

**THE EFFECT OF A MOBILE DEVICE USER
INTERFACE DESIGN BASED ON PERSONALITY
NUANCES ON LEARNER'S PERCEPTUAL
EXPERIENCE AND SATISFACTION**

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by

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**KESAN REKA BENTUK ANTARA MUKA PERANTI MOBIL
BERDASARKAN PERSONALITI NUANSA TERHADAP PERSEPSI
PENGALAMAN DAN KEPUASAN PELAJAR**

ABSTRAK

Pengalaman Pengguna (*User Experience, UX*) merangkumi konsep-konsep kebolegunaan serta kejuruteraan-afektif. Ia merupakan satu faktor penting dalam merekabentuk peranti mobil. Namun begitu, adalah sukar untuk mendapatkan persetujuan umum berkenaan ciri-ciri reka bentuk yang sesuai dengan kepelbagaian personaliti individu apabila menggunakan teknologi peranti mobil. Oleh yang demikian, kajian ini mencadangkan satu reka bentuk antara muka (*User Interface, UI*) mobil yang berasaskan nuansa personaliti pengguna. Reka bentuk sebegini dianggap berupaya merangsang pemprosesan maklumat pelajar supaya sesuai dengan model mental mereka agar memperolehi pengalaman pembelajaran yang bermakna dan memuaskan. Seramai 87 orang pelajar siswazah (15 lelaki dan 35 perempuan) telah terlibat dalam kajian ini. Kecenderungan reka bentuk peribadi pelajar (seperti struktur, pengemudian, susun atur, atribut stail fon, saiz teks, butang, warna, senarai, kepadatan maklumat, sokongan dan jajaran) dikumpul mengikut nuansa personaliti mereka (*extraversion, kebersetujuan, kesungguhan, neuroticism, serta pengalaman*). Bagi mengkategorikan para peserta kajian mengikut personaliti mereka, dua algoritma pembelajaran tanpa pemantauan diaplikasikan: peraturan pengelompokan dan peraturan berkaitan. Ini menghasilkan dua kelompok personaliti, yang dinamakan sebagai kumpulan *neuroticism* dan kumpulan *extra-conscientiousness*. Seterusnya, reka bentuk UI peranti mobil

dibangunkan bagi setiap kumpulan berdasarkan ciri-ciri ahli kumpulan tersebut. Bagi menilai pengalaman pembelajaran para peserta semasa menggunakan setiap reka bentuk UI, peranti “*eye-tracking*” digunakan untuk merekodkan tempoh konsentrasi mata, amplitud *saccade*, dan tahap purata diameter pupil mata bagi mengukur tahap tumpuan, interaksi serta beban kognitif. Seterusnya, kepuasan menyuluruh pengalaman pembelajaran peserta terhadap reka bentuk UI turut dinilai. Dapatan kajian menunjukkan bahawa pengalaman visual para peserta dalam setiap kumpulan (melalui pengamatan, interaksi serta beban kognitif mereka) meningkat semasa menggunakan UI seperti mana yang dicerminkan oleh nuansa personaliti mereka. Dapatan kajian juga menunjukkan bahawa reka bentuk yang berasaskan nuansa personaliti dapat meningkatkan kepuasan pengguna melalui peningkatan tahap interaksi melalui pengurangan tahap pengamatan dan beban kognitif mereka. Tesis ini menawarkan satu teknik baru dalam reka bentuk UI peranti mobil yang mengambilkira hubungan antara nuansa personaliti serta persepsi reka bentuk UI individu. Dapatan kajian ini menyumbang kepada bidang interaksi manusia-komputer dengan membekalkan landasan asas secara teori dan praktikal untuk kajian-kajian selanjutnya yang berdasarkan kepada hubungan psikologi pengguna dan reka bentuk UI.

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ABSTRACT

User experience (UX) encompasses the concepts of usability and affective engineering. It is a crucial factor in the design of mobile devices. However, it has been difficult to gain a common understanding of the design characteristics that suit the different personalities of individuals when using mobile device technology. Therefore, in this thesis, a novel design of a mobile UI-based on the personality nuances was proposed. It was argued that such design would stimulate information processing in according to learners' mental model in order to obtain an effective and satisfying learning experience with a mobile phone. A total of 87 undergraduate students (15 male, and 35 female) were participated in this study. Learners' design preferences (such as structure, navigation, layout, font style attributes, text size, buttons, colour, list, information density, support, and alignment) were collected in according to their personality nuances (extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience). To classify the participants according to their personality, two unsupervised learning algorithms were invoked: clustering and association rule. They yielded two personality clusters, which we call the neuroticism and the extra-conscientiousness group. Then, a mobile device UI design was developed for each participant group based on their members' characteristics. To evaluate the participants' learning experience when using each mobile device UI design, an eye-tracking device was used to record their eye fixation duration, saccade amplitude, and average pupil diameter

level and thus measure their attention, interaction, and cognitive load, respectively. The effect of participants' learning experiences on their overall satisfaction with the UI designs was also assessed. The results showed that the visual experience of the participants in each group (as reflected in their attention, interaction, and cognitive load) was improved when using a UI that reflects their personality nuances. The results also exhibited that a design based on personality helped increase learners' satisfaction by facilitating an increase in their level of interaction and decrease in the level of attention as well as their cognitive load. This thesis offers a new technique for designing the UI of mobile device applications that considers the association between individuals' personality nuances and their UI design preferences. It contributes to the field of Human–Computer Interaction by providing the basic grounds, both theoretical and practical, for future research on enhancing UX based on the interrelation between user's psychological characteristics and UI design.

