Examining gender issues in perception and acceptance in web-based end-user development activities

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Abstract In the recent years in the End-User Development (EUD) research there is a shift from the study of tools that focus on desktop graphical applications, to the development of EUD for web environments. Human-Computer Interaction (HCI) research has shown significant gender differences while users interact with EUD systems. However, most of this research focuses on desktop spreadsheet environments. In this paper we examine the potential gender differences in perception and acceptance in modern web-based EUD environments. We step on previous gender research in the fields of EUD and Technology Acceptance to concentrate a set of appropriate items and examine a set of related hypotheses. To check out our research hypotheses we have conducted a field test using a prototype web-based EUD tool based on a natural language approach (named 'simple talking'), to assist end-users in creating database-driven mobile applications. The results of the field test show significant gender differences in Risk-Perception and Perceived-Ease of Use. As it was predicted, male users perceived significantly higher ease of use and female users perceived significantly higher risk. Gender differences also exist in the correlations between different pairs of perception and acceptance items.

Keywords End-user development (EUD) · Gender in human computer interaction (GenderHCI) · Perceived-ease of use · Perceived-usefulness · Risk-perception · Self-efficacy

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1 Introduction

In the field of Human Computer Interaction (HCI) and its subfield of End-User Development (EUD) many research works (e.g. Beckwith et al. 2005, 2006a, b; Beckwith and Burnett 2004; Burnett 2009, 2010; Burnett et al. 2008, 2010, 2011; Saadé et al. 2012; Subrahmaniyan et al. 2008) have found that end-users tend to be ‘prone’ to the influence of human factors such as gender, while interacting with computer environments.

Research has proved gender a determinant factor to the end-users’ developing performance (Beckwith et al. 2005, 2006a, b; Beckwith and Burnett 2004, 2007) and can determine their choices, debugging strategies, motivations and effort (Burnett et al. 2011; Grigoreanu et al. 2008; Kulesza et al. 2009). Research works have also found that most of the user perception and acceptance items (e.g. Perceived-Ease of Use, Perceived-Usefulness, Self-Efficacy, perceived-risk, etc.) tend to meet different values cross different gender end-user groups (Burnett et al. 2010).

However, most of the previous-mentioned EUD behavioural studies have conducted their experiments on traditional EUD desktop spreadsheet environments (such as Excel sheets) and these environments are not so much ‘optimized’ in terms of user interaction and user-centered design principles if compared to recent web-based and mobile tools.

While first EUD tools mainly focused on desktop graphical and spreadsheet applications, in recent years a considerable amount of work has been carried out to apply the EUD approach to web environments (Paternò 2013).

Since web-based EUD is mostly a recent trend (Paternò 2013), there is limited gender or other user behavioural human-oriented research on web-based EUD environments for web and database-driven applications. There are various research works analysing gender differences in website production, web interface and task preferences and interaction with web in general (e.g. Moss and Gunn 2009; Teo and Lim 2000) but only limited research has been conducted to study users’ behaviour while interacting with web-based developing-oriented (EUD) applications. In a recent example, Tzafilkou et al. (2016) found some main gender differences in web-based EUD performance.

The abovementioned situation triggered our interest to examine a set of perceptual and acceptance potential gender differences in web-based EUD environments. This work aims to find out whether there are gender differences in the end-users’ perception and acceptance while interacting with a web-based EUD environment targeted at the development for database-centric mobile applications.

This paper is organized as follows. The second section presents a theoretical foundation of web-based EUD, gender issues in EUD and Technology Acceptance. The third section presents the research methodology which is composed of four main steps: the prototype tool that was used for the field test, the set of hypotheses that were formed to be examined, the field test procedure that was followed and the data analysis methodology that was chosen. The fourth section shows the results. A discussion section analyses the results and explains the study’s possible issues and limitations. Finally, the conclusions and future research are presented. Appendix 1 presents the questionnaire used for the survey and Appendix 2 provides both a numeric and visual representation of the sample characteristics as regards to normal distribution values across the two genders.

2 Literature review

2.1 End-user development and gender issues

According to Lieberman et al. (2006), End-User Development (EUD) is 'a set of methods, techniques and tools that allow users of software systems, who are acting as non-professional software developers, at some point to create, modify or extend a software artifact'. What characterizes end-user developers is that they express a need to modify on their own the computer systems they use and to gain more control over their computer applications (Lieberman et al. 2006; Repenning and Ioannidou 2006). In other words, people who are not professional developers can use EUD applications to create or modify software artifacts and complex data objects without significant knowledge of a programming language.

EUD is inherently different from traditional software development. Burnett and Scaffidi (2011) declare that trying to support EUD by simply mimicking traditional development approaches will possibly lead to unsuccessful outcomes.

In the past decades numerous studies reported on marked gender differences interacting with computers, such as different conception of computers, different motives for using computers, different preferences, different styles (Saadé et al. 2012) and even different cognitive styles (Hubona and Shirah 2004).

Behavioral studies also accept and explain the existing grounded differences in the way male and female end users process information and generally behave during their interaction with computer systems (Beckwith et al. 2006a, b; Saadé et al. 2012; Subrahmaniyan et al. 2008). Gender has also been singled out as an important variable in the design of user interfaces and visualization techniques. It is also considered as an important user diversity issue for achieving "universal usability" of web-based and other computer services (Hubona and Shirah 2004).

In Tzafilkou et al. (2016) the authors have aggregated the predominant end user behavioral theories stressing the gender factors in HCI and EUD behavioral research, namely Attention Investment Theory, Technology Acceptance Theory, Self-Efficacy Theory, Information Gap Theory, and Personality Traits Theory.

The main conclusion is that researchers have been long reporting theory and empirical data pointing to gender differences in the use of EUD and End-User Programming (EUP) environments. Evidence of these differences has accumulated, indicating gender differences in programming/developing environment appeal, playful tinkering with features, usage and attitudes toward end-user programming features, as well as end-user debugging strategies (Beckwith and Burnett 2004, 2007; Beckwith 2003, 2007; Beckwith et al. 2005, 2006a, b; Burnett 2009; Burnett et al. 2008, 2010, 2011; Kissinger et al. 2006; Grigoreanu et al. 2006, Grigoreanu et al. 2008, 2012; Subrahmaniyan et al. 2008). In these studies, the two genders have been shown to mainly use different features, but also to use same features in a different way. The most important conclusion of these studies is that the features most conducive to females' success are different from the features most conducive to males' success (Beckwith and Burnett 2004).

Traditionally gender aspects of technology in general, and IT products in particular, have been studied as related to education and the impact of society (Beckwith et al. 2005).

Gender HCI (Beckwith and Burnett 2004) explores the different way male and female end-users behave when interacting with computer systems, especially with desktop-based end-user programming environments. The authors' research was a continuation of investigating visual programming for managing spreadsheets. Gender HCI has proved that men and women tend to have different perceptions and preferences with respect to the use and satisfaction with different features of these computer systems. The main aspects of Gender HCI include Self-Efficacy and confidence issues as related to problem solving tasks on a given interface design, willingness to try out new and different features, performance of tasks, tinkering/exploratory behaviour, motivations for system usage, general attitudes towards interface designs, etc. As summarized by Beckwith and Burnett (2004), gender differences in Self-Efficacy and Risk-Perception can be used as explanatory factors for different behaviour, strategies, and performances of end-users.

According to Beckwith and Burnett (2004), ignoring the gender issue while designing end-user programming environments would miss the opportunity of enhancing the effectiveness of end-user programmers. As they explain, such a solution could be achieved by incorporating appropriate mechanisms to support gender associated differences in decision making, learning, and problem solving.

Gender has also been considered as an important user diversity issue for achieving "universal usability" of web-based and other computer services (Hubona and Shirah 2004).

Grigoreanu et al. (2008) have confirmed previous studies' reports of the existence of a gender gap related to the end-user programming software environments and most important, they have shown that it is possible to design features in these environments that help to close the gender gap.

Tzafilkou et al. (2016) have shown the existence of gender differences in performance in a web-based EUD environment and also presented some main gender differences between performance and perceptual items.

A number of studies of women and EUD have also been conducted, focusing on how the design of web applications could be planned (Harshbarger and Rosson 2012; Rosson et al. 2007, 2010).

Stressing this need to address gender-differences in computer interaction, a recent research work of Burnett et al. (2016) designed and suggested a new methodology, named GenderMag, to find gender-inclusiveness issues in software, so that software developers or user experience designers can design and produce problem-solving software that is more usable by the end-users. GenderMag can be used to analyse usability based on a set of gender-oriented attributes such as Self-Efficacy, Risk-Perception, tinkering, motivation and information processing style.

2.2 Technology acceptance and gender issues

Technology Acceptance Model (TAM) (Davis 1989) explains and predicts IT acceptance and facilitate design changes before users have experience with a system. TAM is considered one of the well-known models related to technology acceptance and use since it has shown great potential in explaining and predicting user behaviour of information technology (Park 2009).

According to TAM, when users are presented with a new technology, two key factors influence their decision about how and when they will use it: Perceived-Usefulness and Perceived-Ease of Use (Venkatesh and Morris 2000).

Gender related empirical findings in TAM show that female and male users differ in beliefs, intention and usage. According to Venkatesh and Morris (2000) women are more influenced by Perceived-Ease of Use in adapting new technology whereas men are more strongly influenced by Perceived-Usefulness. The same is concluded in Terzis and Economides (2012) where the authors indicate gender differences in Perceived-Ease of Use, behavioural intention and social influence.

