial

expression that indicates her attention such as eyes and head movements and verbal confirmation such as “Aha” or “Wow”. The fourth and fifth strategies are Idle and Interrupted. Samuela displays her Idle state by looking toward users and indicate inviting gestures for users to start interacting with her. If user interrupts the conversation with more information, Samuela can also respond by stop talking and show gesture to mean “Sorry” and let user talks. In a context of use that the system needs conditioned and scripted input information from user, a Domain Specific Strategy is applied. Designers can write a script or model that the system needs to follow and only respond to elements belong to the script. For example, the system may only respond back to user if user say “Hello!” first. In this case, Samuela is in her Idle Strategy until user starts to interact and send information that fit Samuela’s script. Only then, Samuela will start to collect information from user and respond according to the predefined strategies. (Seiler, 2016, 137-139.)

In her findings, Seiler discussed users that interacted with Samuela shown great emotional respondent ranging from Trust, Joy, Admire, Hope, Satisfaction, to Fascination and Desire, which are all positive emotions. There were no negative emotional respondent like Boredom or Fear toward Samuela. This finding can confirm that users prefer human-like interaction and feel more arousal in positive emotion during the engagement. Furthermore, Seiler referenced Englis (1992), Bates (1994), Reeves and Nass (1996) in their findings about the “willing suspension of disbelief” in which users know that the human-like character they are interacting with, is in fact not human, however, they are willing to accept their illusion that they are having a human-to-human relationship with the computing system. To conclude her research, Seiler argued that the benefits of using virtual assistant in learning could provide long- term effect in healthy emotional and social development skills in young learners. (Seiler, 2016, 164-165.)

Another study about virtual spoken dialogue agent by Sumi (2016) suggests that virtual agent is more influential than robots when motivation and cheering up was needed for users. For example, when users need more emotional encouragement, they are more likely to change their mind from “no” to keep on working on the task if they are asked by the virtual agent. As mentioned before about the “willing suspension of disbelief”, users feel their emotional responses to be similar as human interaction when they are interacting with a virtual agent. Users, whom were testing the speech dialogue agent, expressed their emotions that synchronized with the facial expression of the agent. For example, if user finished a task and felt happy, they would expect the same feeling and expression coming from the virtual agent. Questions about feelings were included in the interview later, such as “Did you enjoy, Do you think you want to continue using this tomorrow, Do you think you raised your thinking power, How did you feel about the character’s explanation and its

effect on your task completing? Did the character's encouragement motivate you during the task? What were your impression of the character? How do you feel about the character, please rate it using the list of the conditional moods: "conversable-inconversable", "reliable-unreliable", "gentle-bitter", "egotistic-humble", "empathetic- unempathetic", "authoritative-unauthoritative", "offensive-inoffensive", "serious –unserious", and "affable-inaffable". The overall impression of test users about the spoken virtual agent is that they favour human-like voice and they feel positive about the interaction with the agent. It can be awkward for users when the agent push them more than necessary even if it has rich human-like emotional expression. Sumi suggests that when there is speech and dialogue as well as speech recognition involved in an interactive virtual agent, the system should be easy to use and the speech recognition technology should be of great accuracy and response time in order to maintain users' emotional engagement. (Sumi, 2016, 87-93, 100-101.)

### **3.3 User Interface (UI)**

The principles of user interface design are intended to improve the quality of user interface design. User interface or UI is the system's interfacial elements including interaction design, visual design and information architecture. These elements ensure that the system is easy to use, access, understandable for users. There are many models and methods of UCD approach when designing systems, however, in this chapter, the thesis author chose a standardized method by Constantine and Lockwood (1999) for software design. (Garrett's and Usability.gov, 2010)

As designers and developers involving in the designing process, the most important thing to remember is to include users and their perspectives. Based on the study about human nature and psychology, system users follow the same pattern when using an interactive system with their common senses, existed knowledge and perception of visual and interfacial elements. An effective UI design can communicate well with users by showing how understanding the system can be of the users' thinking and anticipating behaviours. According to Norman (2004), a system's model should match the user's mental model of expectation and predictable outcomes; otherwise, there will be misunderstandings that lead to misusing or failure to use the system. In order to design system that can match user's mental model, Constantine suggests a set of six principles for UI design, which are structure, simplicity, visibility, feedback, tolerance, and reuse. (Constantine and Lockwood, 1999; Norman, 2004.)

The Structure Principle is similar to Gestalt's psychological perception of human on objects' forms of Similarity and Proximity. The interfacial elements, which are relating to

each other, should be grouped together and using similar theme. On the other hands, elements that are unrelated and dissimilar should be separated and marked by different themes, for example, different shapes and colours. By doing so, the system is able to deliver a clear and consistent model of organizing and recognizable structure for users. The Simplicity Principle means that the elements should be simple and deliver a clear communication to users' own language. The design should help users do their task with ease, providing good shortcuts alternatively to the system's longer procedures. The Visibility Principle is about making important information and content of a system's task visible predominantly when user is focusing in the task. The Figure/Ground Gestalt Principle is involved with the Visibility Principles in term of designing important elements to be at the foreground of user's attention and the lesser to be faded into the background. This way user can focus on the current task and is not distracted by the overloaded information. The Feedback Principle is to help designing a continuation or flow that is transacting smoothly between states of user actions. For example, when user touch the screen of the system to indicate a mean of action or interpretations, the system should response with a clear message to inform the result of user's action, which can be either an approval, alerting, or errors message. The Tolerance Principle suggests that the system design should be adjustable and tolerating of users' actions even if they are making mistakes. The mistakes and misuse should be able to be undone and redone by users so to reduce frustration or negative feelings, such as feeling of failures or unconfident. The Reuse Principle means that the design should reuse and recycle internal and external components and behaviours of the same purpose so that a consistency is maintained throughout the system. For example, the same icon with same function and meaning should be reused in different scenarios and users' tasks to avoid the needs for remembering and rethinking. (Constantine and Lockwood, 1999; Todorovic, 2008)

Todorovic (2008) and Shimpeno and Ezer (2014) find that the Gestalts' principles can be applied to the UI design in interactive, three-dimensional and motioning systems. The notable implementing principles are Continuity, Closure, Symmetry, and Common Fate. The continuity of visual elements is based on the continuous forms and non-disconnected segments. Users often fills in missing segments automatically, completing an incompleted form. Consequently, users automatically attempt to make closure on an "open" object so that they perceive them as whole. Users can still interpret shapes and meanings from a "white space" or a total missing of an object in visual. In an interactive visualization system, the goal is to reduce complexity and overload information for users as well as to reduce the system's workload to display data. When there is elements that are organized in symmetrical shapes, the flow of information processing happens in users' brain with much easier understanding and smoothly translating to users' reactions. Symmetry is the

primary principle used to interpret three –dimensional renderings on a two-dimensional display. Common Fate is the principle that deals with motion and animated objects. All things being equal, if a group of objects moves in a similar way, they are perceived to be a related group. (Todorovic, 2008; Shimpeno and Ezer, 2014)

### **3.4 Usability testing**

Usability is a feature element that evaluates how easy the application's UI is for users to use them in real life. The word "usability" also refers to methods for improving ease-of-use during the design process. Usability is distinct by five quality modules: Learnability, Efficiency, Memorability, Errors and Satisfaction. Learnability is asking question about how easy is it for users to accomplish basic tasks the first time they encounter the design. Efficiency means once users have learned the design, how quickly can they perform tasks? Memorability suggests when users return to the design after a period of not using it, how easily can they re-establish proficiency. Errors is asking question about how many errors do users make, how severe are these errors, and how easily can they recover from the errors. Satisfaction means how pleasant is it to use the design.(Nielsen, 2001).

Before designing the ideas and conceptual system, developers should study targeted users' behaviours and habit. Who users are, what their requirements are, how they do things, and how the idea can solve their problems, are the questions that developers should look for answers from users at this point. By building users' profile, developers can design the system better to suit the users' needs. Paper prototypes and low-fidelity prototyping are the first design method to sketch the ideas and system features based on users' requirements. After several refining rounds, the prototype can become high-fidelity version that would allow testers to test them on a computing device. Performing frequent tests involving users and different versions of the design can ensure the consistency and user-friendly of the final design because usability problems often appear during the implementation and even after a final design and system is built. By assessing the system with users, using the UCD guidelines that were implemented during the development process, developers can evaluate the performance of the system accurately and pinpoint exactly where the problems are and how they can be fixed.(Travis, 2014b).

The process of usability testing is simple, including three components. Firstly, the developer should contact the targeted users and invite them to participate in the testing process of the concept. Secondly, the developer then prepare several system's tasks for users to perform these tasks. During this process, observation is the key to collect new information about what users do things in the conceptual system. Users are encouraged to think aloud and describe whenever they meet with difficulties or pleasantly moments. The developer

should only record the process, observe and write down notes during the user testing session without interrupting users. Finally, after the user testing, the developer can interview users to rate on their experience and to ask for their opinions and feedback about which part of the design is good, and which part is bad, and how it can be improved. (Nielsen, 2001; Travis, 2014b.)

### **3.5 Emotional Engagement Analysis (EEA)**

When testing with users about a system's design, users' emotional feedback and experiences are usually important because the main purpose of a system is to help users do work with pleasure and positive feelings. Dirin and colleagues (2017) have worked on measurement criteria called Emotional Engagement Analysis or EEA to measure emotional factors of user experience, specifically for mobile learning applications. As they stated in their work, by focusing on users' emotions as the key factors, developers can transform the application into its better version. Although there are several methods to measure emotions, depending on the context of the project, the mean and objective to carry out the measurements, Dirin's work specifically focuses on measuring emotional engagement that related to mobile learning application, which suits for this thesis's researching topic of mobile learning, and MAR applications. The objective of the EEA is to look at users' emotional assessment of their user experience about the delightfulness, trustfulness, adjustability, and satisfaction of a system. In table 1, the criteria is explained in detail in which the components are assessed with subjective and behavioural EEA measurements. (Dirin, Laine and Nieminen, 2017.)

Table 1. EEA criteria for the measurement of user experience in m-learning (Dirin, Laine and Nieminen, 2017).

UX Factors	Goals	EEA Criteria
<b>Delightfulness</b>	Learners can successfully perform the tasks defined in educational components: presentation, activities, communications and administration (Brusilovsky and Miller 2001). The application supports learners in performing tasks without difficulty. Learners enjoy and have fun using the application and the content.  Learners consider the application as an efficient and preferred medium for performing educational tasks	<b>Subjective measurements</b> Learners feel that the application is fun to use. Learners feel that the application's educational component provides delight and allows them to achieve their goals. Learners may use words, such as great, fun, fantastic, and easy, etc. <b>Behavioural measurements</b> Observers find that the learners are having fun while using the application. Additionally, observers notice that the learner demonstrate that the tasks are easy and fun to perform.
<b>Reliability</b>	Supports learners in trusting the application, especially regarding data integrity and reliability. Learners are able to successfully upload and download educational materials, Learners receive proper feedback on their actions from the system, such as notification of successful submission.  Learners are able to communicate with other individuals, peers or a group securely.	<b>Subjective measurements</b> Learners feel that the application is trustworthy. They verbally or in the written feedback demonstrate this feeling. <b>Behavioural measurements</b> Observers realize that the learners trust the application by entering information as the test tasks progressed
<b>Adjustability</b>	Supports learners in adjusting and customising the application theme, user interface and content based on each learner's own preferences. Learners are able to customise the presentation types and format.  Learners have the choice of an individual or a group communication medium. Learners are also able to select the communication format, such as email, chat, or newsgroup.	<b>Subjective measurements</b> Learners feel that they have control of the application. They emotionally express as though the application is their own application (feeling of ownership). <b>Behavioural measurements</b> Observers find the learners being relaxed and do not express signs of stress or being lost with the application. Additionally, the learners have done the tasks before the allotted time expires.
<b>Satisfaction</b>	Supports learners in performing essential educational tasks. The application meets learners' educational expectations and preferences. In addition, students may study the material conveniently with the m-learning application.  The m-learning application contains the preferred functionalities so that learners are capable of carrying out all the educational tasks, such as uploading assignments, providing answers & receiving feedback from instructors.	<b>Subjective measurements</b> Learners express their satisfaction with the application functionality. Learners express verbally that the application satisfies their educational needs in all the educational components (presentation, activity, communication, and administration). <b>Behavioural measurements</b> Observers find that the Learners do not express any frustrations while using the application.