CHAPTER ONE

INTRODUCTION

This chapter introduces the study motivation. It describes, from various perspectives, previous studies on enhancing User Experience (UX). The research problem, which addresses the fact that the personality profiles of learners are not currently incorporated in design preferences, is formulated.

1.1 Introduction

The focus of the field of Human–Computer Interaction (HCI) has recently shifted from conventional design to understanding and assessing UXs based on certain psychological features (De Oliveira, Cherubini, & Oliver, 2012). According to Rogers, Sharp, Preece, and Tepper (2007), when building interactive environments the user’s interaction-centered experience, for example, his/her satisfaction level when interacting with a display, should be considered. This can be realized by stimulating the user’s positive learning behavior. In addition, a current key topic in design research is understanding the manner in which individuals’ psychological characteristics can inform design practices for facilitating effective interaction (Farzan, Dabbish, Kraut, & Postmes, 2011). This involves identifying and customizing display elements according to factors related to users’ thought processes, feelings, and behavior. The determination of the design elements in accordance with personality characteristics is a strategic technique that can be applied when designing a personalized User Interface (UI) (De Oliveira, Karatzoglou, Concejero Cerezo, Armenta Lopez de Vicuña, & Oliver, 2011).

According to Cherubini, De Oliveira, Hiltunen, and Oliver (2011), the apparent limitation in personalizing the design of a mobile learning (m-learning) environment is one of the main barriers that prevent users from effectively adapting to technology. This led the author of this thesis to explore further the relationship between personality and design elements, which are usually used to define the usability of a system (De Oliveira et al., 2012). We took the necessary step of linking the users' personality dimensions with the design of a mobile device UI. We also examined the effects of certain UI designs based on personality profiles on the user's learning experience as a measure of its potential.

1.2 Research background

As HCI technology has matured, learning applications have come to be considered a means of providing interactive aids for enhancing the overall learning experience (Hassenzahl & Tractinsky, 2006). In the HCI domain, the fact that the concept of UX has been widely disseminated and rapidly accepted in the higher education community has motivated research, which has significantly contributed to the current evolution of UI design (Garcia, 2014). UX was defined by Park, Han, Kim, Oh, and Moon (2013) as a combination of certain interaction characteristics that involve both the user and the product. According to Kujala, Roto, Väänänen-Vainio-Mattila, Karapanos, and Sinnelä (2011), in industry the purpose of optimizing UX is to increase users' personal satisfaction and devotion to a product. This is achieved by offering a product that provides the utility, comfort of use, and pleasure that leads users to consider that their interaction with it fits their personal and task needs.

However, an understanding is required of the manner in which satisfaction with a mobile device UI is modulated by the user's usage behavior, as influenced by his/her mental model, in an external context defined by his/her community, and leads to an improved overall UX (Sun & May, 2013). However, the design of mobile device UIs is a fundamental factor for enhancing certain usage experiences (Yao & Xin-yi, 2014). This led many scholars to investigate the notion of improving the user's interactive experience through the design of UIs for mobile device applications. For instance, a study conducted by Lan, Jianjun, and Qizhi (2013) indicated that a personalized interface design is commonly associated with user-centered designs aimed at providing users with a visual interaction that gives them a distinct satisfaction. Later studies, such as that of Viveros, Rubio, and Ceballos (2014), showed that users' personality and cognitive abilities can influence the manner in which they perceive the design of the activities provided by mobile device applications.

Prior studies on UI design used different approaches for designing mobile learning environments. For example, Alwi, Ismail, and Ahmad (2016) used the Heutagogy framework as the study of self-determined and learner-centered approach for learning and teaching. Costa, Ojala, and Korhonen (2008) utilized Newman and Lamming's (1995) interactive system design process. Based on these observations, it can be observed that the applied methods in the design of mobile learning interface don't consider the significant role of user's psychological characteristics at the design stage, and this may reflect certain cognition related factors that may potentially influence the way an individual process and understand information. This led the researcher (in current study) to assume that individual personality differences can play a significant role in learners' learning experience

when using mobile device applications. The assumption was supported in general by the clear evidence found in the literature of the relation between individuals' personality profile and their decision to adopt or use technology (see Chapter Two).