Unified Theory of Adoption and Use of Technology (UTAUT) (Venkatesh et al. 2003) is the latest model which has been conceived to understand the nature of technology usage. Gender has been attributed as a significant variable in explaining the technology acceptance behaviour of users. In particular, UTAUT has extended TAM by including a set of direct and indirect factors in predicting intention to use a technology. The indirect factors include gender, age, experience with the technology, and voluntarily use of technology. The direct factors include performance expectancy, effort expectancy, social influence and facilitating conditions.

Many different research works (e.g. Chang et al. 2007, 2008; Hung et al. 2007; Liu et al. 2008; Sumak et al. 2010; Teo 2011; Terzis and Economides 2011; Venkatesh et al. 2008; Wang et al. 2009, 2010; Wang and Shih 2009; Wu et al. 2007, 2008; Zhang et al. 2010; Zhou 2008; etc.) have conducted UTAUT studies by applying a variety of research methodologies in different environments.

According to Lee et al. (2003) reviewing the performance of UTAUT or assessing the findings and limitations is crucial to recognize possible future research topics and guide future research endeavours. In Williams et al. (2015), the authors present a comprehensive literature review on the most prominent UTAUT research works.

According to Goswami and Dutta (2016), gender plays a significant role in determining the intention of accepting new technology and there are cases where gender differences cannot be discerned.

Gender differences have been found in UTAUT (e.g. Venkatesh et al. 2003) although age has influenced some relationships. For example, performance expectancy has been more influential for males' and young workers' intention to use a technology, while effort expectancy has been more important for females' and older workers' intention to use a technology (Venkatesh et al. 2003).

UTAUT extended research has also been conducted to examine gender differences (e.g. Wang et al. 2010) and related gender differences have been detected in the acceptance to mobile activities and mobile learning where they were found to moderate the effects of social influence and self-management of learning (Wang et al. 2009; Wang and Shih 2009).

Many other UTUAT research works that examine the influence of gender on technology adoption can be found in the recent literature review of Goswami and Dutta (2016).

Technology acceptance gender issues are crucial in the interaction between users and EUD systems since Perceived-Ease of Use and Perceived-Usefulness are strong variables that can determine the end-users' perceived experience and their developing task performance (Beckwith et al. 2005, 2006a; Burnett 2009, Burnett et al. 2008, 2010, 2011; Lee 2008). Hence, technology acceptance should be integrated in the behavioural analyses of EUD researches.

2.3 Experience, performance and gender issues

Many differences in the working and thinking mode have been detected to exist between end-user groups of different experience level and various interface styles have been adapted to serve better their distinct needs and preferences (Burnett et al. 2011). Basic behavioural differentiation between novice and more experienced end-users are comprehensively presented in Jason et al. (2010).

Burnett et al. (2010) use in their work the term 'programming populations' to refer to the different users' experience levels and examine the existence of gender-based behavioural differentiation among users within these populations. What comes to a conclusion is the fact that gender differences tend to exist cross all the experience levels. However, their degree of fluctuation seems to shrink and some differences even disappear between genders when users have more expertise.

Research has also pointed out computer gender differences as regards to performance and perceived items (e.g. Hoxmeier et al. 2000; Tzafilkou et al. 2016). According to Stipek and Gralinski (1991), women are more likely to attribute their task failure to their lack of capability. Also, according to Brosnan (1998), women tend to underestimate their performance and ability in computer related tasks.

Based on Bandura's (1986) research, performance accomplishments are typically the strongest determining factor in an individual's assessment of Self-Efficacy. As Johnson et al. (2016) explain, end-users' self-efficacy unsuccessful performance on one task can affect future efficacy estimations for the same or other related task. Hence, since women tend to perceive lower Self-Efficacy than men and are more prone to future lower performance (Beyer et al. 2003; Colley and Comber 2003; Cao et al. 2010; Durndell et al. 2000; Grigoreanu et al. 2008; Margolis and Fisher 2003; Vekiri and Chronaki 2008).

According to Jason et al. (2010), user performance can be increased when the computer interface characteristics match the user skill level (Jason et al. 2010). Indeed, many design solutions have been proposed to assist end-users accomplish programming and development tasks (e.g. Ko and Myers 2004). There have also been some EUD personalization technologies to enable end-users receive optimized advice based upon their experience level (Burnett et al. 2011). A good example is the Wire system, developed by De Angeli et al. (2011), which is used as a EUD recommendation tool.

2.4 Hypotheses

2.4.1 Perceived-ease of use

Perceived-Ease of Use (PEOU) is defined as the degree to which a person believes that using the system would be free of effort (Davis 1989). Its role is crucial in EUD tasks and it can affect users' performance, as mentioned in many researches (e.g. Beckwith et al. 2005, 2006a; Burnett 2009, Burnett et al. 2008, 2010, 2011).

Also, PEOU many times influences Perceived-Usefulness (PU) (Agarwal and Prasad 1999; Hu et al. 1999; Venkatesh and Davis 1996). Venkatesh and Morris (2000) found that women are more influenced by PEOU in adapting new technology whereas men are more strongly influenced by PU.

Researchers also conclude that PEOU is more important for female users since male users tend to be more familiar towards computer use (Kim 2010; Ong and Lai 2006; Venkatesh et al. 2003). For all these reasons, we hypothesized:

H1.1. Perceived-Ease of Use will be significantly higher for women than for men.
H1.2. There will be a stronger correlation between Perceived-Ease of Use and Perceived-Usefulness for women than for men.

2.4.2 Perceived-usefulness

Perceived-Usefulness (PU) is determined as the degree to which a person believes that using a particular system will enhance his/her job performance (Davis 1989). As already mentioned, Venkatesh and Morris (2000) and Terzis and Economides (2012) found that women are more influenced by PEOU in adapting new technology and using computer based assessment whereas men are more strongly influenced by PU.

A strong influence of PU on performance and other perception attributes (e.g. perceived playfulness) has been found by many studies (e.g. Lee 2008; Ong and Lai 2006; Terzis and Economides 2012; Van Raaij and Schepers 2008). Moreover, previous studies have shown a moderate effect of gender on PU (Ong and Lai 2006; Venkatesh and Morris 2000).

Thus we hypothesized:

H2.1. Perceived-Usefulness will be significantly higher for men than for women.

2.4.3 Self-efficacy

Self-Efficacy (SE) is an important behavioural variable that conveys an individual's level of confidence to execute courses of action in a given situation. Self-Efficacy has been studied in depth by Bandura (1977; 1997) who found that it can be influenced by environmental situations, cognitive and personal factors as well as demographic characteristics.

Researchers have reported many gender differences in Self-Efficacy across nationalities and across levels of computer expertise (e.g. Beyer et al. 2003; Colley and Comber 2003; Grigoreanu et al. 2008; Margolis and Fisher 2003). Low computer Self-Efficacy among females is a prevalent research result in the literature (Cao et al. 2010; Durndell et al. 2000; Vekiri and Chronaki 2008).

Previous studies supported a causal link between SE and PEOU (Agarwal et al. 2000; Padilla-Melendez et al. 2008; Terzis and Economides 2012; Venkatesh and Davis 1996). Finally, SE has shown to influence PEOU more strongly for women than for men (Ong and Lai 2006).

Thus we hypothesized:

H3.1. Self-Efficacy will be significantly higher for men than for women.
H3.2. There will be a stronger correlation between Self-Efficacy and Perceived-Ease of Use for women than for men.

2.4.4 Risk-perception

Risk-Perception is explained in Blackwell's Attention Investment Model theory (Blackwell 2002; Blackwell and Green 1999) to strongly influence the end user's behaviour through their cost/benefit evaluation. According to Blackwell (2002), risk is the probability that no pay-off will result, or even that additional future costs will be incurred from the way the user has chosen to spend attention. Perception of risk thus plays an important role in a user's decision making about whether to use particular application features (Beckwith and Burnett 2004).

The Attention Investment Model predicts that higher perception of risk can lead to differences in actual behaviour. Risk-Perception can strongly influence computer related behaviour (e.g. Willingness to Learn, Self-Efficacy, etc.) since it determines the whole 'confidence and security' the end-user feels while interacting with the computer environment.

There is evidence that women perceive higher risk in everyday choices and behaviours than men do (Finucane et al. 2000). Just as the Attention Investment Model predicts, higher perception of risk can lead to differences in actual behaviour, and such differences have been many times tied to gender. For example, research shows that due to the Self-Efficacy differences, a female's perception of the cost of learning a new feature (Willingness to Learn) may be higher than a male's perceived cost to learn the same feature (Burnett et al. 2011).

Thus we hypothesized:

H4.1. Risk-Perception will be significantly higher for women than for men.
H4.2. There will be a stronger correlation between Risk-Perception and Willingness to Learn for women than for men.
H4.3. There will be a stronger correlation between Risk-Perception and Self-Efficacy for women than for men.

2.4.5 Willingness to learn

Willingness to Learn is an important EUD behavioural attribute that affects the end-users' overall performance since it reveals the user's motivation power, determines the amount of effort the user makes and the perspectives of his/her future performance enhancement. Willingness-To-Learn is important because it can 'predict' the end-user's willingness to try, persist, tinker and even study to learn how to use new features and EUD technologies (Burnett et al. 2010; Grigoreanu et al. 2008).