In subjective measurements, users' feelings, opinions, and thoughts about their experience are put into perspective and developers should be able to pick up key words, such as feelings of happiness or sadness, excited or boring. In other words, users are asked about their immediate and current states of emotions. On the other hand, behavioural

measurements emphasize the developers' observations of the users' behaviours and reactions during their test sessions. For example, video records, interview transcripts and memo about users' actions and reactions are the output of behavioural measurements. The delightfulness and trustfulness assessment centre on how users feel and what emotions the system triggers in users during using. In m-learning application context, the system should support users to do tasks successfully, work effectively, trust the system as their assistant, and in return, users enjoy and feel positive feelings such as being happy, proud, and safe and having fun. The adjustability and satisfaction assessment centre on the usability of the system when users use it, such as the customisation level to each user's preferences and the overall satisfaction of having meet the users' expectations of the system in supporting their purposes. (Dirin, Laine and Nieminen, 2017.)

In user testing, EEA method is simply one of the methods to combine with other methods to collect information from users, and should not be used as the sole measurement of usability and user experience evaluation. Nevertheless, by applying these assessments about emotional engagement, developers can learn more about users and how the system can be designed and improved to be more user-centric. (Dirin, A., & Nieminen, 2015; Dirin, Laine and Nieminen, 2017.)

### **3.6 Mobile Augmented Reality (MAR)**

With the rising of MAR applications such as Pokémon Go, Ikea Place, and many more, MAR implementation has the opportunities in other areas as well such as education and tourism. However, there are technical and implementing challenges due to the limitation on the knowledge of MAR as it is truly a new technology. Many mobile devices and smart devices support AR technology and allow users to download and use MAR applications. Nowadays, these devices are becoming rapidly less expensive and more accessible to every users on the globe. Users can experience the MAR applications from anywhere and anytime providing the internet connection in some cases and mobile devices' hardware capabilities. (Dirin and Laine, 2018; Muilu, 2019.)

MAR applications encourages the mobility and flexibility of users when it comes to learning and accessing new knowledge whenever they need to with a visually constructed information that can take them into a realm of reality environment with elements of computerized visual effect in real time. For example, when a tourist visits a certain historical attraction, they can use a MAR application on their phone to see an overlaid filter of what the place used to look like decades ago at the actual attraction. The visiting experience is enhanced to the new level because of the AR technology. Before different organizations realized the usefulness of MAR technology, users would have to be provided with physical



materials such as printed pictures in order to imagine. The main reason why MAR applications can contribute benefits and have a tremendous potential to apply in many areas is that most customers already own the required hardware, which is smart devices that can process MAR applications. (Craig, 2013, 209-219.)

Education is changing and transforming from traditional learning and teaching to technological innovating of new ways to learn. The use of computer, internet and web-based learning, and mobile devices in educational institutions is increasing and has become the norm. With its potential, augmented reality in mobile devices can contribute to the development of better learning and teaching experiences for both students and educators. Since AR technology can add new information into the real scenes in 3D perspective, it can provide an innovative way to learn through artificial visualization. 3D interaction is more relevant to the real-world tasks than 2Ds, especially for simulation purpose, because the system's model is matched with user's mental models of expectation from the real world knowledge (LaViola *et al.*, 2017). This can be very helpful to students that may have difficulties understanding a concept, topic, abstract idea. Nowadays, many students have in their possession mobile devices and thus the benefit to use the devices for AR learning is promising. When students using a MAR application, they tend to feel fun and non-pressured because they are in control of when, where and how they access the information. Students can download MAR application to their own devices and explore new things at their own pace which in return gives them confidence and creates personal attachment to their learning experience. (Nincarean *et al.*, 2013, 657-664.)

#### 4. Case: Freshman App

BITe programme's director – Mr. Jari Hyrkäs had commissioned the case project as part of the thesis author's work experience. The case project was initially a part of a course in autumn 2017 to find an alternative and creative digital solution for future learning environment in Haaga-Helia UAS. The author came up with the idea and worked on a paper prototyping as well as testing the idea with various students. The results were then used as a proposal to BITe programme for a support of the continuation of the project. The project's goal is to create a functional MAR application that can be used for BITe programme's freshman. The proposal for the continuation of the case project was approved by BITe programme in February 2018. The application is in use for BITe programme's freshman students since May 2018. The thesis author has been collecting data from the students of BITe programme and of Haaga-Helia UAS to contribute for the research of the case project and for this thesis project's topic.

The outcome of the case project included one Android MAR application, one WebGL version, one web-based game collection, and other related contents. Furthermore, the development team co-wrote two journals relating to the case project with the project's advisor – Mr. Amir Dirin and Mr. Tuomo Muilu. However, the thesis author will only include the Android MAR app's contents, the results of the analysing, designing, testing and evaluating process that are related to the thesis's primary research area which is about user-centred design, emotional design and evaluation of the app's concept.

The Freshman app is an Android MAR application that introduces freshman of BITe to their campus – Pasila and familiarize the students with hot spots of the campus as well as the procedure of migrating into the university life. The application will help new students to learn quickly about the major steps to become official BITe student, such as, ordering student card, library card, meeting and talking with an AR humanoid guide in Pasila campus, as well as knowing the benefits and facility usage of their new studying place.

The case project is indeed one of a kind, as it was the firsts MAR application project to be approved and used by BITe programme for real users – the freshman students of the next academic semester. Therefore, what the thesis author has found during the time beings are considered first data collection and analysis of the case project. The thesis does not cover the financial aspect of the case project nor the AR technology at large but only contextually and within the case scope. The thesis author will only describe briefly about the technical area of the case project as it will be covered and discussed by Mr. Muilu.

## 5. Results

The implementation of the case project is the demonstration of the knowledge and theoretical study that are applied to the real-life product-based project. In this chapter, the thesis author discusses the process which took place during the implementation of the Freshman app. The process is in four phases that are based on the mLux model: User study, Data analysis, Design, and Concept Evaluation.

### 5.1 User study

The data collected during user study phase helps to learn more about what the students' needs and expectations of a new solution, in a context of orientation course for freshman students. The data that collected from this phase can contribute a specific user context and requirements necessary to the next phase which is to analyse users requirements to create system's features. The initial user study process started with collecting the overall user profile from Haaga-Helia students, as the designated users of the m-learning environment. The learning environment was designed for freshman students, and the user profile was that of a BITE freshman student. The interviewees were junior students from BITE programme who had experienced the orientation course during their freshman time and were asked to recall troubles and problems that they encountered during the orientation week. The detail user profile is shown in table 2 below.

Table 2. User Profile (Nguyen *et al.*, 2018).

User	Gender	Age	Experienced smartphone user	Software often used for school	Go to all orientation days (first 7 days)	Troubles/problems occurred During orientation week
1	F	30	Y, iphone	Google Drive, Outlook	Y	N
2	F	19	Y, android	One Drive, MS Office, Outlook	Y	Y: printing process, logging in to VDI
3	M	22	Y,iphone	MS Office, OneDrive	N (3/7 days)	Y: finding timetable and course description
4	M	21	Y, android	Outlook, OneDrive	Y	Y: accessing/downloading the school software (MS Office, etc.)

The freshman students' persona at Haaga-Helia are smartphone users and are advanced at using the phone's browser, mobile applications in general as well as school-related software such as Drive, Microsoft Office, Outlook (Table 2). The orientation for the Haaga-Helia learning management system put a damper on the first week of the semester for freshmen. Three interviewees said that they had had problems with accessing or finding the right information for the right tasks during the first few weeks of the first semester. Moreover, the students felt that the compulsory course were a disadvantage for students who could not attend the course and therefore, missed out on important information such as how to use the computing system, how to navigate inside the campus facility and so on.

## 5.2 Data analysis and ideation

Based on interviews of four BITE sophomore students whom gave their views on the activities during their first two weeks as freshman students, the thesis author were able to compile the most important user tasks and user requirements. The information that collected from this step help to build features and design content of the application. The aim of these interviews was to explore students' journey and to uncover problems the students had encountered during Orientation Week as they recalled their experiences. Moreover, the in-depth interview helps the research team find the answers to the questions: What is the user's persona? (Table 2) and what are the user's expectations and requirements regarding the Orientation Week of Haaga-Helia's BITE program. The interview transcripts were analyzed to identify repeated terms and actions among the interviewees. The interview transcript is summarized in the user-tasks in Table 3.

Table 3. User's tasks in Orientation Week (Nguyen *et al.*, 2018)

	User 1	User 2	User 3	User 4
Checking courses information	x	x	x	x
Learning how to navigate and to use the facility in Pasila campus	x	x		
Communicating with new classmates and teachers	x		x	x
Learning about students' benefits such as library services, student discount, software packages, student services	x		x	x

The students described the main tasks that they had attended in the Orientation Week, of which three students could not attend to all the main activities and expressed their negative feelings about missing knowledge. To devise solutions and enhance services in the m-learning environment for the students, the research team analysed the interview data using the framework of an affinity diagram. The team used the method called consolidation to extract the information from the interviewees into an overall picture of user requirements as an affinity diagram. The diagram was created to synthesize the interview data to find the key words and actions that were mentioned repeatedly throughout the conversation. The diagram breaks down users' main tasks and the purposes of their activities. Using the diagram helped the research team understand which features and user requirements of the m-learning environment to prioritize. The users' requirements are presented in Table 4.

Table 4. Users' requirements (Nguyen *et al.*, 2018).

<b>Task group</b>	<b>Checking info</b>	<b>Learning school system</b>	<b>Socializing</b>	<b>Receiving student benefits</b>
Subtasks	Checking study info	Learning about Pasila campus's facility	Communicating with other students and teachers	Receiving student's benefits
User expectations	To know the most important info about potential study courses, to plant study	To study more efficiently and to make use of the campus's facility when going to school	To create good relationship, and get support	To support student life in school and in person
Team task aspects	Can share the courses info and rate/write reviews	Can explore places inside campus together	Can interact and work with other people	Can join school activities, and receive services with other students
End-user validation	Users successfully check all info and plan courses without problems	User able to make use of campus's services and navigate around the facility	User able to develop social and soft skills and connect with others of same goals	User able to earn rewards from study and works and use them to support their life

The user starts the journey with a challenge or task, which is coded in red. The goal coded in green is for the user to win the challenge and meet their expectations, coded in

yellow. In addition, the aspect of teamwork in a challenge, coded in blue, suggests activities that users can do together. The diagram provides a clear picture of what users need to complete their tasks and what they want to have gained at the end of each task.

### 5.3 Prototyping and design

The UCD methods and UI principles are applied in this phase during the case project. Firstly, a user scenario was created to picture user's journey when they use the application as shown in Figure 1. Secondly, the content was created based on user's journey of visiting Pasila Campus from the entrance floor to the 6<sup>th</sup> floor of the building as shown in Figure 2. Thirdly, the user's journey in the user scenario was transferred into user's flow inside the application from the first screen to the last screen they see, the user's flow is shown in Figure 3. The colour theme of the application was designed to match the colour palette of Haaga-Helia's official colour palette on their website haaga-helia.fi. The design of icons and functional buttons inside the application were based on the UI standard principles and Gestalts' principles. The design of the virtual AR assistant was based on a real life BITE teacher – Ms. Riitta Blomster. Finally, the dialogue, audio, and feedback form were designed to enhance interaction with users and to support users on receiving, reacting and reflecting their positive emotions during their experience. Moreover, the application has its own instructional document so that students can use the application with ease.