However, the fact that our understanding of individuals' personality characteristics, which vary from one user to another, has yet to be implemented in UI design, may appear to be an obstacle to providing UI design recommendations for achieving a satisfactory learning experience. The variation in individuals' personality characteristics may be reflected in the different behavioral aspects that influence the manner in which different individuals prefer or like to perform a task. This notion motivated previous scholars, such as Oliveira, Cherubini, and Oliver (2013) to consider the manner in which their personality may or may not promote users' satisfaction when learning with mobile device applications. It can be stated that differences in learners' personality nuances (dimensions) may result in certain preferences and tendencies to adopt particular habits or pattern when learning (Butt & Phillips, 2008). Consequently, Nunes, Cerri, and Blanc (2008) noted that UI designers may need to consider leveraging users' personality in the design of interactive environments aimed at improving the overall UX. In addition to these assumptions and views, the author of this thesis was extremely motivated to explore the association between personality profiles and Mobile User Interface Design Elements (MUIDEs) and how it can be utilized to provide a stimulating interactive learning experience.

Mobile learning

Mobile learning can be defined as a means of learning through mobile devices. The use of this technology has changed current learning practices by

offering learners the opportunity to participate in asynchronous instruction (Hyman, Moser, & Segala, 2014). In this context, Harpur and de Villiers (2015) argued that mobile learning may still face numerous challenges related to providing an effective, satisfying, and accessible learning experience. This is because mobile learning should be designed such that it enhances learners' ability, regardless of time and place (Crescente & Lee, 2011). This resulted in an increase in the amount of research conducted on improving on the current design practices of mobile device UIs (Jacob & Issac, 2014). For instance, Capretz, Ali, and Ouda (2012) stated that a particular UI of a mobile device application used in education may include some unclear (hidden) options. They added that most mobile learning applications are difficult to adapt to complex learning situations, because their UI design tends to be lacking in the interaction elements necessary for attracting learners to the learning task. Singh, Sumeeth, and Miller (2012) stated that the students' ability to read learning materials on a mobile device screen is considered to be 50% lower than on a laptop or desktop screen. In the light of this, designers' expectations of the efficacy of UI elements may differ from one to another from a certain design perspective or paradigm. In this study, we addressed the issue of building an interactive UI in which the preferred design elements according to the learner's personality profile are embedded. It is argued that this would facilitate a learners' perceptual experience and satisfaction in a learning situation.

Perceptual experience and the evaluation of UIs

A mechanism for examining people's perceptual state by detecting their eye movement toward the target of interest has been widely used to explore the cognitive process in several domains, such as reading, visual perception, and

information processing (Clark & Clark, 2010; Rayner, 2009). The detection of the manner in which the user's eyes move toward an area of interest is considered a reliable approach for detecting and examining individuals' perceptual experience. This motivated scholars, such as Toker, Conati, Steichen, and Carenini (2013), to examine users' interaction with a display by using eye-tracking technology in order to determine possible trends and distinctions in different users' attention patterns, cognitive processing, and decision behaviors. This is because individual differences in these factors significantly influence users' level of satisfaction (Ziemkiewicz et al., 2011). In addition, in the UI design domain, eye movement analysis is used in particular to explore a user's gaze patterns while interacting with a display, especially when evaluating users' level of concentration and workload when using different UIs (Andrienko, Andrienko, Burch, & Weiskopf, 2012; Nielsen & Pernice, 2010).

The author of this thesis thus examined the changes in users' eye movements in relation to their personality nuances when learning with a particular UI.

1.3 Problem statement

A person's mental model is based on his/her beliefs related to what he/she knows (or thinks he/she knows) about a system. Designers consider that the results of studying the relationship between individuals' reasonably accurate (and thus useful) mental models and their experience using a design will help them build a better interactive UI. However, the formation of a mental model varies from one user to another, and different users may construct different mental models of the same UI because of personal variations which contribute to the formation of that

mental model, thus influencing their preferences and decisions (Aşcı, Tan, & Altıntaş, 2016). Further, one of the ongoing challenges related to enhancing usability is the gap between the mental models of designers and users. This is assumed to occur because UI designers have too much knowledge, leading them to believe that each feature is easy to understand, and thus, they form unrealistic mental models of their own creations.

The evolution in developing applications for mobile devices is one of the strategy topics of current research studies in the field of teaching (Ally & Prieto-Blázquez, 2014). Mobile learning is considered important; however, major problem is a usability of learning from mobile application due to the UI design challenges (as indicated earlier in the “Mobile learning” section). These include the fact that an interface is created from the designer’s point of view, which may not necessarily follow certain design guidelines. Such design practices can cause adaptability problems, especially when learners have to use a learning environment with limited design characteristics, such as that provided by mobile phone devices (Chen & Lin, 2016). Such an environment would result in high cognitive demands, since learners may need to familiarize themselves with the logical structure of a specific design in accordance with their mental model. According to Zheng, Zhao, and Zhang (2012), it is evident that learners may face problems of limited attention and a high cognitive load when learning using mobile devices. This, in turn, leads to other interaction-related problems when learners attempt to navigate and browse the learning content (Zheng et al., 2012). Thus, how to sustain learners’ attention or concentration, improve their interaction, and reduce their cognitive load when learning with a mobile device is an ongoing dilemma. In addition, the conventional UI design and its effect on learners’ mental model may negatively impact their

visual perception (Sarrab, Elbasir, & Alnaeli, 2016), in general because of the incompatibility between certain design layouts and their mental model. Hence, considerable attention should be paid to realizing an interaction-centered experience in mobile device UI design (Ali, Alrasheedi, Ouda, & Capretz, 2015).

