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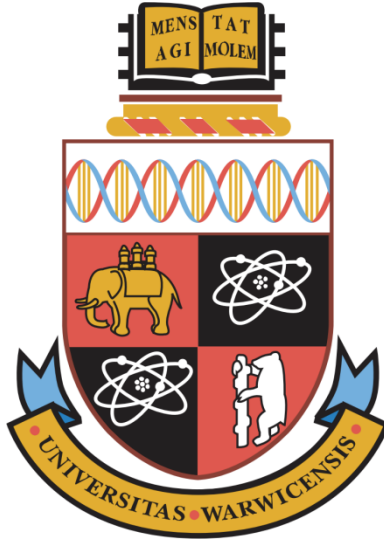
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**Adaptive social e-learning for Saudi Students:  
*virtual project and group formation  
recommendation acceptance***

By

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A thesis submitted in partial fulfilment of the requirements for  
the degree of  
Doctor of Philosophy in Computer Science

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THE UNIVERSITY OF  
**WARWICK**

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## **Declaration**

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. I hereby declare that, except where acknowledged, the work presented in this thesis has been composed by myself, and has not been submitted elsewhere for the purpose of obtaining an academic degree.

**Afaf Alamri**

Signature:     Afaf    Alamri    

Date:     09/10/2016

## Publications

1. Al-Alamri, A.S.,A.I. Cristea. Al-Zaidi, M.S (2014). Saudi Arabian Cultural Factors and Personalised E-Learning. In: International Conference on Education and New Learning Technologies (EDULEARN14), pp. 7114-7121. ISSN: 2340-1117, 7th-9th July, 2014, Barcelona, Spain.
2. Al-Alamri, A.S. and A.I. Cristea. Al-Zaidi, M.S (2014). The Acceptance of Social Personalised Versus Static Web-Based Education by Saudi Students. In: International Conference on Education and New Learning Technologies (EDULEARN14), pp. 3145-3153. ISSN: 2340-1117, 7th-9th July, 2014, Barcelona, Spain.
3. Al-Alamri, A.S. and A.I. Cristea. (2016). Designing a Collaborative Group project Recommender for an e-Learning System. in SAI Computing Conference 2016, to be held from 13-15 July 2016 in London, United Kingdom. (Accepted).
4. Al-Alamri, A.S. and A.I. Cristea. (2016). a three-way comparison: Social Personalised e-learning, versus Traditional e-learning and Classroom Learning. (To be submitted to the Journal of e-Learning and Knowledge Society).
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## **Abstract**

With the aid of information and communication technology, *e-learning* has become the latest model in education. Saudi Arabian universities are currently applying the idea of e-learning to facilitate life-long learning and provide new educational opportunities for students. In particular, e-learning is being strongly supported by the Saudi Ministry of Education. Therefore, the Jusur LMS was created, in order to manage the e-learning process. However, a 'one size fits all' approach, whilst not ideal in general, is especially not appropriate for the Saudi culture. Moreover, there is limited support for students to satisfy their individual needs, especially for implementing *collaborative projects*. To better understand the Saudi students' needs, this research focuses on the ***acceptance of the social personalised e-learning, versus static e-learning and traditional education for Saudi university students***, and how the former can cater to Saudi education, instead of offering an identical delivery to all students, regardless of students' interests, preferences, backgrounds, or knowledge. The results from a relatively large-scale case study at Taibah University point towards Saudi students accepting more easily social personalised e-learning, than static e-learning or classroom education. Additionally, the results revealed that Saudi students cannot be said to perceive usefulness, ease of use, and intention of further use towards the *traditional collaborative e-learning system* they use (the Jusur system) for *group project work*.

Furthermore, this study analyses the *current level of satisfaction and the needs for collaborative team projects, with the aim of predicting further requirements for social personalised e-learning systems*. It investigates the needs of the students for best ways for recommending the project, group members and communication tools for the group project, aiming at collecting the requirements for the implementation of the research environment. Additionally, it proposes *a framework for recommendation of collaborative project work to function within a social e-Learning System*. Additionally, it proposed the architecture of the system. It investigated ***Saudi Arabian higher education students' acceptance of a recommended virtual project and recommended group formation for e-learning versus traditional project- and team-formation methods for e-learning***. The comparison is based on the well-known technology acceptance model (TAM), the theoretical

framework which was used for designing the data collection from students. The results of the case study have indicated that a recommended virtual project and recommended group formation for e-learning is more acceptable to Saudi students than current e-learning methods.

**Keywords— Static e-learning, Social personalised e-learning, recommended project, group members recommendation, task recommendation, communication tools recommendation.**

# Abbreviations

<b>AEH</b>	Adaptive Educational Hypermedia
<b>AEHS</b>	Adaptive Educational Hypermedia System
<b>AH</b>	Adaptive Hypermedia
<b>AHAM</b>	Adaptive Hypermedia Application Model
<b>AHS</b>	Adaptive Hypermedia System
<b>ALEF</b>	Adaptive LEarning Framework
<b>AM</b>	Adaptation Model
<b>ARP</b>	Adaptation Rule Parser
<b>ATR</b>	Action TRacker
<b>BI</b>	Behavioural intention
<b>CM</b>	Communication tools Model
<b>CM</b>	Course model
<b>DM</b>	Domain Model
<b>EDM</b>	Educational Data Mining
<b>FAME</b>	a model-based Framework for Adaptive Multimodal Environments
<b>GM</b>	Group Model
<b>HCI</b>	human-computer interaction
<b>ICT</b>	Information and Communication Technology
<b>IDV</b>	Collectivism vs. individualism index
<b>IS</b>	information systems
<b>ITS</b>	Intelligent Tutoring Systems
<b>K.S</b>	Kolmogorov-Smirnov test
<b>LAOS</b>	Layered WWW AH Authoring Model and their corresponding Algebraic Operators
<b>LCMS</b>	Content Management System tool
<b>LM</b>	Learner Model
<b>MAS</b>	Femininity vs. masculinity index

<b>MOT</b>	My Online Teacher Adaptive Hypermedia Authoring System
<b>MOT2.0</b>	My Online Teacher 2.0 Social Web Adaptive Hypermedia Authoring and Delivery System
<b>NCeDL</b>	National Centre for e-learning and Distance Learning
<b>OLM</b>	Open Learner Model
<b>OSLM</b>	Open Social Learner Model
<b>PDI</b>	Power-distance index
<b>PHP</b>	Hypertext Preprocessor, an open source general-purpose scripting language that is especially suited for web development and can be embedded into HTML
<b>PM</b>	Project Model
<b>PM</b>	Presentation Model
<b>Q&amp;A</b>	Question and Answer
<b>RM</b>	The recommendation model
<b>RM</b>	Resource Model
<b>SDT</b>	Self-Determination Theory
<b>SLAOS</b>	Social LAOS: Social Layered WWW AH Authoring Model and their corresponding Algebraic Operators: A framework for authoring of Adaptive Hypermedia
<b>SN</b>	Social Networking
<b>SPADEL</b>	Social Personalised ADaptive E-Learning framework
<b>SUS</b>	System Usability Scale
<b>TAM</b>	Technology acceptance model
<b>TM</b>	Task Model
<b>TRA</b>	Theory of reasoned action
<b>UAI</b>	Uncertainty avoidance index

<b>UI</b>	User Interface
<b>UM</b>	User Model
<b>UM</b>	User Model
<b>UMAP</b>	Conference on User Modelling, Adaptation and Personalisation

# Chapter 1

## Introduction

### **1.1 E-learning, and e-learning in Saudi Arabia**

With the aid of information and communication technology, e-learning has become the latest model in education [1]. Many universities are currently applying the idea of e-learning to facilitate life-long learning and provide new educational opportunities for students. The key advantages of e-learning are; to make education available for as large groups of students as possible; the students can access course material whenever they want and from any location; it encourages learners to take responsibility for their education; it supports highly interactive discussions, and students can contribute in dedicated discussion forums; it allows students to collaborate and communicate with their instructors and classmates through e-mail at any time [2]. E-learning can expand access to higher education, to meet the education and training needs of the younger generation, as well as provide education to under-served populations. E-learning can also alleviate capacity constraints that have resulted from a surge in student numbers in Saudi Arabia. E-learning has the potential to improve and introduce change to the Saudi system of higher education, by augmenting traditional education or by supporting the establishment of part-time or distance education programs [3]. As such, e-learning has become a priority for higher education institutions in the country. Saudi universities are on their way to applying e-learning, in order to provide high-level educational programmes.

The Ministry of Higher Education has considered the requirements for applying e-learning systems, and the creation of online resources, because traditional means of education cannot compete with the complexities raised in a rapidly changing society, such as Saudi Arabia [3]. Accordingly, a national plan for the utilisation of Information and Communication Technology (ICT) was launched in 2005. The plan urges “the implementation of web-based Education and distance learning and all their



prospective applications in higher education” [4]. In order to fulfil this ideology, the National Centre for e-learning and Distance Learning (NCeDL) was established, to fulfil the following goals:

- to develop infrastructure for web-based education;
- to collaborate with higher education, government and corporate partners to solve complex e-learning problems;
- to provide complete e-learning solutions;
- to develop rules and regulations governing e-learning programs in Saudi Arabia; and
- and to establish awareness of e-learning programs [5].

Moreover, the NCeDL launched a group of projects that aim to effectively contribute in developing this kind of education and benefit from its enormous possibilities, in developing the shape and content of education. Examples of these projects include ‘Jusur’ [6].

## **1.2 Problems with e-learning and their reflection upon Saudi Arabia**

### **1.2.1 Lack of acceptance**

However, there are many stories of failure of e-learning projects. One of the main reasons is that the success of such systems depends heavily on end-users’ acceptance [7]. According to Davis (1989), the acceptance of a new technology by an end-user is based on two factors, as follows:

- Perceived Usefulness – refers to the degree to which a person believes that using a particular system would enhance his or her job performance;
- Perceived Ease of Use – refers to the degree to which a person believes that using a particular system would be free of effort.

These two beliefs both influence users’ attitudes towards using information systems, which influences actual acceptance. Moreover, many influencing factors should be considered, before adopting an e-learning system, to build a well-designed, easily accessible, interactive and effective system. Prior studies [8], [9], [10], [11] presented many factors that have an effect on an e-learning. Some of these

factors are linked to the system itself and others are linked to the culture [12], as it will be discussed in this research (Chapter 2). There is a global movement in institutions of higher education in various countries to implement successful e-learning, including Saudi Arabia. This has caused a new phase in the globalisation of education [13], [14]. The majority of education software companies localise their products to the local preferences of their target countries. The process of localisation adapts user interfaces to local languages, as well as, e.g., date and time formats [15]. This has caused problems for e-learning, in that its content is local, but the instructional model is international, without the model of education being adapted to fit the learning style or the culture [13].

***Aim 1:** To understand how the acceptance of Saudi students towards the various aspects of e-learning is essential, in order to improve them.*

### **1.2.2 Lack of personalisation**

According to Hofstede [16], national culture refers to “*the collective programming of the mind which distinguishes the members of one human group from another*”. He also stated that the cultural environment of an individual has an impact on the person’s thinking, feeling and working style. As culture affects the manner in which people interact in general, culture will also impact on the way in which people will interact with computers [17]. The communication between the system and the user is required to be interactive, in order to achieve tasks. However, e-learning is an activity greatly affected by cultural factors, such as the content and the presentation style of the teaching curriculum, or the education style of an individual, the relationship between student and teacher, collaborative learning, social presence and interaction [18].

Education in Saudi Arabia is strongly affected by Islamic religious and culture traditions, such as separation of the genders. Imitation of e-learning styles from overseas countries might thus not be

appropriate to Saudi students. E-learning localisation is the process of adapting a website, to make it accessible, usable, understandable, and culturally suitable for target audiences. E-learning can be designed for a particular culture, to serve the needs of a particular audience, or specifically for cross-cultural participation, to serve the needs of an international audience. The user's cultural perspective should be taken into account when designing e-learning, to be more attractive and to retain more users [19].

Nevertheless, a weakness of traditional e-learning is that it offers an identical delivery for all students [20]. The content of a page would look almost the same ('one-size-fits-all') regardless of students' characteristics. In recent years, it has become obvious that the 'one-size-fits-all' approaches are neither efficient nor effective for the different students. However, for most higher education establishments, students would have different backgrounds (e.g., come from different cultures), have different knowledge, interests, and preferences [21]. For example, an environment that is appropriate for some students (advanced students) may be inappropriate for other students (beginner students).

***Aim 2:** To understand how Saudi cultural issues that affect learning can simplify the design of more acceptable personalised e-learning systems targeted at Saudi Arabian society, and to design personalised e-learning, targeted at Saudi culture.*

### **1.2.3 Lack of adequate group and project collaboration support**

Collaborative tools can motivate students to creating active learning/project environments, with the collaboration and feedback from their peers [22]. Working in teams can encourage students to engage in focussed learning activities with other students. It increases the students' motivation students spend more time in studying and solving difficult problems, and communication in collaborative projects can lead to an increase in learning products [23]. However, although research on collaborative learning has generally revealed that student interaction can improve team performance and individual learning, these positive outcomes do not always occur [24]. There are *many problems with group*

*collaboration*, which ultimately impact on the effectiveness of collaborative learning or project work. The most critical problem is poor interaction, where some members may not contribute in a discussion at all, and others may contribute in a limited way; or members who are too active make it hard for others to participate [25]; or members whose contribution is unrelated to the topic, or work [26]. Efficient interaction is a vital factor in collaborative learning. If the students become apathetic, they tend to not participate in the required task [27]. Furthermore, the lack of clear personal responsibility is another problem that is limiting the advantages of group collaboration projects. Numerous related issues triggered by this are, for example, not meeting deadlines, not completing the given tasks, etc. [6]. The main reason for these problems is that collaborative systems do not offer the personalisation features required to meet to the student needs. In fact, some students struggle with communication tools and interpersonal skills or have poor knowledge related to the topic of the project, and this influences on the outcome of a project. For example, some students have little collaboration experience, thus they need a great deal of support. Students tend to have different interests, preferences, skill, experience, backgrounds or even knowledge. Therefore, allocating the topic of the project, the group formation, the tasks and communication tools utilised during a group collaboration project, should be considered as a personalisation process. The aim is then to allocate individuals to a project, to a group and to specific tasks. A well-defined task structure influences positively the efficiency, effectiveness, and satisfaction level of global virtual teams [28]. Individual responsibility and commitment towards the collaborative work are the vital factors for creating trust among group members [29].

Looking into what is needed to enhance project-based collaboration, most research about adaptive systems for collaborative learning support (ASCLS) systems has focused on the group formation process, which is determined systematically, based on the students' profiles, and the information sharing process in groups. However, there have been very few studies *about adaption for project task management*.

***Aim 3:*** *To address the gaps in prior research, and propose an approach for using a student-centred method in project-based e-learning; to support the student in decisions regarding **project definition**,*

*based on students' knowledge and skills, and **group membership**, based on student profile characteristics.*

### **1.3 Research Questions**

In order to achieve the aims resulting from the issues described above, research questions have been formalised, as follows.

The main umbrella research questions are the following.

**R1:** *Is Saudi students' acceptance of social personalised e-learning higher than their acceptance of the traditional e-learning and classroom learning?*

**R2:** *Do Saudi students demonstrate acceptance of traditional collaborative e-learning for group project work?*

**R3:** *Are personalised virtual project and team formation methods for e-learning more acceptable to Saudi students than traditional project and team formation methods?*

### **1.4 Research Objectives**

To achieve the above research questions, the following objectives are to be addressed.

**O1:** Review the fields of adaptive social e-learning, adaptive collaborative learning environments, and cultural and virtual project and team formation, to investigate their effect on the e-learning process, and more specifically, on the virtual project process (project formation process and project completion process) for e-learning.

**O2:** Explore Saudi students' acceptance of social personalised e-learning versus the traditional e-learning system and classroom learning.

**O3:** Explore Saudi students' acceptance of traditional collaborative e-learning for group project work.

**O4:** Explore the cultural characteristics of Saudi Arabian students using Hofstede's cultural value dimensions.

**O5:** Explore the needs of the students in relation to the recommended project group membership, the recommended task and the recommended communication tools for the group project, with the aim of determining what is necessary for implementation of the recommendation environment.

**O6:** Propose a framework for recommendation of collaborative projects within e-learning. Based on this framework, the architecture of the system to be implemented will be defined and implemented.

**O7:** Investigate Saudi Arabian higher education students' acceptance of a recommended virtual project and recommended group formation for e-learning versus traditional project- and team-formation methods for e-learning.

## **1.5 Thesis Outline**

Chapter One, the current chapter, defines the problem statement, explaining the situation of e-learning in Saudi Arabia. From this, the aims and research questions of the current thesis are derived, as well as the objectives necessary in carrying out this research.

Chapter Two presents the background literature and the related work. First, it presents an overview of traditional (classroom) education as well as traditional e-learning in higher education. Subsequently, it introduces the state of the art in adaptive educational hypermedia (AEH), presenting its advantages and limitations. More recent developments related to virtual teams and virtual communities for project-based learning in higher education are presented, as well as their advantages and limitations. From this, suggestions emerge about the questions and techniques that this research aims to address. Finally, it overviews several theoretical backgrounds used in the thesis, namely Hofstede's cultural dimensions theory, the technology acceptance model theory and the usability theory.

Chapter Three introduces the research methodology for this thesis. Moreover, it presents the structure of several of the experiments and details the data collection approaches and processes.

Chapter Four reports on experimental results, which aimed to explore Saudi students' acceptance of a social personalised e-learning, versus the traditional e-learning and classroom learning, and to further explore Saudi students' acceptance of the traditional collaborative e-learning for group project work.

Chapter Five presents a case study investigating the cultural characteristics of Saudi Arabian students, by using Hofstede's cultural value dimensions. Moreover, it reports on a case study investigating the needs of the students in relation to the recommended project group membership, the recommended task and the recommended communication tools for the group project, with the aim of determining what is necessary for implementation in the recommendation environment. Additionally, the Chapter describes the design, a framework for recommendation of collaborative projects for e-learning, the architecture of the Topolor 3 system and the system implementation.

Chapter Six reports on further case studies, as follows. It presents a case study investigating the usability of collaborative recommender systems for online group projects. It introduces a case study evaluating the design features of a collaborative recommender system for online group projects using cultural dimensions. It presents a case study evaluating the acceptance of a collaborative recommender system for online group projects versus traditional project- and team-formation methods for e-learning for Saudi Arabian higher education students.

Finally, Chapter Seven concludes this thesis through a review of the overall research achievements, and its contributions. It also highlights research limitations and proposes future work that could be undertaken in this area.

## **1.6 Conclusion**

This chapter has introduced the research in this thesis, by giving a brief account of e-learning in general, and in Saudi Arabia in particular. The chapter has also introduced the problems encountered with e-learning in general, and in Saudi Arabia, in particular, as well as the aims, research questions and objectives towards carrying out this research. The chapter has finally presented the overall structure of this thesis.

# Chapter 2

## Background and Related Work

### 2.1 Introduction

The main purpose of the work presented in this chapter is to address the study objective **O1**: *‘Review the fields of adaptive social e-learning, adaptive collaborative learning environments, and cultural and virtual project and team formation, to investigate their effect on the e-learning process, and more specifically, on the virtual project process (project formation process and project completion process) for e-learning’*, which provides the theoretical foundation of the thesis.

The remainder of the chapter is organised as follows. First, Section 2.2 presents an overview of traditional education and traditional e-learning in higher education. Second, Section 2.3 reviews the related work in adaptive educational hypermedia (AEH). Third, section 2.4 presents the more recent developments related to virtual teams and virtual communities for project-based learning in higher Education. Section 2.5 introduces an overview of e-learning in Saudi Arabia, and of Jusur. Finally, section 2.6 presents an overview of several theoretical backgrounds, namely Hofstede’s cultural dimensions theory, the technology acceptance model and usability theory.

### 2.2. Traditional Education and E-learning in Higher Education

#### 2.2.1 Traditional Classroom Education in Higher Education

Traditional education takes place in a university environment with classrooms of multiple students learning together with a trained, certified teacher of the subject. The method of education (especially, how learners interact with teachers) in these academies can be considered to contain three aspects: *didactic*, the tutor talks and the learners take notes (e.g., lectures); *discursive*, the tutor starts a



conversation and the learners join in (e.g., tutorials); and *exploratory*, the tutor allocates a task and the learners research it (e.g., experiments) [21].

Traditional classroom education is still the main form of education encountered in higher education in universities worldwide, in general, and in Saudi Arabia, in particular. For this reason, any new educational approach needs to be evaluated against this traditional type of classroom education first whether it is deemed to serve as its replacement or as an extension to it. Hence, in this thesis, traditional classroom education is compared to other proposed approaches, as in Chapters 4.