Through scenarios, developers gain a deeper understanding what is important in the application. A scenario presents the normal use case of the application. The beginning of the scenario for the Freshman application is as follows:

*Eric is a new student, who received his acceptance letter to Haaga-Helia in June. He is a freshman student in the BITE program. With the letter of acceptance, Eric also received a barcode or link labeled "HH Orientation Game." Eric accesses the link and loads the game on his mobile phone. He can then start to learn about Haaga-Helia and BITE while playing the game. Within a few days, Eric has gained visualized knowledge of his campus, his Haaga-Helia profile and teachers, as well as practical information about using campus and online services...*

Figure 1. Excerpt of the scenario that was given to users. (Nguyen N, 2018).

Based on the scenario, Eric learns practical information of his campus. In the case of Freshman app, the campus is the Pasila Campus of Haaga-Helia. The content of the application needed to reflect the practical information of real life. Relevant information of Pasila Campus was categorized by floors on a whiteboard as shown in Figure 2.

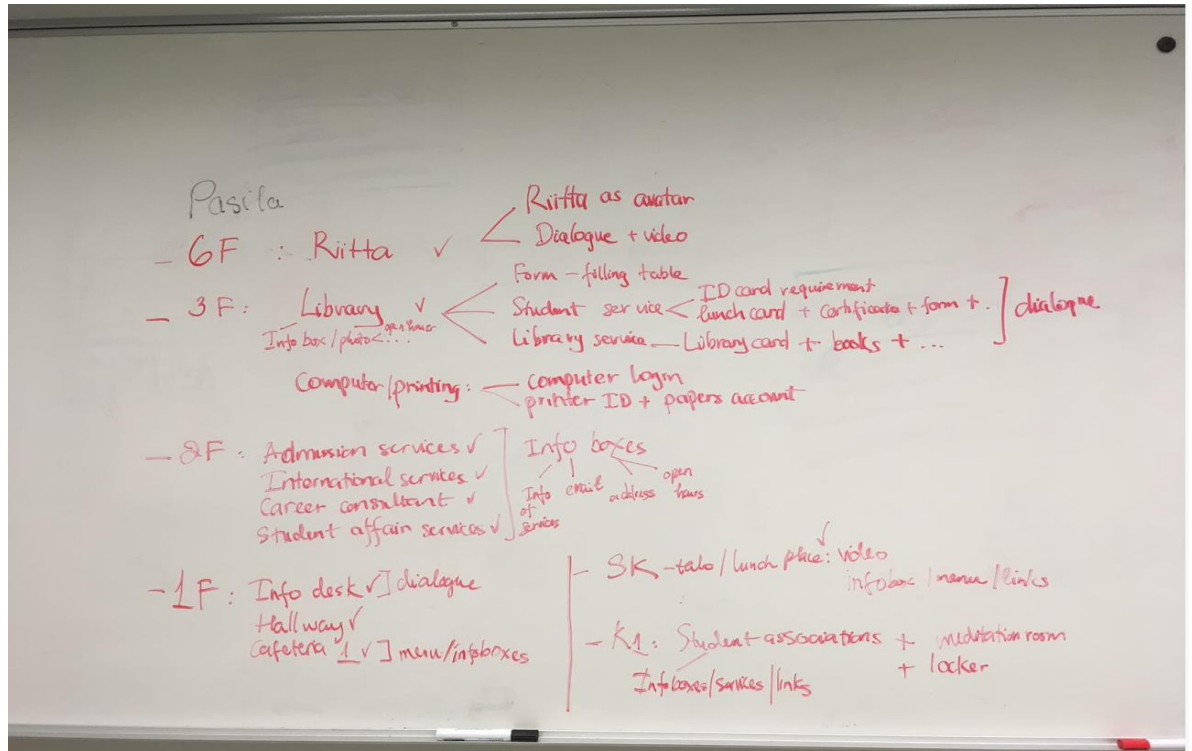


Figure 2. Freshman app's content categorized by Pasila Campus's floors

The application has information on four floors of Pasila Campus, 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 6<sup>th</sup> floors. Floors 4 and 5 were not included in the application as they do not have notable points of interest. The initial types of content designed for first floor was a dialogue at the Info desk, a hallway, and a menu or info boxes for the cafeteria. Similar type of content was designed for the second floor, which located the Admission, Informational and Student Affair services and Career Consultant. The third floor was designed to have mini-games for the Library and Computer operation and printing services. Sixth floor would have a Riitta avatar and a dialogue with video. The user flow helps developers to design screen flow that match user's mental model of the real world within the application's world. With the features and points of interest of the application set, a user flow diagram for the prototype was created and shown in Figure 3.

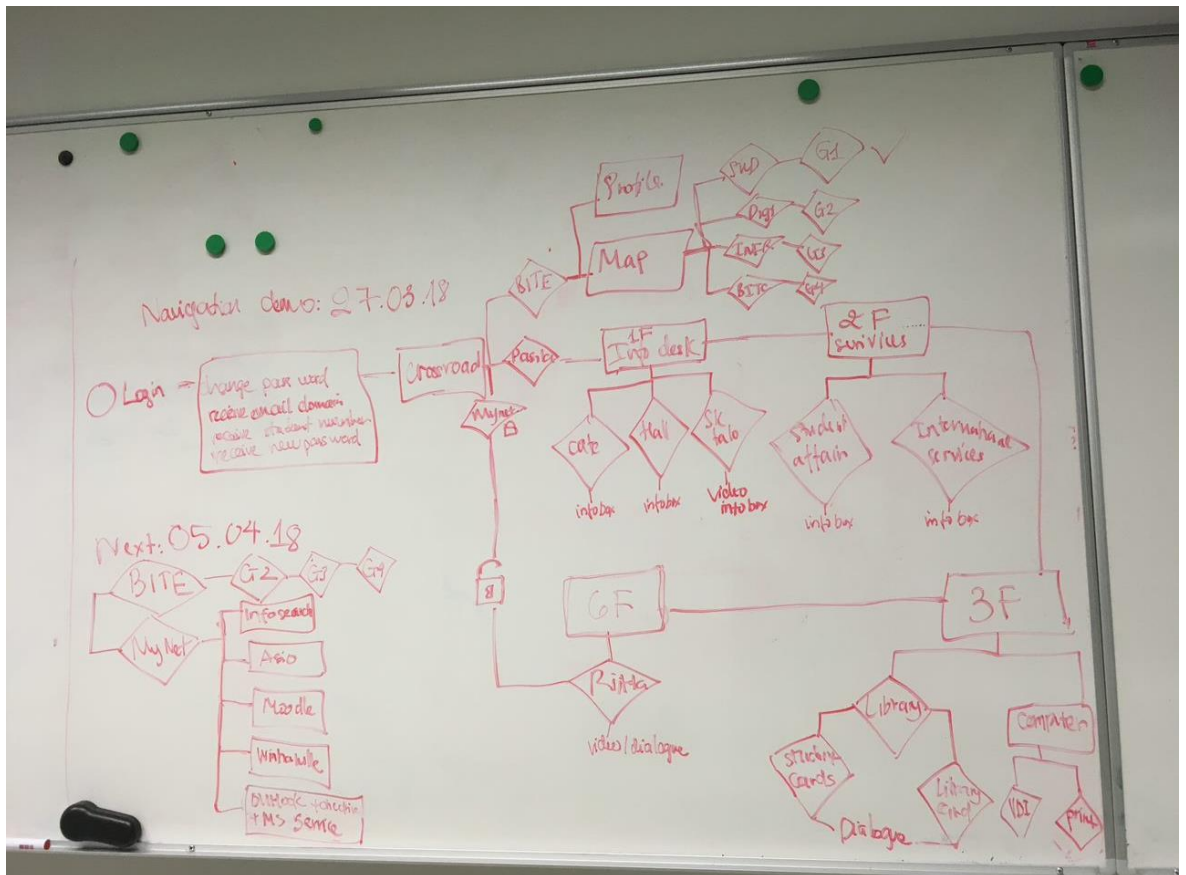


Figure 3. Original user's flow for the prototype

The user flow diagram shows how the user can interact with the application and how the user's choices affect their play through. The user flow features pathways that are locked until the user finishes a certain task that allows them to pass. An example of this requiring the user to print a report and receive a student ID before arriving in 6<sup>th</sup> floor. However, later on, the features changed so that the application encourage users to explore the campus freely in the application without having to submit to the compulsory of any tasks.

After the content and user flow was established, a colour palette for the application was created. All final colours chosen for this project are taken from Haaga-Helia's public site (<http://www.haaga-helia.fi>) and their Moodle and MyNet pages by screenshotting and using Adobe Photoshop's colour selector. The colour palette is shown below.





Figure 4. Haaga-Helia colour palette (Nguyen N, 2018).

“Since Haaga-Helia has its own colour palette, we did not need to create the specific colours. However, we did need to utilize the colours efficiently to give the application a certain theme. For example, the main colour we chose for the application is the green #7cd568. Green has a strong emotional correspondence to safety as well as freshness and harmony. We want the users to be at ease when using the application. The other variations of green, #93c669 and #accd15 are used sparingly to give more relaxed guidance with text boxes. The grey colour #b2ced9 is a neutral colour and used in formal conversations, for example with Riitta (the coordinator) and the librarian. Blue is generally associated with tranquillity, calmness and intelligence and darker blue to stability and technology. The three variations of blue, #1e79bf, #0c77c0 and #00b4d0 are used quite little, mostly since they have little contrast to our main green colour. The blues, however, can be considered an analogous colour to the green and complement it. The strong cyan #00b4d0 for example is used for indicators of a conversation. Overall, we used the colour palette quite little in the virtual tour of the Pasila campus, since we used real photos of the campus that already has colour. We did not want to clutter the UI with too many items. The highest contrast with others in the colour palette was the pink (#df0063), and it was used to direct the user’s attention towards important sections.” (Nguyen, 2018).

The colour palette was applied to all UI elements of the application in a consistent manner. Examples of UI elements are found below.



Figure 5. Old voice icon (left), new voice icon (right), navigation icon (in blue), elevator panel

In Figure 5, the old voice icon was changed to the new icon because it was too dark and did not have enough contrast to the background of the application. A mixture of Adobe Photoshop and Illustrator was used to create the icons and elevator panel. In the elevator panel, unnecessary floors were blurred and floors with content were highlighted with green. Before the changes, the elevator panel was just a photo of the school's elevator panel, and users tried to click floors without content which did nothing which is why it was changed to current version. The application icon was based on the Haaga-Helia logo, shown in Figure 6.



Figure 6. Haaga-Helia logo and App logo (Nguyen N, 2018)

The virtual AR assistant was created in 3D format using Adobe Fuse CC and was uploaded to Mixamo for animation design. Adobe Fuse CC is a 3D character creation soft-

ware and was chosen for its intuitive UI and freedom to customize and design the character based on pre-sets. The thesis author first took photos of Riitta in real life and then re-created her looks in Adobe Fuse CC. Riitta's facial expression in general is not changing as much but to deliver a continuously state of calming, happy, neutral expression so that user when looks at her can relate to their own feelings. Riitta's facial expression is based on the strategies to create Samuela's expression in which the facial expression should be in a neutral or positive state of emotion so that it can influence users' emotions when they interact with the assistant. The final rendition of the 3D avatar can be seen in Figure 7.