From the literature (see section 2.5.1) it can be observed the research gap mainly emphasis on the limited evidence of personality effectiveness in the design of the mobile UI. Our review of the literature shows limited evidence of the feasibility of designing mobile device UIs in accordance with learners' personal characteristics (Karapanos, 2013). Studies on UI design based on personal characteristics have verified the potential of determining the individual personality differences that could be used to customize the presentation in order to meet certain learning demands (Karanam et al., 2014). This customization can be achieved by determining certain design elements that accurately fit certain individual needs and preferences. However, because of the molecular levels of behavior (Furr, 2009), Fleeson and Nofle (2008) asserted that there is "very little knowledge about how personality is present in behavior and about what behaviors are relevant to personality" which is "partly because of the difficulty in specifying the level at which behavior should be studied"(pp. 1668/1679). Therefore, in this study we attempted to overcome the current design problems by considering the role of personality nuances in the engineering of the design of the mobile learning environment. This was deemed essential for sustaining learners' interaction, attention, and reducing their cognitive load to achieve an improvement in their satisfaction.

1.4 Research objectives

In this study, we attempted to gain a clear understanding of the relation between users' personality nuances and their preferences of different MUIDEs. In addition, we explored the effect of certain UI designs based on the personality characteristics of a person in a learning situation. The following research objectives were formulated:

1. To provide UI design framework/guideline for mobile device based on the variation in users' personality nuances.
2. To explore the effect of a mobile device UI design based on personality nuances on learners' perceptual experience when using such a UI.
 - a. To explore the effect of a mobile device UI design based on personality nuances on learners' perceptual attention.
 - b. To explore the effect of a mobile device UI design based on personality nuances on learners' perceptual interaction.
 - c. To explore the effect of a mobile device UI design based on personality nuances on learners' cognitive load.
3. To explore the effect of learners' perceptual experience with a mobile device UI design based on personality nuances on their satisfaction in a learning situation.
 - a. To explore the effect of learners' perceptual attention when using a mobile device UI design based on personality nuances on their satisfaction.
 - b. To explore the effect of learners' perceptual interaction when using a mobile device UI design based on personality nuances on their satisfaction.

- c. To explore the effect of learners' cognitive load when using a mobile device UI design based on personality nuances on their satisfaction.

1.5 Research questions

Based on the research objectives above, the questions of this study were as follows:

1. How to design a mobile UI based on the personal characteristics an individual?
2. To what extent does a mobile device UI design based on personality nuances affect learners' perceptual experience in a learning situation?
 - a. What is the effect of a mobile device UI design based on personality nuances on learners' perceptual attention?
 - b. What is the effect of a mobile device UI design based on personality nuances on learners' perceptual interaction?
 - c. What is the effect of a mobile device UI design based on personality nuances on learners' cognitive load?
3. What is the effect of learners' perceptual experience on their satisfaction when learning with a mobile device UI design based on personality nuances?
 - a. What is the effect of learners' perceptual attention when using a mobile device UI design based on personality nuances on their satisfaction?
 - b. What is the effect of learners' perceptual interaction with a mobile device UI design based on personality nuances on their satisfaction?

- c. What is the effect of learners' cognitive load when using a mobile device UI design based on personality nuances on their satisfaction?

1.6 Conceptual framework

The manner in which a user processes the information provided by a presentation is shaped by his/her mental model, and it is therefore very case specific, as it extremely depends on user's experience, perception, and problem-solving approaches (Asgharpour, Liu, & Camp, 2007) when dealing with certain task. However, this may vary from one user to another according to his/her association between different environmental conditions and his/her current cognitive state. In other words, users who decide to use certain design elements are believed to have preferences that were previously built in their mental model.

In practice, people's fixation duration is guided by visual factors (e.g., font), as well as by the features of the word on which they fixate, including its frequency and predictability within a context. These effects are demonstrated by individuals' eye movements during on-going cognitive processes related to a task (Foulsham, Wybrow, & Cohn, 2016). Moreover, visual narrative comprehension requires integration of information into a mental model (Underwood & Foulsham, 2006) and this, in turn, could also explain why an individual's mental model contributes to his/her perceptual experience. This relation is believed to significantly influence the user's satisfaction when performing a task. Therefore, providing the user with satisfactory interaction elements is essential for providing a positive UX.