### 2.2.2 E-learning in Higher Education

At the end of the last century, there was a considerable increase of student numbers in universities[30]. For example, Saudi Arabia has experienced a great growth over the last years in higher education. The number of student registrations in Saudi higher education institutions has doubled since 1999, as shown in Table 1 [31].

**Table 1: Students enrolled in Saudi universities Adapted from [31].**

Year	Total
2000	404,094
2005	603,767
2009	757,770
2010	903,567
2011	943,275
2012	1,116,230

The use of information technology is commonly seen as a possible solution to support this exponential growth [30]. Education can be delivered by e-learning [32], and Advantages of this approach include that any student can access a lesson by traditional e-learning anywhere and anytime

[28]. Traditional e-learning refers to ‘the various uses of technology for learning, teaching, training, and wider knowledge management’ [33]. Traditional e-learning can be delivered via an electronic medium, such as the Internet, intranets, extranets, satellite transmission, audio/video tape, and CD-ROM [34]. Tavangarian et al. [35] stated that e-learning includes:

*“All forms of electronic supported learning and teaching which are procedural in character and aim to effect the construction of knowledge with reference to the individual experience, practice and knowledge of the learner. Information and communication systems, whether networked or not, serve as specific media (specifically in the sense elaborated previously) to implement the learning process”* [35].

In some implementations, e-learning can facilitate communication opportunities with other students around the world without limits, crossing national, regional, or time boundaries [30]. They can share ideas to increase experience and skills with a variety of students. Examples of popular traditional e-learning systems are a learning management system (LMS) and a learning content management System. There is difference between an LMS and an LCMS. An LMS targets students whereas an LCMS targets to education content authors. The main role of an LMS is to simplify the procedure of administrating education[36]. An LMS is not used to author course content[32]. In such a system, the instructors can manage their courses and manage contact with students. In addition, LMSs permit students to use and download course material, submit their homework assignments electronically, and communicate with other students [37]. In contrast to LMSs, LCMS helps authors (lecturers) to create and manage learning content, that is, the media, pages, quizzes, and lessons [32]. It allows designers to author and reuse e-learning content. Examples of popular LMSs are Blackboard [38] and Moodle [39].

Moodle [39] stands for ‘Modular Object-Oriented Dynamic Learning Environment’, and it is an open-source LMS. Moodle facilitates course management using the following modules: assignment module, chat module, choice module, forum module, glossary module, lesson module, quiz module, resource, survey module, wiki module, and workshop module.

Blackboard [38] is a commercial LMS that was developed by Blackboard Inc. Blackboard's features include course management, a customisable portfolio, and a scalable architecture that facilitates integration with student information systems and authentication protocols. Blackboard also includes communication announcements, discussions, mail, course content, calendars, learning modules, assignments, grade books, and a media library.

In Saudi Arabia in particular, Jusur (see section 2.5) is one of the most used LMS systems. Based on the fact that Jusur is so popular in Saudi Arabia, which is the focus of this study, as well as on the fact that the learning approach taken in this thesis is based on e-learning, any new implementations or suggestions need to be able to compare against this baseline. This is the approach applied in Chapter 4 section 4.4.

Traditional e-learning has, beside its many advantages, also some disadvantages. One of the latter is that it offers an identical delivery for all students [20]. The content of a page would look almost the same ('one-size-fits-all') regardless of students' characteristics. However, for most higher education establishments, students would have different backgrounds (e.g., come from different cultures), have different knowledge, interests, and preferences [21]. For example, a course that is suitable for advanced students may not be fit for beginner students. Therefore, Adaptive Educational Hypermedia systems attempt to address the problems encountered with traditional (static) e-learning systems, by providing tailored learning for each individual student [20].

### **2.3. Adaptive Educational Hypermedia**

As a direction of research, adaptive hypermedia (AH) began in the early 1990s, from research on both hypermedia and user modelling [40]. The aim of AH is to cater to the needs of the user, both to their indicated desires, as well as to their less obvious needs [41]. Whereas traditional approaches offer the same information (grouped, on the web, in pages) to all users, AH adjusts the presentation and direction of the hypertext and hypermedia to an individual user, by employing user modelling. It stores the user's characteristics (goal, preferences, or knowledge) and presents pages adapted for each user [42]. According to Brusilovsky, AH is defined as follows:

*“By adaptive hypermedia systems we mean all hypertext and hypermedia systems which reflect some features of the user in the user model and apply this model to adapt various visible aspects of the system to the user. In other words, the system should satisfy three criteria: it should be a hypertext or hypermedia system, it should have a user model, and it should be able to adapt the hypermedia using this model” [42].*

In general, adaptive hypermedia systems can be *adaptive* or *adaptable*. The aim of *adaptive systems* is to adapt automatically, without the requirement for the user’s implicit input (by observing their interactions with the system), whereas *adaptable systems* adapt to users through explicit user input (for example, by asking them to fill out a questionnaire to specify exactly how the system should be altered) [43].

Moreover, in AH research, the adaptation techniques are classified into two types of adaptation: *adaptive navigation* and *adaptive presentation* [44].

*Adaptive navigation support* is one of the most studied areas of adaptive hypermedia [45] [46] [47], and involves adaptation of links, such as direct guidance, restricting access, sorting links, removing, disabling or hiding links, annotation, and map adaptation. *Adaptive presentation* describes the adaptation of the content. There are different types of adaptive presentations, such as 1) adaptive sorting, which reorders the text of a lesson, as required for each specific user, 2) adaptive altering, which may involve altering the text of each chunk of information, 3) stretch-text, where, for example, if more information was available for advanced students, it could be delivered by ‘stretching’ a keyword or phrase, 4) Adaptive Insertion & Removal, information can be inserted and/or removed to adapt the overall content of the lesson and 5) dimming fragments, which is where fragments of text that are not appropriate could be dimmed, rather than removed.

E-learning is the most frequent application area for the AH research field. The aim of adaptive e-learning is to cater to the needs of each student, such as their knowledge level, stereotypes, cognition, learning styles, preferences, and learning goals. Adaptive e-learning merges AH systems (AHSs) and intelligent tutoring systems (ITSs) [48], and forms the field of adaptive educational hypermedia

(AEH). The adaptive personalised education systems attempt to address the difficulties with static 'one-size-fits-all' e-learning systems [49]. The adaptive personalised e-learning system is:

*“An online system that will measure your personal behaviours and preferences, store them and use these to alter the nature of the education given to you. The aim is to deliver a personalised and unique education to you and in so doing give you the best education you can receive [21].”*

There are various research studies on adaptive learning systems that have been developed. Examples of such systems include ISIS-Tutor [50], InterBook [42], KBS Hyperbook [51], Task-based Adaptive learner Guidance On Web (TANGOW) [52], (ADE) [53], My Online Teacher (MOT) [54] , KnowledgeZoom (KZ) [55] QuizGuide [46] and the Ontology-based learning content management system [56]. In the following, some of the characteristics of these pioneering, as well as some more recent adaptive educational hypermedia systems, are described.

The ISIS-Tutor was one of the first AEH systems, and has been introduced by Brusilovsky and Pesin [50]. It was designed by combining the capabilities of intelligent tutoring, hypermedia, and education environment systems. It was created by combining the mutually complementary methods of directed guidance (from intelligent tutoring systems) and exploratory learning (from educational hypermedia systems) together into one system. A domain model and user model (of both learner and tutor) are used in the system structure, to allow the adaptive functionality of the ISIS-Tutor.

The Task-based Adaptive learner Guidance On-Web (TANGOW) [52] was designed to offer a variety of course views, based on a series of teacher-outlined parameters (adaptation rules). These parameters influence the demonstration of the system's 'tasks', which are usually viewed as webpages. TANGOW includes learner profiles, behaviours, and teaching strategies. Course sequencing is generated dynamically thus, the course is taught to students in different ways, based on the students' profiles and their activities while interacting with the system.

The adaptive display environment (ADE) [53] is another example of a complete adaptation delivery engine, implementing the full Brusilovsky taxonomy[41], which delivers AEH. ADE is a modular

system, which supports several forms of content formats and adaptation languages. It was also created based on the LAOS framework [57] for AHSs, which implements a division between the content and adaptation specifications.

The problem with most of the adaptive and personalised learning systems is that authoring adaptive curricula in e-learning is more complex than non-adaptive e-learning, demanding more time, effort, and expertise [54]. Therefore, the MOT system [57] [58] attempted to cater to the requirement for an adaptive and flexible approach to education. It is designed to facilitate personalised learning support for an individual learner. The MOT system was built based on the Layered WWW AH Authoring Model and their corresponding Algebraic Operators (LAOS) framework for authoring [59] [60] [61] and layer adaptation model LAG frameworks [62]. The MOT system implements the LAOS framework: it has a domain model, the goal, and a constraints model. The domain model is in the shape of a conceptual hierarchical layer, and the goal and constraints models are in the structure of a lesson layer, dealing with other presentations of content at an attribute level. The LAG framework has a three-layer model for authoring adaptations, which are direct adaptation techniques and rules, an adaptation language and adaptation strategies. Adaptation strategies and the adaptation language can be reused by saving the adaptation strategies. The adaptation strategy goal is to reflect repeated designing in AH authoring, so that the authors save the recurring call to use adaptation techniques. The authors are given the freedom to create their own of choice courseware, depending on their preferences and experience. They can design dynamic elements (i.e., personalisation, adaptation, and behaviour desires) or static component courseware (i.e., learning resources) or both. Brusilovsky [55] presents KnowledgeZoom (KZ) that implements a fine-grained user model centred on concepts hierarchically organised as an Ontology for Java programming. KZ permits the student to have an overall view and a detailed view of their progress and knowledge gaps, just a few clicks away. QuizGuide [46] is an adaptive system that guides students to the right learning material and aids them in choosing the most related quizzes for self-assessment of their topic knowledge. Quizzes are allocated to topics and adaptively marked, with respect to which topics are now important and which need for further work. An ontology-based learning content management system [56] was created, to

provide the personal collections of learning resources for students. The ontologies for the electronic learner's profile, learning course domain, learning resources, and personal collections are elaborated, to manage the learning process.

However, another limitation of most adaptive or personalised learning systems is that they lack support for social and collaborative learning activities. As social presence is becoming an increasingly important factor in e-learning [37], the social adaptive learning field emerged, further discussed below, and is also of more direct relevance to this thesis.

#### **2.4. Virtual Teams and Virtual Communities for Project-Based Learning in Higher Education**

With the aid of Web 2.0, social e-learning has been applied to support collaborative learning environments. Web 2.0 tools (e.g., message, chat, and sharing resources) can motivate students to create active learning/project environments, with the collaboration and feedback from their peers [22].

However, some earlier empirical research, including [29] [63] [64] [65] have revealed that there are many factors affecting group collaboration, which influence the effectiveness of the collaborative learning or project work. For example, Edwards [28] conducted an exploratory research study, involving 24 virtual groups. The study indicates that *ease of use* of technology, *trust* between the groups, and a *well-defined task structure* positively influence the efficiency, effectiveness, and satisfaction level of global virtual groups. The vital factors for creating trust with group members were group organisation, familiarity with group members, individual responsibility, and commitment towards quality work [66]. Additionally, Napier [63] looked at factors that might affect group work satisfaction in a group database project in an undergraduate information systems (IS) course, using a blend of qualitative and quantitative methods. He found that the highest three factors leading to students' dissatisfaction were: lack of participation in group meetings, insufficient technical skills to accomplish the assigned task, and poor communication among group members. Furthermore, Dubé and Robey [64] investigated the challenges in virtual group work. They conducted interviews with 42 people in virtual groups in 26 organisations in Quebec, Canada. They identified some challenges with virtual group work: 1) virtual groups require physical presence, 2) the flexibility of virtual group work

is aided by structure, 3) interdependent work in virtual groups is accomplished by members' independent contributions, and (4) task-oriented virtual group work succeeds through social interactions. Moreover, they identified strategies that respondents used to manage the challenges of virtual group work, such as using information and communication technology (ICT) to define clear aims and make detailed plans, maintain a shared group calendar, attain all members' input, and develop relationships. Moreover, Beise et al. [65] investigated a case study on the communication processes engaged in by virtual project groups. Their study suggested that virtual group projects require not only structured virtual groups, but also links to the technology, to achieve tasks.

Currently, common virtual teams and virtual communities in higher education use LMSs (e.g., Blackboard [38], Moodle [39], and LAMS [67]), which deliver courses with features for online collaboration. Learners can study an online course and contribute in activities (e.g., noticeboards, announcements, sharing resources, chats, forums, wikis, choices, questions and answers, and submitting files) organised for the course.

However, several researchers have moved towards social adaptive learning, to cover the social aspects of online interaction within adaptive learning, with systems such as MOT 2.0 [68], Whurle 2.0 [69], Topolor [70], Progressor [71], INSPIREus system [72] and Mastery Grids [73]. In the following, the characteristics of some of these social adaptive e-learning systems are described.

MOT 2.0 [68], a pioneering system in social adaptive e-learning, has been created based on the theoretical underpinning of MOT 1.0 [74], with the distinct aim to create the best balance between Web 2.0, content personalisation, and adaptive peer recommendations. It has created a new direction for adaptive e-learning, by merging Web 2.0 characteristics (such as tags, rating systems, feedback, etc.) with adaptive e-learning. This method was deemed very useful for students [68], because it allows them to interact with each other in various ways and allows opening to other Web 2.0 systems. Additionally, from a research point of view, the papers of MOT 2.0 offer various important methods for an overall research approach on forming new methods of education and teaching, via employing the synergetic merger of different fields, such as 1) Web 2.0, 2) e-learning, 3) social annotation



(student can rate, comment, and tag content), 4) collaborative authoring (the content can be edited by other students, describing content by commenting on the content, editing, tags, adaptation authoring for collaboration - supporting author activities, such as subscribing to other authors, identifying author groups, etc.) and 5) adaptive rights (where students are allowed to contribute to the content authoring process with various rights, which can be determined by their knowledge level). Results shows that combining recommendations of peers with content adaptation effectively enhances the educational outcome in an e-learning system in terms of attractiveness and time spent learning [68].

In one of the more recent research studies, the Topolor system [70] was introduced, which is a social personalised e-learning system. It was created by combining the capabilities of adaptation based on user modelling, social interaction, gamification, and open-learner modelling for e-learning methods and technologies (Table 2). Topolor's creation is based on the hypothesis that 'extensive social features, personalised recommendations and Facebook-like appearance of a system, anticipated to make the environment more familiar to students, will subsequently increase the usefulness and usability of the system'. The first version of Topolor was developed in November 2012. Then, the second version of Topolor was developed, by applying contextual gamification strategies and multifaceted open social learner model (OSLM) features, with the aim of raising students' intrinsic motivation and, by means of this construct, providing an effective self-determined student experience. Gamification is 'the use of gameplay mechanics for non-game applications'. Visualisation is designed with a Facebook-like look&feel and based on features extracted from common games, rather than on classical educational environment visualisations. Contextual gamification strategies have been revealed to be able to confirm that students using the system adopt the required educational behaviours and achieve pre-specified educational aims, supported by a great level of motivation. A multifaceted OSLM [75] was offered to permit visualising both students' contributions and their performance within a learning community. It supports several types of comparisons and is adapted and linked to educational content. Multifaceted open social learner modelling can provide a high level of usefulness, satisfaction, and efficiency among students [75]. Social personalised e-learning (as represented by Topolor) is one of the basic research areas supporting the research in this thesis.

As said, Topolor is a relatively newly introduced system. However, it is one of the best systems to illustrate the combination of personalisation and social interaction, and it has received several awards at different conferences, including best demonstration award (five awards have been received for this research, including Best Student Paper Award from ICWL'14 [75], Best Demo Award from UMAP'14 [76], Best Poster Award from ICALT'13[77], Best Paper Award from IADIS-EL'13 [70], and Best Extended Abstract Award from YDS'13 [78]). It is a system that has also been widely deployed (in the UK, Bosnia-Herzegovina, the US, Jordan, Brazil, etc.). It is a system that is generating new research, with its most recent paper accepted for ITS'16 [79]. These are reasons why Topolor was used as a basis for the developments in the research presented in this thesis, as the aim was to work with a relatively established system. Moreover, there is no current commercial system that can offer such a combination of features. Finally, Topolor is an open-source system, and allows for further development, which was the ultimate intention with this research.

**Table 2: Overview of the Topolor 1 and Topolor 2 Systems.**

Course Tool	Description	Topolor 1	Topolor 2
Take tests	Take tests after learning a topic.	✓	✓
Learning progress	View learning progress percentage.	✓	✓
Learning path	Choose to view the whole or partial learning path.	✓	✓
Create groups	Create groups that are registered for the same topic.  Create groups that share common learning interests.	✓	✓
Discuss	Discuss the current learning	✓	✓

	topic with other students.		
Ask/answer	Ask and answer questions of other students.	✓	✓
Feedback	Use feedback and questions forum at the end of each lesson.	✓	✓
Share materials	Share and/or recommend learning materials.	✓	✓
Communication tools	Use communication tools to chat and leave messages.	✓	✓
Comments	Write comments/notions wherever and whenever wanted.	✓	✓
View history	View history discussion when selecting a particular topic.	✓	✓
Recommend topics	Recommend other topics according to current learning topic. Recommend topics according to student's knowledge level.	✓	✓
Adapt learning path	Adapt learning path according to learning progress.	✓	✓
Recommend students	Recommend other students according to the current	✓	✓

	topic. Recommend other groups according to student's interests.		
Upload files	Use multiple types of files (e.g., PDFs, photos, videos, slides).	x	✓
View learning progress	View learning progress percentage.	x	✓
Contribute to learning	Contribute to learning content by creating and uploading files.	x	✓
Recommend topics	Recommend topics by referring to other students' ratings.	x	✓
Adapt learning tools	Adapt learning tools according to student's user level.	x	✓
Adapt social interaction	Adapt social interaction tools according to student's user level.	x	✓
System status	View system status.	x	✓
Using graphical	Use graphical user interfaces.	x	✓
Tips	Get instructions and tips.	x	✓

More recent systems exist, although they were not directly available for the research in this thesis at its start. For instance, Hsiao, et al. have introduced the Progressor system [71] that offers data about how other students (peers) have used and progressed through the learning resources, and therefore, it supports reflection on the user's own work and progress.

The INSPIREus system [72] was proposed for creating interpretative views of the learners' interaction behaviour. It is supporting students, teachers, and peers to view students' behaviour and an indication of reference, such as the instructor's proposal, or peers' behaviour, in order to allow monitoring. It can be applied in any adaptive and/or hypermedia e-learning system that has data with semantic information.

From the point of view of interest for this thesis, personalised projects, the following is noticed. Although most LMSs (e.g. Blackboard [38], Moodle [39], and LAMS [67]) offer a variety of supporting functionalities for virtual communities (online collaborative e-learning), they are not created to support personalised project teams or customised for individual students, and the methods adopted for constructing group projects are not tailored to individual students' characteristics. As students are usually assigned to groups manually by teachers, or students, or randomly by systems, students could have different backgrounds (cultures), knowledge interests, and preferences.

Furthermore, most of the social adaptive learning systems (e.g. MOT 2.0 [68], Whurle 2.0 [69], Topolor [70], Progressor [71] and Mastery Grids [73]) offer supporting functionalities for virtual communities, which are significantly different from virtual teams. Honglei clarified the differences between virtual communities and virtual teams as:

*“Virtual teams are formed to solve specific problems or tasks, organised by specific organisations and teams usually dissolve after the task is finished or the problem is solved. In contrast, virtual communities focus on relationship development in real life, where people do not have definite reasons to remain in them; virtual communities are spontaneously shaped by people with similar interests and can exist for a very long time, as long as people with similar interests do not disperse” [80].*

Thus, a collaborative learning environment does not easily imply the use of technology for interactive aims. The effective collaborative learning system's goal is to reach efficient group monitoring and more support, by capturing and modelling the information and knowledge of group activities [81]. Recently, research efforts have focused on adaptive collaborative learning environments that tailor to individual students' characteristics, to address some particular limitations in non-adaptive collaborative e-learning systems. These systems can achieve collaborative aims that are hard to achieve using non-adaptive collaborative learning environments.