According to Lowenstein's information gap theory (1994), a user needs to have a certain level of Self-Efficacy in order to reach a useful level of curiosity, and curiosity will leverage the levels of their exploratory behaviour (tinkering) and Willingness to Learn, enhancing their performance (Burnett et al. 2011). Willingness to Learn is one of the main aspects Gender HCI studies. Previous research found that female users tend to have lower levels of Willingness to Learn and use new technologies and features in end-user programming tasks (Beckwith et al. 2005; Burnett et al. 2010; Grigoreanu et al. 2008).

Thus we hypothesized:

H5.1. Willingness to Learn will be higher for men than for women.

3 Research methodology

The research methodology follows a three-step approach to examine potential gender differences in a prototype web-based EUD environment for database-driven mobile applications. First we present the prototype tool that was used for the field test. Then we describe the field test including the sample and procedure details, the user-task and the measured variables and questionnaire. Finally, we present the data analysis process.

3.1 Prototype web EUD tool

The prototype EUD tool was based on a natural language approach (named 'simple talking') Protogeros and Tzafilkou (2015), designed to assist end-users creating database-driven mobile applications. The authors also developed a prototype wizard-based web EUD tool to integrate and evaluate their EUD approach. The end-users' high performance results and their high levels of Perceived-Ease of Use indicated the efficiency and usefulness of the tool as well as a positive user experience. A detailed presentation of the particular EUD approach for database-driven web applications can be found in Protogeros and Tzafilkou (2015).

3.2 Field test

3.2.1 Participants and procedure

The field test was conducted on 47 end-users, 22 male and 25 female, ages 20–30, in an introductory informatics course in the Department of Accounting and Finance of a Greek University, and in an e-commerce course in the Departments of Master in Information Systems and in Expert Systems in the same Greek University. There were no significant age and expertise differences among the participants and they were almost equally distributed concerning their gender.

Based on the EUD terminology given by Lieberman et al. (2006) that end-users act as non-professional developers to build or modify applications, we require from our participants to belong to the end-user developer generic population. That is, they should be familiar enough with web and computer software and concepts but they should not be experts and of course not programmers.

The conducted field test did not take into account the students' large population but the EUD generic population which according to Costabile et al. (2003a, b) 'it is not a uniform population, but divided in no mutually exclusive communities characterized by different goals, tasks and activities. The EUD population can be different according to cultural, educational, training, and employment background, experience in computer use, age (the very young and the elderly), types of (dis)abilities, etc.' (Costabile et al. 2003b). Based on the EUD terminology given by Lieberman et al. (2006), that end-users act as are non-professional developers to build or modify applications, we require from our participants to belong to the generic end-user developer population. That is, they should be familiar enough with web and computer software's and concepts but they should not to be experts and of course not programmers.

Drawing from all these, the targeted EUD group population is young (age 18–25) users from a European country (Greece), with no disabilities, having the regular computer skills and experience (e.g. computer use and web surfing) but they are not professional developers, meaning that they do not have any programming or web development skills.

To confirm these criteria, some personal information (sex, age, educational background) was collected and as mentioned, prior to the EUD task the participants were also asked to answer a short questionnaire regarding their experience level on database concepts, programming, World Wide Web and overall computer use. The experience level was measured in a scale from 1 to 5 (see Fig.1). We required all participants to have some small database familiarity (less than 2/5) and some average web and computer familiarity (around 2.5/5).

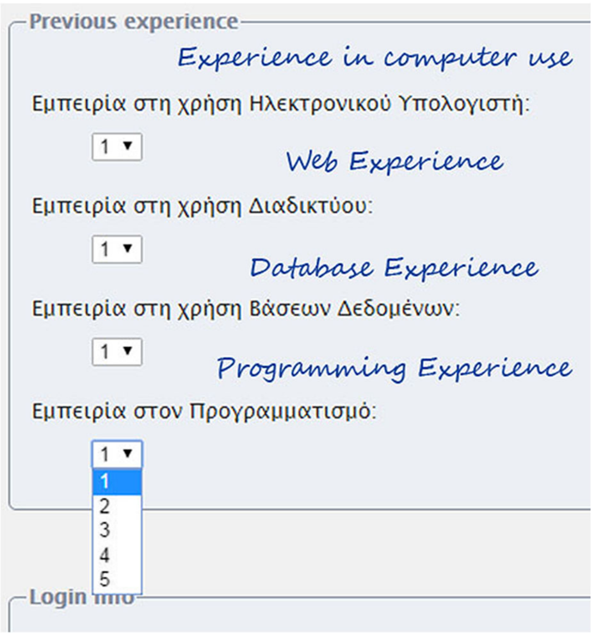

Fig. 1 Prior to task questionnaire regarding the user previous experience (translation in English is provided in hand-written fonts)

As the results showed, the measured mean value of the participants' database familiarity was 1.07, revealing that they could be 'safely' considered as non-professional/non-expert end-users in database-development tasks. Additionally, their programming experience was 0.94, their familiarity with web was 2.71 and their general familiarity with computer use was 2.65 (see Table 1). These mean values satisfy our target group (end-user developers) requirements, i.e. users that are non-experienced programmers, with no or limited knowledge on database concepts but with efficient familiarity with web interaction and computer use in general. This information could allow us to generalize the results from a small sample and make broad claims about web-based EUD behavior of similar EUD populations.

After completing the user task (see 3.2.2), each participant had to answer a questionnaire-based survey consisted of 22 items measuring a set of perception and acceptance variables (see Appendix 1). The questionnaire was in Greek language and it was provided to the users as an online survey form, embedded in the last page of the EUD application.

The participants had no previous training on how to use the EUD tool. As explained, the EUD interface was in a wizard like logic and the users had to move from one step to another using simple buttons and answering to simple questions in order to construct their database-driven mobile application. In the end of the user task a link was generated so that the end-users could access their application (both in web and in mobile view) to see what they had done and use it if they wanted to. Teachers did not give any other special instructions at the beginning of the test, except to present the exercise (i.e. the requested development task). Few students who were not very comfortable with the use of the system, asked for help on its use and received some further assistance.

3.2.2 User task

The exercise (user task) needed to be small enough to be resolved in a limited time by the end-users, and as comprehensive as possible in order to capture most of the relational logic concepts. The example of a DVD store management system is simple and comprehensive as well, since its basic functionalities are familiar to most end-users and its database structure encompasses the creation of all the basic database (relational)

Table 1 Participants' experience level

Measured Item	Users (N = 47)		
	mean (1–5)	St. Deviation	St. Error
Database Experience	1.07	1.17	0.16
Programming Experience	0.94	1.04	0.14
Web Experience	2.71	1.32	0.18
Computer Use Experience	2.65	1.32	0.18

items: Tables, fields and relationships. So, the exercise given to the participants was to develop a simple database-centric mobile application, to record, edit and retrieve movie rentals and customer data.

What we expected from the users was to efficiently design the database schema of Fig. 2.

3.2.3 Measured variables and questionnaire

In the following list we present the set of variables we will measure. The independent variable (IV) is gender and there are five dependent variables (DV) that will be compared between the gender groups.

- IV– Gender
- DV– Self-Efficacy (SE)
- DV–Risk-Perception (RP)
- DV–Perceived-Ease of Use (PEOU)
- DV–Perceived-Usefulness (PU)
- DV–Willingness to Learn (WL)

Regarding the questionnaire survey, it consisted of 22 questions (items) which measure the five independent above-listed variables. A five point Likert-type scale with 1 = "strongly disagree" to 5 = "strongly agree" or 1 = "never" to 5 = "many times" was used to measure the items.

Our questionnaire structure was based on previous research of computer perception and acceptance related questionnaires (e.g. Compeau and Higgins 1995; Davis 1989; Moon and Kim 2001; Venkatesh et al. 2003; Wang et al. 2009) and was not entirely self-made. However, we have adjusted the questions in order to cover all the survey attributes.

The original questionnaire was in a five-point Likert scale form consisted of a prompt, "during the usage of the EUD tool I felt that I was totally confused, or I was bored, or I was confident" etc. (see Appendix 1).

As presented in Appendix 1, five items were used to measure Self-Efficacy, Risk-Perception and Perceived-Ease of Use, four items were used to measure Perceived-Usefulness and three items were used to measure Willingness to Learn.

The internal validity of the questionnaire is presented in Table 4 in the next section.

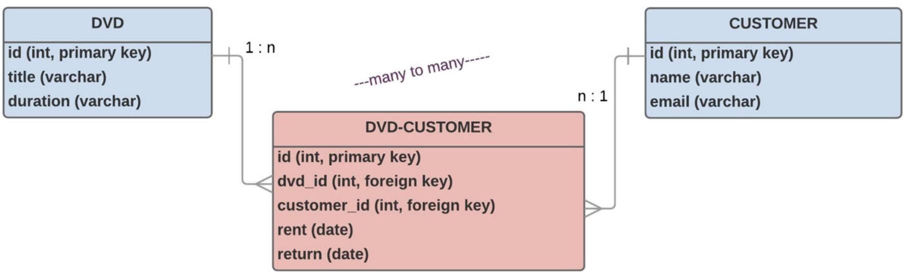

Fig. 2 Entity Relationship Diagram of the expected database schema (solution)

3.3 Data analysis

3.3.1 Sample characteristics

A normality distribution test was conducted to test whether the values of every measured dependent variable were approximately normally distributed for every gender.

A Shapiro-Wilk's test ($p > 0.05$) (Shapiro and Wilk 1965) and a visual inspection of their box plots (see Fig. 3 Appendix 2) showed that the values of Self-Efficacy, Risk-Perception, Perceived-Usefulness, Perceived-Ease of Use and Willingness to Learn were approximately normally distributed for both male and female end-users. Also, Normality Q-Q plots showed that there was a normal distribution per attribute for the whole sample (see Fig. 4 Appendix 2). The fact that the sample size is approximately normally distributed reinforces the validity of the statistical results.