In cognitive psychology, that is, the study of mental processes, researchers have considered the role of Cognitive Load Theory (CLT) developed by Sweller (1988) for explaining how the mental model of individuals affects the manner in

which they process information according to its design. Thus, UI design based on the characteristics of personality nuances can help facilitate the cognitive processes of learners in the mobile learning context (see Section 2.8.1). In addition, CLT offers guidelines for presenting information such that the individual's performance is improved (Kirschner, 2002). Meanwhile, in this study we also considered the role of the "capacity model of attention." The application of this model in the engineering of the UI design based on personality nuances can result in learners being guided to learn effectively in an environment that meets the capacity of their mental model. A study conducted by Haroz and Whitney (2012) showed that the capacity limits of attention strongly modulate the effectiveness of information visualizations. Thus, cognitive load, attention, and interaction are considered the main factors that drive the satisfaction of a learner with the design of a mobile learning UI. However, the incorporation of these factors in formal instruments is difficult. Hence, eye movement parameters, such as fixation, saccade, and pupil dilation, were used in this study to examine learners' perceptual experience. This type of experience is believed to influence the learners' overall satisfaction when learning using a mobile device UI design (see Figure 1.1).

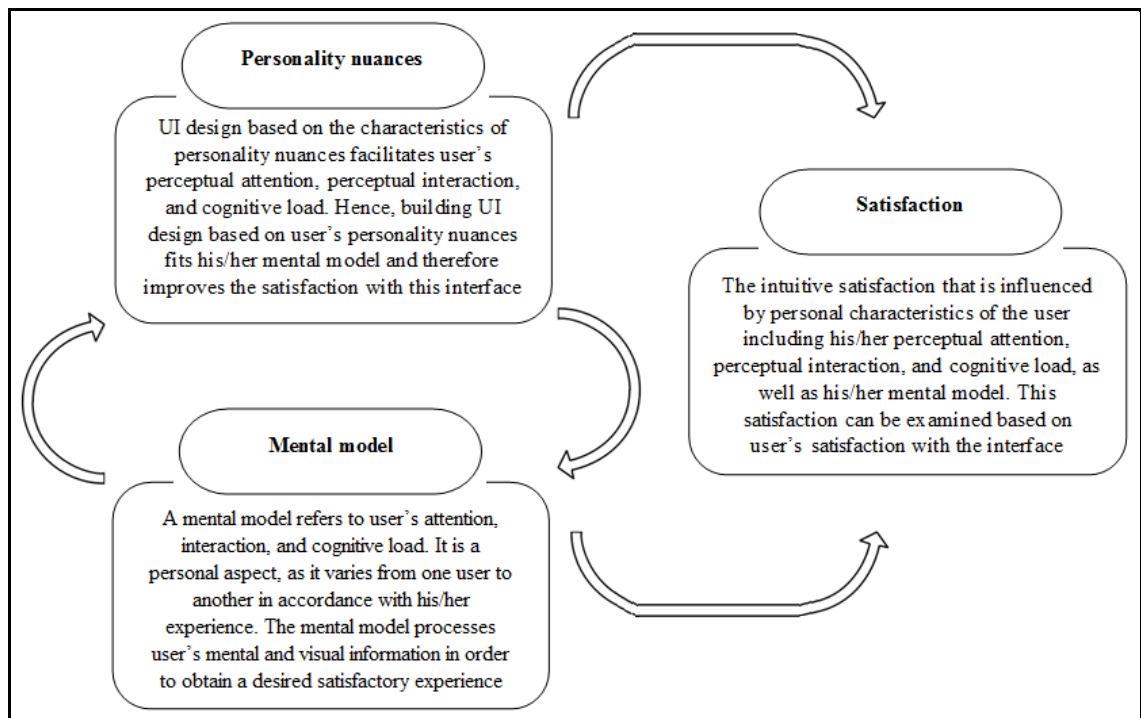


Figure 1.1: Conceptual framework

In summary, this study contributes to the design of learning applications by realizing the design of a mobile device UI based on the features of the users'/learners' personality nuances.

1.7 Research model

The conventional UI design and its effect on learners' mental model may potentially influence their visual perception during learning process (Sarrab, Elbasir, & Alnaeli, 2016). Here, the mental model here refers to user's attention, interaction, and cognitive load. The personal characteristics of a user including his/her perceptual attention, perceptual interaction, and cognitive load, are deemed important to complete the learning task effectively (Bradford, 2011; Sarrab et al., 2016; Zheng, Zhao, & Zhang, 2012). Consequently, in this study, the direct effect of a mobile device UI design based on personality nuances on learners' attention,

interaction, cognitive load, and satisfaction was measured. Precisely, the degree of learners' concentration during a learning task is a crucial factor in the interaction-centered experience (Harrison, Hsieh, Willis, Forlizzi, & Hudson, 2011). This is because a typical learning task may involve multiple design elements that require learners to consciously pay attention at certain levels when learning through mobile learning (Longman, Lavric, & Monsell, 2013). From the eye movement perspective, the point on the target where the eye is fixated can reflect user's attention state in which the time duration allocated to that fixation can help determine the user's processing difficulty and amount of concentration (Tsai, Hou, Lai, Liu, & Yang, 2012). In other words, the longer the eye is fixated on the target, the more is a complex learning experience indicated. Hence, learners' personality can be associated with his/her perceptual attention (Conati, Carenini, Toker, & Lallé, 2015) toward the display.