Brusilovsky [82], in his review on adaptation technologies, also mentioned technologies for adaptive group formation and peer help and technologies for adaptive collaboration support. Technologies for adaptive group formation and peer help:

*“Attempt to use knowledge about collaborating peers (most often represented in their student models) to form a matching group for different kinds of collaborative tasks”.*

Technologies for adaptive collaboration support:

*“attempt to provide an interactive support of a collaboration process just like interactive problem support systems assist an individual student in solving a problem. Using some knowledge about good and bad collaboration patterns (provided by the system authors or mined from communication logs)”.*

Several techniques were used for *group formation*. Spoelstra et al. [83] presented a group formation process model to determine a fitness value for a group of learners for a particular project. The model determined three types of variables that manage the *group formation* process: knowledge, personality, and preferences. One major approach in group formation is to form groups based on students' learning styles. For example, in [84], [85], the Felder-Silverman learning style model (FSLSM) [86] and its index of learning styles (ILSs) questionnaire are applied, in order to group students based on their preferences, as represented on the four dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global). Another example, in [87], also used one dimension (active/reflective) of the FSLSM in the iGLS system to form groups. They found that learning styles influence the performance of the learners, when working together. Other researchers have proposed

*forming groups* based on a predefined ontology, based on information on an individual user. More specifically, ontologies could incorporate several features of a user's profile, like preferences, learning domain knowledge level, learning style, and stereotypes. For example, Ounnas et al. [88] proposed applying semantics to permit teachers to form different types of groups, by differentiating between semantic student profiles.

Other researchers investigated how to best group students, considering communication by observing user behaviour, in order to offer to students feedback or recommendations, if they do not contribute or do not participate enough, encouraging them to increase their level of participation and contribution [89, 90].

However, there have been few investigations about adaptation within project management. Sun and Shen [90] introduced a group work-as-a-service (TaaS) system that allocates students to specific tasks, based on learning styles and preferences, using two heuristic algorithms: a genetic algorithm and a simulated annealing method. Another example, ACS system [91] was introduced to support students when doing a team project by supporting adaptive recommendations with respect to communication and managing the project. Students are assigned to tasks manually by teachers or by themselves. ACS is created to be attached to an LMS.

As can be seen from the above discussions, these research studies have been applied successfully in limited areas. The majority of the existing social e-learning systems offer supporting functionalities for virtual communities, which are significantly different from virtual teams. Most research about the adaptive systems for collaborative learning support (AICLS) focused on the *group formation process*, which is determined systematically based on the students' profiles, and the information sharing process in groups. These methods force a student to join the recommended group and cannot be used to give students support on how to participate, which may eventually be more effective. Additionally, the algorithmic methods are complex for non-experts, and thus the link between cause and effect might be obstructed or impossible to extract and reuse diminished. Moreover, a pre-defined ontology about several traits of user profiles requires experts' effort on building the ontology and students'

efforts on clearly expressing their descriptions of interests. These systems do not automatically use characteristics of learning and collaborative behaviour in an existing e-learning system to support students in decisions about project selection, group formation, etc. Instead, they use independent tools for supporting group formation environments. Furthermore, the adaptive systems for AICLS have only marginally explored the integration of project management features and adaptation techniques.

In the business context, there are various successful digital tools for helping in project management such as, Asana [92], Trac Project [93], and Basecamp [94]. They allow persons working together to discuss and organise everything needed to get a project done. It is believed that project management tools would be useful for virtual team projects in e-learning, which require organising activities and planning and resources to deliver a successful outcome.

In this thesis, an alternatively way is introduced, the *Topolor 3 approach* for *providing adaptive recommendations to support students' decisions about project selection, based on students' knowledge and skills; group membership, based on student's profile characteristics; project tasks, based on students' personality; and communication tools*. The users' characteristics are collected automatically from social networks and from a social adaptive e-learning system, which allows for frequent updates and includes collaborative aspects. The aim of these recommendations is to offer performance monitoring and dynamic support to the user, to increase the acceptance of the virtual team project.

## **2.5. Overview of e-learning in Saudi Arabia Jusur**

Most of universities in Saudi Arabia use the Jusur e-learning system. Jusur in Arabic means *bridges*. It is an LMS designed by the National Centre for e-learning and Distance Learning (NCEDL), in order to manage the e-learning process in Saudi Arabia. Using the Jusur system, users can log in and access courses. As the student completes the course, scores are tabulated and reports generated. Likewise, instructors and administrators can access reports on the LMS and track the students' progress.



The Jusur LMS has been developed according to universal standards, and has 16 tools; namely, the *Courseware Controls* tool, the *Course Description* tool, the *Announcements* tool, the *Learning Content Management System* tool (LCMS), the *Glossary* tool, the *Forum* tool, the *General Chat* tool, the *File Sharing* tool, the *Assignments* tool, the *Tests and Assessment* tool, the *Lecturer Information* tool, the *User Administration* tool, the *Survey Manager* tool and *Grades and reports*, as shown in Table 3 [5]. Jusur also has a Learning Content Management System, which is a system that can access learning objects from a repository and can enable contact with subject matter experts. This, with a little technological expertise, allows universities to design, create, deliver, and measure the results of their e-learning courses rapidly (NCEDL, 2015). In fact, e-learning offers flexibility, especially for Saudi woman students. It allows for increased interaction between female students and male lecturers, whereas face-to-face communication is not allowed. Moreover, as female students are not allowed to stay in the university after 4 pm, e-learning can aid them to interact with the most relevant peers anytime. Students can use collaborative tools (e.g., message, chat, sharing resource) within the virtual community. However, Jusur system is not created to offer personalised learning that helps an individual student. Moreover, it is not supporting virtual project team formation, or other aspects of project work. This thesis proposes that students and lecturers need access to advanced web-based education, to encourage and allow them to take control of their learning as well as lecturers to discover new styles of teaching, respectively.

**Table 3: Overview of Jusur LMS Tools**

<b>Course Tool</b>	<b>Description</b>
<i>Courseware Controls</i>	A menu of tools that can be displayed or hidden in the course.
<i>Course Description</i>	Course synopsis.
<i>Announcements</i>	Course information/updates.
<i>LCMS</i>	Manages course content, by adding course files (text, audio, interactive) and adding SCO and organizing this content to make

	an integrated course.
<i>Glossary</i>	This Glossary tool is edited daily, with a recently downloaded term or notes made by the lecturer. Students can also send terms not included in the database. Terms are linked to course materials, and discussion groups on the Internet.
<i>Forum</i>	A Course forum tool to discuss subjects initiated by the lecturers, to receive students' comments, and to discuss topics raised by the students for their common benefit.
<i>General Chat</i>	A chat room for live conversation; the system saves and archives this activity.
<i>File Sharing</i>	A tool to store and share files amongst the lecturers and students registered in the relevant course.
<i>Assignments</i>	A tool to enable students to enquire about assignments and deliver the accomplished ones to the lecturer. The lecturer can download and send assignments to all or some students, or to a particular student. Students can download and send finished assignment via the Internet, or on paper, or by both methods, as defined by their college. Lecturers can readily trace students who fail to deliver assignments. Lecturers can download all students' assignments, by pressing a single button, whereupon the system unzips the assignments' compressed files.
<i>Tests and Assessment</i>	To conduct short tests and exercises across the Internet, and through which the student can directly obtain results, remarks, and suggestions.

<i>Grades and reports</i>	Records students' grades.
<i>Students Data</i>	A list of students registered in a course, and their personal information, email address etc, for lecturers to access for communication purposes.
<i>Lecturer Data</i>	A list of lecturers teaching a course, and their personal information, email address, etc., for students to access for communication purposes.
<i>Survey Manager</i>	For course surveys.

## 2.6. Theoretical Background

### 2.6.1 Hofstede's cultural dimensions theory

Earlier studies presented cultural factors that have an effect on an e-learning environment [18] [19] [95], and e-learning styles from overseas countries might not be appropriate for other countries [13]. For example, education in Saudi Arabia is strongly affected by Islamic religious and cultural traditions, such as the separation of genders. Therefore, the user's cultural perspective should be considered in e-learning, in order to be more attractive and to retain more users [3]. There is a great deal of research related to culture [16, 95, 96]. A well-known model is that of Hofstede [16], who proposed a model defining the patterns of thinking, feeling, and acting that form a culture's mental programming. There are reasons why this model has been selected, to be further applied to the research in this thesis. Firstly, it has a strong foundation in exploring culture at the national level. It also has the highest related research and outcomes, and thus will be the most valuable in any long-term investigation applications [21]. Subsequent research [12, 19, 21] has confirmed that Hofstede's theory has the power to gain a suitable understanding of a culture in a particular country of the world. It provides an obvious idea of the specific culture that will be studied.

Hofstede [16] introduced a useful classification system to understand the influence of the national culture on people's behaviour. This entailed four dimensions: *power distance*, *individualism versus*

*collectivism, masculinity versus femininity, and uncertainty avoidance.* These have been used extensively in the research presented in this thesis, and are thus described below briefly (the dimensions definitions presented below are from Hofstede's website [97]).

### **Power-distance index (PDI)**

*“This dimension expresses the degree to which the less powerful members of a society accept and expect that power is distributed unequally. The fundamental issue here is how a society handles inequalities among people. People in societies exhibiting a large degree of Power Distance accept a hierarchical order in which everybody has a place and which needs no further justification. In societies with low Power Distance, people strive to equalise the distribution of power and demand justification for inequalities of power.”*

### **Collectivism vs. individualism index (IDV)**

*“Individualism on the one side versus its opposite, collectivism, that is the degree to which individuals are integrated into groups. On the individualist side we find societies in which the ties between individuals are loose: everyone is expected to look after him/herself and his/her immediate family. On the collectivist side, we find societies in which people from birth onwards are integrated into strong, cohesive in-groups, often extended families (with uncles, aunts and grandparents) which continue protecting them in exchange for unquestioning loyalty. The word ‘collectivism’ in this sense has no political meaning: it refers to the group, not to the state. Again, the issue addressed by this dimension is an extremely fundamental one, regarding all societies in the world.”*

### **Femininity vs. masculinity index (MAS)**

*“Masculinity versus its opposite, femininity refers to the distribution of roles between the genders which is another fundamental issue for any society to which a range of solutions are found. The IBM studies revealed that (a) women's values differ less among societies than men's values; (b) men's values from one country to another contain a dimension from very assertive and competitive and maximally different from women's values on the one side, to modest and caring and similar to women's values on the other. The assertive pole has been called ‘masculine’ and the modest, caring*

*pole 'feminine'. The women in feminine countries have the same modest, caring values as the men; in the masculine countries they are somewhat assertive and competitive, but not as much as the men, so that these countries show a gap between men's values and women's values."*

### **Uncertainty avoidance index (UAI)**

*"Uncertainty Avoidance Index deals with a society's tolerance for uncertainty and ambiguity; it ultimately refers to man's search for Truth. It indicates to what extent a culture programs its members to feel either uncomfortable or comfortable in unstructured situations. Unstructured situations are novel, unknown, surprising, different from usual. Uncertainty avoiding cultures try to minimise the possibility of such situations by strict laws and rules, safety and security measures, and on the philosophical and religious level by a belief in absolute Truth; 'there can only be one Truth and we have it'. People in uncertainty avoiding countries are also more emotional, and motivated by inner nervous energy. The opposite type, uncertainty accepting cultures, are more tolerant of opinions different from what they are used to; they try to have as few rules as possible, and on the philosophical and religious level they are relativist and allow many currents to flow side by side. People within these cultures are more phlegmatic and contemplative, and not expected by their environment to express emotions."*

These dimensions were initially considered by Hofstede following the outcomes of an attitude investigation administered to IBM employees in 71 different countries, including some Arabic countries (Egypt, Iraq, Kuwait, Libya, the UAE, and Lebanon), and he generalised the outcomes achieved for all Arab countries, including Saudi Arabia. These were rated for each dimension, usually on a scale from 0 to 100 [16]. According to Hofstede [16], Arab countries were classified as having high power distance (80), high uncertainty avoidance (68), a collectivist culture (91 on individualism), and a masculine culture (52). Whilst Hofstede's results were confirmed by various subsequent studies, some other studies showed that they could not simply be generalised to the whole Arab world. For example, Rasha H. O. Tolba [19] studied Jordanian users' cultural characteristics and the link between cultural dimensions and user interface acceptance. She found that users in Jordan show characteristics of high power distance, collectivism, feminism, have high uncertainty avoidance, and are time-

oriented, which is close to Hofstede's analysis for the Arab world. She also found that user interface acceptance improved with the ease of use, there was a significant relationship between cultural dimensions and user interface acceptance for dimensions (power distance, individualism, and uncertainty). Moreover, Twai [98] studied the Libyan users' cultural characteristics and the relationship between cultural dimensions and the adoption of information systems (IS). His study showed that Libya is high on the power distance dimension, high on uncertainty avoidance, and a more feminine culture. Additionally, the results suggested that there is a direct positive link between Hofstede's [16] societal cultural dimensions and the adoption of IS. Another example, Aust et al. [99] examined Hofstede's theory on national culture dimensions to explore the national values of Qatar. His results showed that the scores of Qatar's national culture were different from the scores of Arabic countries measured by Hofstede.

Researchers have used Hofstede's model in human-computer interaction (HCI) to investigate differences and similarities in the design of websites in different cultures. Marcus and Gould [100] endeavoured to use these dimensions for global web interface design, by mapping the Hofstede dimensions to metaphors, mental models, navigation, interaction, and appearance. They proposed that websites in high power distance cultures will have highly structured access to information on security and limitations of access and on the prominence given to leaders. On the other hand, websites in countries with low power distance will have less structured access to information, lower hierarchies, and fewer access barriers. Frequent pictures of achievement and the presence of personal information will be characteristic of highly individualistic countries. In contrast, websites in collectivist countries will present group achievements and emphasise experience. Masculine interfaces will emphasise tasks and the efficiency of their completion. Navigation will be oriented towards exploration, control, and interaction. Feminine interfaces will support cooperation and exchange of information. In the uncertainty avoidance dimension, interfaces in countries with a high uncertainty avoidance index will be simple with clear metaphors and limited choices; low uncertainty avoidance websites will be more complex.

### **2.6.1.1.1 Connecting Hofstede's dimensions to e-learning**

The cultural dimensions have an effect on the construction of educational situations, the learning process, the content and presentation style of teaching, and the interaction between lecturer and learner. The educational software design should consider a variety of cultural factors [101]. Therefore, the research presented in this thesis uses these cultural dimensions, as follows.

#### **2.6.1.1.1 Power distance**

Power distance refers to, as said, 'the extent to which the less powerful members of organisations and institutions (like the family) accept and expect that power is distributed unequally' [16]. In other words, the cultural dimension looks at how much a society does or does not value hierarchical relationships and respect for authority. In high power distance cultures, there is a very low level of free communication between teachers and students during class. Class divisions within society are accepted. Students are controlled by the teacher, and learners are expected to follow them. It is not simple to change the system, because it relates to culture and society. In the e-learningal context, the relationship between teachers/leaders and students is hardly close or personal. Students are not trusted and they need clear guidance from teachers or leaders or the e-learning system. In contrast, in low power distance cultures, teachers expect learners to start interaction and find their own paths. For e-learning, this means that teachers may often socialise with students, and students may be trusted with important assignments. Cultures lean more towards equality in a low power distance cultures [101].

#### **2.6.1.1.2 Uncertainty avoidance**

Uncertainty avoidance, as said, refers to 'the extent to which the members of a culture feel threatened by ambiguous or unknown situations' [102]. This dimension of culture has the power to measure the degree of acceptance or rejection of ambiguity or unknown situations in the future. In the e-learningal context, this dimension of culture is associated with the students' behaviour towards the construction of their education. In high uncertainty avoidance societies, students want to know about their future in their studies and prefer simple designs with clear descriptions and limited amounts of data, while in

low uncertainty avoidance societies, the students accept the unknown, as well as more complex designs and a variety of choices [101].

#### **2.6.1.1.3 Femininity versus masculinity index (MAS)**

Hofstede [102] defined the masculinity versus femininity dimension as follows: ‘a society is called masculine when emotional gender roles are clearly distinct: men are supposed to be assertive, tough, and focused on material success, whereas women are supposed to be more modest, tender, and concerned with quality of life’. This dimension of culture relates to gender roles in societies and the expected behaviour of the two genders. In low masculinity (feminine) cultures, men and women accept collaboration and exchange information, whereas in high masculinity cultures collaboration between men and women is refused.

#### **2.6.1.1.4 Individualism vs collectivism**

According to Hofstede [103], an individualism vs collectivism cultural orientation refers to, as said, ‘the degree to which people in a country prefer to act as individuals rather than as members of groups’. In e-learning, this dimension can explain a student’s preference to be a part of a student group, rather than having a traditional relationship with the tutor (relation only with the tutor) [21].

With regard to culture in e-learning, Emmanuel Blanchard [104] used Hofstede’s individualism/collectivism dimension in future culturally aware e-learning systems. He introduced a Culturally AWARe System (CAWAS). This system tests learner preference for individual or collaborative work. Additionally, Eboa et al. [105] presented the Cultural Adaptation Methodology for Pedagogical Resources in E-learning (CAMPERE). They suggested a cultural adaptation approach using a two-phase method: a) A cultural background about the student (the environment, religion, language, countries of residence, etc.) is collected to initialise the adaptation process, and b) a collaborative filtering method is applied to adapt educational resources using the student’s cultural profile. Furthermore, Welzer et al. [106] conducted research on cultural awareness in e-learning. They introduced the project called Enhancing Lifelong Learning for the Electrical and Information Engineering Community (ELLEIEC). They integrated the importance of culture in a Virtual Centre of Entrepreneurship (VEC), to offer e-learning courses (in foreign languages) for developing



entrepreneurial skills and competencies. It has a special course (Cross Cultural Communication) to help students to understand the importance of the topic and make them aware of the importance of culture in an information society and global communication. Moreover, in 2012, Stewart [21] looked at how adaptive interfaces can cater to cultural diversity in education. His research provides a framework for cultural adaptation, Cultural Artefacts in Education (CAE), based on Marcus and Gould's web model, as well as its source, Hofstede's indices. The CAE questionnaire findings are used to create two cultural ontologies for use in educational settings (CAEF ontology and CAEL ontology). The CAEF ontology describes an adaptive cultural stereotype in detail. Stewart's study validated Marcus and Gould's extension of Hofstede's cultural indices for the field of web design for e-learning.

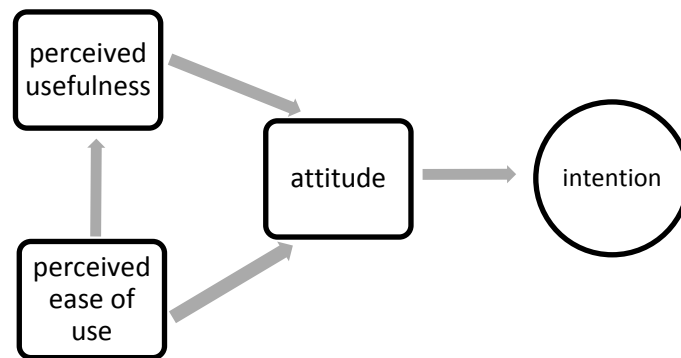
Part of the work presented in this thesis focuses on investigating Saudi Arabian users' cultural characteristics from *the students' perspectives*, by applying Hofstede's cultural indices, to identify design features for a collaborative recommender system for online group projects in e-learning, to meet the Saudi cultural requirements (see Chapter 5).

### **2.6.2 The Technology Acceptance Model**

The *technology acceptance model* (TAM) was introduced by Davis [7] to explain computer usage behaviour. Since then, TAM has been the most frequently cited and influential model for understanding the acceptance of information technology and has received extensive empirical support [107]. The theoretical basis of TAM was Fishbein and Ajzen's theory of reasoned action (TRA) [108]. The TRA is a widely-studied model from social psychology, which is concerned with the determinants of consciously intended behaviour. According to TRA, a person's performance of a specified behaviour is determined by his or her behavioural intention (BI) to perform the behaviour. Behavioural intention is jointly determined by the person's attitude and subjective norm concerning the behaviour in question.

TAM was built on TRA. In addition, the TAM hypothesises that intention is determined by attitude, which is in turn determined by external factors. The model expands on the external factors. TAM proposes that only two external variables are the source of all the effects of other external factors:

*perceived usefulness* and *perceived ease of use*. These two beliefs both influence users' attitudes towards using information systems (IS), which influences actual acceptance, as illustrated in Figure 1. Moreover, the model postulated that perceived ease of use influences perceived usefulness.



**Figure 1: TAM, the Technology Acceptance Model**

Despite the potential of e-learning as a tool to enhance education and training performance, its value will not be realised, if users do not accept it as a learning tool. Since e-learning utilises information technology, TAM has been extensively utilised and extended for studying the acceptance of various technologies by diverse user groups in different contexts (e.g., word processors [7], spreadsheet applications, Mathieson [109]). TAM aids the researcher to ‘identify why a particular system may be unacceptable, and pursue appropriate corrective steps’ [7].

#### **2.6.2.1 Perceived usefulness**

The perceived usefulness is, as said, ‘the degree to which a person believes that using a particular system would enhance his or her job performance. A useful system allows the user to benefit from its use’ [7]. Furthermore, there are several research studies on the use of educational systems that have also found perceived usefulness significant in explaining attitudes towards their acceptance [110-112]. As such, the literature shows that students who perceive the technology to be useful would have a more positive attitude towards employing it.