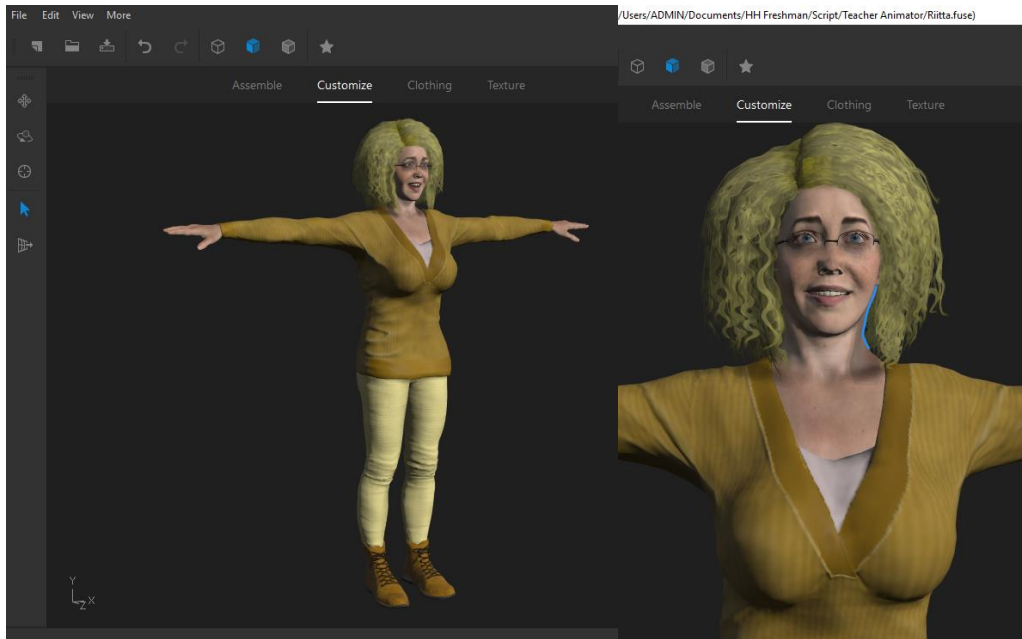


Figure 7. Adobe Fuse CC 3D Model Design (Screenshot of Adobe Fuse CC, 2019).

The Fuse CC model was then uploaded to Mixamo, an online service part of the Adobe family for auto-rigging and animations, shown in Figure 8.

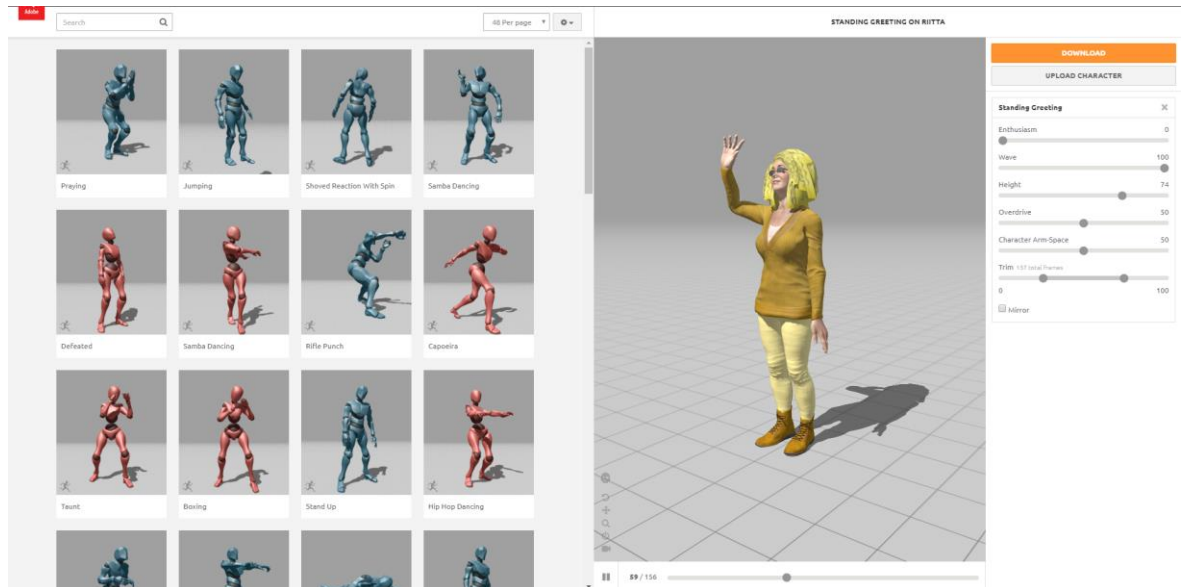


Figure 8. Riitta model with a standing greeting animation selected (Screenshot of Mixamo, 2019).

Mixamo provided customizable animations and certain parameters such as enthusiasm of emotional expression, how high or low the arm is, and how the character waves in the animation. The software is very useful to create actions and reactions with emotional expressions for Riitta. For Riitta, movements such as waving in the air to say hi and looking toward the users when talking is to show cheerfulness and kindness to guide users' emotional state toward a positive state. Riitta in Idle state is shown to look at users and in waiting gesture to invite users to interact with her.

The AR assistant is shown up on the screen when users point their camera onto a QR code. The current image target used in the application is shown in Figure 9. The areas around the QR code were created in Photoshop.



Figure 9. Current image target (Nguyen N, 2018).

The image target from Figure 9 was used to augment the 3D assistant in relation to it, as shown in Figure 10 below.

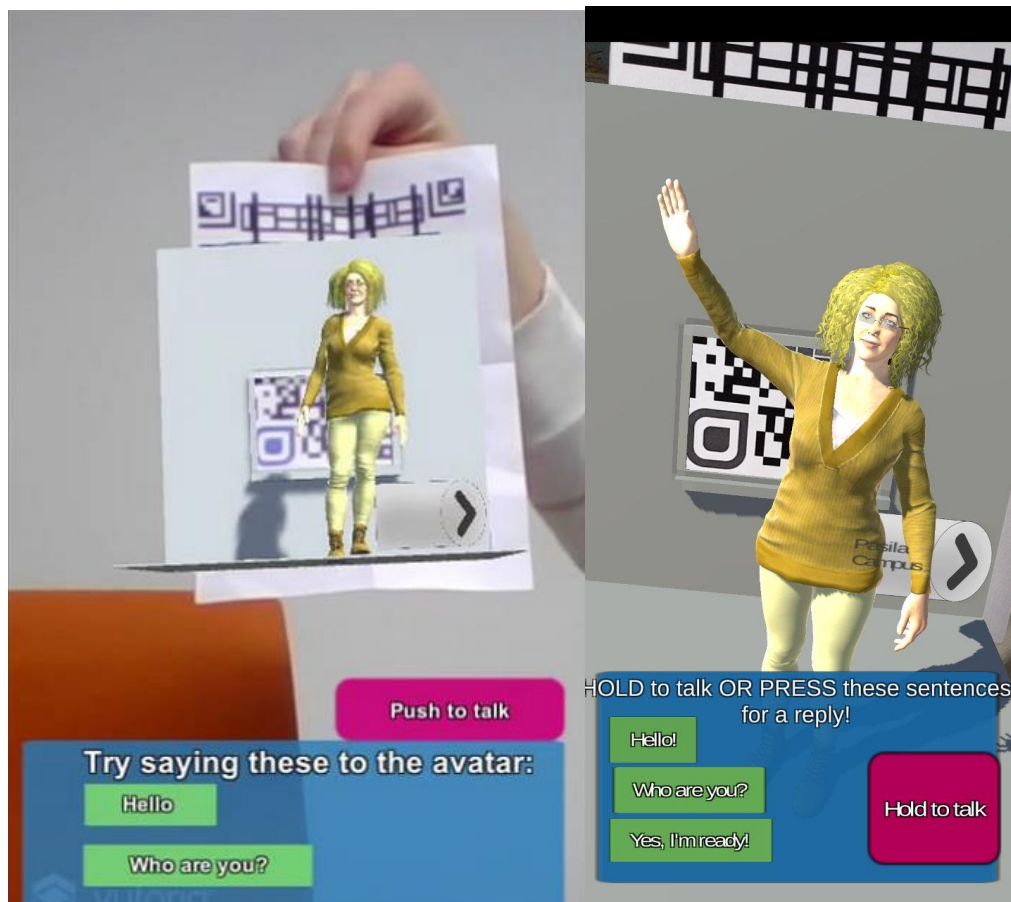


Figure 10. Old version (left) and current UI (right) of the AR scene in HH Freshman (Screenshot of older and current versions of Freshman app, 2019).

In Figure 10, the screen is the first screen that user see Riitta and starts to interact with her. For starter, when user holds the “hold to talk” button and speaks the first sentence “Hello” or when user presses the “Hello” button, Riitta will respond with waving hand and looking up to the users while saying “Hi there! Welcome to Haaga-Helia! After that, user will follow with the next scripted sentences to interact with Riitta and to hear her suggestion of what to do next. This part of design is similar to what the thesis author discussed earlier about virtual assistant’s Domain Specific Strategy where the developers input specific pre-sets of conditions such as scripted sentences and commands and only when users use these commands that Riitta would respond. Figure 11 shows the script that were used for the interaction of Riitta and users.

*Scene 1 - First contact*  
*U – User*  
*R- Riitta*

*U opens the camera with the QR code.*

*U sees R avatar in idle/waiting pose.*

*Screen suggests: “Hold to talk or press the sentences for a reply!”*

*U: Hello!*  
*R: Hi there! Welcome to Haaga-Helia!*  
*U: Who are you?*  
*R: My name is Riitta Blomster. I’m here to support your new studying journey. Are you ready to explore your campus?*  
*U: Yes, I’m ready.*  
*R: Alrighty, when you’re ready, try to press the button next to my feet!*

Figure 11. Script of Riitta and users interaction for first contact

The speech dialogue of the AR character was also changed between usability tests. “Alrighty, when you’re ready, try to press the button next to my feet!” was changed to “Alrighty! When you’re ready, use your hand to cover the Pasila Campus area on the QR code”. However, the button function to transfer user to another screen which is Pasila Campus is still kept to allow adjustability and freedom of choice for users whether they would like to press the button or to interact with the QR code. The choice of speech style is to mimic the same way Riitta would speak in real life with her own personality. Moreover, the speech dialogue was recorded with real Riitta’s voice to enhance the realistic and intimate feelings between users and the virtual assistant.

The evolution of concept prototype to the application in the 360-degree experience is shown in Figure 12. The low fidelity prototype was made in AxureRP and later on, the high fidelity was made with Unity. The 360-degree space allows users to look around by moving their fingers across the phone screen and see the whole campus. This way, the application wants to deliver a realistic knowledge about spatial awareness that matches users’ mental model and expectations of the real world.