A graphical user interface (GUI), by its nature, offers individuals potentially unbounded possible means of interacting with the display itself (Yuan, Cohen, & Memon, 2011). However, the current designers of information visualization systems are still applying a one-standard design format to accommodate the perceptual needs of all users, without considering their different requirements (Steichen, Carenini, & Conati, 2013). This negatively affects the way learners interact with the display. Furthermore, an enhancement of the perceived interactions was found to be positively associated with users' high levels of satisfaction (Gonzales, Finley, & Duncan, 2009). A key topic in any design research is understanding the association between certain users' psychological features typically to inform design practices for providing an effective interaction (Farzan, Dabbish, Kraut, & Postmes, 2011). This led the research to examine the

perceptual interaction of the learners when using the proposed UI design based on personality nuances.

Wang, Yang, Liu, Cao, and Ma (2014), however, stated that CLT characterizes the limits that are imposed by a person's working memory. Haroz and Whitney (2012) showed that users' severe capacity limits of attention strongly modulate the efficiency of information visualizations. Goren-Bar et al. (2006) pointed out that personality-based design can potentially reduce individuals' cognitive load. Based on this understanding, present study adopted the cognitive load as a significant personal factor that is related to both mental and visual perspectives of the use towards the display. In addition, this motivated the researcher to adopt both CLT and the attention capacity model in order to explain the relationship between the design of mobile UI based on personality nuances and learners' perceptual attention and cognitive load in a learning situation. In contrast, previous studies also showed how the classical concept of usability (Rudy, 1997) has been extended to involve user satisfaction in certain contexts. User satisfaction with a product can be achieved through incorporating elements that the user prefers, or even likes. This satisfaction is related to user's perceptual attention (Bose, Singhai, Patankar, & Kumar, 2016), perceptual interaction (Gonzales et al., 2009), and cognitive load (Reynoso, Chutimaskul, Ofman, Ramos, & Ractham, 2015). Thus, in the current study learners' eye movements (fixation duration, saccade amplitude, and cognitive load) were measured to examine the perceptual attention, perceptual interaction, and cognitive load, respectively, when using mobile learning application, where the UI was designed based on participants' personality nuances. In association with the valuables of this study, three main theories were used in present work are: CLT, a capacity model of attention, and the five-factor theory.

Figure 1.2 shows the proposed research model. Further details about its formation are provided in the following chapter.

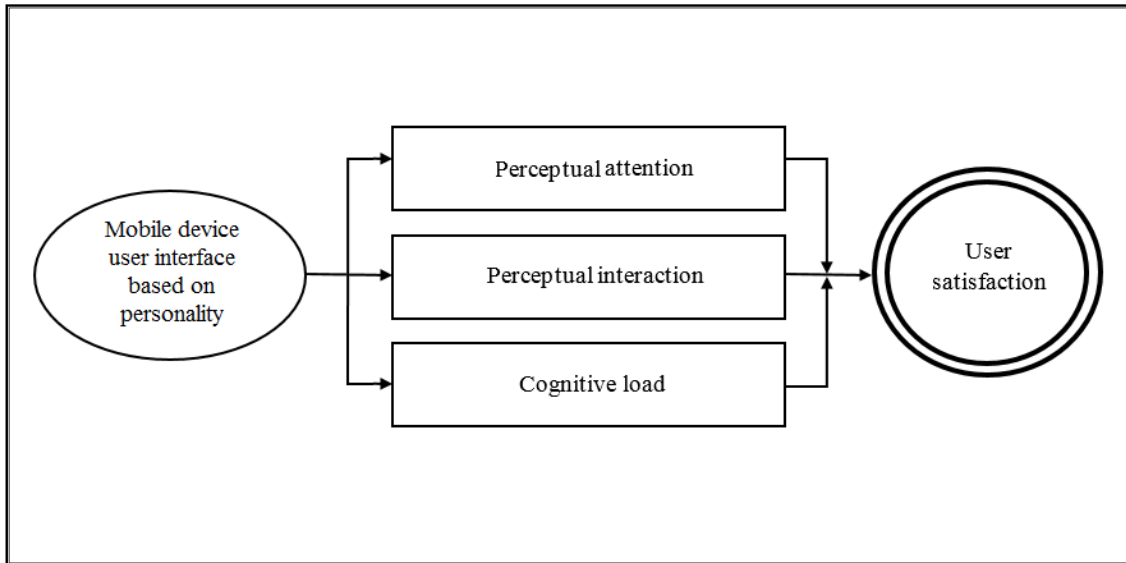


Figure 1.2: Research model

1.8 Significance of the study

This thesis offers an in-depth understanding of the relationship between mobile device UI design based on personality nuances and learners' perceptual experience of learning through mobile. It also offers a solid understanding of the tendency toward a mobile phone with a UI design based on personality nuances and its effect on learners' satisfaction, which has yet to be explored. The current work provides the basis for future research on enhancing the interaction-centered experience, based on the association between learners' personality characteristics and the design of an interface.