3.3.2 Data analysis method

Since our data are approximately normally distributed we can use a parametric analysis method.

Since we have one categorical independent variable (gender) with two levels (male, female) and a small set of continuous dependent variables, and we plan to examine whether there is a statistically significant difference between the two gender groups for each one of the dependent variables, we will conduct an independent samples T-Test.

In our case, T-Test is a simple and adequate method to examine potential differences between male and female participants.

In order to measure the correlations between the measured variables for each gender group we will use the Pearson correlation, since it is an appropriate method to define the correlation among a small set of continuous variables.

In order to evaluate the questionnaire internal consistency we will calculate the value of Cronbach alpha (α).

Finally, to present the general results concerning every variable for every gender we will use general descriptive statistics.

4 Results

Construct validity and reliability have been tested to ensure that the results are reliable and consistent. The questionnaire's reliability has been tested through Cronbach alpha which requires as minimum 30 participants (Yurdugül 2008). The current work respects this minimum limit since the field test was conducted on a sample size of 47 participants.

Calculating Cronbach's alpha coefficient tested the construct reliability. This coefficient measures the internal consistency by indicating how a set of items are closely related as a group (Moolla and Bisschoff 2012). Nunnally (1967) suggests that a Cronbach alpha value of 0.7 is acceptable, with a slightly lower value might sometimes be acceptable.

In Table 2, Cronbach's alpha values for all factors are above 0.70 indicating that all measures employed in this study demonstrate a satisfactory internal consistency, and the measurement model is supported.

Table 3 presents the descriptive statistics results for all the measured variables for the two gender groups separately. The variables' mean values are all measured in a scale 1–5.

Table 4 shows the T-Test analysis for the users' differences in relation to gender. The confidence interval percentage was set to 95%.

Tables 5 and 6 show the correlation coefficients between pairs of the measured variables for every gender group. As the results show there are some basic differences between the two groups regarding the correlations' significance (where sig. = p-value).

Table 2 Results for the whole sample and validity of the measurement model

Construct Item	Mean (1–5 | n = 47)	Standard Deviation	Cronbach α (>0.70)
Self-Efficacy	3.08	0.49	0.78
SE1			
SE2			
SE3			
SE4			
SE5			
Risk-Perception	2.94	0.77	0.76
RP1			
RP2			
RP3			
RP4			
RP5			
Perceived- Ease of Use	3.60	0.74	0.77
PE1			
PE2			
PE3			
PE4			
PE5			
Perceived-Usefulness	3.68	0.96	0.92
PU1			
PU2			
PU3			
PU4			
Willingness to Learn	3.90	0.77	0.81
WL1			
WL2			
WL3			

Table 3 Descriptive statistics results for gender groups

Variable	Male Users (N = 22)			Female Users (N = 25)		
	mean (1–5)	St. Deviation	St. Error	mean (1–5)	St. Deviation	St. Error
SE	3.20	0.50	0.10	3.06	0.47	0.09
RP	2.81	0.75	0.16	3.15	0.77	0.20
PEOU	3.85	0.65	0.13	3.49	0.78	0.15
PU	3.80	0.91	0.19	3.69	1.02	0.20
WL	3.84	0.90	0.19	4.08	0.63	0.12

5 Discussion

Although previous gender research (e.g. Beckwith and Burnett 2004, 2007; Beckwith 2003, 2007; Beckwith et al. 2005, 2006a, b; Burnett 2009; Burnett et al. 2008, 2010, 2011; Kissinger et al. 2006; Grigoreanu et al. 2006, 2008, 2012; Subrahmaniyan et al. 2008) has been conducted in End-User Programming (e.g. desktop spreadsheets) environments, the current work showed that some gender differences can also exist in modern web-based EUD environments.

As mentioned in the literature review, previous works (e.g. Beckwith and Burnett 2004, 2007; Beckwith 2003, 2007; Beckwith et al. 2005, 2006a, b; Burnett 2009; Burnett et al. 2008, 2010, 2011, 2016; Kissinger et al. 2006; Grigoreanu et al. 2006, 2008, 2012; Lee 2008; Subrahmaniyan et al. 2008) showed significant gender differences in all the measured acceptance and perception items (Self-Efficacy, Risk-Perception, Perceived ease of Use and Perceived Usefulness).

Table 4 T-Test analysis results

Variable	Male Users (N = 22)	Female Users (N = 25)	Gender differences	
	variance	variance	t-value	p-value
SE	0.25	0.22	1.05	0.14 ns
RP	0.56	0.60	−1.50	**0.06 ***
PEOU	0.62	0.43	−1.69	**0.04****
PU	1.06	0.82	−0.44	0.32 ns
WL	0.40	0.81	1.00	0.16 ns

ns not significant

*p < 0.1: medium significance

**p < 0.05: high significance

Table 5 Correlations for female users ($N = 25$)

		SE	RP	PU	PEOU	WL
SE	Pearson Correlation (r)	1	−0.27	0.36*	0.44*	0.10
	Sig.		0.09	0.04	0.01	0.32
RP	Pearson Correlation (r)	−0.27	1	−0.15	−0.38*	0.47**
	Sig.	0.09		0.24	0.03	0.01
PU	Pearson Correlation (r)	0.36*	−0.15	1	0.58**	0.40*
	Sig.	0.04	0.24		0.00	0.02
PEOU	Pearson Correlation (r)	0.44*	−0.38*	0.58**	1	0.19
	Sig.	0.01	0.03	0.00		0.18
WL	Pearson Correlation (r)	0.09	0.47**	0.40*	0.19	1
	Sig.	0.32	0.01	0.02	0.18	

* Correlation is significant at the 0.05 level

**Correlation is significant at the 0.01 level

However, in the current research only some significant gender differences are detected in end-users' acceptance and perception. In the current research experiment users interacted with a modern web-based EUD tool, while most of the previous research works were conducted on desktop spreadsheet-like environments. The limited number of gender differences, compared to previous studies, can possibly be explained by the tool's different nature (web-based) but also by some interface design concepts, like user friendliness, experience, etc. Also the fact that the prototype EUD tool was designed to assist end-users constructing and then accessing their own web applications has might affected the end-users' and especially females' perception and acceptance in a way that eliminated the discussed gender gap (e.g. Grigoreanu et al. 2008) in EUD and other development activities.

Table 6 Correlations for male users ($N = 22$)

		SE	RP	PU	PEOU	WL
SE	Pearson Correlation (r)	1	−0.08	0.42*	0.33	0.14
	Sig.		0.37	0.02	0.07	0.27
RP	Pearson Correlation (r)	−0.08	1	0.12	−0.16	0.15
	Sig.	0.36		0.29	0.23	0.24
PU	Pearson Correlation (r)	0.42*	0.12	1	−0.02	0.80**
	Sig	0.02	0.29		0.46	0.00
PEOU	Pearson Correlation (r)	0.33	−0.16	−0.02	1	−0.11
	Sig.	0.07	0.23	0.46		0.31
WL	Pearson Correlation (r)	0.14	0.15	0.80**	−0.11	1
	Sig.	0.27	0.24	0.00	0.31	

* Correlation is significant at the 0.05 level

**Correlation is significant at the 0.01 level

Following we explain the confirmation or not of our hypotheses one by one, discussing on their main outcomes.

H1.1. *Perceived-Ease of Use will be significantly higher for women than for men.*

Results in Table 2 do not confirm hypothesis H1.1 since they show that female users' PEOU (=3.49) is lower than males' PEOU (=3.85), reversing our expected outcome. However, results in Table 4 reveal a significant correlation since *p*-value = 0.04 which is lower than $\alpha = 0.05$. We see that there is a statistically significant difference in PEOU for female and male users.

H1.2. *There will be a stronger correlation between Perceived-Ease of Use and Perceived-Usefulness for women than for men.*

Results in Table 4 confirm hypothesis H1.2 since the correlation coefficient between PEOU and PU is significant at the 0.05 level for women, revealing a high correlation, whereas it appears to be of a non-significant correlation for the group of men.

H2.1. *Perceived-Usefulness will be significantly higher for men than for women.*

Results in Table 2 show that male users' PU (=3.80) is indeed higher than females' (=3.69) but results in Table 4 do not reveal a statistically significant difference since *p*-value = 0.32 which is higher than $\alpha = 0.05$. Hence, hypothesis H2.1 is not confirmed.

H3.1. *Self-Efficacy will be significantly higher for men than for women.*

Results in Table 4 show that male users' SE (=3.20) is indeed higher than females' (=3.06) but results in Table 5 do not reveal a statistically significant difference since *p*-value = 0.14 which is higher than $\alpha = 0.05$. Hence, hypothesis H3.1 is not confirmed. This is a very important outcome since most previous research works underline the lower levels of female SE while interacting with computer environments. However, in the prototype EUD tool there is not a significant difference between males' and female's SE.

H3.2. *There will be a stronger correlation between Self-Efficacy and Perceived-Ease of Use for women than for men.*

Results in Table 5 confirm H2.3 since there is a significant correlation between SE and PEOU for women but there is not a significant correlation for men.

H4.1. *Risk-Perception will be significantly higher for women than for men.*

Results in Table 3 show that male users' RP (=2.81) is indeed lower than females' (=3.15) but results in Table 3 do not reveal a statistically significant difference since *p*-value = 0.06 which is a little higher than $\alpha = 0.05$. Hence, hypothesis H4.1 is not confirmed. However, the p-value is less than 0.1 revealing a possibility of significance (medium significance) in RP gender differences.