#### **2.6.2.2 Perceived ease of use**

The perceived ease of use is, as said, ‘the degree to which a person believes that using a particular system would be free from effort’ [7]. There are various studies [113], [114] on the use of e-learning systems that have presented the significance of perceived ease of use in explaining attitudes towards

their acceptance. They found that perceived ease of use has an important influence on attitudes in using e-learning. It is believed that e-learning systems can have great educational advantages, but if the user perceives that a system is not easy to use, they may have a negative attitude towards it and refuse to use it.

### **2.6.2.3 Attitude**

A user's attitude towards such a system has been investigated in prior research. According to Ajzen, attitude is a 'disposition to respond favourably or unfavourably to an object, institution or event' [115]. The attitude factor has been examined in numerous studies [116], [10, 18] that have used TAM, in order to understand the acceptance of using new technologies. The following section outlines a selection of studies that have used TAM to investigate users' acceptance of different applications.

Huang et al. [114] adopted the TAM to examine 322 users of a e-learning system. The researchers found that perceived usefulness was the strongest predictor of the intention to accept the system, whereas attitude revealed a weaker, yet significant effect. Perceived usefulness also had an important effect, whereas perceived ease of use demonstrated a weaker effect. Moreover, perceived ease of use resulted in a strong effect on perceived usefulness, as the model postulated.

Similarly, Masrom [117] used TAM to investigate diploma students' (N = 198) intentions to apply e-learning for work-linked tasks. It was found that perceived ease of use and perceived usefulness were determinants of the attitude towards using e-learning. Perceived usefulness was also a significant determinant of the intention to use e-learning; yet, attitude was stronger than perceived usefulness.

Abdel-Wahab [10] applied TAM to study Egyptian students' acceptance of e-learning. His study found that the core relations of the model hold true in the Middle Eastern context as well. Egyptian students share a similar culture with Saudi students, who are the target participants of the research presented in this thesis. In a similar manner, Park [11] used TAM in the Korean context, to examine students' intention (N = 628) to accept e-learning. The investigation confirmed TAM to be a helpful theoretical model to explain Behaviour Intention (BI) to use e-learning. Moreover, Findik and Ozkan [118] surveyed 123 engineering instructors regarding web-based LMSs in a Turkish institute. The study concluded that perceived usefulness was a significant determinant of the intention to use the system. However, perceived ease of use was found to be insignificant. This finding was also been

echoed in other studies. In contrast, Hong et al. [119] investigated Taiwanese users' acceptance of a digital system by applying TAM. The study found that perceived ease of use was a significant factor influencing intention to use the system, while perceived usefulness was not significant. The discussed studies offer an empirical support of the validity of TAM.

#### **2.6.2.4 Criticism of TAM**

TAM has been considered a powerful model for the past two decades [120] and has been used extensively to explain the intention to accept various technologies within different cultures (e.g., the UK, the USA, China, Egypt, and Turkey) and by various users groups (students, engineers, and physicians). TAM is capable of offering vital information about acceptance of technology. Yet, it limits the set of potential important factors to only two factors, perceived usefulness and perceived ease of use. Moreover, TAM does not show how these beliefs can shape users' acceptance and usage [109]. Another limitation of TAM was discussed by Legris et al. [121], who stated that most research on TAM is based on self-reported measurements, as a source of usage instead of actual usage [121]. This type of research is plagued with problems, such as common method bias. Some authors also criticised TAM for being constantly applied to a limited set of samples, particularly students or knowledge workers. The two groups are usually conversant in using new systems, thus, the results emerging from such literature cannot be generalised to other samples [122].

Therefore, the research presented in this thesis uses TAM (Attitude, perceived usefulness, perceived ease of use and behavioural intention) with cultural factors (power distance, individualism vs collectivism, masculinity vs femininity, and uncertainty avoidance) and usability (effectiveness, efficiency, and satisfaction (Section 1.1.6)) to study Saudi Arabian students' acceptance of e-learning (collaborative recommender system for online group projects) (Chapter 6).

### **2.6.3 Usability**

According to the International Standard Organisation (ISO) [123] usability refers to “effectiveness, efficiency and satisfaction with which a specified set of users can achieve a specified set of tasks in a particular environment”. Usability should be considered when considering building an effective e-learning system [124]. Usability is perceived as a significant principle in developing high quality

website products. There are three key aspects of usability: efficiency, effectiveness, and satisfaction. ISO 9241-11 [123] defines *efficiency* as “the resources expended in relation to the accuracy and completeness with which users achieve goals”. The efficiency of a system provides the designer a valuable chance to explore the speed with which end-users achieve specific tasks and how a different user reacts to the input system. The key elements of efficiency cover task execution time and task learning time. ISO 9241-11 [123] defines *effectiveness* as “the accuracy and completeness with which users achieve specified goals”. The core elements of effectiveness include the quality of solutions and error rates. These can epitomise an assessment of the result of the user’s dealings with the system.

ISO 9241-11 [123] defines *satisfaction* as “the freedom from discomfort, and positive attitudes towards the use of the product”. The satisfaction aspect emphasises the user’s feelings and satisfaction regarding the system’s features (the user should be highly satisfied and pleased with the system, leading him/her to use it again). In this work, *effectiveness*, *efficiency* and *satisfaction* were used to measure usability an e-learning system (Topolor 3) using the System Usability Scale (SUS) questionnaire (see AppendixD).

The SUS questionnaire was created in 1996 by Brooke as a ‘quick and dirty’ questionnaire measuring a given product or service. Since then it has been widely used by researchers around the globe. SUS has a number of features. For example, SUS is comparatively easy to use and speedy for both study participants and researchers; SUS offers a single score on a scale that is clearly understood and is non-proprietary, making it a cost effective tool. SUS is technology agnostic, therefore, it is flexible and sufficient to evaluate several products and services, such as software, websites, and hardware platforms [125]. In this thesis, the system usability scale (SUS) questionnaire was used to evaluate the collaborative recommender system for online group projects more details are presented in Chapter 6 sections 6.3.

#### **2.6.4 Conclusion**

This chapter presented background research in adaptive and personalised e-learning, social adaptive learning, and adaptive collaborative learning environments. It investigated advantages of prior

approaches, as well as their limitations. It has discussed the advantages of existing earlier studies, how this study field can continue to develop the new system.

In conclusion, the research presented in this chapter has addressed the study objective **O1**:

*'Review the fields of adaptive social e-learning, adaptive collaborative learning environments, and cultural and virtual project and team formation, to investigate their effect on the e-learning process, and more specifically, on the virtual project process (project formation process and project completion process) for e-learning'*. By addressing this study objective, this chapter describes the background knowledge, to support the research questions defined in chapter 1.

In the next chapter, the overall research, design, implementation and evaluation methodology, which was employed in order to answer the research questions in chapter 1, is described.

# Chapter 3

## Methodology

### 3.1 Introduction

Having highlighted the study aim and questions and discussed the pertinent literature in chapter 1, this chapter will present the methods used to collect data for the study, in order to answer the research questions. The choice of a suitable research design is an essential decision and should be centred on “the nature of the research problem or issue being addressed, the researcher’s personal experiences and the audiences for the study”[126]. It is essential, thus, to establish the research methods to be used in this research, based on a good understanding of methodology theory. The present chapter discusses some essential issues connected to research methods, as well as how these issues have influenced the design of the research presented in this thesis.

### 3.2 Literature Review

A thorough literature review is essential for any research work. This research starts by reviewing the fields of *adaptive social e-learning*, *adaptive collaborative learning environments*, and *cultural factors affecting Saudi Arabian students’ acceptance of e-learning environments and virtual project and team formation* within e-learning systems, to identify a gap within the literature. This research will endeavour to address this gap. This will be conducted through a set of suitable research questions. The review started in 2012 for this thesis. It then continued, both to understand the wider picture, as well as to ensure that the research progress is compared with up to date literature. An extract of the literature review is reported on in chapter 2, by selecting specific literature that had direct impact on this thesis.

### 3.3 Case Studies and Evaluations

A case study is a research approach applied to investigate a specific phenomenon within a real-life context and is employed to provide answers for questions [127]. For the aim of this thesis, knowledge has been generated from experimental studies, to explore and investigate the main research questions in chapter 1. A number of case studies were conducted, to collect feedback from students. This was

done, e.g., in order to gather information from students regarding their perceived acceptance towards the different types of e-learning systems. The chosen research methods to collect data for this study were: survey (questionnaire) [128], interviews [129] and focus groups [130] methods, to achieve the thesis objectives. These methods are further described below.

### **3.3.1 Questionnaires**

The questionnaire method is categorised under the *quantitative* and *qualitative* data research methods. That is, it can be used to generate quantitative data (i.e., numbers) and qualitative data (i.e., via open questions). The questionnaire is one of the most commonly used methods in technology acceptance research [131]. The questionnaire method is ‘a set of fixed format, self-report items that is completed by respondents at their own pace’ [128]. In the questionnaire, the researcher determines a sample to collect quantitative data by questionnaire. Then, the researcher statistically analyses the data, to draw conclusions [132]. There are various advantages of using a questionnaire. The questionnaire can be employed to investigate broad areas of topics and samples, to assess or explain any generalised aspects [133]. It is more economical and practical than other methods, such as interviews. It can be sent by mail or email, or it can be posted online inexpensively in a short period of time [134]. The outcomes of the questionnaires can generally be rapidly and effortlessly calculated by either an investigator or using a software package. In this thesis, the researcher used the questionnaire because quantified data can be utilised to compare different types of e-learning systems. Additionally, the researcher is female. Females are not allowed to enter the men’s campus in Saudi Arabian universities because the separation of genders is obligatory and the classes for each gender are in separate buildings (see more discussion in Chapter 5). The questionnaire could be distributed by the investigator or by any number of persons. Therefore, the researcher utilised the questionnaire, and it was given to the staff in the men’s campus at the University of Taibah.

### **3.3.2 Interviews**

Interviews are ‘discussions, usually one-on-one between an interviewer and an individual, meant to gather information on a specific set of topics. Interviews can be conducted in person or over the phone. Interviews differ from surveys by the level of structure placed on the interaction’ [129]. There



are three types of interviews. The first type of interview is the *structured interview*, which is predetermined and standardised. The conversations include specific questions, and the answers are usually close-ended. The second type of interview is the *unstructured interview*, which is not predetermined and standardised. Unstructured interviews are open-ended conversations. The third type of interview is the *semi-structured interview*. In this type, the investigator ‘has a list of questions on fairly specific topics to be covered, often referred to as an interview guide, but the interviewee has a great deal of leeway in how to reply’ [135]. In this thesis, the investigator used semi-structured interviews at the end of the empirical study, to attain additional insight into the students’ perceptions of the different types of e-learning systems (Chapter 4).

### **3.3.3 Focus Groups**

The focus groups method is classified under the qualitative data research method. Focus groups are ‘dynamic group discussions used to collect information’. Focus groups are a method of group interview, where the dependence is on the communication within the group, which discusses a topic given by the investigator, to produce detailed information from several people, rather than a personal opinion. Focus groups can be used as a main technique, or with other methods (such as questionnaire or interviews) for data collection, to gain more information in the research. Researchers can use focus groups at any stage of their study, such as at the preliminary or exploratory phases of a study, or programme of activities development, or evaluation. Focus groups have been used for several aims. For example, they encourage new ideas and perceptions for both the investigator and the participants, allow gaining knowledge or impressions about the product, collect general data about a specific topic, produce new hypotheses for future research opportunities and define what further research implements may be valuable for development information gathering [130]. Focus groups have many advantages. For example, focus groups can save time, when compared to several one-to-one interviews. They are useful for gaining in-depth data about individual and group opinions, perceptions, and feelings. They provide the chance to search for clarification [129].

In this thesis, focus groups were used after the running of the experiment, to confirm and clarify the outcomes of the surveys. They were implemented as a small-group discussion, guided by a researcher.

They were used to learn more about students' perceptions on different types of e-learning systems. The researcher started by providing clear explanations about the purpose of the group. Participants (students) were encouraged to feel free to converse openly. Students were encouraged by the researcher to not only express their own attitudes toward different types of e-learning, but also respond to other members, and to questions asked by the researcher, to offer a depth and variety to the discussion that would not be obtainable through surveys (see Chapter 3).

### **3.4 Discussion on the Research Sample Choice**

Saudi Arabia's university population comprised 898,251 students in 2014 [31]. In order to sufficiently draw any inference at the 95% confidence level with 5% margin for error, a sample size of 384 would be required. The sample size examined as a whole for this thesis is close, but slightly lower: 310. The reasons for using this number are as follows. Since the researcher was in the UK, it was difficult to find a sample from Saudi Arabia or to travel to Saudi Arabia.

On the other hand, the sample was drawn from the desired population: Saudi Arabian students. Additionally, a deliberate endeavour was made to take account of postgraduate and undergraduate students (first, second, third, and fourth year students) from several universities in Saudi Arabia, to cover the students' different views. The students were from Taibah University, King Faisal University, Qassim University, and the University of Tabuk in Saudi Arabia. Moreover, Saudi students from the University of Nottingham and Nottingham Trent University in the UK also participated.

Comparing the sample size with related literature, other studies used similar or even lower numbers such as in [21] [30] when selecting their samples. In fact, it is a well-known matter that case studies with students are rarely of significant sizes, due to the difficulty in finding enough participants (e.g., if a lecture is to be monitored, there are rarely lecture audiences of such large sizes). In this thesis, in order to somewhat alleviate this problem, different students from different universities and studies were collected, to enhance the numbers.

### **3.5 Analysis and Results**

The data analysis is used to investigate whether to confirm or reject the study hypotheses. The best fitting statistical method depends on the nature of the data as well as the research questions [136]. In the following, various data analysis methods are described, and the ones used in the thesis are highlighted including the reason why they were employed.

#### **3.5.1 Normality Analysis**

An evaluation of the normality of data is a requirement for several statistical tests, due to the fact normally data is an underlying supposition in parametric testing. A normality test is utilised to define whether sample data has been extracted from a normally distributed population. Several statistical tests, such as the student's *t*-test and the one-way and two-way ANOVA have need of a normally distributed sample population. If the hypothesis of normality is not acceptable, the outcomes of the tests will be untrustworthy.

There are two key techniques for measuring normality: *graphically* (such as frequency histograms and P-P plots) and *numerically* (such as the Kolmogorov-Smirnov test (K.S)). If the probability P value is greater than 0.05, the data originates from a normally distributed population. If the P value is less than or equal to 0.05, the data originates from a non-normally distributed population [136]. If data are not normally distributed, data should be analysed using a non-parametric test, such as the Kruskal–Wallis test, instead of a one-way analysis of variance (ANOVA), the Wilcoxon signed-rank test instead of a paired *t*-test, or the Friedman test instead of a repeated-measure data [137]. To evaluate the normality in this study, all items were assessed, by applying the SPSS Kolmogorov-Smirnov test [138]. The reason for using this particular test is because it is frequently used to measure normality.

#### **3.5.2 Parametric and Non-parametric Statistics**

There are two kinds of the statistical tests: *parametric* and *non-parametric*. Statistics centred on the means and standard deviations are effective for normally distributed or normal data. Usually, these data are utilised in the parametric statistics [139]. However, means and standard deviations may not present reliable results, if the data are ordered, but obviously non-normal (i.e., ordinal). In such cases, the median and a nonparametric test are more appropriate [139]. Nonparametric tests rank the result

variable from small to large and next analyse the ranks. In this thesis, both parametric and non-parametric tests were utilised where suitable, to analyse the study data (see Chapter 4 section 4.51, Chapter 5 section 5.5.2 and Chapter 6 section 6.4.4) [140].

### 3.5.3 Data Analysis

In this research, *descriptive* and *inferential* statistics were applied to analyse data. Argyrous defined descriptive statistics as ‘the numerical, graphical, and tabular techniques for organising, analysing, and presenting data’ [141]. In this research, examples of descriptive statistics applied in this study include measures of dispersion (e.g., standard deviation), measure of central tendency (e.g., mean and mode), and the frequency distribution. Argyrous defined inferential statistics as ‘the numerical techniques for making conclusions about a population based on the information obtained from a random sample drawn from that population’ [141]. There are several inferential statistics applied in this thesis.

- *Parametric Paired t-test*: It is used to test whether the mean variance in the pairs is different from zero [137] (Chapter 6). It is used if the distribution of differences between pairs is normally distributed (the median difference between pairs of observations is zero or the sign test, which is that the numbers of differences in each direction are equal).
- *Non-Parametric Friedman test*: it uses to compares three or more matched groups. It can be used for repeated-measure data if the samples are measured on two, three, or more periods or conditions. It should be used if the data are not normally distributed [140]. “The Friedman test analyse the ranks of the data rather than their original numeric values. Ranks are found by ordering the data from smallest to largest across all groups, and taking the numeric index of this ordering” [142]. Paired or more groups correspond, for example, to different repeated measures. In chapter 3, for the data set used there, the three different methods “*a social personalised e-learning, the traditional e-learning and classroom learning*” used can be considered as repeated measures. The Friedman test ranks the values in each row, representing each single

student, separately. Afterward, it calculates the ranks for each set (column). The P value will be small (P value is less than 0.05) if the sums are very different [142] (see Chapter 4).

- *Non-Parametric Wilcoxon test*: It can be used for repeated-measure data if the samples are measured on two periods or conditions (before and after). It is similar to the paired t-test, and it can be used if the distribution of differences between pairs may be non-normally distributed (the median difference between pairs of observations is not zero or the sign test, which is that the numbers of differences in each direction are not equal) [140]. The Wilcoxon tests first calculate the variance between each pair and after that ranks the overall value of those variances (see Chapter 6).

### **3.5.4 Assessment of Instrument Reliability**

#### **3.5.4.1 Validation**

The aim of the validation procedure is to provide the research community with a high degree of confidence that the techniques used are appropriate in the search for scientific truth [143]. There are several kinds of validity: content validity, criterion validity, and construct validity. Elisabeth [144] defined the *criterion validity* as “the conformity of a scale to a true state or a gold standard, and depending on the purpose of the study sub concepts like clinical, predictive and concurrent validity will be used.” The other type of validity is *construct validity*. It is defined as “the consistency between scales having the same theoretical definition in the absence of a true state or a gold standard” [144]. The additional kind of validity is *concept content* validity. It is defined as “the completeness of the scale or multi-scale questionnaire in the coverage of important areas. Sub concepts like face, ecological, decision, consensual, sampling validity, comprehensiveness and feasibility have been used [144]”. Content validity concerns whether the measurement instrument represents the construct being measured [145]. Face validity is a method of content validity, which is created by asking examinees (some experts) to evaluate the content of the survey [146]. Face validity refers to the extent to which an instrument seems to measure what it plans to measure. This measurement technique should

offer an exact representation of the variable (or construct) it is assessing, if it is to be a valid measure [146]. In this present work, some of the study measures were developed questionnaire (Appendix B and Appendix C) or improved questionnaires (Chapter 4 sections 4.4, Chapter 6 section 6.3) to be appropriate for the study objectives. Therefore, it was essential to make sure that these items had content validity.

Three Arabic language teachers and six PhD candidates in Computer Science at the University of Warwick and the University of Nottingham were thus asked to review each of the questionnaires for any mistakes, repetitions, ambiguities, and potential for misunderstandings, and to recommend additional inclusions, removals, or explanations for any item. Some of the participants (Arabic language teachers) reported a few misunderstandings about some statements in the questionnaires. Then, the researcher modified them and asked the Arabic language teachers to review again the altered version. They did not state any other problems with the understanding and answering of the questionnaires. This supported the face validity of the questionnaires.

#### **3.5.4.2 Reliability**

Reliability is ‘the extent to which measurements are repeatable and that any random influence which tends to make measurements different from occasion to occasion is a source of measurement error’ [143]. It addresses the degree to which scores gotten by an individual are the similar if the individual is re-examined by a similar assessment on different cases [145]. When using Likert-type scales, it is necessary to examine the study questionnaire reliability. Reliability is an assessment of the instrument accuracy [147]. There are many kinds of reliability, each of which employs various aspects of consistency and is defined by a different technique. Typical kinds of reliability comprise test-retest reliability, scorer/rater reliability, equivalence, reliability coefficients, internal consistency reliability, and standard error of measurement [145]. In this thesis, the internal consistency reliability was calculated by using Cronbach’s alpha ( $\alpha$ ), as it a frequently used method to gauge reliability [148]. Its values range from 0 to 1, with greater values indicating higher reliability [136]. Scores above 0.70 imply reliable measurement, 0.50–0.70 implies moderate reliability, and values of less than 0.50 are considered unreliable [147]. All the Cronbach’s alpha values were greater than .7, and consequently, the questionnaires were evaluated to be acceptable for use in the present work.