In summary, the objective of the present study was to provide a novel mechanism for customizing the UI of mobile device applications. Thus, our main contribution is a new robust method for designing the UIs of mobile device applications to fit the users' mental model in order to provide enhanced UX.

1.9 Operational definitions

This section defines the main terms used in the present study. It clarifies the exact aim of the terms and/or their usage in the present work.

1. **Mobile devices (smartphones)** constitute a ubiquitous technology that has advanced functionalities due to the improved hardware and software capabilities (Kambourakis, Damopoulos, Papamartzivanos, & Pavlidakis, 2016). They are considered a fundamental computing platform and communication device in modern life. In this study, we developed a novel mobile device UI design based on personality nuances for use in the learning context.
2. **Perceptual attention** acts as a gateway to awareness (Most, Scholl, Clifford, & Simons, 2005), selectively processing a small subset of our visual sensations (Memmert, Simons, & Grimme, 2009). It refers to the attention that is evaluated by the manner in which a user looks at a display. The more attention the user gives to a target item, the longer is his/her fixation duration. Thus, fixation duration, as an eye movement parameter, is used to explore the level of a user's perceptual attention.
3. **Perceptual interaction** indicates a series of procedures between devices and humans when the user makes use of such devices (Lee & Lee, 2016). In this study, we used saccadic eye movement to examine the level of perceptual interaction of learners when learning using a mobile device UI design based on personality nuances.
4. **Cognitive load** is the amount of information processing activity imposed on an individual's working memory, and is associated with understanding a

presentation (Anderson et al., 2011). Anderson et al. (2011) added that cognitive load can be utilized as an indicator of the efficacy of a display environment. The learners' pupil diameter was used in this study to determine the level of learners' cognitive load when learning using a UI design based on personality nuances.

5. **User satisfaction** is defined as the user's approval of a certain experience (Liaw & Huang, 2013). We measured the participants' satisfaction using the User Interface Satisfaction (UIS) questionnaire proposed by Chin, Diehl, and Norman (1988).
6. **Eye-tracking** is a powerful research tool that can be adopted to gain deeper insights into the visual experience of human behavior (Lohmeyer, Matthiesen, Mussnug, & Meboldt, 2014). An eye-tracking glasses (ETG) device was used in this study to examine the participants' perceptual behavior in the proposed environmental settings, according to the recommendation of researchers such as Loetscher et al. (2015).
7. **Personality nuances** refers to the Big Five dimensions of harmonious regularity in individuals' attitude (Milfont & Sibley, 2012). According to Milfont and Sibley (2012), these dimensions (or nuances) are neuroticism, agreeableness, conscientiousness, openness to experience, and extraversion. Because of the importance of personality and its crucial role in the regulation of users' behavior, we used the International Personality Item Pool Representation of the NEO PI-R™ (IPIP-NEO) to obtain the personality traits of all the participants. Therefore, the personality profile of each participant is represented by a combination of the five nuances

(neuroticism, agreeableness, conscientiousness, openness to experience, and extraversion).

8. *User experience (UX)* covers aspects related to users' emotions, motivations, and values, and basic subjective satisfaction (Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009). It takes a wide perspective of the individual's interaction with the product. Hence, UX includes efficient and satisfactory interaction with a certain product.
9. *Perceptual experience (perceptual behavior)* is a viewing behavior of the user when an individual sustains his/her viewing of an ambiguous stimulus (Einhäuser, Stout, Koch, & Carter, 2008). Such experience can be observed from individual's perceptual attention, perceptual interaction, and average pupil diameter when engaging in certain activities.

1.10 Summary and thesis structure

This chapter highlighted the overall aspects that were involved in this study. It provided a general understanding of the motivation and background of this study, as well as addressing solutions to the current UI design problems. The research questions and objectives were addressed and supported by the conceptual framework.

This thesis consists of seven chapters that describe the study. The chapters are organized according to the practical order in which the proposed mobile device UIs based on personality nuances were designed and evaluated.

Chapter One (Introduction) provides a general understanding of current design practices for mobile device applications, as well as other design issues. It covers the theoretical relations between the variables utilized in the study.

Chapter Two (Literature review) provides general information about previous studies, and the contribution of the current study. It covers the existing theories and rationale for our formulated hypotheses.

Chapter Three (Design methodology) describes both the design and the evaluation steps performed in this study to produce guidelines for UI design for mobile devices based on the preferences among university students as shaped by their personality nuances.

Chapter Four (Design patterns across personality nuances) addresses the data mining methods utilized in this study to form a UI design based on personality.

Chapter Five (UI design) defines the modified Alessi and Trollip model. This model was used to realize the resulting design features in practice.

Chapter Six (Result) presents the results and findings of the current study based on statistical tests.

Chapter seven (Discussion) provides the possible justifications for each result to gain an in-depth understanding of the factors behind it.

CHAPTER TWO

LITERATURE REVIEW

This chapter introduces the historical background of User Interface (UI) design that are related to the interface design of mobile learning, along with its advantages in enhancing User Experience (UX) during learning process. It also reviews the work of previous scholars to inference their views on similar aspect, as well as link it with the present study's goals. In addition, this chapter covers main theories to explain the relationships between the proposed research variables to learners' satisfaction with a mobile device UI design based on personality nuances.