H4.2. *There will be a stronger correlation between Risk-Perception and Willingness to Learn for women than for men.*

Results in Table 5 and Table 6 confirm H4.3 since RP is significantly correlated to WL for women, but not for men.

H4.3. *There will be a stronger correlation between Risk-Perception and Self-Efficacy for women than for men.*

Results do not confirm H4.3. As Tables 5 and 6 depict there isn't a significant correlation between SE and RP neither for men nor for women.

H5.1. *Willingness to Learn will be significantly higher for men than for women.*

Results in Table 4 show that male users' WL (=3.84) is lower than females' (=4.08), but results in Table 4 do not reveal a statistically significant difference since p-value = 0. 16 which is higher than $\alpha = 0.05$. Hence, hypothesis H3.1 is not confirmed.

The gender differences detected in the current work are not of low value, since they reflect an important aspect of the contemporary interaction with web EUD environments and stress the need for gender-neutral design. In particular, the significant gender differences existing in Perceived-Ease of Use should be taken under consideration when designing web-based EUD systems.

As already explained in the reviewed literature, Perceived-Ease of Use can determine the end-users' perceived experience and their developing task performance (Beckwith et al. 2006a; Beckwith et al. 2005; Burnett 2009, Burnett et al. 2008, 2010, 2011; Lee 2008).

Also, the significant gender differences existing in Risk-Perception integrate the concept of the Attention Investment Model (Blackwell 2002; Blackwell and Green 1999) in the EUD field and contribute in the research effort of explaining the EUD-related user behaviour. According to the Attention Investment Model and behavioural EUD studies (e.g. Beckwith et al. 2005), Risk-Perception can affect the users' behaviour such as their willingness to use new features and their overall user experience. In the current paper, we showed that women's Risk-Perception is significantly correlated to Perceived-Ease of Use and Willingness to Learn. Additionally women proved to have significantly higher Risk-Perception levels than men.

Although not many significant differences were revealed, this research is important to understand the current 'gender-gap' in modern EUD environments that seems to be eliminated compared to 'traditional' desktop EUD software. Taking under consideration users' behavioral and gender differences in modern web-based environments, and gender-neutral tools can be designed. As explained in the Conclusions and Future Work section, this could be achieved by implementing user modeling methodologies that use as user feedback their gender-oriented behavioral attributes.

The differences underlined in the current work, re-confirm previous studies of Grigoreanu et al. (2008) implying the persistent existence of a gender gap in end-user development software environments as well. This gender-gap should be further eliminated in future web EUD environments since according to Beckwith and Burnett (2004), "ignoring the gender issue while designing end-user programming environments would miss the opportunity of enhancing the effectiveness of end-user programmers."

5.1 Possible issues and limitations

Since this research is the first in the area of measuring/analyzing gender differences in web-based EUD environments for database driven mobile applications, there are some limitations.

First, the approach involves a limited number of variables and there are a number of other important variables that could be added in future studies. These variables could for instance include some behavioural EUD-related variables like curiosity (Hartzel 2003; Grigoreanu et al. 2008; Scaffidi et al. 2010), tinkering/exploratory behaviour (Beckwith et al. 2005, 2006a, b; Burnett et al. 2010, 2011; Grigoreanu et al. 2008; Martinson 2005; Rode 2008), overconfidence (Beckwith and Burnett 2004), etc.

A second possible limitation is the generalizability issue. The current field test is conducted on a generally small sample size and this can possibly affect the ability to generalize the findings. The current study does not take into account the generic users' or students' population but a EUD subset and based on this, it evaluates the sample representation. As mentioned, we refer to a EUD subpopulation since according to Costabile et al. (2003b), EUD population is not uniform and is divided in a set of communities characterized by different goals, tasks and activities. EUD population can be different according to cultural, educational, training, and employment background, experience in computer use, age, types of (dis)abilities, etc.

Finally there may be another possible limitation involved by the wizard-based design of the prototype tool. Wizard-logic has been shown to be preferred by female users (Beckwith et al. 2005; Burnett et al. 2010) and it can positively affect their perception and acceptance. Also, this can possibly lead to differentiated results in future web-EUD research that will be conducted on non-wizard like interface designs.

6 Conclusions and future work

This paper presents a basic examination of the influence of gender on the end-users' perception and acceptance while interacting with a modern, web-based EUD environment for database-driven mobile applications.

The conducted field test on 47 end-user participants in a Greek university showed that there are some significant gender-oriented differences while end-users interact with today's web-based EUD environments. However, in some cases the results indicated non-significant gender differences and even strong similarities.

In particular, significant gender differences were shown to exist in the end-users' Perceived-Ease of Use and some differences of medium significance were showed to exist in their Risk-Perception levels. Regarding the correlation between the measured variables, significant gender differences were found in the correlations between Self-Efficacy/Perceived-Usefulness, Perceived-Ease of Use/Perceived-Usefulness and Willingness to Learn/Perceived-Usefulness.

The experiment did not reveal other significant perception-related or acceptance-related differences between male and female end-users. An important finding of gender similarity was that there was a strong correlation between Perceived-Ease of Use and Self-Efficacy both for male and female users.

The main contribution of the current work is to provide the EUD research community with a supplementary research background and a motivation to study further the end-user perception and acceptance of web-based EUD environments for database driven applications, as well as the influence of gender.

In the future these findings could be significantly enriched by analysing performance or other indicators as well. This analysis is important to better understand the factors that influence the end-users' performance in EUD tasks.

Also, as mentioned in the limitations section, our approach involves a limited number of variables and there are a number of other important variables (e.g. curiosity, overconfidence, etc.) that could be added in future studies. These studies could possibly reveal new gender differences that complementary to ours could enrich the knowledge on end-user' developing behavior and the influence of gender.

It would also be useful to conduct a similar study on a larger sample size, to address generalizability issues and represent broader EUD populations (such as the student population).

In our future works we plan to use gender-based differences as user feedback in the design of gender-neutral self-adaptive EUD systems. In particular, as explained in Tzafilkou et al. (2016), gender differences in end-users' behavioral attributes could be used as user feedback in user modeling mechanisms for adaptive and personalized feedback in EUD environments. In the future, self-adaptive web-based EUD environments could be developed to assist users perform better and eliminate gender differences both in their developing behavior and performance.

Another interesting future research direction could also be to examine gender issue in users' behavior using mouse monitoring or eye tracking methodologies. In our future works we plan to conduct new web-EUD exploratory studies monitoring both eye and mouse movements to detect possible new behavioral differences between genders. By capturing the end-users' development behavior, dynamic user-modeling methodologies could be developed to adapt/personalize the EUD environments, aiming to eliminate the gender gap and enhance the end-user performance and experience.

Gender studies should be further integrated in HCI and EUD research to analyse nowadays end-users' behavior. Hopefully our research will shed light on the necessity of similar human-oriented behavioural analyses in the EUD evolution and to encourage relative future work.

Appendix 1 Questionnaire

Table 7 Survey Questionnaire

Constructs	Items	Questions
Perceived-Usefulness		
	PU1	The system is useful.
	PU2	The system makes me more productive.
	PU3	The system makes me save time.
	PU4	The system satisfies my needs and requirements.
Perceived-Ease of Use		
	PE1	The system is easy to use.
	PE2	I do not need to try too hard to use the system effectively
.	PE3	I can use the system without written instructions.
	PE4	I can learn how to use the system easily and fast.
	PE5	I can easily correct my mistakes while I use the system.
Self-Efficacy		
	SE1	I felt confident while I was using the system.
	SE2	I believed that I could perform well.
	SE3	I felt I had the control of the task.
	SE4	I felt that everyone else knew what to do but me.
	SE5	I felt confused while using the system.
Willingness to Learn		
	WL1	I wanted to learn how to use the system while I was using it.
	WL2	I'd like to learn more how to use the system.
	WL3	I'd like to learn how to use other similar systems too.
Risk-Perception		
	RP1	It was taking me time to decide on how to move while using the system.
	RP2	I felt nervous every time I took an action (e.g. pressed a button).
	RP3	I well checked my actions before moving to the next steps.
	RP4	I had no hesitation to take an action.
	RP5	I had no difficulty to decide which feature (among others) to use.