### **3.5.5 Limitations of the methodology**

There were some challenges faced when conducting this thesis. First, the research participants were from Saudi Arabia universities. Therefore, the questionnaires utilised in this thesis were first published in English (to be checked with the supervisor and with other colleagues, as stated above) and then translated manually into Arabic, which is the mother language of Saudi Arabian students, in order to simplify understanding of the questions, as well as ease of answering.

Moreover, the questionnaire method itself has some limitations. For example, information generated by self-reports may be influenced by social desirability bias (participants respond to the questions in a way that will be seen favourably by others). Moreover, this method is insufficient to facilitate the understanding of some of the influence factors that can determine the data (i.e., changes in emotions, behaviour, feelings, etc.). Therefore, this research endeavoured to reduce this drawback by conducting individual interviews and focus groups, to follow-up on the results from the self-report questionnaires, in order to gain richer data and to facilitate a better in-depth understanding of the participants' experiences about different type of education approaches.

As a further limitation, there are known problems with the focus groups method. It can suffer from unfair contributions, when some participants dominate the conversation. However, such drawbacks were prevented by good moderating of the discussion.

An additional limitation can be the construction of the aim sample. For the work of this thesis, the sample is formed of Saudi students, as is the target population, thus the research links well with this aim. Preferably, students should be selected from different levels of education: this goal has been reached. Moreover, students should be selected from various areas of study: this level is somewhat achieved, as the study uses samples from various areas of study. However, the study is not comprehensive in this respect, as it does not cover all study areas for students in higher education in Saudi Arabia. Finally, the sample size is lower than that of the desired sample. Nevertheless, the sample size is relatively close to the desired one. Moreover, as it was previously explained, other researchers often use smaller sizes than desired, due to various issues with finding the respondents.

### **3.6 Ethical Considerations**

The questionnaire is a helpful way to generate private data from many respondents, but it could be considered also an interference in their lives [133]. It is, therefore, essential to address ethical issues, when any subjects participate in any research. All available information about a study should be provided by the researcher, so that a person can choose to contribute or not [133]. Hence, the idea of this study was explained to the students involved when the case studies were conducted (questionnaire and interviews) and when the online questionnaire was posted on the site (Appendixs A, B, C, D and G). Furthermore, in the introductory post to the thread that introduced the questionnaire, a brief introduction to the study was given. The students were also informed that they could withdraw or stop answering the questionnaire or interview at any stage. They were also informed that their contribution would be used only in this study for the purpose stated in the post. Students were assured that data on all participants would be anonymised. Paper copies of questionnaire and interview data would be stored in a locked filing cabinet in the computer science department and accessible only by the researcher and supervisor. Additionally, the electronic data would be stored on an encrypted file system in the computer science system, for which only the researcher and supervisor hold the encryption/decryption keys. Data would be stored for 10 years, as required by Biomedical and Scientific Research Ethics Committee (BSREC) [149] REGO-2014-1022.

### **3.7 Overview of the Case Studies**

The following section outlines the case studies used in this thesis. Table 4 presents an overview of the methodology in this work.

#### **Table 4: Overview of the methodology**



Case Study	Objective	Hypotheses	Research method	Sample
First Case Study (See Chapter 4)	To explore Saudi students' acceptance of a social personalised e-learning system (Topolor) versus traditional e-learning systems (Jusur system) and classroom learning.	H1 Saudi students' perceived acceptance of social personalised e-learning system is greater than the perceived acceptance of the traditional e-learning system and classroom learning.	Questionnaire and interviews.	University of Taibah.
	To explore Saudi students' acceptance of a traditional collaborative learning system (Jusur system) for group project work.	H2: Saudi students' perceived acceptance towards the traditional collaborative learning system (Jusur system) for group project work.		

<p>Second Case Study (See Chapter 5)</p>	<p>To explore the cultural factors of Saudi Arabian students using Hofstede's cultural value dimensions.</p>	<p>H3: Saudi Arabian users' cultural characteristics are similar to Hofstede's 1980 analysis for the Arab world and can be applied for Saudi Arabian e-learning.</p>	<p>Online Questionnaire</p>	<p>King Faisal University, Qassim University, and the University of Tabuk</p>
<p>Third Case Study (See Chapter 4)</p>	<p>To explore the needs of the students in relation to the recommended project group membership, recommended task, and recommended communication tools for the group project, aiming at collecting the requirements for the implementation of the recommended environment.</p>	<p>H4: The students' knowledge levels, skills, collaborative behaviours, and genders can be considered for recommending group members.</p>	<p>Questionnaire</p>	<p>Nottingham Trent University and University of Nottingham</p>
		<p>H5: The students' knowledge levels, skills, collaborative behaviours, and genders can be considered for recommending group members.</p>		
		<p>H6: The students' personalities and collaborative behaviours can be considered for recommending</p>		

		communication tools.		
		H7: The students' personality parameters can be considered for recommending project tasks.		
		H8: The students' self-defined virtual project group memberships based on system-generated profiles are preferable, when compared to the system-organised virtual project group membership		
		H9: Students consider the usage of Web 2.0 tools to make group projects within e-learning useful.		
		H10: Social networks are useful for building students' profiles.		
Fourth Case Study	To explore the usability of Topolor	H11: A student's perceive high	Questionnaire and interviews	Nottingham Trent University and

(See Chapter 6)	3.	effectiveness, efficiency, and satisfaction of using the Topolor 3 system.		University of Nottingham
Fifth Case Study (See Chapter 6)	To investigate the acceptance of Saudi Arabian higher education students of a recommended virtual project and recommended group formation for e-learning versus traditional project- and team-formation methods for e-learning	<p>H12: The functionalities offered in the Topolor 3 system are acceptable to Saudi Arabian students if they are matched to their own cultural characteristics.</p> <p>H13: Personalised virtual project- and team-formation methods for e-learning are more acceptable to Saudi students than traditional project and team-formation methods for e-learning</p>	Questionnaire and interviews.	University of Taibah

### **3.7.1 First Case Study: Comparison of Existing Systems**

In this case study, questionnaire and interview (Appendix A) methods were chosen, to address the research objectives.

**O2:** Explore Saudi students' acceptance of a social personalised e-learning versus the traditional e-learning system and classroom learning.

**O3:** Explore Saudi students' acceptance of the traditional collaborative e-learning for group project work (see Chapter 4).

### **3.7.2 Second Case Study**

In this case study, a questionnaire-based experiment (Appendix B) was conducted, to address the research objective **O4:** explore the cultural characteristics of Saudi Arabian students using Hofstede's cultural value dimensions.. This study explores the cultural features of Saudi Arabian students using Hofstede's cultural value dimensions to identify design features in e-learning to meet Saudi Arabian cultural requirements (see Chapter 5).

### **3.7.3 Third case study: Collecting the requirements for the implementation system**

The third case study was carried out to address the research objective **O5:** to explore the needs of the students in relation to the recommended project group membership, the recommended task and the recommended communication tools for the group project, with the aim of determining what is necessary for implementation of the recommendation environment (see Chapter 5). The questionnaire (Appendix C) was used in this case study.

### **3.7.4 Fourth Case Study: Testing the Implemented Systems (Usability)**

This case study was carried out to explore the usability of Topolor 3 (Chapter 6). The students were invited to use the system and complete an online questionnaire.

A usability questionnaire [150] was used in this case study. The usability questionnaire consisted of 10 questions. Each question was rated on a 5-point Likert scale, where 1 = strongly disagree, 3 = neutral, and 5 = strongly agree (Appendix D).

### **3.7.5 Fifth Case Study: Evaluation Collaborative Recommender System**

The fifth experiment was conducted to address the research objective to investigate Saudi Arabian higher education students' acceptance of a recommended virtual project and recommended group formation for e-learning versus traditional project- and team-formation methods for e-learning. The questionnaire and interview (Appendix E) methods were chosen to address this research objectives in chapter 6.

## **3.8 Project phases for software development using the Waterfall Model**

In this thesis, the waterfall method [151] is applied. It is widely used in software engineering, to ensure the success of the project. In the waterfall approach, all processes of software development are separated into stages. The stages in the waterfall model are: requirement specifications phase, software design, implementation, testing and deployment of system [151].

### **3.8.1 Requirement Analysis**

This discovery phase will allow the researcher a high-level understanding of user requirements, in order to understand what the currently service landscape looks like and a sense of what the primary prototypes will do. Information can be found through: mock-ups or workshops, or simple paper prototypes or experiments.

In this thesis, the researcher analysed the requirements for a recommended virtual project and recommended group formation for e-learning, and understood the limitations of current virtual projects for e-learning through literature review and experiments (see chapters 2 and 5).

### **3.8.2 Design**

Before a designer starts the actual coding, it is essential to understand how they are going to build the system and what it should look like? In this thesis, the requirement features from the previous phase (chapters 2 and 5) are considered and the researcher has prepared the system in this phase (see chapter 5). The system design aided in identifying the system needs and also aided in determining the overall Topolor 3 system architecture, as presented in chapter 5 section 5.7. The system design specifications work as input for the following stage of the model.

### **3.8.3 Implementation**

The Topolor 2 system was selected as a basis for development, as it already supports some of the desired general features. Topolor 2 is a social personalised adaptive e-learning system. It has been created at the University of Warwick [152]. However, it has limitations to support group formation, project recommendation, tasks recommendation and communication tools recommendation. Thus, it was extended with new features into Topolor 3, so that it can allow the forming of groups with fitting membership, and permit a wider application to collaborative learning, especially the type based on projects. After the design has been agreed on in the previous phase, the researcher has started the technical implementation for Topolor 3. Topolor 3 is implemented by applying PHP, HTML, CSS, SQL and JavaScript and is built on the Yii Framework (<http://yiiframework.com>). Topolor 3 has been implemented in order to meet the system requirements proposed by the learners, as defined in Chapter 5 section 5.5, as well as to maintain compatibility to Topolor 2.

### **3.8.4 Testing**

Upon achievement of the full implementation, the development system should be testing requirements before the development system can be released to students. Therefore, a case study was designed, to explore the usability of Topolor 3 (Chapter 6 section 6.4.1).

### **3.8.5 Deployment of the system**

After the functional and non-functional testing is achieved, the Topolor 3 system has been presented to Saudi Arabian students at the University of Taibah (Chapter 6 section 6.3).

## **3.9 Summary**

Several research approaches were used in this thesis, in order to facilitate the collection of rich and in-depth data about Saudi students' perceptions toward the different types of e-learning systems and their needs for recommended virtual projects and recommended group formation for e-learning. The chapter began with explaining the various stages of the research process, and then followed by the overall description of the methodological approach for each stage, starting from literature review, case studies, design and implementation. This process was aimed at answering the research questions posed in chapter 1.

For the case studies, an illustration and a discussion of the study methodology for gathering data and the methods of analysing the collecting data were presented. Questionnaires data were used to collected data. Moreover, in-depth interviews were implemented, with a chosen sub-sample of the contributing students. Furthermore, this chapter has presented details of the selection of the sample population for this research. Additionally, it has presented a description of the data analysis techniques in this thesis. Moreover, it has illustrated the limitations of the methodology, followed by a discussion of ethical issues related to the research. Finally, it has described the case studies that were conducted in this thesis.

The design and implementation were also discussed from a methodological point of view, as a means to build the case studies on, and as an instantiation of the theoretical ideas of the thesis.

The following chapters illustrate the application of this methodology for the different aspects researched in this thesis.

In the next chapter, Saudi students' acceptance of a social personalised e-learning system (Topolor) versus the traditional e-learning systems (Jusur system) and classroom learning are explored. Moreover, Saudi students' acceptance of the traditional collaborative learning system (Jusur system) for group project work is explored.



## Chapter 4:

# Social Personalised e-learning, versus Traditional e-learning and Classroom Learning

### 4.1 Introduction

Most universities in Saudi Arabia use the Jusur learning management system (LMS) [6]. This is typically used in traditional e-learning settings. The main, typical role of an LMS is to simplify the procedure of administrating education. In such a system, the instructors can manage their courses and manage contact with students. In addition, the LMS permits students to use and download course material, submit their homework assignments electronically, check their course results, and use other specific supporting functionalities in a collaborative learning environment (CLE), to communicate with other students (see Chapter 1). Although LMSs offer a variety of supporting functionalities for online collaborative eLearning, the methods adopted for constructing groups do not tailor to individual students' characteristics, due to the fact that students are usually assigned to groups manually by teachers, or students, or randomly by the systems. Traditional collaborative eLearning is not created to support personalised projects, customised for individual students. Student could have different backgrounds (culture), knowledge interests and preferences. Traditional collaborative eLearning offers supporting functionalities for virtual communities, which are significantly different from virtual teams (see Chapter 2 for further discussion on this).

Importantly in this thesis' context, such systems are not created to offer personalised learning that helps an individual student. Moreover, they provides very limited support for forming and managing collaboration [87] especially for project groups [90]. The content of a page would look almost the same (*'one-size-fits-all'*), regardless of a student's interests, preferences, background, or even knowledge [20]. Students and lecturers may, however, in reality, need advanced e-learning features

available, which encourage and allow them to take control of their learning, as well as for lecturers to discover new styles of teaching, respectively.

In this thesis, the idea is supported that a one-size-fits-all approach may not be appropriate for the Saudi culture. Hence, this chapter focuses on the acceptance of the *social personalised* versus static e-learning and classroom learning by Saudi university students, and how a more social personalised system can cater to Saudi education, instead of offering an identical delivery for all students regardless of students' interests, preferences, backgrounds, or knowledge.

This chapter aims to address thus the research objectives **O2** '*explore Saudi students' acceptance of a social personalised e-learning versus the traditional e-learning system and classroom learning*' and

**O3**: '*explore Saudi students' acceptance of the traditional collaborative e-learning for group project work*.

The process of addressing this focus supports answering the research questions **R1**: '*Is Saudi students' acceptance of social personalised e-learning higher than their acceptance of the traditional e-learning and classroom learning?*' and **R2**: '*Do Saudi students demonstrate acceptance of traditional collaborative e-learning for group project work?*'

In order to answer research question R1, the comparison starts based on the well-known technology acceptance model (TAM) [7]. For answering research question R1, and R2, data collection methods from students, as described in chapter 3, are applied.

## **4.2 Hypotheses**

Chapter 2 (section 2.6) has presented the basis for this study, by discussing the theory that guided the development of the research model. This chapter postulates the following hypotheses, each further refined.

**H1**: Saudi students' *perceived acceptance* of social personalised e-learning system is *greater* than the perceived acceptance of the traditional e-learning system and classroom learning.

**H1.1** Saudi students' *attitudes* towards a social personalised e-learning system are *more positive* than their attitudes towards the traditional e-learning system.

**H1.2** Saudi students' *perceived ease of use* towards a social personalised e-learning is greater than their perceived ease of use towards the traditional e-learning system and classroom learning.

**H1.3** Saudi *students' perception of the usefulness* of a social personalised e-learning system is higher than their perception of the usefulness of the traditional e-learning system and classroom learning.

**H1.4** Saudi students' *perceived intention of further use* of a social personalised e-learning system is *higher* than that of their perceived intention of further use of the traditional e-learning system and classroom learning.

If the score of Saudi students' *perceived acceptance* of social personalised e-learning system is *greater* than the *perceived acceptance* of the traditional e-learning system and classroom learning, this would confirm hypothesis (H1), whereas if the score of Saudi students' *perceived acceptance* of social personalised e-learning system is less or equal than the perceived acceptance of the traditional e-learning system and classroom learning, this would not confirm the hypothesis (H1).

**H2:** Saudi students *perceive acceptance* towards the traditional collaborative learning system (Jusur system) for group project working.

**H2.1** Saudi students *perceive usefulness* towards the traditional collaborative learning system (Jusur system) for group project working.

**H2.2** Saudi students *perceive ease of use* towards the traditional collaborative learning system (Jusur system) for group project working.

**H2.3** Saudi students *perceive intention of further use* of the traditional collaborative learning system (Jusur system) for group project working.

If the score is higher than 3.5, this would confirm hypothesis (H2), whereas if the score is less than 3.5, this would confirm the null hypothesis for H2.

#### **4.4 Case Study Design**

In this study, *quantitative* and *qualitative* methods were chosen to achieve this chapter's objectives. The questionnaire (Appendix A) was developed based on measures that have been validated by prior researchers. The TAM measures of *perceived usefulness*, *perceived ease of use*, and *behavioural intention* were based on the work of Lee [8] as they are related to the learning situation. The questionnaire was modified in order to be appropriate for this study as presented in Table 5.

All questionnaire items were first published in English and then translated manually into Arabic. The target population for this research consisted of the students of the University of Taibah, Saudi Arabia. The University of Taibah normally also uses the Jusur system (a traditional e-learning system), as explained in the introduction. Thus, the target population is quite familiar with that system. In order to introduce the social personalised e-learning alternative, it was necessary to offer them a brief presentation about the meaning of the social personalised e-learning system and hands-on experience with such a system. Therefore, a social personalised e-learning system (Topolor [152]) was selected, as it already supports some of the desired general features. Topolor is an e-learning system which allows for a modicum of adaptation as well as social interaction. It was developed at the University of Warwick [152]. The case study presented here was carried out in June 2013. The students were asked to learn a short online course on 'collaborative filtering' by using the system.

The time assumed necessary to complete the course was around 25 to 30 minutes. After finishing the course, the students were asked to evaluate and compare the Topolor system and Jusur system. The questionnaire consisted of comparison questions that asked about the perceived usefulness, perceived ease of use, and behavioural intention towards the two systems. Additional questions were added in the second part of the questionnaire, in order to measure and obtain feedback on some specific issues

related to working on a collaborative project using the traditional e-learning system, to *explore the Saudi students' acceptance of the traditional collaborative learning system (Jusur system) for group project work*. Each question was answered on a 5-point Likert scale, where 1 = strongly disagree, 3 = neutral, and 5 = strongly agree.

Note that when defining the 'closest interpretation' for each question, the mean is used. Hence, the mean response from 3.41 to 4.20 gives as closest interpretation 'Agree', and 2.61 to 3.40 would be 'Neither', but if the mean is 2.60, then the interpretation is set to 'Not Agree'.

Moreover, the questionnaires (150) were distributed to students. From the 150 questionnaires distributed, 101 questionnaires were returned. The questionnaire answers were analysed using a non-parametric Friedman test analysis [153], with the help of the SPSS program, to confirm or reject hypothesis H1. Descriptive statistics and one sample t-test in SPSS were used, to confirm or reject hypothesis H2. There are some potential issues with this study's setup. On one hand, the study only collects data from one Saudi Arabian institution, and not from several. Ideally, several institutions should be involved. Follow-up studies are performed on a wider scale. However, as said, students at the selected university are very familiar with the e-learning system studied, so the selection was appropriate from that point of view. Moreover, whilst the conclusions are drawn for generic personalised social e-learning, versus traditional e-learning, and classroom teaching, in fact, what the students compare are two systems, Topolor and Jusur, and their own classroom learning experience. Jusur is the most frequently used e-learning system in Saudi higher education. Thus, using it is adequate for this study's purposes. Topolor is a relatively newly introduced system. However, it is one of the best systems to illustrate the combination of personalisation and social interaction, and it has received several awards at different conferences, including best demonstration award. It is a system that has also been widely deployed (in the UK, Bosnia-Herzegovina, US, Jordan, Brazil, etc.), and thus it is at a higher technological readiness level than usual academic research developments. These are reasons why using Topolor for these evaluations was appropriate, as the intention was to compare relatively established systems. Moreover, there is no current commercial system that can offer such a combination of features. Finally, Topolor is an open source system, and allows for further

development, which was the ultimate intention with this research. Please find further discussions on limitations encountered in setting up this and other case studies in chapter 3.