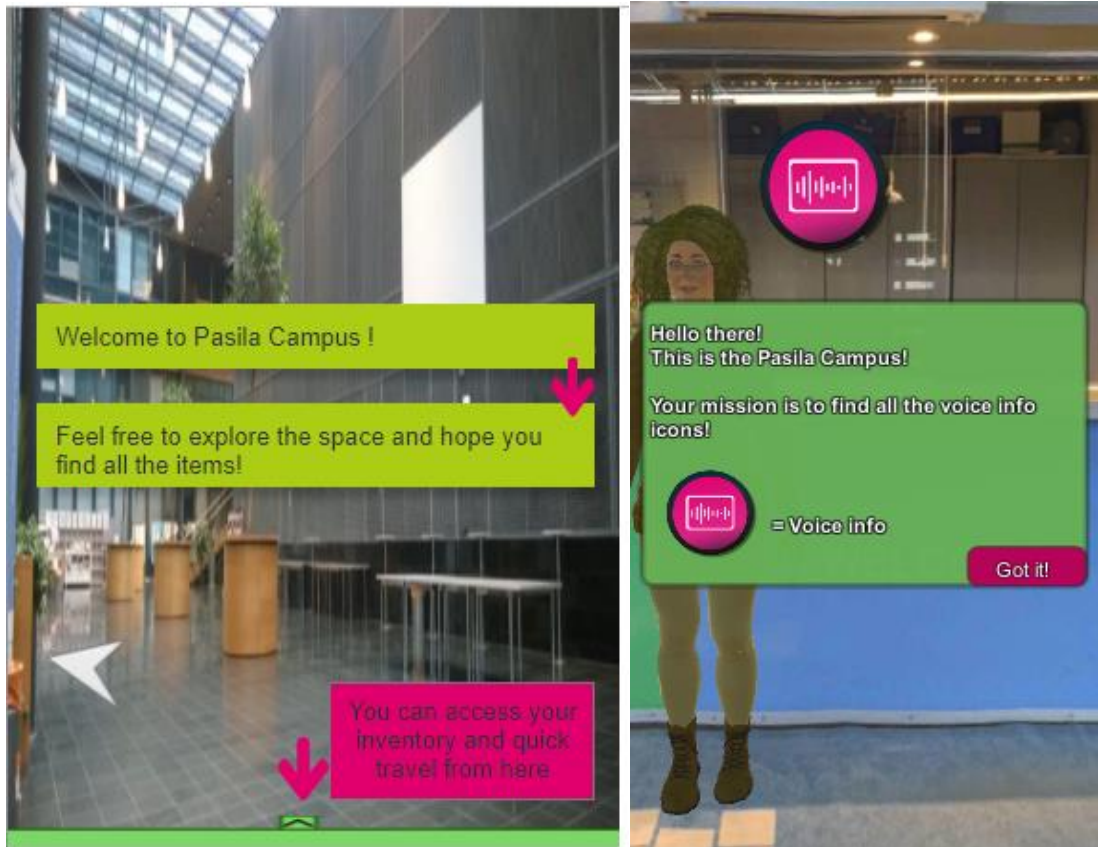


Figure 12. Introduction to 360-degree space lo-fi prototype (left) and hi-fi (right) comparison (Screenshot of AxureRP and Freshman app, 2019).

The colour palette was kept the same, where the pink acts as the high-contrast colour to draw the user's eye to where the information needs to be stand out. By clicking the voice icons, users can hear the Riitta voice talking in the background with displayed subtitles for multisensory learning of new information. The 360-degree environment acts as the bridge between virtual world and real world by allowing users to look at the campus just as they would in real life, in three dimension. The 360-degree graphic was made using iPhone camera with the app Google Street View and a camera tripod. Based on the user's journey map, the thesis author took the 360-degree pictures with the mindset of how a student would see the surroundings in real life.

In the lo-fi prototype, users have the choice of collecting items and checking them in the inventory tab, for example, they can collect student card, printing papers and library card. However, in the hi-fi prototype, because the idea of the application has changed into simply showing students around the campus and learning new information instead of collecting items, the content encourages users to find all the voice info around the campus by exploring the navigation map. The lo-fi and hi-fi design of the map is shown in Figure 13.

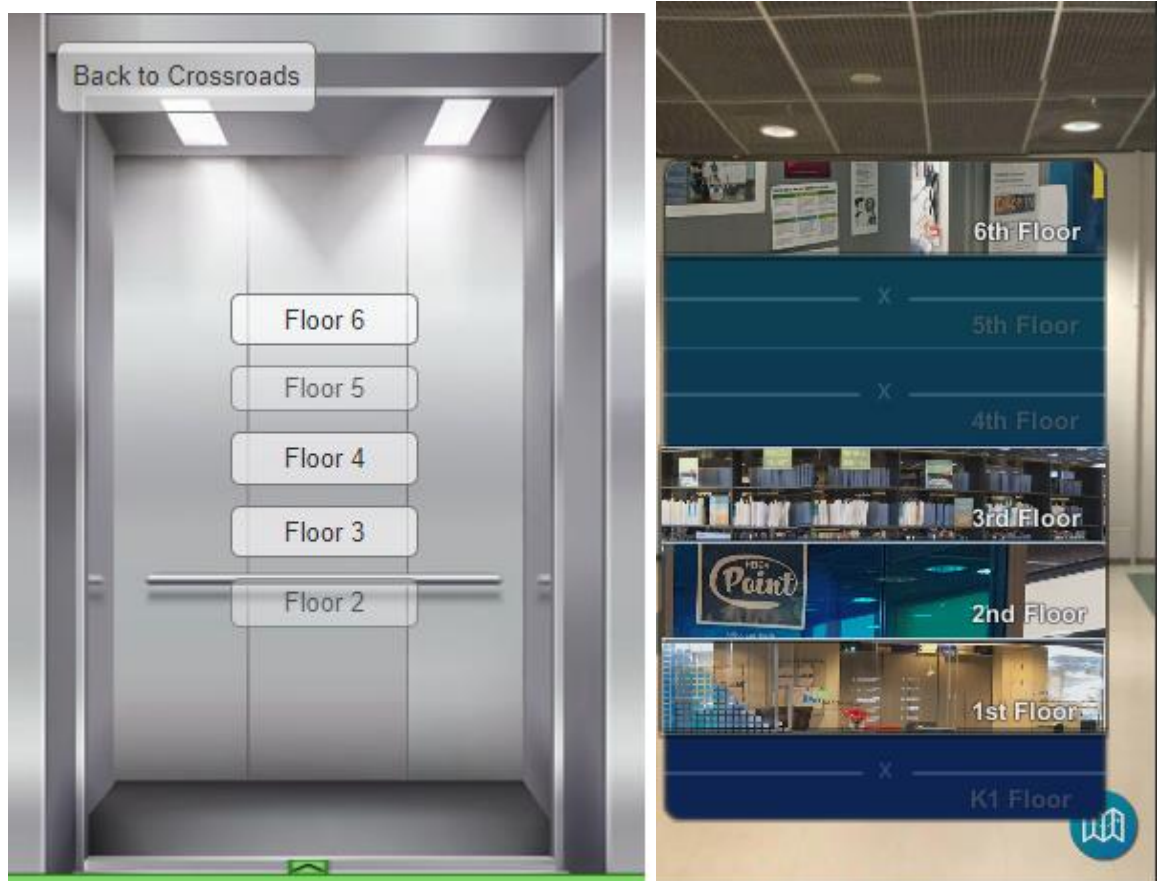


Figure 13. Navigation map comparison (Screenshot of AxureRP prototype and Freshman app, 2019).

The current (right) allows users to access the different floors without having to return to the elevator scene every time to navigate between floors. Navigational map was changed to a more colourful and purposeful design. The bar icons for each of the floors were a partial photo that showed the main point of interest of the floor and a sneak peek of predictable content. For example, the 2<sup>nd</sup> floor picture can be seen showing Helga Point – the student union of Haaga-Helia, and the 3<sup>rd</sup> floor picture shows picture of book shelves in the library. The navigation map design emphasizes the availability and foreground information by making prominent floors appeal with colourful and meaningful pictures while the floors such as basement, 4<sup>th</sup> and 5<sup>th</sup> floors are blurred with a “X” symbol to show users that they are currently not available.

After exploring the campus and listening to Riitta’s audio voices about the campus’s facility and the offering services, users will reach the final destination, which is Riitta’s office on the 6<sup>th</sup> floor, as shown in Figure 14.



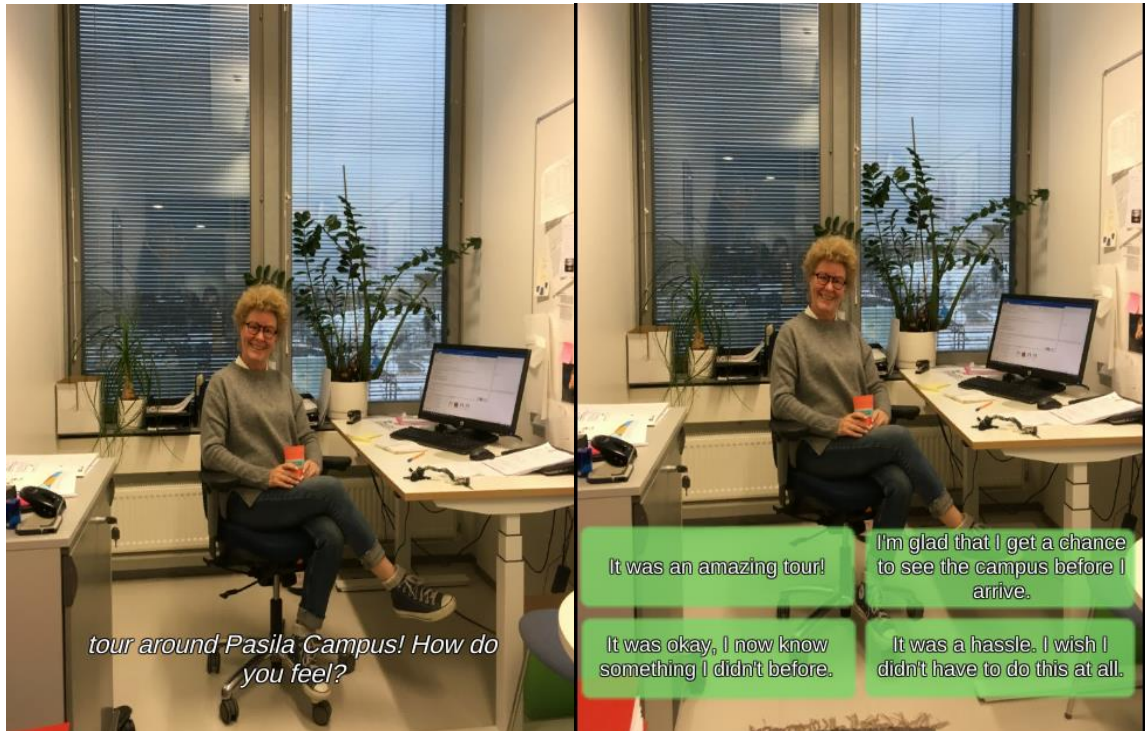


Figure 14. Real Riitta at the end of Freshman app asking for student feedback. (Screenshot of Freshman app, 2019.)

The application ends in Riitta's office where the user is shown the real life teacher's picture that the virtual assistant is based on. Users are able to hear Riitta talk and ask them about their user experience and emotional engagement that they have during their virtual tour. The user is asked to rate the application based on four options, as shown in Figure 15 below. The answer were recorded anonymously in a Firebase database.

<p>"It was an amazing tour!" equals to a grade 4-5</p> <p>"I'm glad that I get a chance to see the campus before I arrive." equals to a grade 3-4</p> <p>"It was okay, I now know something I didn't know before." equals to a grade of 2-3</p> <p>"It was a hassle. I wish I didn't have to do this at all." equals to a grade of 1-2</p>
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Figure 15. Feedback options for students at the end of the virtual tour

#### 5.4 Concept evaluation

During the time of prototyping and design, a survey was conducted to record students' reactions and feedbacks about the idea of an AR application relating to the possibility of a new way to learn and enjoy the orientation period of a freshman. Finally, during the application test sessions, another questionnaire was given to the testers to gather responses

about the application's concept, content, usability and performance. Since the thesis author focuses on user-centred design and user experience, the questions included both specific UCD-themed questions and open questions so that the respondents can give their own opinions and thoughts freely. The structure questionnaire were used in the thesis project during the evaluation of the Freshman app's usability testing. Semi-structured interview style follows a framework to talk about key themes and allows flexible interaction between interviewer and interviewee. The style provides information related to the interviewees' feelings and emotions when experiencing the Freshman app. The thesis author collected and analysed the information to highlight the implementation of the project, the results and the answers to the thesis' research questions.

#### **5.4.1 Heuristic evaluation**

The collected qualitative data from the test users is based on users-tasks measurement, heuristic questionnaires, and interviews and open feedback. In this thesis, the author included only the testing rounds for the hi-fi prototype and the functional Android application, which happened in May and November 2018.