Appendix 2 Normal distribution test results

Table 8 Test of Normality

Measured Variable	Gender	Shapiro-Wilk	
		Statistic	Sig.
Risk-Perception	Female	0.948	0.246
	Male	0.973	0.824
Perceived-Usefulness	Female	0.927	0.083
	Male	0.941	0.253
Perceived-Ease of Use	Female	0.956	0.371
	Male	0.967	0.687
Willingness to Learn	Female	0.929	0.090
	Male	0.927	0.135
Self-Efficacy	Female	0.926	0.081
	Male	0.912	0.070

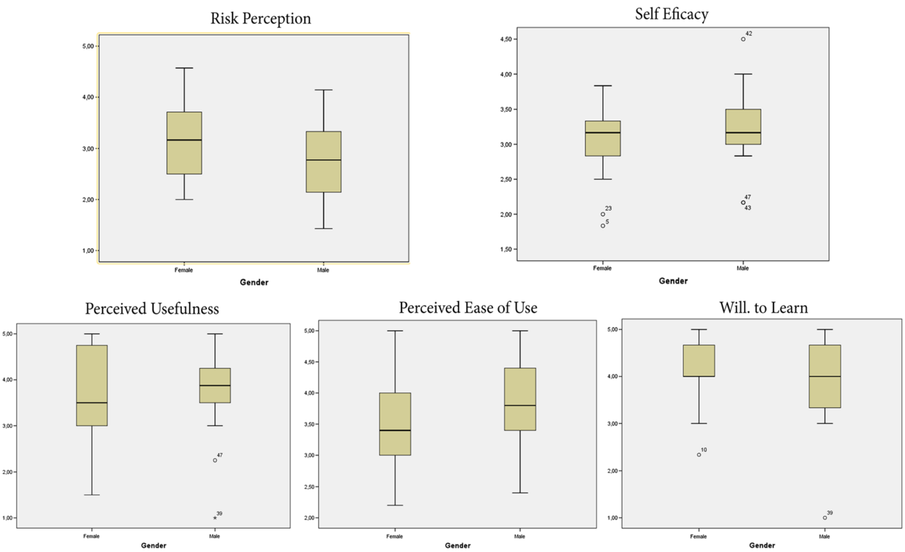

Fig. 3 Box Plots based on gender

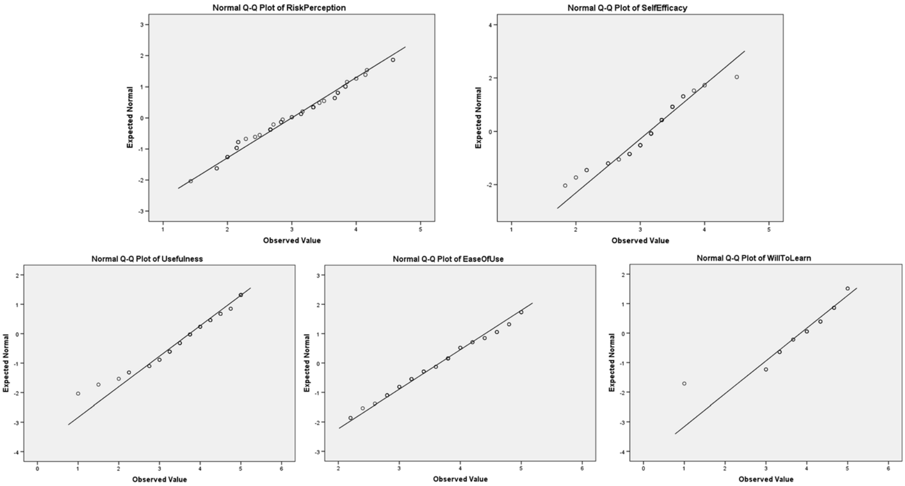

Fig. 4 Normal Q-Q Plots for the whole sample

References

Agarwal, R., & Prasad, J. (1999). Are individual differences germane to the acceptance of new information technologies? *Decision Sciences, 30*(2), 361–391.

Agarwal, R., Sambamurthy, V., & Stair, R. M. (2000). Research report: the evolving relationship between general and specific computer self-efficacy—an empirical assessment. *Information Systems Research, 11*(4), 418–430.

Bandura, A. (1977). Self-efficacy: the exercise of control. New York: Freeman.

Bandura, A. (1986). Social Foundations of Thought and Action: A social Cognitive Theory. Prentice-Hall, Englewood Cliffs, N. J.

Beckwith, L. (2003) Gender HCI issues in end-user software engineering. IEEE Symposium on Human Centric Computing Languages and Environments 2003 Proceedings, pp. 273–274.

Beckwith, L. (2007) Gender HCI issues in end-user programming, Ph.D. Thesis, Oregon State University.

Beckwith, L., & Burnett, M. (2004). "Gender: an important factor in end-user programming environments?" 2004 *IEEE Symposium on Visual Languages - Human Centric Computing*, pp. 107–114.

Beckwith, L., Sorte, S., Burnett, M., Wiedenbeck, S., Chintakovid, T., & Cook, C. (2005). Designing features for both genders in end-user programming environments. In *Proceedings of the 2005 I.E. Symposium on Visual Languages and Human-Centric Computing* (VLHCC '05) IEEE computer society, Washington, DC, pp. 153–160.

Beckwith, L., Burnett, M., Grigoreanu, M., & Wiedenbeck, S. (2006a). Gender HCI: what about the software? *Computer*, Nov. 2006, pp. 83–87.

Beckwith, L., Kissinger, C., Burnett, M., Wiedenbeck, S., Lawrance, J., Blackwell, A., & Cook, C. (2006b). Tinkering and gender in end-user programmers' debugging. In R. Grinter, T. Rodden, P. Aoki, E. Cutrell, R. Jeffries, & G. Olson (Eds.), *Proceedings of the SIGCHI conference on human factors in computing systems (CHI '06)* (pp. 231–240). New York: ACM.

Beyer, S., Rynes, K., Perrault, J., Hay, K., & Haller, S. (2003) Gender differences in computer science students. SIGCSE: Special Interest Group on Computer Science Education, pp. 49–53.

Blackwell, A. (2002). First steps in programming: a rationale for attention investment models. In *IEEE Human-Centric Computing Languages and Environments*, pp. 2–10.

Blackwell, A., & Green, T.R.G. (1999). Investment of attention as an analytic approach to cognitive dimensions. In T.R.G. Green, T. Abdullah, & P. Brna (Eds.), 11th Workshop of the Psychology of Programming Interest Group, pp. 24–35.

Blackwell, A. F., Rode, J. A., & Toye, E. F. (2009). How do we program the home? Gender, attention investment, and the psychology of programming at home. *International Journal of Human-Computer Studies, 67*, 324–341.

Brosnan, M. (1998). The role of psychological gender in the computer-related attitudes and attainments of primary school children (Aged 6–11). *Computers and Education, v30* n3–4 203–08, Apr–May 1998.

Burnett, M. (2009). What is end-user software engineering and why does it matter? *End-User Development*, pp. 15–28.
Burnett, M. (2010). Gender HCI: what about the software? In Proceedings of the 28th ACM International Conference on Design of Communication (SIGDOC '10) ACM. New York, pp. 251–251.
Burnett, M. M., & Scaffidi, C. (2011). End-user development. In M. Soegaard & R. F. Dam (Eds.), *Encyclopedia of human-computer interaction*. Aarhus: The Interaction-Design.org Foundation.
Burnett, M., Wiedenbeck, S. Grigoreanu, V., Subrahmaniyan, N., Beckwith, L., & Kissinger, C. (2008). Gender in end-user software engineering. In *Proceedings of the 4th international workshop on End-user software engineering (WEUSE '08)* ACM, New York. pp. 21–24.
Burnett, M., Fleming, S., Iqbal, S. (2010) Gender differences and programming environments: across programming populations. *Proceedings of the 2010 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement*.
Burnett, M. M., Beckwith, L., Wiedenbeck, S., Fleming, S. D., Cao, J., Park, T. H., Grigoreanu, V., et al. (2011). Gender pluralism in problem-solving software. *Interacting with Computers, 23*(5), 450–460.
Burnett, M., Stumpf, S., Macbeth, J., Makri, S., Beckwith, L., Kwan, I., Peters, A., & Jernigan, W. (2016). GenderMag: a method for evaluating Software's gender inclusiveness. *Interacting with Computers*. https://doi.org/10.1093/iwc/iwv046.
Cao, J., Rector, K., Park, T., Fleming, S., Burnett, M. & Wiedenbeck, S. (2010). A debugging perspective on end-user mashup programming. In *Proc. IEEE visual languages and human-centric computing* (pp. 149–156). IEEE: Los Alamitos.
Chang, I.-C., Hwang, H.-G., Hung, W.-F., & Li, Y.-C. (2007). Physicians' acceptance of pharmacokinetics-based clinical decision support systems. *Expert Systems with Applications, 33*(2), 296–303.
Cheng, D., Liu, G., Qian, C. & Song, Y.F. (2008). Customer acceptance of internet banking: integrating trust and quality with UTAUT model. IEEE International Conference on Service Operations and Logistics, and Informatics, Beijing, 12–15 October.
Colley, A., & Comber, C. (2003). Age and gender differences in computer use and attitudes among secondary school students: what has changed? *Educational Research, 45*(2), 155–165.
Colquitt, J. A., LePine, J. A., & Noe, R. A. (2000). Toward an integrative theory of training motivation: a meta-analytic path analysis of 20 years of research. *Journal of Applied Psychology, 85*, 678–707.
Compeau, D., Higgins, C. (1995). Application of social cognitive theory to training for computer skills. *Information Systems Research, 6*(2), 118–143. *Computers in Human Behaviour, 17*, 21–33.
Costabile, M.F., Fogli, D., Letondal, C., Mussio, P., & Piccinno, A. (2003a). Domain-expert users and their needs of software development. Proc. Special Session on EUD, UAHCI Conference, Crete, Greece, pp. 532–536.
Costabile M.F., Fogli, D., Fresta, G., Mussio, P., & Piccinno, A. (2003b). Building environments for end-user development and tailoring, human centric computing languages and environments, 2003. Proceedings. 2003 I.E. Symposium on, 2003, pp. 31–38.
Cuccurullo, S., Francese, R., Risi, M. & Tortora, G. (2011). MicroApps development on mobile phones. In M. Costabile, Y. Dittrich, G. Fischer, & A. Piccinno, (Eds.), *End-User Development*, vol. 6654 of Lecture Notes in Computer Science (pp. 289–294). Berlin: Springer.
Danado, J. & Paternò, F. (2012a). A prototype for EUD in touch-based mobile devices. In *Proceedings of the IEEE Symposium on Visual Languages and Human-Centric Computing* (VL/HCC '12), pp. 83–86.
Danado, J. & Paternò, F. (2012b) Puzzle: a visual-based environment for end user development in touch-based mobile phone. *Human-Centered Software Engineering*, vol. 7623 of Lecture Notes in Computer Science, pp. 199–216.
Danado, J., Davies, M., Ricca, P. & Fensel, A. (2010). An authoring tool for user generated mobile services. In A. Berre, A. Gomez-Pérez, K. Tutschku, & D. Fensel (Eds.), *Proceedings of the 3rd future internet conference on future internet* (FIS '10) (pp. 118–127) Springer.
Davis, F. D. (1989). Perceived-usefulness, perceived-ease of use, and user acceptance of information technology. *MIS Quarterly, 13*, 319–340.
De Angeli, A., Battocchi, A. Roy C. S., Rodriguez, C., & Daniel, F., Casati, F. (2011). Conceptual design and evaluation of WIRE: a wisdom-aware EUD tool. Technical Report DISI-11-353, Ingegneria e Scienza dell'Informazione, University of Trento.
Durndell, A., & Thomson, K. (1997). Gender and computing: a decade of change? *Computers & Education, 28*(1), 1–9.
Durndell, A., Hagg, Z., & Laithwaite, H. (2000). Computer self-efficacy and gender: a cross cultural study of Scotland and Romania. *Personality and Individual Differences, 28*(6), 1037–1044.
Farahat, T. (2012) Applying the technology acceptance model to online learning in the Egyptian universities. *Procedia - Social and Behavioural Sciences*, Volume 64, 9 November 2012, pp. 95–104.