**Table 5: Development of the questionnaire**

Original Perceived Attitude Item	Modified Perceived Attitude Item	Hypotheses
<ul style="list-style-type: none"> <li>• Using web-based learning is a good idea [154].</li> <li>• Overall, I like using web-based learning [154].</li> </ul>	<p><b>Q6 Competing Attitude</b></p> <ul style="list-style-type: none"> <li>a) Social personalisation e-learning (Topolor) is a good idea. I like it more than classroom learning.</li> <li>b) Social personalisation e-learning (Topolor) is a bad idea. I dislike it. I prefer classroom learning.</li> <li>c) Social personalisation e-learning (Topolor) is a good idea. I like it more than traditional e-learning (Jusur).</li> <li>d) I don't mind it either way (social personalised e-learning (Topolor) or classroom learning).</li> <li>e) I don't mind it either way (social personalised e-learning (Topolor) or traditional e-learning (Jusur)).</li> <li>f) Social personalisation e-learning (Topolor) is a bad idea. I dislike it. I prefer traditional e-learning (Jusur).</li> </ul>	<p><b>H1.1</b> Saudi students' <i>attitudes</i> towards a social personalised e-learning system are <i>more positive</i> than their attitudes towards the traditional e-learning system.</p>
Original Perceived Ease of Use Items	Modified Perceived Ease of Use Items	Hypothesis
<ul style="list-style-type: none"> <li>• I find the e-learning system to be easy to use [8].</li> <li>• Learning to use e-learning will be easy for me [8].</li> </ul>	<p><b>Q7: Competing Perceived Ease of Use</b></p> <ul style="list-style-type: none"> <li>a) Social personalisation e-learning (Topolor) is easy to use. I find it easy to use or to learn to use, when compared to e-learning (Jusur).</li> <li>b) Social personalisation e-learning (Topolor) is easy to use. I find it easy to use or to learn to use, when compared to classroom learning.</li> <li>c) Social personalisation e-learning (Topolor) is similar in difficulty with classroom learning in both usage and learning to use it.</li> <li>d) Social personalisation e-learning (Topolor) is similar in difficulty with e-learning (Jusur) in both usage and learning to use it.</li> <li>e) I find traditional e-learning (Jusur) easy to use or to learn to use, when compared to social personalisation e-learning (Topolor).</li> <li>f) I find classroom learning easy to use or to learn to use, when compared to social personalisation e-learning (Topolor).</li> </ul>	<p><b>H1.2</b> Saudi students' <i>perceived ease of use</i> towards a social personalised e-learning is greater than their perceived ease of use towards the traditional e-learning system and classroom learning.</p>

	<b>Perceived Ease of Use of the Jusur System for Collaborative Group Project</b>	<b>Hypothesis</b>
	10 Using the Jusur system for collaborative group project would make it easier to do my academic project.	H2.2 Saudi students <i>perceive ease of use</i> towards the traditional collaborative learning system (Jusur system) for group project working.
	10 Learning to deal with the Jusur system for group projects is easy for me.	
	11 I find the Jusur system to be flexible to interact with my group project.	
	12 I find it easy to do what I want to do with my group project in the Jusur system.	
	13 It is easy for me to become skilful at using the Jusur system for collaborative projects.	
	14 I find the Jusur system easy to use for group projects.	
	15 My interaction with the collaborative tool in the Jusur system is clear and understandable.	
<b>Original Perceived Usefulness Items</b>	<b>Modified Perceived Usefulness Items</b>	
<ul style="list-style-type: none"> <li>Using the e-learning system improves my learning performance [8].</li> <li>I find the e-learning system to be useful in my learning[8].</li> </ul>	<b>Q8: Competing Perceived Usefulness</b>	H1.3 Saudi <i>students' perception of the usefulness</i> of a social personalised e-learning system is higher than their perception of the usefulness of the traditional e-learning system and classroom learning.
	a) Social personalisation e-learning (Topolor) is useful. It would improve my course performance, when compared to classroom learning.	
	b) Social personalisation e-learning (Topolor) is useful. It would improve my course performance, when compared to e-learning (Jusur).	
	c) Social personalisation e-learning (Topolor) will have no influence on my course performance, when compared to classroom learning.	
	d) Social personalisation e-learning (Topolor) will have no influence on my course performance, when compared to e-learning (Jusur).	
	e) Social personalisation e-learning (Topolor) is not useful. It would decrease my course performance, when compared to classroom learning.	
	Social personalisation e-learning (Topolor) is not useful. It would decrease my course performance, when compared to e-learning (Jusur).	
	<b>Perceived Usefulness of the Jusur System for Collaborative Group Projects</b>	<b>Hypothesis</b>
	10 Using the Jusur system for collaborative group project improves my academic performance.	H2.1 Saudi students <i>perceive usefulness</i> towards the
	11 Using the Jusur system for collaborative group project system would enable me to	

	accomplish tasks more quickly.	traditional collaborative learning system (Jusur system) for group project working.
	12 I would find the Jusur system for collaborative group project useful in my work project.	
	13 Using the Jusur system for collaborative group project increase my productivity.	
	14 Using the Jusur system for collaborative group project would enhance my effectiveness on my study.	
<b>Original Behavioural Intention items</b>	<b>Modified Behavioural Intention Items</b>	
<ul style="list-style-type: none"> <li>I intend to use e-learning to accomplish a learning task whenever it has a feature to help me perform it [8].</li> </ul>	<b><u>Q9 Competing Behavioural Intention</u></b> a) I intend to use social personalised e-learning (Topolor) (e.g., during the semesters, from home, or for coursework). b) I intend to use a blend of social personalised e-learning (Topolor) and traditional Learning (Jusur). c) I intend to use a blend of social personalised e-learning (Topolor) and classroom learning. d) I intend to use a blend of traditional e-learning (Jusur) and traditional learning. e) I prefer non-personalised e-learning (Jusur) for courses, coursework, self-learning. f) I intend to use classroom learning (for courses, coursework, self-learning).	H1.4 Saudi students' <i>perceived intention of further use</i> of a social personalised e-learning system is <i>higher</i> than that of their perceived intention of further use of the traditional e-learning system and classroom learning.
	<b>Behavioural Intention Towards Using the Jusur System for Collaborative Group Project</b>	
	16 I intend to use the Jusur system frequently with my group project.	H2.3 Saudi students perceive intention of further use of the traditional collaborative learning system (Jusur system) for group project working.
	17 I intend to use the Jusur system in doing my academic tasks for group project.	

## 4.5 Results

Table 6 shows the demographics of the students who answered the questionnaire. The students were asked about their year of study and college. Furthermore, two colleges were represented, teaching quite different disciplines, thus corresponding to this thesis's aim to target higher education students from different areas. Saudi Arabian higher education takes four years in total.



In this case study, I have also managed, as planned, to have responses from students from all of these years of study, as shown in Table 6.

**Table 6: Demographics of the respondents of the questionnaire**

Gender	No.	College	No.	Year	No.
Female	68	English	41	1st	11
Male	33	Computer Science	60	2nd	25
				3rd	40
				4th	25

Additionally, for this study, all items in the questionnaire (Appendix A) were first assessed by applying the Kolmogorov-Smirnov [138] Test in SPSS, to evaluate the normality of the distribution. If the P value is greater than 0.05, the data originate from a normally-distributed population. If the P value is less than or equal to 0.05, the data originate from a non-normal distributed population (see Chapter 3). The results of the normality test for all items were less than 0.05, which show non-normal distribution of the items as shown in Table 7. Therefore, a non-parametric Friedman test [153] was used in this study.

**Table 7: Normality Test**

Q6 PA	Kolmogorov-Smirnova		
	Statistic	df	'p' value
a) Social personalisation e-learning (Topolor) is good idea. I like it more than classroom learning.	.46	101	.000
b) Social personalisation e-learning (Topolor) is a bad idea. I dislike it. I prefer classroom learning'.	.43	101	.000
c) Social personalisation e-learning (Topolor) is good idea. I like it more than classic e-learning (Jusur).	.39	101	.000
d) I don't mind it either way (social	.29	101	.000

personalised e-learning (Topolor) or classroom learning).			
e) I don't mind it either way (social personalised e-learning (Topolor) or classic e-learning (Jusur)).	.39	101	.000
f) Social personalisation e-learning (Topolor) is a bad idea. I dislike it. I prefer classic e-learning (Jusur)'	.42	101	.000
Q7 PEOU	<b>Kolmogorov-Smirnova</b>		
	<b>Statistic</b>	<b>df</b>	<b>'p' value</b>
a) Social personalisation e-learning (Topolor) is easy to use. I find it easy to use or to learn to use, when compared to e-learning (Jusur).	.36	101	.000
b) Social personalisation e-learning (Topolor) is easy to use. I find it easy to use or to learn to use, when compared to classroom learning.	.37	101	.000
c) Social personalisation e-learning (Topolor) is similar in difficulty with classroom learning in both usage and learning to use it.	.32	101	.000
d) Social personalisation e-learning (Topolor) is similar in difficulty with e-learning (Jusur) in both usage and learning to use it.	.40	101	.000
e) I find traditional e-learning (Jusur) easy to use or to learn to use, when compared to social personalisation e-learning (Topolor).	.32	101	.000
f) I find classroom learning easy to use or to learn to use, when compared to social personalisation e-learning (Topolor).	.46	101	.000
Q8 PUF	<b>Kolmogorov-Smirnova</b>		
	<b>Statistic</b>	<b>df</b>	<b>'p' value</b>
a) Social personalisation e-learning (Topolor) is useful. It would improve my course performance, when compared to classroom learning.	.36	101	.000
b) Social personalisation e-learning	.39	101	.000

(Topolor) is useful. It would improve my course performance, when compared to e-learning (Jusur).			
c) Social personalisation e-learning (Topolor) will have no influence on my course performance, when compared to classroom learning.	.36	101	.000
d) Social personalisation e-learning (Topolor) will have no influence on my course performance, when compared to e-learning (Jusur).	.38	101	.000
e) Social personalisation e-learning (Topolor) is not useful. It would decrease my course performance, when compared to classroom learning.	.311	101	.000
f) Social personalisation e-learning (Topolor) is not useful. It would decrease my course performance, when compared to e-learning (Jusur).	.312	101	.000
Q9 PI	<b>Kolmogorov-Smirnova</b>		
	<b>Statistic</b>	<b>df</b>	<b>'p' value</b>
a) I intend to use social personalised e-learning (Topolor) (e.g., during the semesters, from home, or for coursework).	.43	101	.000
b) I intend to use a blend of social personalised e-learning (Topolor) and traditional Learning (Jusur).	.33	101	.000
c) I intend to use a blend of social personalised e-learning (Topolor) and classroom learning.	.47	101	.000
d) I intend to use a blend of traditional e-learning (Jusur) and traditional learning.	.50	101	.000
e) I prefer non-personalised e-learning (Jusur) for courses, coursework, self-learning.	.467	101	.000
f) I intend to use classroom learning (for courses, coursework, self-learning).	.44	101	.000

#### 4.5.1 Results on the Acceptance of Social Personalised e-learning, versus Traditional e-learning and Classroom Learning

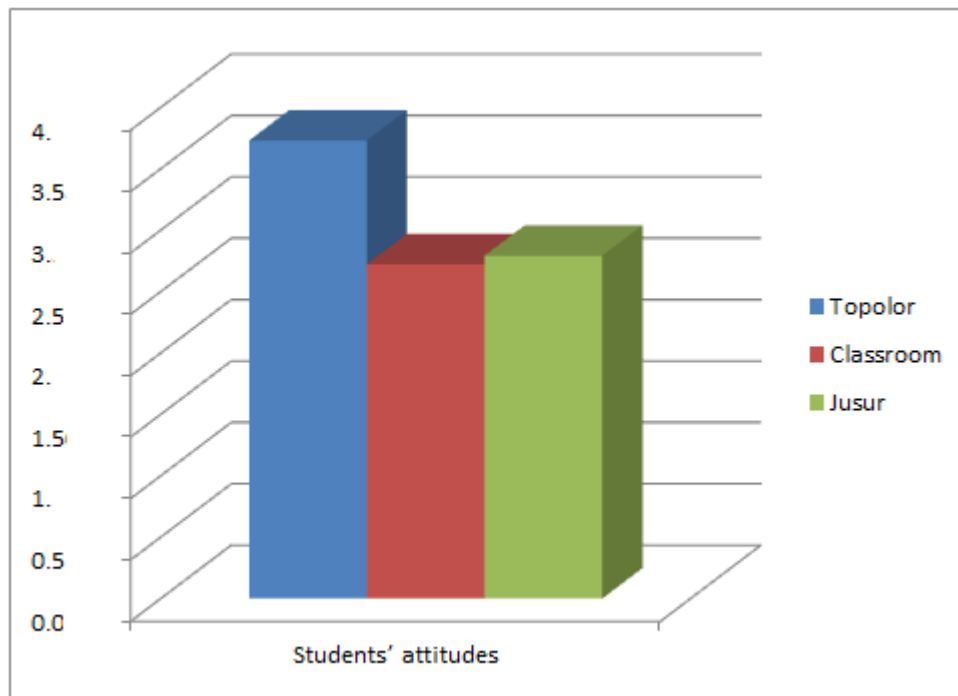
Table 13 presents overview results on the acceptance of social personalised e-learning, versus traditional e-learning and classroom learning.

Question 6 in the questionnaire (Annex A) was aimed to examine students' **attitudes** towards social personalised e-learning. In this question, the vast majority of respondents (56.4%) were *positive* towards *social personalised e-learning*, and they liked it more than traditional e-learning. Still, a few (21.8%) students' attitudes were negative towards social personalised e-learning, and they preferred traditional e-learning.

Furthermore, 51% of the respondents preferred social personalisation e-learning more than classroom learning, whereas 7.9% of the respondents disliked it and preferred classroom learning.

Additionally, Figure 2 reveals that the average Saudi student's attitude towards a *social personalised e-learning* system  $M= 3.73$  is more positive than their attitude towards the traditional e-learning system  $M=2.79$  and classroom learning  $M=2.72$ .

Moreover, a non-parametric Friedman test of differences amongst the three education methods was conducted and rendered a Chi-square value of 148.45 which was statistically significant ( $p<.05$ ) as shown in Table 8. Thus, the differences in the students' attitudes about the three alternatives presented, the personalised social e-learning system, versus the traditional e-learning system, versus classroom teaching, are statistically significant. Students prefer the former to the latter, and consider traditional classroom teaching the worst. Therefore, hypothesis H1-1 has been supported.



**Figure 2: Students' Attitudes**

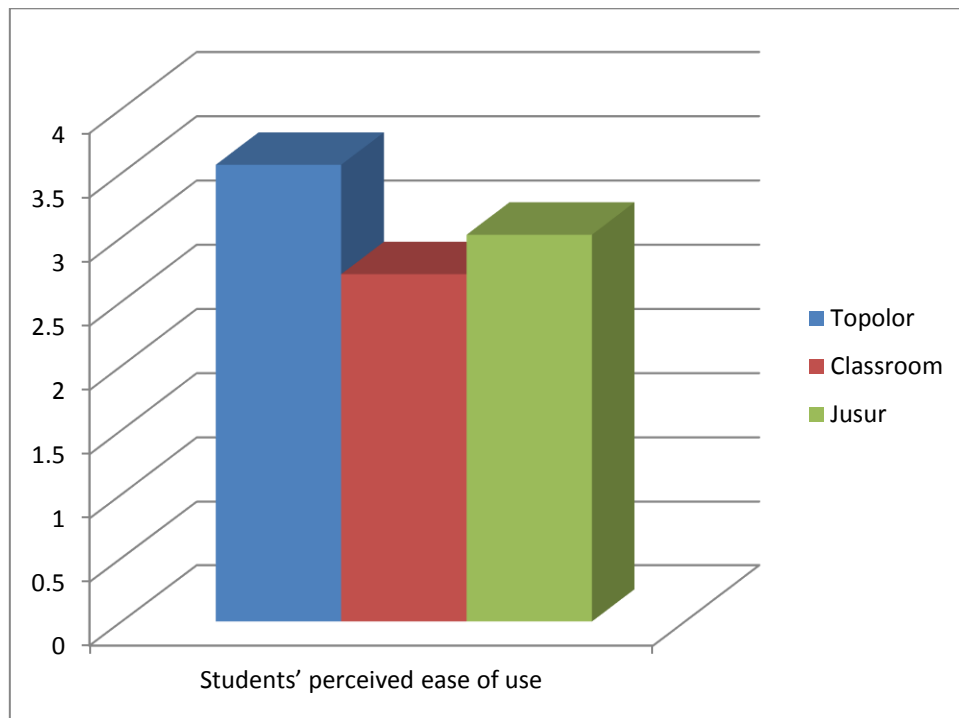
**Table 8: Friedman Test: Students' Attitudes**

<b>N</b>	101
<b>Chi-Square</b>	148.45
<b>df</b>	2
<b>Asymp. Sig.</b>	.000

Moreover, Question 7 in the same questionnaire (Annex A) was aimed to test students' perceived **ease of use** for *social personalisation e-learning*. In this question, 54.9% of the respondents supported the statement '*Social personalisation e-learning is easy to use. I find it easy to use or to learn to use, when compared to e-learning (Jusur)*' while 23.5% of the respondents indicated that '*I find traditional e-learning (Jusur) easy to use or to learn to use, when compared to social personalisation e-learning (Topolor)*'. Moreover, 57.4% of the respondents indicated that '*Social personalisation e-learning (Topolor) is easy to use. I find it easy to use or to learn to use, when compared to classroom learning.*' whereas 5.9% of the respondents indicated that '*I find classroom learning easy to use or to learn to use, when compared to social personalisation e-learning (Topolor)*'. Figure 3 shows that the average Saudi students' *perceived ease of use for a social personalised e-learning system*  $M= 3.56$  is

more than their *perceived ease of use* for the traditional e-learning system M=3 and classroom learning M=2.71.

Moreover, a non-parametric Friedman test of the differences among students' perceived ease of use for the three education approaches was conducted and rendered a Chi-square value of 104.02, which was statistically significant ( $p < .05$ ) as shown in Table 9. Thus, students clearly found personalised social e-learning (in the form of Topolor) easier to use than traditional e-learning (in the form of Jusur), and both easier to use than classroom teaching. Therefore, hypothesis H1-2 has been supported.



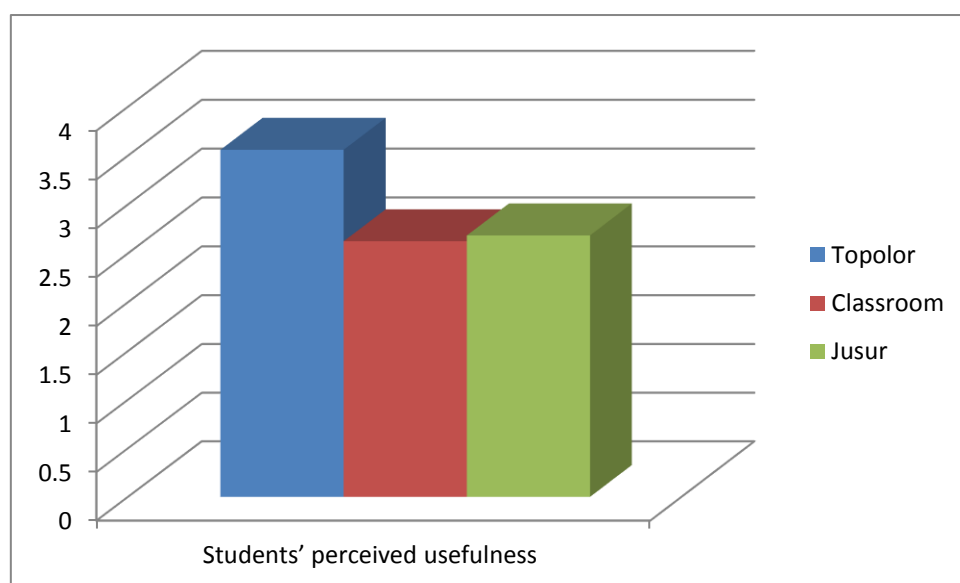
**Figure 3: Students' perceived ease of use**

**Table 9: Friedman Test\_ Students' perceived ease of use**

<b>N</b>	101
<b>Chi-Square</b>	104.022
<b>df</b>	2
<b>Asymp. Sig.</b>	.000

Furthermore, Question 8 in the same questionnaire (Annex A) was designed to examine students' *perceived usefulness* of social personalised e-learning.

In this question 61% of the respondents believed that ‘social personalisation e-learning is useful. It would improve my course performance, when compared to classroom learning’, whereas 8.8% of the respondents doubted it. Moreover, 60.8% of the respondents believed that ‘social personalisation e-learning is useful. It would improve my course performance, when compared to e-learning’, while 10.8% of the respondents doubted it. Additionally, 12% of the respondents indicated that social personalisation will have no influence on their course performance, when compared to e-learning, and 5% of the respondents indicated that social personalisation will have no influence on their course performance, when compared to classroom learning. Figure 4 shows that the average Saudi student’s perceived usefulness towards a social personalised e-learning system  $M= 3.55$  is higher than their perceived usefulness towards the traditional e-learning system  $M=2.68$  and classroom learning  $M=2.62$ . Additionally, a non-parametric Friedman test of variances among students’ perceived usefulness towards three learning approaches was conducted and rendered a Chi-square value of 102.82, which was statistically significant ( $p<.05$ ) as shown in Table 10. Again, students found personalised social e-learning (in the form of Topolor) more useful than traditional e-learning (in the form of Jusur), and both more useful than classroom teaching although the difference between classroom and Jusur was somewhat smaller than for the ease of use. Therefore, hypothesis H1-3 was supported.