Users were given scenario context before they started using the app. The scenario is: *"You are a new Haaga-Helia's Business Information Technology programme's student and you have received an acceptance letter from Haaga-Helia which contains this file called "Freshman App's Guide". You open the file. You read and follow the instruction in the file to download an app called HH Freshman. The app is part of your orientation and is a new way that Haaga-Helia adapted this year."* The instruction document is called "Freshman App's Guide" that includes a note about the application's AR features, which is only available for Android phones. The help document also contains the systematic instruction for new users of what they need to do. The instruction document is needed because there are two types of users. One is the Android phone user and the other is the web-browser user. Some of the notable instructions in the document are the QR code for Android phone users and the website link for web-browser users.

Heuristic Evaluation is the usability evaluation created by Nielsen that test participants are given at the end of the test session to assess the application's performance. The Heuristic Evaluation includes 10 usability heuristic statements about the application and users can give their agreement level about these statements. The scale of agreement level is from 1 to 5 with 1 (disagree), 2 (somewhat disagree), 3 (neutral/no comment), 4 (somewhat agree), and 5 (agree). In May 2018, there were two testing groups, of which, group A were students outside of Haaga-Helia and group B were Haaga-Helia students. The reason that

there were two groups is to collect diverse opinions and views about the application's concept from both Haaga-Helia students and potential Haaga-Helia students. Group B would be helpful to contribute improvement and feedback about the content and usability relating to the campus's facility because they already experience the real life campus so that they can compare the content of the app and the campus. On the other hand, group A would be able to co-create a better emotional engagement experience because it is their first time interacting with Riitta and the campus through the application; therefore, they are closer to the target users as a freshman or potential freshman of BITE. The compiled results from the May 2018 test can be found in the next chapter.

Another test was conducted in November 2018, in which, the students sat in a group session and tested the application together with the support from the test conductors as well as instructional document. Afterward, the students were asked to answer questions about their overall expression as well as their suggestions for improvements. The students were the freshman group of the autumn semester; therefore, their opinions on the application were very helpful to developers to improve the app better for the next freshman students as well as applicants. The questions are "How old are you?" "Those that have used the application before today's test. Was the application useful?" "Those that have not used the application before today? Why not?" "How realistic is the application?" "What is your overall impression of the application?" "How do you feel after trying the application?" "What do you like about the application?" "Is there anything that you feel is missing in application? If you can, what points would you do to improve the application?" "Do you find the application useful, for you, and other people? Why?" "Would you use this application in the future for similar places or have someone help you?" "Do you have any final comments or questions?"

Overall, eleven students gave proper answers to the questions and the overall impression was mostly positive toward the application, especially the virtual assistant that was based on real person, Riitta. The majority of the students thought that the application can be helpful to freshman, applicants and aspiring Haaga-Helia students because it gave out very basic and informative knowledge about the school. However, there were also many suggestions that the application could improve the user interface and the responding time as well as expanding the mobile version for iOS systems so that the interaction between users and the virtual assistant as well as the virtual world is more accurate to the users' expectation. The students' answers can be found in Appendix 1.

#### 5.4.2 Emotional design evaluation

The emotional design evaluation was to collect users' feedback that focusing on their feelings, their emotional impression and if their feelings are positive emotions in the end of their experience. The test was conducted in March 2019 with two users who has previously experienced the application and three users who experienced the application for the first time. During the testing, users were asked to express themselves aloud especially when they encountered events that grasp their attentions and triggers their emotional reactions. After the testing, users were also asked to share their feelings with questions such as "How do you feel?" "Did you enjoy the app?" "Do you trust the app?" "Are you excited when exploring...?" "Did you feel frustrated at some points?" "Do you feel that the app has empowered you...?" "Do you think the app is more effective than the tradition?" "Do you feel pleased and rewarded after using the app?" "Do you feel engaged with others when using the app?" "Has the app enabled you to adjust using it on different devices and your own preferences?" "Do you feel in control of what you do in the app?" "Does the app contribute in your learning process?" "Do you feel secured about the app's privacy quality" "What are the most important feelings that you think the app should be deliver to you?"

The purpose of the questions is to understand the range of emotions that users might have during their experiences and to study which emotions user feel the most and least and the relation between users' emotion and the application's design. The more positive emotions users feel means that the application's emotional design has done right. The detail of the questions and users' answers is included in Appendix 2.

## 6. Discussion

### 6.1 User-centred design in Freshman app

The thesis's goal is to find answer to the research questions: *“What are the students’ emotional engagement and feedback about the Freshman app’s concept that was created using the UCD approach?”* and *“How can the user-centred design (UCD) methodologies help to design an emotional MAR application?”* The implementation chapter included the process of applying UCD methodologies into the actual application development to design Freshman app for emotional-engaging and user friendly purpose. To assess how well the developers have designed an emotional engaging MAR app, the thesis author collected the students’ feedback about their emotions and feelings of the Freshman app upon using the app. The information from the students were important because they provided key points that can bring answer and draw conclusion for the research questions. The thesis author collated the students’ feedback about Freshman app in tables, figures and direct quotations to answer the first research question: *“What are the students’ emotional engagement and feedback about the Freshman app’s concept that was created using the UCD approach?”*

In the table 5, the green colour cells are the indicated of positivity from the users regarding the system’s usability.

Table 5. Heuristic Evaluation (Nguyen N, 2018).

Heuristic\User:	Group A			Average Agreeing Level	Group B			Average Agreeing Level
	U 1	U 2	U 3		U 1	U 2	U 3	
Visibility of system status	4	4	2	3,3	5	4	4	4,33
Match between system and the real world	5	3	3	3,7	5	5	5	5,00
User control and freedom	3	4	3	3,3	5	4	2	3,67
Consistency and standards	5	4	4	4,3	4	5	4	4,33
Error prevention	5	3	3	3,7	5	4	3	4,00
Recognition rather than recall	4	3	2	3,0	5	5	5	5,00
Flexibility and efficiency of use	3	3	3	3,0	5	5	5	5,00
Aesthetic and minimalist design	5	5	4	4,7	4	4	3	3,67
Help users recognize, diagnose, and re-cover errors	5	4	2	3,7	5	5	3	4,33
Help and documentation	5	4	3	4,0	4	5	5	4,67

The test participants were asked to express their thoughts and feelings regarding their experience as well as their overall feedback about the application's concept. These feedbacks are from all test users and shown in Figure 16.

*"It is a helpful and realistic concept. I can imagine people use this to learn about their school not only when they are freshman but as a come-back application that they can remind themselves of useful information". "It's good to know something about the school and it shows the real environment of a school. It is easy to use when user moves the mouse or finger, it feels intuitive and the environment responds to the users' actions. However, the image of the avatar is a bit scary and not friendly for people who do not know who Riitta is." "It was good that I know something about the school and it shows the real environment of a school. However, the map button need to be changed because I didn't notice it at all and tend to forget that it is there for me. The animated ring/rolling sign is confusing to me because there is no indication that I can move forward or go there with that ring. The elevator part is also confusing because some of the buttons are not working and make me think it was broken." "I like it because of the game aspect and it is more exciting than the orientation week I had. I'd prefer this game than having to go to the orientation week only. I really like the AR character that I can talk to. I have never used and seen the kind of app like this so it impresses me." "It was so cool! I like Riitta the most! It is really useful for the freshmen for the library and the student affair. I wasn't able to find the student affair when I was a freshman. I'd prefer to do this virtual tour, it was so much fun. It was kind of dizzy moving around but it is a common problem using 360-view. Everything looks real to me and in a good scale." "Nice concept and will be benefiting to people. It is very intuitive that you can use your fingers. There is a nice animated ring that is really nice design. The elevator buttons should be more indicative for freshman. The freshman would feel closer to the campus when they use the app, they will think that their future school is cool and get excited."*

Figure 16. The compilation of test users' open feedback about their experience with Freshman App in May 2018 (Appendix 3, 4, 5, 6).

Overall, the usability evaluation shown that the application is usable by first and experienced users. Moreover, the existing functions are useful and only need to be improved per performance and user experience enhancement. In addition, the application received positive rate and positive feedback from group A and group B. Thanks to the students' feedback; the team continues to improve further to fix the existing problems and to complete every aspect of the application. The open feedback were overall positive about the app's concept especially about the AR and 3D model. However, some users expressed

that since they did not know who Riitta is, they thought the avatar was intimidating to them. This suggests that a new design for Riitta to appeal more friendly should be implemented for the future development. There were also statements about the user control and freedom as well as the aesthetic and minimalist design that need to be assessed internally. Users suggested that the app should display more information regarding the places that users explored. User's control and freedom can also be improved by creating more indicative navigation symbols like the elevator panel. As shown in the results of the Usability study, users had problems with exiting states and remembering all the information for example which floor the library is located in. This can be improved by clearer UI, colour coded for categorized information.

After listening to the feedback of the test users in May 2018, the thesis author improved the application accordingly, especially in making Riitta's model looks more friendly and the location indication and navigational map to be more clear and easy to use. In the next testing round in November 2018, when users were asked how realistic the application was and what their impressions were as well as what they liked about the app, the majority of the responds was positive. The comments from the students are shown in Figure 17 below.

*"This is quite realistic." "I would give 80% for this one." "It is very realistic, very useful too". "Realistic enough for now, there is room for improvement". "Good impression. It was a nice virtual tour". "Very realistic. Graphic is amazing". "4/5". "It looks cool. For freshman, it is very useful". "It is a good initiation. Would be awesome if taken to the next level with better interface and user experience." "It is interesting, very useful and can be helpful to a lot of new students". "Great picture quality and quite informative". "Its's OK but should be improved in a way that it's more informative and qualitative". "User friendly, great graphics..." "It is easy to use and very real." "It is entertaining" "It was interesting". "It has the very basic information and it is user friendly" "Clicking into the lift and floor number takes you to the respective floor." "I like how realistic it is." "Very detailed." "Great to see Riitta there." "... The virtual tour is good." "Riitta" "It shows you the overall of the campus. It is helpful for freshman". "I like Riitta". "Riitta's model was on point".*

Figure 17. Positive feedback from the students about the application's improved graphics and user interface (Appendix 1).

Although there were positive feedback about first impression and the quality of the UI design as well as the content, there was stillroom for improvement. Therefore, the thesis author asked the students to give their suggestions about how the app can improve and how

the developers can add more value and create better experience for the students. Figure 18 includes the students' suggestion of improvement relating to the Freshman app' content, features and design.

*“It would be nice to have more Explanation buttons and a possibility to follow by a request. For example, I can pick up from the list “Library” and automatically follow the path to library”. “I think it would be good to have something like a glossary or a list of categories which would act like shortcuts to a specific topic that somebody would prefer to know more about”. “Other than the voice over explanation, when it come to the de- scription, a recorded video of Riitta explaining and guiding would have been ideal”. “In- formation about the other places...” “I would like to have search function. So that you can find information you are interested in”. “Own avatar creation”. “... would be better to put more data/information” “More options” “.. have more instructions on how to use the app”.*

Figure 18. Students' suggestion of improvement for Freshman's app (Appendix 1).

By learning about the opinions and feedback from direct users as well as involving them in the process of creating and designing the application, the thesis author can develop the application that can actually serve users and bring positive experience to them. Because the Freshman app is made for students, therefore, the students should be the one who help make their own experience better and by sharing their thoughts and feelings as well as suggestions to improve, the developers and the students are in the same team with the same goal, to create and have fun while experiencing a helpful system. Not only the stu- dents can contribute for the usability and performance of the application but also provide insightful information about how the app can affect their lives and influence their emotions.