Finucane, M. L., Slovic, P., Mertz, C. K., Flynn, J., & Satterfield, T. A. (2000). Gender, race, and perceived risk: the 'white male' effect. *Health, Risk, & Society, 2*(2), 159–172.

Ghiani, G., Paternò, F. & Spano, L. D. (2011) Creating mashups by direct manipulation of existing web applications. *End-User Development*, vol. 6654 of Lecture Notes in Computer Science (pp. 42–52). Springer, Berlin.

Ghiani, G., Paternò, F., Spano, L. D., & Pintori, G. (2016). An environment for end-user development of web mashups. *International Journal of Human-Computer Studies, 87*, March 2016, 38–64.

Goswami, A., & Dutta, S. (2016). Gender differences in technology usage—a literature review. *Open Journal of Business and Management, 4*, 51–59.

Grigoreanu, V., Beckwith, L., Fern, X., Yang, S., Komireddy, C., Narayanan, V., Cook, C., & Burnett, M.M. (2006). Gender differences in end-user debugging, revisited: what the miners found. In *Proceedings of the IEEE Symposium on Visual Languages and Human-Centric Computing*. pp. 19–26.

Grigoreanu, V., Cao, J., Kulesza, T., Bogart, C., Rector, K., Burnett, M. & Wiedenbeck, S. (2008). Can feature design reduce the gender gap in end-user software development environments? In *Proceedings of the 2008 IEEE Symposium on Visual Languages and Human-Centric Computing* (VLHCC '08). IEEE computer society, Washington, DC, USA, 149–156.

Grigoreanu, V., Burnett, M., Wiedenbeck, S., Cao, J., Rector, K., & Kwan, I. (2012). End user debugging strategies: a sense making perspective. *Transactions on Computer-Human Interaction, 19*(1), 5.

Harshbarger, N.L., & Rosson, M.B. (2012). wProjects: data-centric web development for female nonprogrammers. *Proceedings of 2012 I.E. Symposium on Visual Languages and Human-Centric Computing*, pp. 67–70.

Hartzel, K. (2003). How self-efficacy and gender issues affect software adoption and use. *Communications of the ACM, 46*(9), 167–171.

Hoxmeier, J. A., Nie, W., & Purvis, G. T. (2000). The impact of gender and experience on user confidence in electronic mail. *Journal of organizational and end user computing (JOEUC), 12*(4), 10.

Hu, P. J., Chau, P. Y. K., Sheng, O. R. L., & Tam, K. Y. (1999). Examining the technology acceptance model using physician acceptance of telemedicine technology. *Journal of Management Information Systems, 16*(2), 91–112.

Hubona G.S., and Shirah G.W. (2004). The gender factor performing visualization tasks on computer media. In *Proceedings of the Proceedings of the 37th Annual Hawaii International Conference on System Sciences (HICSS'04) - Track 4 - Volume 4* (HICSS '04), Vol. 4. IEEE Computer Society, Washington, DC, USA, 40097.3.

Hung, Y.H., Wang, Y.S. & Chou, S.C.T. (2007). User acceptance of e-government services, Pacific Asia conference on information systems, Natl sun Yat-Sen university, Kaohsiung, Auckland, 4–6 July.

Jason, B., Calitz, A., Greyling, J. (2010). The evaluation of an adaptive user interface model. In *Proceedings of the 2010 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists (SAICSIT '10)*. ACM, New York, NY, USA, 132–143.

Johnson, R. D., Li, Y., & Dulebohn, H. J. (2016). Unsuccessful performance and future computer self-efficacy estimations: attributions and generalization to other software applications. *Journal of Organizational and End User Computing (JOEUC), 28*(1 (January 2016), 1–14.

Kim, Y. M. (2010). Gender role and the use of university library website resources: A social cognitive theory perspective. *Journal of Information Science, 36*(5), 603–617.

Kim, J. K., & Ritter, F. E. (2015). Learning, forgetting, and relearning for keystroke- and mouse-driven tasks: relearning is important. *Human–Computer Interaction, 30*(1), 1–33.

Kissinger, C., Burnett, M., Stumpf, S., Subrahmaniyan, N., Beckwith, L., Yang, S., Rosson, M., (2006). Supporting end user debugging: What do users want to know? Advanced Visual Interfaces, ACM, pp. 135–142.

Ko, A. J., Myers, B. A. (2004). Designing the Whyline: A Debugging Interface for Asking Questions About Program Failures. CHI 2004, Vienna, Austria, April 24–29, 151–158.

Kulesza, T., Wong, W., Stumpf, S., Perona, S., White, R., Burnett, M.M., Oberst, I., and Ko, A.J. (2009) Fixing the program my computer learned: barriers for end users, challenges for the machine. In *Proceedings of the 14th international conference on intelligent user interfaces (IUI '09)* (pp. 187–196) ACM: New York.

Kulesza, T., Stumpf, S., Wong, W., Burnett, M., Perona, S., Ko, A., & Oberst, I. (2011). Why-oriented end user debugging of naïve Bayes text classification. ACM trans. Interact. Intell. Syst. 1, 1, Article 2 (October 2011), 31 pages.

Lee, Y. C. (2008). The role of perceived resources in online learning adoption. *Computers & Education, 50*(4), 1423–1438.

Lee, Y., Kozar, K. A., & Larsen, K. R. T. (2003). The technology acceptance model: past, present, and future. *Communications of the Association for Information System, 12*(1), 752–780.

Lieberman, H., Paternò, F., & Wulf, V. (2006). End User Development: an emerging paradigm. *End User Development, 9*, 1–8.

Lin, J., Wong, J., Nichols, J., Cypher, A. & Lau, T.A. (2010). End-user programming of mashups with vegemite. In Proceedings of the 13th international conference on intelligent user interfaces (IUI '09), pp. 97–106, February 2009.

Liu, S.H., Liao, H.L., Chung Yuan, C.J. (2005). Applying the technology acceptance model and flow theory to online e-learning users' acceptance behaviour. *Issues in Information Systems, 6*(2), 95–104.

Liu, G., Huang, S.-P. & Zhu, X.-K. (2008). User acceptance of internet banking in an uncertainand risky environment. The 2008 international conference on Risk Management & Engineering Management, Beijing, 4–6 November.

Loewenstein, G. (1994). The psychology of curiosity: a review and reinterpretation. *Psychology Bulletin, 116*(1), 75–98.

Macías, J. A., & Paternò, F. (2008). Customization of web applications through an intelligent environment exploiting logical interface descriptions. *Interacting with Computers, 20*(1), 29–47.

Margolis, J., & Fisher, A. (2003). *Unlocking the clubhouse*. Cambridge: MIT Press.

Martinson, A. M. (2005). Playing with technology: Designing gender sensitive games to close the gender gap. In Working Paper SLISWP-03-05. School of Library and Information Science: Indiana University.

Miller, R.C., Bolin, M.L., Chilton, B., Little, G., Webber, M. & Chen-Hsiang, Y. (2010). Rewriting the web with chicken foot. In *No code required: giving users tools to transform the web* (pp. 39–62) Burlington: Elsevier.

Moolla, A., & Bisschoff, C. (2012). Validating a model to measure the brand loyalty of fast moving consumer goods. *Journal of Social Sciences, 31*(2), 101–115.

Moon, J., & Kim, Y. (2001). Extending the TAM for a world-wide-web context. *Information Management, 38*(4), 217–230.

Moss, G. A., & Gunn, R. W. (2009). Gender differences in website production and preference aesthetics: preliminary implications for ICT in education and beyond. *Behaviour & Information Technology, 28*(5), 447–460.

Nestler, T., Namoun, A. & Schill, A. (2011). End-user development of service-based interactive web applications at the presentation layer. In *Proceedings of the 3rd ACM SIGCHI Symposium on Engineering Interactive Computing Systems (EICS '11)*, June 2011, pp. 197–206.