2.1 Mobile learning

Mobile learning or m-learning is a very common multidisciplinary research area around the world (Keskin & Metcalf, 2011). After realizing the role of m-learning as a modern way for enhancing learners' learning experience, researchers like Kadirire and Guy (2009) have defined m-learning as another form of "Electronic learning" or "e-learning" that can be used everywhere at anytime. However, the progressive developments in mobile devices has continuously led to produce new devices with additional novel characteristics and functionalities (Wu et al., 2012). This led Wu et al. (2012) to extensively express the potential role of UI for mobile as the key mean for learners to learn and process information efficiently. According to Wu et al. (2012), learning with mobile devices is typically categorized into two research directions; the design and evaluation of UI. A study conducted by De-marcos et al. (2010) stated that the design of mobile application

for learning purposes aims at fostering learners' knowledge through self-assessment approach. Despite the rapid growth in mobile application for learning purposes, limited attention has been paid to the design of UI for mobile device for learning purposes. This includes identifying design characteristics for ensuring positive UX. Here, the researcher proposed a novel mobile UI design followed by an exploration of the effect of such design on learners' learning experience and satisfaction.

2.2 User interface (UI) design

With the rapid development of UI design practices in the design industry, "Human-computer Interface Design" has become an important avenue for driving users' usage convenience by offering better control of existed facilities regardless the other environmental conditions (Toby, 2001). This, in turn, led many previous studies to map the interaction experience of user while interacting with the display. For instance, Yang and Li (2011) stated that "the working process of interface designing mostly can be divided into 3 parts: structure design, interactive design and visual design" (p. 1). Other scholars studied Graphic User Interface (GUI) from the perspectives of visual design such as Yang and Li (2011) who asserted that characteristics of GUI act like intuitional item in the displays in which it stimulates users' interaction with the task when user engage in a task. They also highlighted several core components of GUI in terms of "windows, menus, buttons and symbols" (p.1). As such, GUI can be classified into icons, menus (Piskunov, 2014), windows, and other data input components (buttons, fields, widgets, etc.) (Fr chet te, L tourneau, Valin, & Michaud, 2012).

Despite the incremental popularity of mobile usage, there is still a lack in promoting UX based on the formation of GUI. This can be reasoned to the absence

of a universal format for design UI. This is obviously true because different task implies different cognitive demands and therefore different experience. Therefore, current studies are more concerned about providing an effective UX that can be implemented generally by mapping the preferred mobile characteristics in relation to the individual background. Some few efforts were made to customize design of interface, for example, Vdovenko, Marchenkov, and Korzun (2013) developed a design unification for different mobile platforms in order to deliver a convenience experience for educational purposes. Despite these efforts, the review of the literature still shows a little emphasis or a shallow understanding about the role of user's preferences in the design of UI for carrying out positive/useful UX. Hence, the researcher in this study proposed establishing the link between learners' personality profile and their design preferences as an attempt to design an effective mobile UI.

2.3 User experience (UX)

According to Pucillo and Cascini (2014), UX is defined as a “consequence of the presentation, functionality, system performance, interactive behavior, and assistive capabilities of an interactive system, both hardware and software. It is also a consequence of the user's prior experiences, attitudes, skills, habits and personality” (p. 161). Consequently, several studies highlighted the necessity to ensure efficient UX in terms of time, processing, and obstacles handling that may users face while viewing a display. Kujala et al. (2011) stated that the purpose of UX is to produce a general positive utility of experiences to the user based on the regulation of usage simplicity and enjoyment that can be obtained when interacting with the interface. Another impact of UX can be observed in the study of Zahidi,

Lim, and Woods (2014) who formed the relation between UX and user satisfaction to which increase in user satisfaction is a result of having good UX and vice verses. Furthermore, UX comprehends user's emotion (Hartson & Pyla, 2012) especially when the design of an interface is shaped with considering design elements, such as position, size, shape, and colour.

After all, it can be assumed that previous works have mostly emphasised on the regulation of users' satisfaction of a design and its relation to the UX. This led us to take a further step by looking at the extent to which a mobile device UI design based on personality nuances can facilitate learners' learning experience and satisfaction.

2.3.1 Mobile UX

The popularity and recent development in mobile learning applications was the main motivation for linking the design of its interface to the learners' personality. Our argument is supported assumptions of Djamasbi et al. (2014) who stated that creating a positive mobile experience become increasingly necessary in retaining a competitive edge to learn about certain subject. For this reason, assessing the usability of mobile UI design has gradually increased (Welch & Kim, 2013). Our extensive review of the literature showed numerous design aspects for promoting positive UX. Welch and Kim (2013) found that increasing the size of menu elements would significantly result in increasing user's navigational performance. Meanwhile, De Barros, Leitão, and Ribeiro (2014) addressed the potential of different types of navigations (Panorama or Panorama along with Pivot controls, and home screen menu) in regulating UX. They recommend the idea of