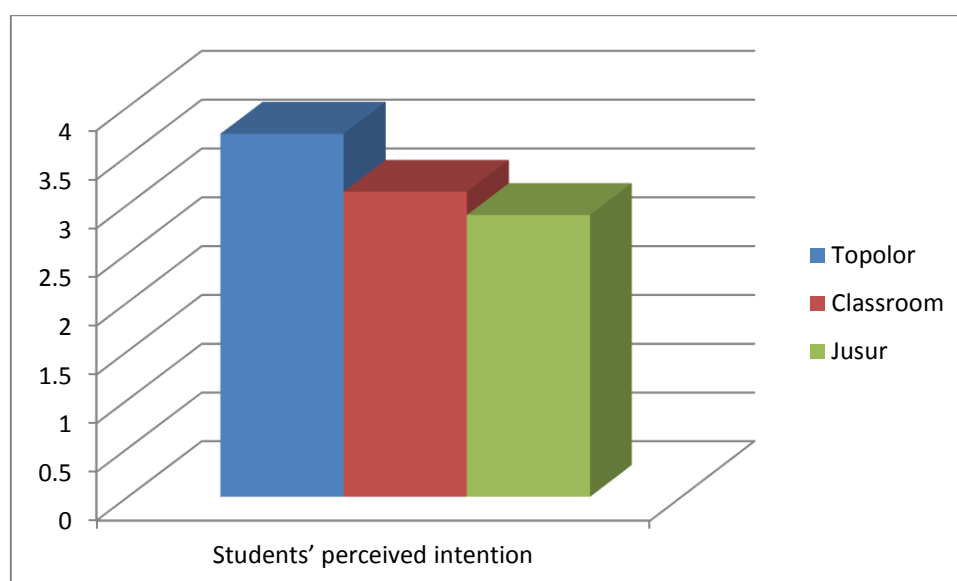
**Figure 4: Students’ perceived usefulness**

**Table 10: Friedman Test Students' perceived usefulness**

<b>N</b>	101
<b>Chi-Square</b>	102.820
<b>df</b>	2
<b>Asymp. Sig.</b>	.000

Furthermore, Question 9 in the same questionnaire (Annex A) was designed to examine students' perceived **intention to use** social personalised e-learning. The students' intention to use social personalised e-learning (51%) was higher than that of that of being involved in classroom learning (18.8%). The remaining student respondents (33.7%) intended to use a blend of social personalised e-learning and classroom learning. Figure 5 shows that the average *Saudi students' perceived intention* to use a social personalised e-learning system  $M= 3.72$  is *more* than their *perceived intention* to use the traditional e-learning system  $M=3.12$  and classroom learning  $M=2.89$ . Moreover, a non-parametric Friedman test of differences among the students' perceived intention to use the three education approaches was conducted, and rendered a Chi-square value of 91.70 which was statistically significant ( $p<.05$ ) as shown in Table 11. Here, students' intention of further use of personalised social e-learning (in the form of Topolor) is higher than both traditional e-learning and classroom teaching. Therefore, hypothesis H1-4 has been supported. However, students intend to use classroom teaching more often than traditional e-learning, as can be seen in Figure 5.

**Figure 5: Students' perceived intention of further use**





**Table 11: Friedman Test: Students' perceived intention**

<b>N</b>	101
<b>Chi-Square</b>	91.709
<b>df</b>	2
<b>Asymp. Sig.</b>	.000

These outcomes were further confirmed by the qualitative feedback. There are some examples in .

Table 12, as translated from Arabic.

**Table 12: Students' feedback**

<b>N_Students</b>	<b>English</b>	<b>Arabic</b>
8	1. <i>Jusur has poor opportunities for social interaction and the exchange of different views related to a topic, unlike the Topolor system, which has rich features for social interaction, such as for sharing learning materials, using communication tools to chat, writing comments, and sending messages.</i>	جسور لديها فرص الفقيرة للتفاعل الاجتماعي وتبادل وجهات النظر المختلفة المتعلقة موضوع، على عكس ، التي لديها ميزات غنية للتفاعل Topolor نظام الاجتماعي، مثل لتبادل المواد التعليمية، وذلك باستخدام وسائل الاتصال للدراسة، وكتابة التعليقات، وإرسال الرسائل.
8	2. <i>I prefer the Topolor system to Jusur, because I can have an overall view of my learning status, such as about the topics that I have learnt, and which next topic to</i>	أفضل نظام تبلور عن جسور، لأنني أستطيع الفى نظرة شاملة للوضعى تعليمي، مثل المواضيع التي تعلمتها، الموضوع التالي للتعلم، والاختبارات القصيرة التي ادبتها، عرض التاريخ مناقشات، عند اختيار موضوع معين

	<p><i>learn, quizzes I have done, and I can view the history of the discussion, when selecting a particular topic.</i></p>	
9	<p>3. <i>My view is that the Topolor system is more useful than Jusur, because students can improve their learning, by exchanging their knowledge, taking quizzes on a learning topic and can access the learning topics related to the questions, in a quiz.</i></p>	<p>رأبي هو أن النظام تبلور هو أكثر فائدة من جسور، لأنه يمكن الطلاب على تحسين التعلم من خلال تبادل معارفهم، وايضا الاختبارات القصيرة لموضوع التعلم، ويمكن الوصول إلى مواضيع التعلم ذات الصلة على الأسئلة،الاختبارات القصيرة .</p>
7	<p>4. <i>I prefer the Topolor system to Jusur, because I can test my knowledge about lesson before I move to next lesson and I can easily find students to ask questions, which related to the same lesson</i></p>	<p>فضل نظام تبلور عن جسور، لأنه يمكنني اختبار معرفتي لدرس قبل أن أنتقل إلى الدرس التالي و بسهولة ان اجد الطلاب لطرح الأسئلة، التي تتعلق بنفس الدرس</p>
5	<p>5. <i>I see Topolor system is more useful than Jusur, because Topolor system encourage to self-reliance</i></p>	<p>نظام تبلور مفيد اكثر من جسور لانه يشجع على الاعتماد على الذات في التعلم</p>

	<i>in learning more than Jusur.</i>	
9	6. <i>I like Topolor and Jusur e-learning than traditional learning because they offer chance for study, ask questions without any hesitation and participation at my convenience time.</i>	<i>افضل نظام تبلور وجسور بدلا من التعليم التقليدي لأنها توفر فرصة للدراسة و طرح الاسئلة بدون اي تردد والمشاركة في اي وقت مناسب لي</i>

**Table 13: Overview Results on the Acceptance of Social Personalised e-learning, versus Traditional e-learning and Classroom Learning**

Q6	Mean	StDev	Range	Interpretation
a) Social personalisation e-learning (Topolor) is good idea. I like it more than classroom learning.	3.79	.43	3	Agree
b) Social personalisation e-learning (Topolor) is a bad idea. I dislike it. I prefer classroom learning'.	2.72	.68	3	Neither
c) Social personalisation e-learning (Topolor) is good idea. I like it more than traditional e-learning (Jusur).	3.69	.52	3	Agree
d) I don't mind it either way (social personalised e-learning (Topolor) or classroom learning).	2.87	.84	3	Neither
e) I don't mind it either way (social personalised e-learning (Topolor) or traditional e-learning (Jusur)).	2.80	.66	3	Neither
f) Social personalisation e-learning (Topolor) is a bad idea. I dislike it. I prefer traditional e-learning (Jusur)	2.79	.63	3	Neither

Q7:EOU	Mean	StDev	Range	
a) Social personalisation e-learning (Topolor) is easy to use. I find it easy to use or to learn to use, when compared to e-learning (Jusur).	3.55	.49	1	Agree
b) Social personalisation e-learning (Topolor) is easy to use. I find it easy to use or to learn to use, when compared to classroom learning.	3.57	.49	1	Agree
c) Social personalisation e-learning (Topolor) is similar in difficulty with classroom learning in both usage and learning to use it.	2.94	.77	3	Neither
d) Social personalisation e-learning (Topolor) is similar in difficulty with e-learning (Jusur) in both usage and learning to use it.	2.69	.70	3	Neither
e) I find traditional e-learning (Jusur) easy to use or to learn to use, when compared to social personalisation e-learning (Topolor).	3.01	.74	3	Neither
f) I find classroom learning easy to use or to learn to use, when compared to social personalisation e-learning (Topolor).	2.71	.57	2	Neither
Q8:UF	Mean	StDev	Range	
a) Social personalisation e-learning (Topolor) is useful. It would improve my course performance, when compared to classroom learning.	3.50	.78	3	Agree
b) Social personalisation e-learning (Topolor) is useful. It would improve my course performance, when compared to e-learning (Jusur).	3.65	.48	1	Agree
c) Social personalisation e-learning (Topolor) will have no influence on my course performance, when compared to classroom learning.	2.65	.68	3	Neither
d) Social personalisation e-learning (Topolor) will have no influence on my course performance, when compared to e-learning (Jusur).	2.88	.69	3	Neither
e) Social personalisation e-learning (Topolor) is not useful. It would decrease my course performance, when compared to classroom learning.	2.62	.77	3	Neither
f) Social personalisation e-learning (Topolor) is not useful. It would decrease my course performance, when compared to e-learning (Jusur).	2.68	.77	3	Neither
Q9:PI	Mean	StDev	Range	
a) I intend to use social personalised e-learning (Topolor) (e.g., during the semesters, from home, or for coursework).	3.72	.47	2	Agree
b) I intend to use a blend of social personalised e-learning (Topolor) and traditional Learning (Jusur).	2.97	.33	2	Neither
c) I intend to use a blend of social personalised e-learning (Topolor) and classroom learning.	3.23	.42	1	Neither
d) I intend to use a blend of traditional e-learning (Jusur) and traditional learning.	3.13	.44	2	Neither

e) I prefer non-personalised e-learning (Jusur) for courses, coursework, self-learning.	2.89	.34	2	Neither
f) I intend to use classroom learning (for courses, coursework, self-learning).	3.12	.59	2	Neither

As can be seen, the students specifically praised the personalisation and social interaction features in Topolor, which were not available in Jusur: *personalisation features* [40], such as: *direct guidance* [40] via the ‘next topic’, directions to topics, related topics, connecting topics to related questions and quizzes; and *social features* [20], such as: discussion, sharing learning materials, communication tools, comments writing, sending of messages, exchanging knowledge with peers.

#### 4.5.2 Results on performing a Collaborative Project via a Traditional e-learning System

The questionnaire (Appendix A) outcomes conforming to students’ *perceived e-learning usefulness* (Items 10 to 15), *ease of use* (Items 16 to 21), and *intention of further use* (Items 22 and 23) for group projects are shown in Table 14.

As can be seen, the means for *usefulness* range between 2.62 and 2.73, and the *medians* are mostly 3. The *standard deviations* (SD) range between 0.33 and 0.48. The result was statistically significant ( $p < .05$ ). Moreover, *Cronbach’s alpha* of the results for the *usefulness* score is 0.86 ( $> 0.8$ ), showing a ‘good’ level of reliability [147]. All the *means* are less than 3.50. Therefore, hypothesis H2.1 cannot be supported.

Moreover, the means for the ease of use range between 2.79 and 2.98, and the *medians* for the ease of use are 3. The *standard deviations* range between 0.30 and 0.41. The result was statistically significant ( $p < .05$ ). Moreover, *Cronbach’s alpha* of the results for *ease of use* is 0.70 ( $> 0.7$ ), showing an ‘acceptable’ level of reliability [147]. All the *means* are less than 3.50. Therefore, hypothesis H2.2 cannot be supported.

Furthermore, the *means* for the *intention of further use* score 2.29, and the *medians* are 2. The *standard deviations* range between 0.59 and 0.60. The outcome was statistically significant ( $p < .05$ ). Moreover, *Cronbach’s alpha* of the results for *ease of use* is 0.75 ( $> 0.7$ ), showing an ‘acceptable’

level of reliability [147]. All the *means* are less than 3.50. Therefore, hypothesis H2.3 cannot be supported.

**Table 14: Results Using Jusur System for a Collaborative Project.**

Items	Mean	Median	StDev	Interpretation
10 Using the Jusur system for collaborative group project would improve my academic performance.	2.73	3	.46	Neither
11 Using the Jusur system for collaborative group project system would enable me to accomplish tasks more quickly.	2.71	3	.47	Neither
12 I would find the Jusur system for collaborative group project useful in my work project.	2.62	3	.48	Neither
13 Using the Jusur system for collaborative group project would increase my productivity.	2.72	3	.44	Neither
14 Using the Jusur system for collaborative group project would enhance my effectiveness on my study.	2.69	3	.46	Neither
15 Using the Jusur system for collaborative group project would make it easier to do my academic tasks project.	2.89	3	.33	Neither
16 Learning to deal with the Jusur system for group project is easy for me.	2.89	3	.31	Neither
17 I find the Jusur system to be flexible to interact with my group project.	2.79	3	.40	Neither
18 I find it easy to do what I want to do with my group project in the Jusur system.	2.81	3	.39	Neither
19 It is easy for me to become skilful at using the Jusur system for collaborative project.	2.98	3	.41	Neither
20 I find the Jusur system easy to use for group projects.	2.92	3	.30	Neither
21 My interaction with the collaborative tool in the Jusur system clear and understandable.	2.81	3	.41	Neither
22 I intend to use the Jusur system frequently with my group project.	2.29	2	.59	Disagree
23 I intend to use the Jusur system in doing my academic tasks for group project.	2.29	2	.60	Disagree

These results were further confirmed by the qualitative feedback such as in Table 15 (as translated from Arabic).

**Table 15: students' feedbacks about using Jusur system for a collaborative project**

N_students	English	Arabic
3	<p>1. <i>It is difficult for me using collaboration tools in e-learning, because I do not have experience in using collaboration tools.</i></p>	<p>بالنسبة لي صعب استخدام أدوات التعاون في التعليم الإلكتروني، لأنني ليس لدي الخبرة في مجال العمل التعاوني</p>
7	<p>2. <i>E-learning is useful for online students' communities, to exchange knowledge, but it is not useful for a group project. We need more tools to help us to plan and divide the project tasks, including communication tools used during a group collaboration project.</i></p>	<p>التعلم الإلكتروني هو مفيد للمجتمعات الطلاب عبر الإنترنت لتبادل المعرفة، ولكن ليس مفيد لعمل الجماعي لمشاريع. نحن بحاجة الى مزيد من الأدوات لمساعدتنا في تخطيط وتقسيم مهام المشروع، بما في ذلك وسائل الاتصال المستخدمة خلال مشروع تعاون فريق</p>
8	<p>3. <i>It does not offer the possibility for group members to work together on a project. It does not provide a secure space for a group of students to share personal learning resources and to work collaboratively.</i></p>	<p>التعليم الإلكتروني لا توفر إمكانية لأعضاء المجموعة للعمل معا من اجل اداء مشروع. فإنه لا يوفر مكان آمن لمجموعة من الطلاب لتبادل الموارد التعليمية الشخصية متعلقه مشروع والعمل بشكل تعاوني</p>
9	<p>4. <i>It is difficult to decide upon the selection of group members, because some</i></p>	<p>من الصعب اختيار أعضاء المجموعة، لأن بعض الطلاب لا تساهم في مناقشة واداء مهام المشروع، التي تؤثر على المشروع، ومن ثم نتيجة النهائيه بدرجة المشروع</p>

	<p><i>students do not contribute in a discussion and task, which influences the project productivity, and then our score result.</i></p>	
8	<p>5. <i>E-learning is not useful for group projects, because it does not support managing the project. It does not enable group members to define clear aims and make detailed plans, create, and edit documents, maintain a shared team calendar, and integrate input from all members.</i></p>	<p>التعلم الإلكتروني ليس مفيدا لمشاريع المجموعة، لأنه لا يدعم إدارة المشروع. فإنه لا تمكن أعضاء المجموعة لتحديد أهداف واضحة و وضع خطط مفصلة وإنشاء وتعديل مستندات المشروع ، وإدارة تقويم مشترك لأعضاء المجموعة، ودمج انتاج المهام من جميع الأعضاء</p>

#### 4.6 Discussion

The case study presented above was conducted to explore *students' acceptance* towards *social personalised* versus traditional e-learning, in a Saudi university. Four perceptions were evaluated: *students' perceived attitudes*, *usefulness*, *ease of use*, and *intention of further use* of the two systems. In terms of data collection, survey questionnaires and interviews were conducted. The qualitative feedback was consistent with the outcomes of the questionnaire.

The results showed that *attitudes* were more positive towards *social personalised* e-learning than towards the traditional e-learning, based on actual hands-on experience with both types of systems. Further supporting evidence of this came when analysing the *perceived usefulness* of such systems. The results revealed that the majority of students perceived *social personalised* e-learning as more



*useful* than traditional e-learning. More interestingly, the vast majority of students stated that *social personalised* e-learning is actually *easier to use* than traditional e-learning. If a student perceives e-learning as useful, they are more likely to have a favourable attitude towards accepting it [113]. Thus, to facilitate the acceptance of e-learning, it is very helpful to enhance the students' perceptions of the usefulness of this type of education. Prior research has shown that if a system is difficult to use, the user may be discouraged from using it [113]. Therefore, designing easy to use and user-friendly systems is very important for their acceptance.

With regard to collaborative projects using the traditional e-learning system (Jusur system), there are three tools that are used to support group work: chats, forums, and glossaries. The Jusur system provides simple support for structuring and managing collaboration. Group membership is decided by the teacher or student. The study results indicate that Saudi students cannot be said to *perceive usefulness, ease of use, and intention of further use* towards the traditional collaborative learning system (Jusur system) for group project work. This gives grounds to believe that students need advanced e-learning tools for collaborative projects, to encourage and allow them to take control of their projects. As derived from the qualitative answers of the students, as well as prior research (see Chapter 2), the key features of such a system would be to assist students to build teams, provide a secure space for students to share personal learning resources and to work collaboratively, and enable them to define clear aims, make detailed plans, create and edit documents, maintain a shared team calendar, and integrate input from all members. It is essential that e-learning systems assist students to work together in collaborative groups.

Additionally, some students struggle with communication tools and interpersonal skills, or have poor knowledge related to the topic of the project, and this influences the outcome of a project. An environment that is appropriate for some students may be inappropriate for other students. For example, some students have little collaboration experience; thus, they need a great deal of support. Students tend to have different interests, preferences, skills, experiences, backgrounds, or even knowledge. This means that the current solution of a one-size-fits-all approach may not be appropriate for Saudi education. The results may suggest a need for offering training or guidance to students who

have little collaboration experience on how to interact and use such systems (e.g., video tutorials or system guidance). Using adaptive collaborative e-learning tools can help to overcome these perceived difficulties of collaborative e-learning and improve the interaction between learners, to effectually share knowledge and ideas, which can support the development of mutually beneficial relationships and productive projects.

Moreover, the results may suggest a need for offering project management for group projects with collaborative e-learning tools. A well-defined task structure positively influences the efficiency, effectiveness, and satisfaction level of global virtual teams [28]. Individual responsibility and commitment towards work are vital factors for creating trust among group members [29].

This corresponds to the Saudi students' desire for social personalised aspects in e-learning. Moreover, Saudi students do not *perceive acceptance* towards the traditional collaborative learning system (Jusur system) for group project work.

Some general remarks need made about the limitations of this particular study. The target population is that of Saudi students, so the study matches well with this goal. Ideally, students should be selected from different levels of education: this goal is reached. Moreover, students should be selected from different areas of study: this level is somewhat reached, as the study uses students from two quite different areas of study. However, the study is not exhaustive in this respect, as it does not cover all study areas for students in higher education in Saudi Arabia, and this needs noted. Furthermore, ideally, different universities would need to be represented: this goal is not reached, as the study focuses, for convenience and access to students' purposes, on one university only. Thus, this represents another limitation of this study. More considerations on the limitation of this study and such studies in general, can be found in chapter 3.

Based on these results, we have decided to introduce a special type of personalisation supporting virtual project and team formation methods (adaptive team-formation, on the recommended project, adaptive task, and adaptive communication mechanism) due to the needs I have identified, as well as

in order to explore a specific niche in the e-learning literature, especially in project-based learning. These are further studied and evaluated in the following chapters.

#### **4.7 Conclusion**

In this chapter, the study has considered the requirements for applying social and personalised e-learning targets to the Saudi higher education system. This research is one of the few studies to have investigated the acceptance of social personalisation e-learning versus traditional learning (classroom or e-learning) in Saudi Arabia. Additionally, the study has used the Technology Acceptance Model (TAM) [155], to explain the acceptance of social personalised e-learning by the students of Taibah University. Furthermore, this study has contributed to the understanding of issues linked to the acceptance of web-based education. Factors that need to be taken into account, such as attitude and perception of usefulness and ease of use, are just as important as the actual usefulness and ease of use, and lead to the strong need of proper training regarding the benefits of e-learning. More importantly, social personalisation seems to be stringently needed in the implementation of e-learning in Saudi Arabia.