Nichols J., & Lau, T. (2008). Mobilization by demonstration: Using traces to re-author existing web sites. In *Proceedings of the 13th international conference on intelligent user interfaces (IUI '08)*, pp. 149–158.

Nunnally, J. (1967). *Psychometric theory*. New York: McGraw.

Ong, C., & Lai, J. (2006). Gender differences in perceptions and relationships among dominants of e-learning acceptance. *Computers in Human Behaviour, 22*(5), 816–829.

Padilla-Melendez, A., Garrido-Moreno, A., & Del Aguila-Obra, A. R. (2008). Factors affecting e-collaboration technology use among management students. *Computers & Education, 51*(2), 609–623.

Padilla-Meléndez, A., del Aguila-Obra, A. R., & Garrido-Moreno, A. (2013). Perceived playfulness, gender differences and technology acceptance model in a blended learning scenario. *Computers & Education, 63*(April 2013), 306–317.

Park, S. (2009). An analysis of the technology acceptance model in understanding university students' Behavioural intention to use e-learning. *Education Technology & Society, 12*(3), 150–162.

Paternò, F. (2013). End user development: survey of an emerging field for empowering people. *ISRN Software Engineering*. vol. 2013, Article ID 532659, 11 pages.

Protogeros, N., & Tzafilkou, K. (2015). Simple-talking database development: Let the end-user design a relational schema by using simple words. *Computers in Human Behaviour, 48*(July 2015), 273–289.

Repenning, A., & Ioannidou, A. (2006). What makes end-user development tick? 13 Design guidelines. In H. Lieberman, F. Paternò, & V. Wulf (Eds.), *End-user development: empowering people to flexibly employ advanced information and communication technology*. Dordrecht: Kluwer.

Rode, J. A. (2008). An ethnographic examination of the relationship of gender and end-user programming, Ph.D. Thesis, University of California Irvine.

Rode, J., Rosson, M.B., & Pérez-Quiñones, J. (2006). End user development of web applications. *End User Development, Human-Computer Interaction Series* Volume 9, 2006, pp 161–182.

Rosson, M.B., Sinha, H., Bhattacharya, M., & Zhao, D. (2007). Design planning in end-user web development. In *Proceedings of 2007 I.E. Symposium on Visual Languages and Human-Centric Computing*, pp. 189–196.

Rosson, M.B., Sinha, H., & Edor, T. (2010). Design planning in end-user web development: gender, feature exploration and feelings of success. In *Proceedings of 2010 I.E. Symposium on Visual Languages and Human-Centric Computing*, pp. 141–148.

Saadé, G., Nebebe, F., & Tan, W. (2007). Viability of the technology acceptance model in multimedia learning environments: a comparative study. *Interdisciplinary Journal of Knowledge and Learning Objects, 3*, 175–184.

Saadé, R. G., Kira, D., & Otrakji, C. A. (2012). Gender differences in interface type task analysis. *International Journal of Information Systems and Social Change, 3*(2), 1–23.

Sam, H. K., Othman, A. E. A., & Nordin, Z. S. (2005). Computer self-efficacy, computer anxiety, and attitudes toward the internet: a study among undergraduates in Unimas. *Educational Technology & Society, 8*(4), 205–219.

Scaffidi, C. C., Bogart, M. M., Burnett, A., Cypher, B., & Myers, M. S. (2010). Using traits of web macro scripts to predict reuse. *Journal of Visual Languages & Computing, 21*(5), 277–291.

Seifert, J., Pfleging, B., Bahamóndez, E., Hermes, M., Rukzio, E. and Schmidt, A. (2011). Mobidev: a tool for creating apps on mobile phones. In proceedings of the 13th international conference on human computer interaction with mobile devices and services (MobileHCI '11), pp. 109–112, ACM.

Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). *Biometrika, 52*(3–4), 591–611.

Soriano, J., Lizcano, D., Canas, M. A, Reyes, M. & Hierro, J.J. (2007). Fostering innovation in a mashup-oriented enterprise 2.0 Collaboration environment. In Proceedings of the SIWN international conference on adaptive business systems (ICABS '07), pp. 62–669, Chengdu, China.

Spahn, M., Dörner, C., & Wulf, V. (2008). End user development: approaches towards a flexible software design questions to answer. ECIS 2008, 9th – 11th June 2008, Galway, Ireland.

Stipek, D., & Gralinski, J. H. (1991). Gender differences in children's achievement-related beliefs and emotional responses to success and failure in mathematics. *Journal of Educational Psychology, 83*(3).

Subrahmaniyan, N., Beckwith, L., Grigoreanu, V., Burnett, M., Wiedenbeck, S., Narayanan, V., Bucht, K., Drummond, R., Fern, X. (2008). Testing vs. code inspection vs. what else? Male and female end users' debugging strategies. In *ACM conference on human factors in computing systems* (pp. 617–626). New York: ACM.

Sumak, B., Polancic, G. & Hericko, M. (2010). An empirical study of virtual learning environment adoption using UTAUT. Second international conference on mobile, hybrid, and on-line learning, pp. 17–22.

Sundar, S. S., Bellur, S., Oh, J., Xu, Q., & Jia, H. (2014). User experience of on-screen interaction techniques: an experimental investigation of clicking, sliding, zooming, hovering, dragging, and flipping. *Human–Computer Interaction, 29*(2), 109–152.

Teo, T. (2011). Factors influencing teachers' intention to use technology: model development and test. *Computers & Education, 57*(4), 1–25.

Teo, T. S. H., & Lim, V. K. G. (2000). Gender differences in internet usage and task preferences. *Behaviour & Information Technology, 19*(4), 283–295.

Terzis, V., & Economides, A. A. (2011). The acceptance and use of computer based assessment. *Computers & Education, 56*(4), 1032–1044.

Terzis, V., & Economides, A. A. (2012). Computer based assessment: gender differences in perceptions and acceptance. *Computers in Human Behaviour, 27*(6, November 2011), 2108–2122.

Tzafilkou, K., Protogeros, N., Charagiannidis, C., & Koumpis, A. (2016). Gender-based behavioral analysis for end-user development and the 'RULES' attributes. *Education and Information Technologies, 22*, 1–42.

Van Raaij, E. M., & Schepers, J. J. L. (2008). The acceptance and use of a virtual learning environment in China. *Computers & Education, 50*(3), 838–852.

Vekiri, I., & Chronaki, A. (2008). Gender issues in technology use: perceived social support, computer self-efficacy and value beliefs, and computer use beyond school. *Computers & Education, 51*(4), 1392–1404.

Venkatesh, V., & Davis, F. D. (1996). A model of the antecedents of perceived-ease of use: development and test. *Decision Sciences, 27*, 451–481.

Venkatesh, V., & Morris, M. (2000). Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behaviour. *MIS Quarterly, 24*(1), 115–139.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly, 27*(3), 425–478.

Venkatesh, V., Brown, S. A., Maruping, L. M., & Bala, H. (2008). Predicting different conceptualizations of system use: The competing roles of behavioral intention, facilitating conditions, and behavioral expectation. *MIS Quarterly, 32*(3), 483–502.

Wang, Y. S., & Shih, Y. W. (2009). Why do people use information kiosks? A validation of theunified theory of acceptance and use of technology. *Government Information Quarterly, 26*(1), 158–165.
Wang, Y.-S., Wu, M.-C., & Wang, H.-Y. (2009). Investigating the determinants and age and gender differences in the acceptance of mobile learning. *British Journal of Educational Technology, 40*(1), 92–118.
Wang, H.-Y., Chan, T.-J., Huang, Y.-F., Wang, N.-C., & Chang, Y.-S. (2010). "Research hypotheses for gender activities in mobile internet", IWCMC'10, Caen, 28 June-2 July.
Williams, M. D., Rana, N. P., & Dwivedi, Y. K. (2015). The unified theory of acceptance and use of technology (UTAUT): a literature review. *Journal of Enterprise Information Management, 28*(3), 443–488.
Wong, K.-T., Teo, T., & Russo, S. (2012). Influence of gender and computer teaching efficacy on computer acceptance among Malaysian student teachers: An extended technology acceptance model. *Australasian Journal of Educational Technology, 28*(7), 1190–1207.
Wu, Y. L., Tao, Y. H., & Yang, P. C. (2007). Using UTAUT to explore the behavior of 3G mobile communication users. In M. Helander, M. Xie, M. Jaio, & K. C. Tan (Eds.), *International conference on industrial engineering and engineering management* (Vol. 1, pp. 199–203). Singapore: IEEE.
Wu, Y.-L., Tao, W.-H., & Yang, P.-C. (2008). The use of unified theory of acceptance and use of technology to confer the behavioural model of 3G mobile telecommunication users. *Journal of Statistics & Management Systems, 11*(5), 919–949.
Yurdugül, H. (2008). Minimum sample size for Cronbach's coefficient alpha: a Monte-Carlo study. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 35*(35), 397–405.
Zbick, J., Jansen, M., & Milrad, M. (2014). Towards a web-based framework to support end-user programming of mobile learning activities. In *2014 I.E. 14th International Conference on Advanced Learning Technologies (ICALT), pp. 204–208*. IEEE Press IEEE International Conference on Advanced Learning Technologies.
Zhang, J., Huang, J., & Chen, J. (2010). Empirical research on user acceptance of mobile searches. *Tsinghua Science & Technology, 15*(2), 235–245.
Zhou, T. (2008). Exploring mobile user acceptance based on UTAUT and contextual offering. International symposium on electronic commerce and security, pp. 241–245.