## **6.2 Emotional design and concept evaluation**

The emotional evaluation test was conducted in March 2019 with two users whom had used the app before and three users whom used the app for the first time. The range of feelings that the thesis author wants to explore are *trust, excitement, frustration, empow- erment, enjoyment, being effective, satisfaction, being engaged, being flexible and in con- trol, being supported, and being secured*. The users expressed that they feel trusted in the application and at Riitta, especially because the application is provided and made by a verified authority, Haaga-Helia. The AR function which encourages users to interact with the 3D assistant makes the users feel excited and empowered because they feel sup- ported. Moreover, the application helps users to make successful decisions that in return creates the feeling of being effective, being in control and being pleased with the com- pleted results they have gotten inside the application. The most important emotions that



the application should be able deliver as the test users voted for were trustfulness, excitement, enjoyment, effectiveness and feeling secured. The comments from the users are compiled in Figure 19.

*"I feel safe and entertained, this is something new". "I feel trusted because it was provided by Haaga-Helia and when I saw Riitta whom I feel trusted in". "I feel frustrated at the part when the loading time is slow and there was technical issues". "First I feel quite confused, not frustrated, because I don't know that it is 360 degree". "I enjoyed the experience, it was great". "I'd like to use it at school instead of orientation courses". "It is quite interesting and I enjoy using the app". "It is extremely effective, however, sometimes, you want to create personal relations and socialize". "Definitely effective and can become a combo with the tradition way". "You can use the app more than once so it is more effective than the course". "If there will be more spaces to explore, the app can be even more effective." "I feel pleased because I tried something new and creative" "I feel good, it was good". "I felt it was completed and that I achieved something". "I engaged with Riitta". "It just my personal experience and I don't engage with others while using the app". "The app helps me because I get to learn something new" "I trust the school and Riitta".*

Figure 19. Users share their range of feelings when using the Freshman app (Appendix 2).

The in-app feedback at the end of the virtual tour is also recorded anonymously and is shown in Figure 20. The data was collected in Firebase database. By the time of the thesis project, seven respondents logged their choices in the application.

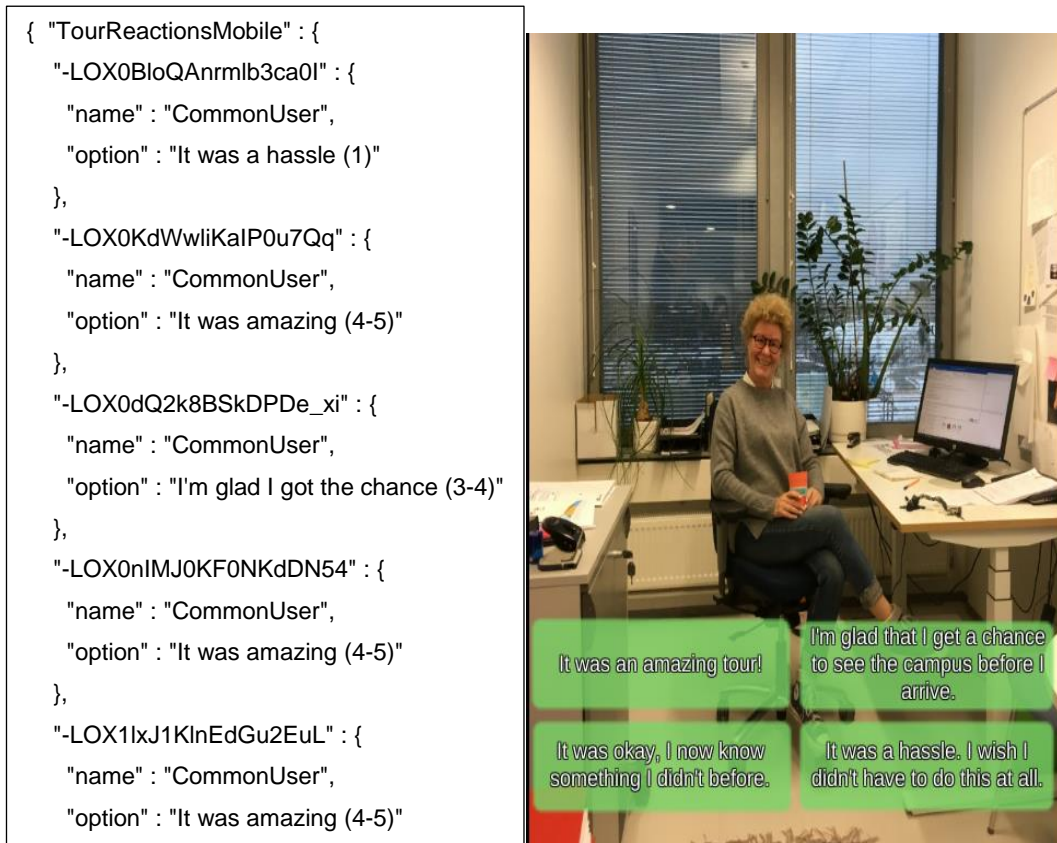


Figure 20. Users' rating inside the application at the end of the virtual tour

Users can rate their experience with the feedback's four choices and their opinions are completely anonymously so that they do not feel pressured when rating their experiences. Among the seven respondents from the in-app feedback, four users rated the experience as 4-5, one user rated the experience as 3-4, and one user rated the experience at 2-3 and one user rated the experience as 1-2.

*"How can the user-centred design (UCD) methodologies help to design an emotional MAR application?"* When users use a tool to support their daily lives in their daily tasks, the tool becomes part of their lives as well and has an impact on their perception and emotions. To bring emotional value to users is to be able to make an impression and trigger positive feelings in them. The thesis author conducted emotional evaluation with users and discussed with them about the ranges of feelings they had during their encounter with the Freshman app, especially with the AR model Riitta. Most of the test users shared that they are surprised and excited because of the AR functions and because the Riitta encountering is something new, creative and entertaining. Some of the users said that they have shared the application and explored the app again with their friends because of the Riitta interaction as well as the well-made 360-degree virtual tour. The excitement returns in their mind when they see a picture of real Riitta at the end of the tour and that they feel connected with the virtual assistant because of the picture and the real voice over. The

overall impression of the test users were that the app creates excitement and curiosity that make users want to explore more of the app because they want to learn more about the app's content. The users that are Haaga-Helia sophomore students also shared their thoughts about their excitement to experience their school in a different way and to interact with Riitta through the application even though they already know the campus and meet Riitta in real life. Some said that because the app contains useful information that they can reuse the app for when they forgot or want to be reminded about something, especially about the student services such as library and student affair services.

The students' feedback show that the UCD methodologies that were applied during the implementation of the Freshman app have created better experience and bring ranges of positive feelings to users. When users were involved in every step of the application design, the results show that users feel useful and in control because they can see the improvement that they have suggested before. Moreover, users feel more connected and having fun because they are able to explore alternative versions and contents before finding out their own preference of using the application for their own purposes. Overtime, the test users become more attached to the development of the application and they themselves want to contribute to make the application better because they know what would make them feel good in the app and what not. When the application is designed, the thesis author and the developers make sure that the interaction with virtual assistant can be as natural as possible.

Similar to the case of Samuela – the virtual assistant, Riitta was able to connect with users because they can hear her real voice and are accompanied by her voice during their whole exploration. By the end of the virtual tour, users felt closer to the virtual assistant, especially when they know that it was based on a real person and they would be able to interact with her in real life. Even though the virtual assistant were scripted to support them in the app, users can see past the fact that it is programmable. The reason is that the UCD strategies that were implemented for the AR assistant and the 360-degree environment, have been able to bridge the gap between virtual world and real world, as proved by the students' feedback about the application's realness.

## 7. Conclusion

The thesis project is a product-based project in which the thesis author has produced concrete results that would benefit the project's commissioner, which is Haaga-Helia's BITE programme. The thesis author has successfully implemented the Freshman app and conducted several user tests to collect new and insightful information about the app's user-centric performance and its users' feedback. The application and the users' new data are the contribution to the thesis research topic about User-centred Design approach in MAR application like Freshman app.

The thesis author was able to find the answers for the research questions which are *"How can the user-centred design (UCD) methodologies help to design an emotional MAR application?"* and *"What are the students' emotional engagement and feedback about the Freshman app's concept that was created using the UCD approach?"* In conclusion, the UCD methodologies have successfully helped the thesis author to design Freshman app – a MAR application for new students in BITE programme. The thesis author studied literatures and similar cases of applying UCD strategies to components of the Freshman app, such as emotional design, user interface, virtual assistant, multisensory learning and mobile augmented reality for education. Moreover, the thesis author were able to define the key components for the Freshman app that would need to be design with user-centric mind set and crucial implementation phases which were based on mLux model of concept development. By involving users in the creation process, the application becomes a product of co-creation between the developers and the users and in return, the application was invested with users' real emotional feedback and suggestions for improvements that serve the users' needs. After the testing and concept evaluation with real users, the thesis author was able to draw conclusion in which way the UCD methodologies have been used correctly to create Freshman app. Based on the students' feedback, the thesis author now has empirical benefits of the UCD methodologies in designing user's emotional engaging application.

The final discussion about the thesis topic which is UCD approach in a specific MAR application's concept development and evaluation, is that the approach indeed has practical benefit and usefulness to the Freshman application. The fact that the thesis author has been able to collect many constructive feedbacks from users about their user experience with the Freshman app, has proven that the UCD approach was applied correctly during the development process. Not only the students show great interest in the application's concept but they also invest into suggesting improvements based on their experiences. The students, who have already used the application, stated that they feel the application

is user friendly and it is useful for them and for future students. The new information and results have been received by the commissioner and will be used to further develop the Freshman's concept and its MAR applications so that the next group of freshman students can enjoy the product of co-creation from their school and their predecessors.

Based on the thesis author's own observation and work experience in the Freshman's development process, the improvements that the students suggested, especially about the loading time, new contents and search function are legit and indeed would add emotional value to the app. Moreover, the AR interaction can also be improved by creating smoother responding time between users and Riitta to make the conversation flows naturally and continuously. The UCD approach can continue be the backbone of the further development by always involving real users to test out the improvements and changes that the developers make. Another drawback now is that students cannot find information and proper instruction about the application on Haaga-Helia's official website, even though the initial plan was to send the instruction with the acceptance letter to freshman. Consequently, BITE programme should provide proper tools, equipment, diverse developing members, and plan to support the promoting of the app toward students so that the app is acknowledged as Haaga-Helia and BITE's official app. Among the feedback, the students also expressed that there would be more fun if there were a socializing aspect to experiencing the app. A possible suggestion is that students can see the reviews and rates of the different places inside the campus made by other students. They may also create their own profile with own avatar and can also see other students who are also active on the application.

There are yet challenges in using only UCD approach and mLux framework because there are also other approaches such as IT Project Life Cycle Management to develop IT artefact and solutions. Another setback in the thesis project is that the amount of user tests and in-app feedback are small, compared to the total amount of Haaga-Helia's students, therefore, the diversity of the feedback and suggestions is low. The limitation of the thesis is that there are many aspects in developing a digital product such as MAR application like Freshman App because it involves much more than just UCD approach but IT solution development, project management, technological management, maintenance, and research and development with input data. Nevertheless, the thesis author has achieved the goals and objectives of the thesis to collect new and useful information about the practise and benefits of using UCD approach and methodologies in concept development for Freshman App. Moreover, the thesis author was able to answer the research questions and provide concrete findings to back up the answers. The thesis project was completed within the date planned and the thesis author was able to deliver a final report.

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# Appendices

## Appendix 1. Questionnaire Answer 1

Age	Those that have used the application before today's test. Was the application useful?	Those that haven't used the application before today? Why not?	How realistic is the application?	What is your overall impression of the application?	How do you feel after trying the application?	What do you like about the application?	Is there anything that you feel is missing in application? If you can what points would you do to improve the application?	Do you find the application is useful, for you and other people? Why?	Would you use this application in the future for similar places or have someone help you?	Do you have any other final comments or questions?
26	Yeah, it is useful.	I downloaded it in August but the download was around 10 so I didn't trust it.	I would give 80% for this one.	It is a good imitation. Would be awesome if taken to next level with better interface and user experience.	But technical drawbacks but is a potential app for newcomers.	Clicking into the lift and floor numbers takes you the respective floor.	1. Response time is high. Please fix it to less than 3 seconds (He means the voice) 2. Interface/User Experience to upgrade 3. I recommend to use techniques from company like blokai	It has already the contents that I knew in Pasia. But technically it has better potentiality to help newcomers.	Maybe.	It can help newcomers in many way. Please have enough instructions on webpage or app to use them. More focus on interface/user interface. It's a great effort I would say
30	-	I did not know about it.	It is very realistic, very useful too.	It is interesting, very useful and can be helpful a lot to the new students.	I feel like I was actually walking through the campus.	I liked how realistic it is.	I think it would be good to have something like a glossary or a list of categories which would act like shortcuts to a specific topic that somebody would prefer to know more about.	-	I would use the application	53
-	Yes, actually I used it today for the first time.	Yes those that haven't used it before today, why not?	Realistic enough for now, room for improvement.	Great picture quality and quite informative	I feel quite informed.	Very detailed	Other than the voice over explanation, when it come to the description, a recorded video of Riikka explaining and guiding would have been ideal.	New students and aspiring students would find this very useful.	Yes indeed, would have liked to use it before starting studies, just didn't understand the need for it.	-
34	-	I didn't know about it.	Good impression. It was a nice virtual tour.	Needs more improvements.	Good.	Great to see Riitta there.	Hard to navigate. Navigation should be as easy as in Google Earth.	Yes, it helps to find different locations in the campus.	Maybe.	No.
38	-	I didn't receive any information about the app	App needs improvements	It's OK but should be improved in a way that it's more informative and qualitative.	After trying the app, I have simple questions. Do we need in general to have this kind of application? Is it easier to have just virtual tour application without any virtual assistant?	Although it doesn't give any real image of Pasical campus, the virtual tour is good.	Information about other places such as library. Etc.	It is useful maybe for applicants and new students.	Hard to say. I prefer just virtual tours without any voice assistance.	-
23	-	I don't need.	Very realistic. Graphics is amazing.	User friendly, great graphics, but I find it a bit useless.	Spent too much time to switch it on. Entertaining	Riitta	I still don't really understand. Why use it. :) sorry	Maybe for people who have never been to other universities and in Finland	Probably	Nope
-	Yes, android	-	Very	Is it easy to use and very real	Good for freshman to get familiar with the campus	It shows you the overall of the campus. It is helpful for freshman.	I would like to have search function. So that you can find information you are interested in.	Yes. As a freshman it is useful for you to get an overall information before school starts.	I don't think so.	-
30	Yes	-	Very	It is entertaining	NICE	Riitta	Own avatar creation	Yes, it is useful, it (unreadable word) + nice picture of Haaga-Helja	Might be	No
18	-	I didn't know about the application.	Very realistic	It was interesting	I am surprised	Riitta's model	Everything is good	I don't think that application is useful	No.	No.
19	-	No. I never heard about it before.	4/5	-	-	-	-	I think this is useful for applicants	-	-

## Appendix 2. Questionnaire Answer 2

<p>Do you feel <b>TRUST</b> in the app?</p>	<p>Are you <b>EXCITED</b> when you explore the app's features and functions?</p>	<p>What part of the app that makes you feel <b>Frustrated</b>?</p>	<p>Do you feel that the app has <b>EMPOWERED</b> you and offered positives steps toward your achievements?</p>	<p>Do you <b>ENJOY</b> using the app with ease?</p>	<p>Do you think that the app is more <b>EFFECTIVE</b> than the traditional way?</p>
<p>I feel safe and entertained, this is something new</p>	<p>Yes</p>	<p>Loading time</p>	<p>Yes</p>	<p>Kind of</p>	<p>It is extremely effective, however sometimes you want to create personal relations and socialize</p>
<p>Definitely also very interesting!</p>	<p>Yes, could be just tiny bit smoother but the point was clear.</p>	<p>None</p>	<p>Yes it was very informative.</p>	<p>It was great!</p>	<p>Definitely or a combo of those two.</p>
<p>Yes, because it was provided by Haaga-Helia and I saw Riitta who I trust</p>	<p>YEEEEES</p>	<p>Somewhere at the beginning because I couldn't download it. So, it was more about technical issues</p>	<p>Yes</p>	<p>Yes, and I'd like to use it at school instead of orientation courses</p>	<p>Probably yes, because you can use it more that once</p>
<p>Yes</p>	<p>yes</p>	<p>None</p>	<p>yes</p>	<p>yes</p>	<p>yes, if there will be even more spaces to explore</p>
<p>Yes</p>	<p>Yes</p>	<p>First I feel quite confused because I don't know that it is 360 Degree</p>	<p>Yes</p>	<p>Yes it's quite interesting</p>	<p>Yes</p>

Do you feel PLEASENMENTED after the experiences with the app?	Do you feel ENGAGED with others when using the app?	Has the app enabled you to ADJUST on different devices?	Do you feel in CONTROL of what you're doing to achieve the app's goals which then would help achieving your own goals?	Does the app CONTRIBUTE in helping your learning process?	Do you feel SECURED about the app's ability to provide data privacy and easy access at the same time?	What are the most important feelings that you think the app should be able to deliver to its users?
Yes, because I tried something new and create	For me it's just my personal experience	Yes	I would say so	Yes	Trust, Excitement, Empowerment, Enjoyment, Efficiency, Contribution	
It was good	No not really	Yes	Yes	Yes it was clear and helpful	Trust, Efficiency	
Yes, I felt that it was completed and I achieved something	Yes, engaged with Ritia	Yes	Yes	Of course	Trust, Excitement, Enjoyment, Efficiency, Engagement, Security	
Yes	not really	I don't know	Yes	yes	Trust, Excitement, Enjoyment, Efficiency, Security	
Yes	Yes	only use one device	Yes	Yes	Yes	Enjoyment

### **Appendix 3. Interview Transcript 1**

**Bi: How do you feel?**

A: I feel excited, it was so cool. I don't know maybe because I had the orientation before and we didn't have this that time. That's so cool. And this animation with Riitta. I really like it.

**Bi: So you like the Riitta part?**

A: Yeah, I like Riitta and I like that you should find where to go and it's like a game.

**Bi: So how would you, um, if you would prefer to go back to when you first orientation and between the one where you have to go to school or this one, which one would you-**

A: I think I would prefer this one

**How would you rate the design of the game, colours and everything?**

A: I like everything

**Okay. Now to wrap up the whole test session, how do you feel about the whole app?**

A: I already said that I'm excited, I don't know what else. But seriously that's a great idea I would like to have this app.

**B: What do you think about the app, if you had to scale it from 1-5?**

A: I would give it a 5. Especially Riitta was so cool. I'm just a person who's not into games and all this stuff, but seeing all this stuff impressed me, so... I like it a lot.

**B: Would you say that the app itself versus the real Pasila, is it the same, like what you see in the app is also-**

A: Yeah, yeah, exactly the same. And also I mention if I just come here as a freshman and I start my study with the app, I think its... I wanted to study more after that, not just sit in boring lessons. Just start with this game, encourages me to study maybe.

**So, you think with this app you feel you're more in control and you have more freedom to study and you know what you want?**

A: Yeah, and it would help me choose the path I think.

## Appendix 4. Interview Transcript 2

**B: How do you feel?**

It's so cool.

**B: What do you like most about and tell me what you like most?**

Riitta.

**B: Okay, so, how do you think about the whole experience that you just went through and if there's something that maybe caught your eye?**

I would say it's really really useful for the students especially to think about the librarians and so on. Like in the student affairs offices, it was tricky for me to find it when I was the freshman here, but with this app it's like no more questions needed. I would say it's really cool.

**B: If you were a freshman again, would you do this or would you prefer to go to the orientation?**

Of course I would prefer to do this, so much fun.

**B: What about the usability of it, how do you think the buttons and features, is it easy for you to go around?**

I think it's okay. It's easy, like the rotation sometimes you like have to rotate again, but I think it's like just an issue of orientation, like it's AR rotation so it's a problem, but it's not like your problem, just a common thing because like when you're in 360 degree and you always have to rotate sometimes and yeah- so there's no like issue with the ceiling and the floor so you don't have to be lost between them so everything is in a good place and scale so I don't have any issue there.

## Appendix 5. Interview Transcript 3

**Bi: How do you feel so far?**

Uh, yeah, I think it's very nice and sensitive and something that will benefit a lot of people.

**Bi: What do you think about for example, the way the app was designed, is it easy to use, or is it hard to remember?**

Yeah, I think it's quite intuitive, you can sort of navigate by moving your finger and I think most people have used Streetview before at least on Google Maps will be quite- like it'll be instinctive to just like browse that way. As I said, during the test, it was really nice the way that your interactable sort of navigation points have that like vibrating... **Bi: Animating ring** Yeah, I really hope they implement it to the elevator control, especially, uh, on each button or something.. **Bi: To make it pop out** Yeah, but also that they understand that if they push 2 they go to the second floor or something like that, because of course since we're familiar with Haaga-Helia, we know on the second floor what it looks like but to someone who doesn't know what it looks like it may be a bit confusing. I think it would be really great if the navigation option wasn't offered until you visit the elevators on the first time properly. Oh yeah, and may be to just test, not necessarily with the phone, but just um, the text that Riitta talks about, or the things that she says, just to make sure that like you have the best information for that spot there. Because at some spots it's really great and some spots maybe you could've talked about something else or something different and yeah I think it's really great and I hope you will expand and you'll continue to develop.

**Bi: Yeah thank you, so, what do you think about the freshman of this year, would they feel more closer to the campus before going to the school if they using the app?**

Yeah, I think so, and I think it's really important to showcase the community aspects of the school there as well. Because already we're starting to feel familiar and close to the school, so if you contact like Helga and other associations as well as the StartUp School that they can actually promote themselves with the app so students are more um, already excited about that aspect of the school and already somewhat familiar instead of like not knowing anything and having all this stuff thrown at them. So I think this is a really great way to dip their feet in the water and definitely would be great to continue because I think already now from just navigating you start or at least... again, I'm not from that like, or I'm not from the school but from doing this "oh yeah, this is my school and this is a pretty cool school actually if I think about it". So yeah, maybe they'll also have that sort of feeling that they have some connection to the campus.

## Appendix 6. Interview Transcript 4

### **How do you feel?**

Uh, like, good.

### **What is your first impressions about this application, anything?**

At first, it took me like one minute to adjust to how everything moves, I mean at first I didn't realize that I can go around the school and you know use my finger to wipe across, but it became evident soon. The circles, blinking circles, were really good to navigate around and they were really intuitive. The map was also good, and I later realized with a bit help that I can jump between the floors. The information, I mean, given, in the bubbles was really easy to use, yeah, I mean, there's nothing, nothing wrong with that either, and I feel like I know a bit more how I would orientate in the building and where I can go. So, yeah, I guess, it's a nicely working concept in my opinion.

### **So, let's just say that you are given to go to the school and doing a whole week orientation or you can choose to use this app beforehand to get around the school, which one would you prefer?**

Yeah, um, that's a hard question. The orientation is like a physical orientation, is nice in the sense that you get to meet other people there, but, uh, I would definitely use this once or twice to, to remember where everything is, because like from my own orientation I remember that I was lost for the first two months, so, it's not like having just one orientation day with you know walking around fast everywhere, you don't remember everything necessarily, so, I would definitely use it.

### **Bi: Yeah, nice, um, do you feel positive when using this app, or do you feel that you're confident after using this, that you have gained some sort of new knowledge, and it's like you can remember thing easy?**

Yeah, definitely, that's the biggest bonus I think that, because this is my first time in this building, and now I already feel like I know where I can go if I want to get somewhere and I've just been sitting in front of my computer, or your computer, with my phone. So, it's definitely a working concept I think.