In conclusion, this chapter aimed to address the research objectives **O2** ‘explore Saudi students’ acceptance of a social personalised e-learning versus the traditional e-learning system and classroom learning’ and **O3** ‘explore Saudi students’ acceptance of the traditional collaborative e-learning for group project work’.

The key objectives of the study presented in this chapter were to answer the following research questions.

**R1:** *‘Is Saudi students’ acceptance of social personalised e-learning higher than the traditional e-learning and classroom learning’?* The answer is **‘Saudi students’ acceptance of social personalised e-learning (Topolor) is higher than the traditional e-learning (Jusur system) and classroom learning’**.

**R2:** *‘Do Saudi students demonstrate acceptance of traditional collaborative e-learning for group project work’?*

The answer is '**Saudi students do not perceive acceptance towards the traditional collaborative learning (Jusur system) for group project working**'.

In the next chapter, the needs of the students for the recommended project, group members, and communication tools for group projects, are explored, aiming at collecting the requirements for the implementation of the research environment. Additionally, a framework for the recommendation of collaborative project work is proposed, to function within a social e-learning system. Based on this framework, the architecture of the Topolor 3 system is defined, and the system is implemented.

# Chapter 5: Design and Implementation of a Collaborative Recommender System for Online Group Projects

## 5.1 Overview

Collaborative work in projects aids students to combine their personal expertise, experience and ability to achieve a shared work goal. However, a collaborative working environment that is appropriate for some students may be not suitable for other students. Students tend to have different interests, preferences, backgrounds or even knowledge. There is limited support for them that satisfies individual student's needs in the collaborative process.

However, the review of the previous work (see section 2.4) indicates that current research about adaptive systems for collaborative learning support (ASCLS) systems have focused on the group formation process, which is determined systematically, based on the students' profiles, and the information sharing process in groups. However, there have been very few studies about adaptation for project task management. Therefore, to address the gaps in prior research, this study aims to propose an approach for using a student-centred method in project-based e-learning, to support the student in decisions regarding project definition, based on students' knowledge and skills; group membership, based on student profile characteristics; project tasks, based on students' personalities; and communication tools, by providing adaptive recommendations.

This chapter looks into the specific case of Saudi Arabia, to identify the *cultural factors* that influence acceptance of e-learning, including the more recently developed area of *group projects in e-learning*. This research identifies *Saudi Arabian users' cultural* characteristics, by analysing Hofstede's cultural value dimensions, and their appropriateness for Saudi Arabian e-learning. Additionally, it considers the needs of the Saudi Arabian students, with respect to the

project, group members, and project task and communication tools for the group project, aiming at collecting the requirements for the implementation of the recommender environment.

The objectives that this chapter addresses are as follows.

**O4:** Explore the cultural characteristics of Saudi Arabian students using Hofstede's cultural value dimensions.

**O5:** Explore the needs of the students in relation to the recommended project group membership, the recommended task and the recommended communication tools for the group project, with the aim of determining what is necessary for implementation of the recommendation environment.

**O6:** Propose a framework for recommendation of collaborative projects within e-learning. Based on this framework, the architecture of the system to be implemented will be defined, and implemented.

The process of addressing these research objectives, together with the result from the work that will be presented in chapter 6, supports answering research question **R3**: '*Are personalised virtual project and team formation methods for e-learning more acceptable to Saudi students than traditional project and team formation methods for e-learning*'?

## 5.2 Hypotheses

According to Hofstede [16], the Arab countries were classified as having high power distance (80), high uncertainty avoidance (68), a collectivist culture (91 on individualism), and a masculine culture (52). This study *explores the cultural factors of the Saudi Arabian students, by using the Hofstede cultural value dimensions* to identify design features into e-learning and to meet the Saudi Arabia cultural requirements. Therefore, the following *hypothesis* is constructed, and further detailed into sub-hypotheses.

**H3:** Saudi Arabian *users' cultural characteristics* are similar to Hofstede's 1980 analysis for the Arab world and can be applied for Saudi Arabian e-learning.

**H3.1** Hofstede's *High Power Distance* can be applied to Saudi Arabian e-learning.

**H3.2** Hofstede's *Masculinity Index* characteristics can be applied to Saudi Arabian e-learning.

**H3.3** Hofstede's *High Uncertainty Avoidance Index* characteristics can be applied to Saudi Arabian e-learning.

**H3.4** Hofstede's *Collectivism Index* characteristics can be applied to Saudi Arabian e-learning.

### **5.3 Investigating the needs of students in relation to recommended project groups**

Students are the central participants in the e-learning environment, so students' opinions should be considered in the design of e-learning. They can aid the designer in the design process, by expressing their needs, which can lead to the development of more effective learning environments [156]. Therefore, one of the objectives of this chapter is to *explore the needs of the students in relation to the recommended project group members, to the recommended task and the recommended communication tools for the group project, aiming at collecting the requirements for the implementation of the recommendation environment.*

The resulting **hypotheses** are as follows.

**H4:** The students' *knowledge level, skill, interests and personality* parameters can be considered for recommending the project topic.

**H5:** The students' *knowledge level, skill, collaborative behaviour, and gender* can be considered for recommending group members.

**H6:** The students' *personality and collaborative behaviour* can be considered for recommending communication tools.

**H7:** The students' *personality parameters* can be considered for recommending project tasks.

**H8:** The student's *self-defined* virtual project group membership based on system-generated profiles, is preferable, when compared to the system-organised virtual project group membership.

**H9:** Students consider the usage of *Web 2.0 tools* to activate from group projects within e-learning useful.

**H10:** *Social networks* are useful for building students' profiles.

## 5.4 Experimental Setup

The experiment was conducted over two phases, as follows.

In the first experiment, a questionnaire-based experiment was conducted, to study Saudi Arabia users' cultural characteristics. The population was students from Saudi Arabia. A deliberate effort was made to include students from various universities in Saudi Arabia to cover the students' different opinions. As a result, websites were chosen that were affiliated with King Faisal University, Qassim University, Taibah University and the University of Tabuk, where students from these universities were subscribers and contributors to the sites. The questionnaire (Appendix B) was distributed online using one of the websites designated for research purposes; specifically the survey gizmo (<http://www.surveygizmo.com>). A link to the questionnaire was provided on the introductory post to the websites. The questionnaire was developed based on measures that have been validated by prior researchers [21]. All questionnaire items were firstly published in English and then were translated into Arabic. The questionnaire items (individualism vs. collectivism, power distance, uncertainty avoidance, masculinity vs. femininity), were measured on a five-point Likert-scale anchored at both extremes to 1 (strongly agree) and 5 (strongly disagree).

The second case study was carried out in October 2013. In this small-scale experimental study, six undergraduates and eleven undergraduates participated from the School of Computer Science at the University of Nottingham and the Department of Computer Science from Nottingham Trent University, in the UK. All the students were asked to answer an optional questionnaire (Appendix C).



The questions related to their opinions about the parameters that are relevant for the recommended group project, system-supported or system-defined virtual project group members' selection, and the type of toolset needed for social interaction related to the group project. The questionnaire provided also a list of suggestions of requirements, to aid the students in their choices. However, they had the option to express additional requirements, based on their previous experience of group projects.

Students were asked to rate the parameters considered for the recommended group project topic, the group members, the communication tools and the project task. Each question was answered on a 5-point Likert scale, where 1 = strongly disagree, 3 = neutral and 5 = strongly agree.

## 5.5 Results

### 5.5.1 The results of first experiment

The online questionnaire was replied by 175 responses from various Saudi Arabia Arabian universities. There were 68.4% female students and 31.6% male students as illustration in Table 16. This is probably due to the fact that Saudi Arabia women students do not allowed staying in the campus after 4 clocks. Therefore, they use university's forum more than men.

**Table 16 Gender of the students**

Gender	N	Percent
Male	55	31.6%
Female	119	68.4%

Based on the level of study, most of the respondents were at BSc level as these were the main target of my investigation, as they would be the first to be exposed to e-learning, as introduced in Saudi Arabia. However, other types of learners were also considered, as the Table 17 shows.

**Table 17 Students' level of study**

<b>level</b>	<b>N</b>	<b>Percent</b>
<b>PhD</b>	1	0.6%
<b>MSc</b>	13	7.4%
<b>BSc</b>	145	82.9%
<b>Other</b>	16	9.1%

Saudi Arabia Arabian higher education takes five years in total. In this case study, 25.6% students were from the First Year, whereas 21.5% students were in the Second Year. 12.8% students were from the Third Year, whereas 18% students were from the Fourth year. 22% students were from the Fifth Year.

The summarised outcomes for all of the questions are shown in

Table 18. Notice, when defining the 'Closest Interpretation' for each question, the mean is used. Hence, mean response of from 1 to 2.60, gives a closest interpretation of 'Agree' or 2.61 to 3.40 could be 'Neither', but if the mean is 3.41 then the interpretation is set to 'Not Agree'. Moreover, the responses that agree with the statement 1,2,3,4,5,7,8 should be given a high score:

- Strongly Agree 100 points
- Agree 75 points
- Neither 50 points
- Disagree 25 points
- Strongly Disagree 0 points

On other hand, the responses that disagree with the statement 6 should be given a high score:

- Strongly Agree 0 points
- Agree 25 points
- Neither 50 points
- Disagree 75 points
- Strongly Disagree 100 points

It is a result that the Power Distance Index for Saudi Arabia is a score of 61.86 versus Arabic countries (80) which is considered a high Power Distance (See Table 19). This result is not significantly lower than the Hofstede score, indicating that it shares Arabic countries' characteristics by accepting and expecting that power is distributed unequally. Hence, the hypothesis H3-1 was supported. Saudi Arabians students believe that following your teacher is of the utmost importance. Saudi Arabians accept this high power distance as part of their cultural heritage.

When examining the Femininity vs. masculinity index, Table 19 demonstrates that there are no significant differences between Saudi Arabian's score (66.96) and Arabic countries scores (52) and is therefore a masculine society. This outcome indicates that the people will be focused by competition, achievement and success and Saudi Arabian society does not accept the collaboration between men and women. Hence, the hypothesis H3-2 was supported.

Furthermore, this study revealed that Saudi Arabian students score 73 versus Arabic countries (68) on Uncertainty avoidance dimension as shown in Table 19. This result is not much higher than the Hofstede score which implies that the Saudi Arabia society does not readily accept change, security is an important part in personal motivation and ambiguity or unknown situations in future is rejected. Hence, the hypothesis H3-3 was supported.

Moreover, this study shown that Saudi Arabia students score 27.72 on Individualism vs. Collectivism dimension versus Arabic countries (38) as revealed in Table 19. This result is not much different to the Hofstede score to Arabic countries which means that people in Saudi Arabia are closed and prefer to act as members of groups than as individuals. Therefore, the hypothesis H3-4 was supported.

**Table 18: the scores and interpretation for all questions**

#	Statement	Mean	StDev	Median	Range	Closest Interpretation	Hypotheses
1.	When given educational information in a web-based system I prefer it presented in a tightly structured and regulated manner.	2.95	1.05	3	4	Agree	H1.1
2.	In web-based education, I need a lot of guidance from the leader / teacher to direct me.	2.09	1.01	2	4	Agree	H1.1
3.	In web-based education, I work best when members of the opposite gender are not present. Separation of the genders in education enables more effective teaching, with a teacher better able to target each group.	2.26	1.20	2	4	Agree	H1.2
4.	I prefer that a personal image for females is not displayed in e-Learning.	2.38	1.30	2	4	Agree	H1.2
5.	In web-based education, there should be as much structure and directions in a lesson as possible to ensure that there is no ambiguity.	1.52	.72	1	4	Strongly Agree	H1.3

6.	In web-based education, I enjoy learning from my mistakes and dislike being 'protected' from making them.	3.38	1.11	4	4	Disagree	H1.3
7.	In web -based education, being accepted as a member of a group is better than being independent.	2.14	1.17	2	4	Agree	H1.4
8.	In web -based education, recommendations from peers (or chats with my peers) will have a positive influencing on my learning.	2.11	1.07	2	4	Agree	H1.4

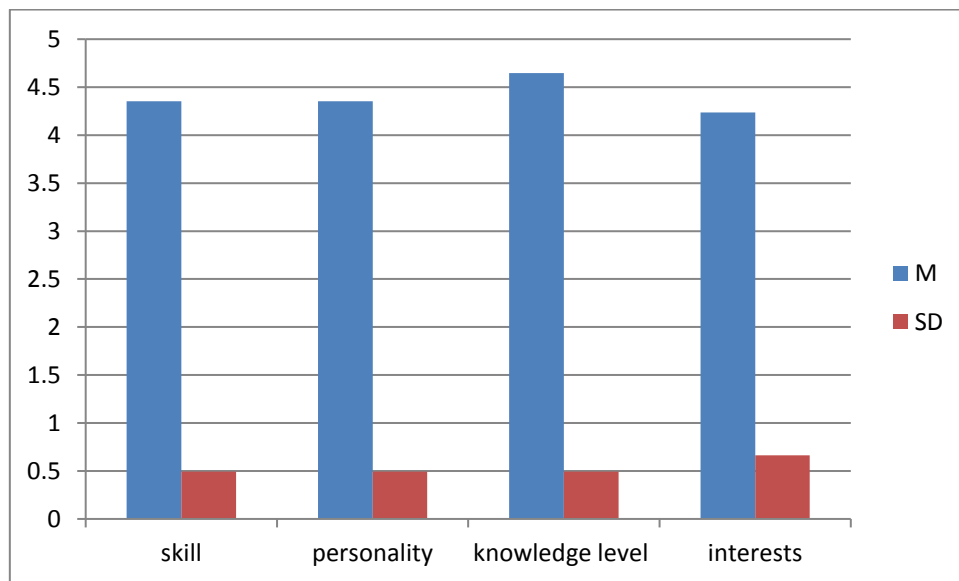
**Table 19: Results of Hypothesis 3**

<b>Hypothesis</b>	<b>Strongly Agree</b>	<b>Agree</b>	<b>Neither</b>	<b>Disagree</b>	<b>Strongly Disagree</b>	<b>Average</b>	<b>Hofstede score to Arabic world</b>
<b>H3-1: PD</b>	18.5	29.48	8.75	5.12	0	61.86	80
<b>H:3-2 Masculinity</b>	33.4	21.56	8.57	3.42	0	66.96	52
<b>H:3-3 Uncertainty</b>	34.4	30.78	5.77	2.23	0	73.19	68

<b>H:3-4</b>	4.35	7.875	5.385	10.11	0	27.72	38
<b>Collectivism</b>							

### 5.5.2 The results of second experiment

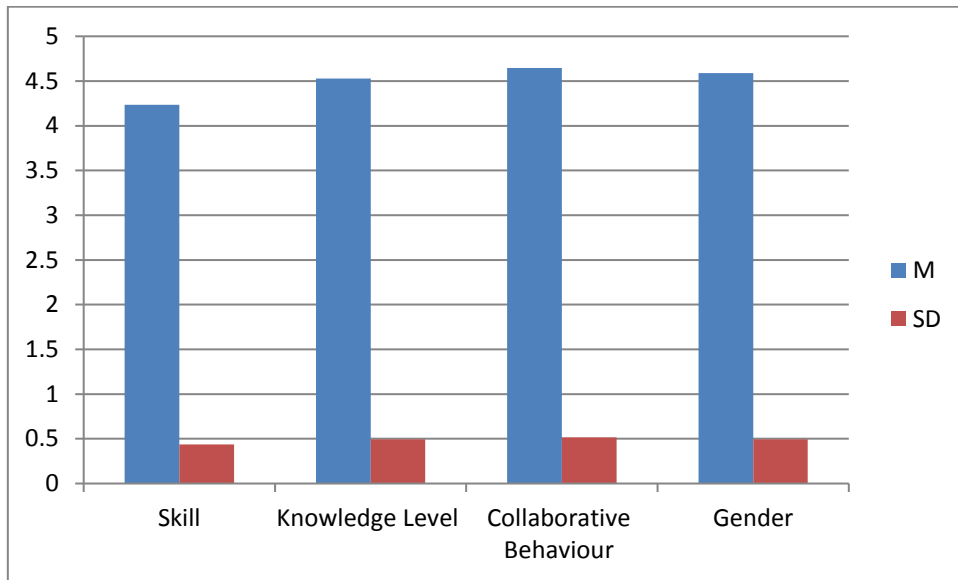
The results indicated that parameters that were considered relevant for the project topic were: student knowledge level (M= 5, SD= 0.49), skill (M= 4, SD= 0.49), interests (M= 4, SD= 0.66) and personality (M= 4, SD= 0.49). All the means are larger than 3.5) as presented in Figure 6. Therefore, the hypothesis H4 has been supported.



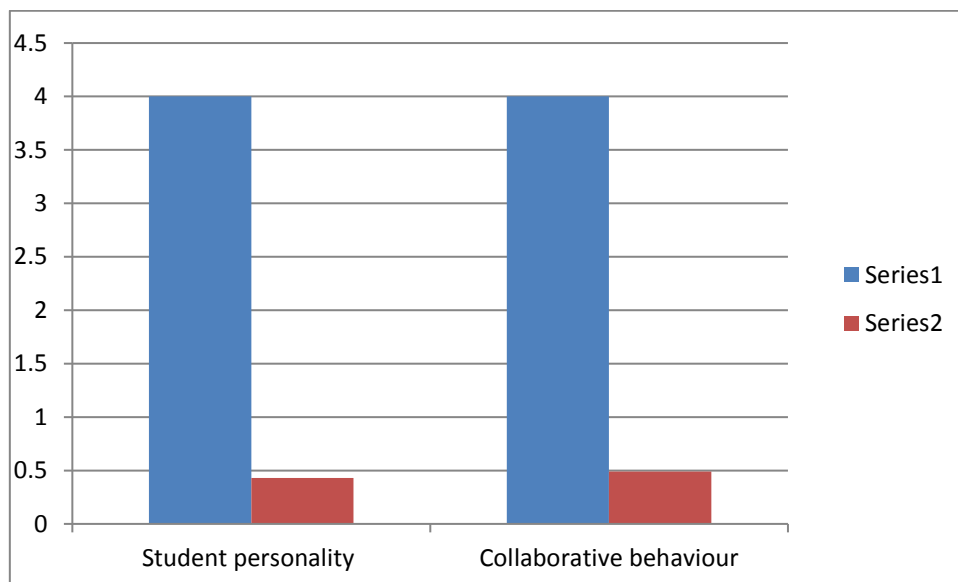
**Figure 6: Recommending the project topic**

Recommend group members was considered to be dependent on the student knowledge level (M= 5, SD= 0.51), skill (M= 4, SD= 0.43), collaborative behaviour (M= 5, SD= 0.49), and gender (M= 5, SD= 0.50) as revealed in Figure 7. All the means are greater than 3.5. Hence, the hypothesis H5 has been confirmed. Communication tools were considered to be useful to be based on student personality (M= 4, SD= 0.43) and collaborative behaviour-level (M= 4, SD= 0.49) as presented in Figure 8. All

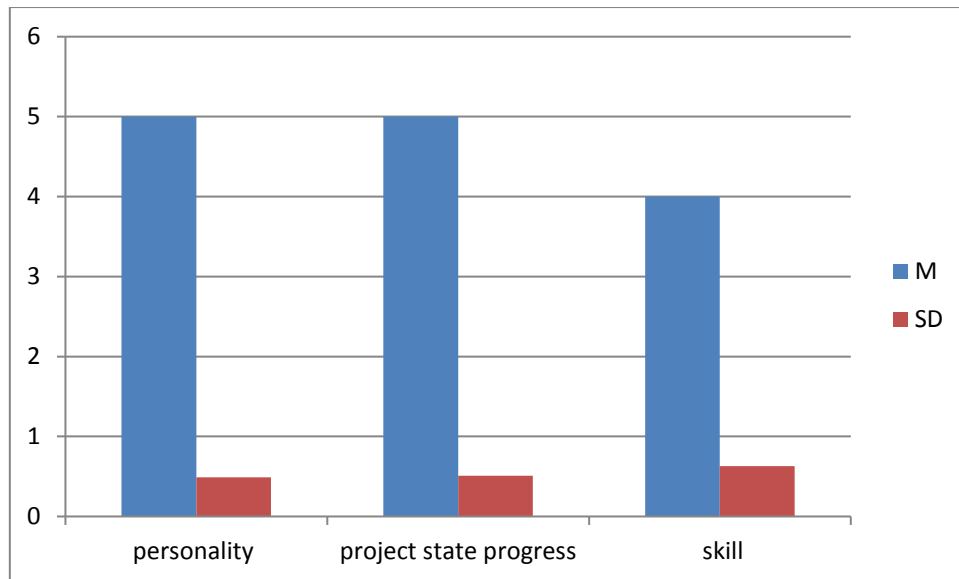
the means are higher than 3.5. Therefore, the hypothesis H6 has been supported. Project task was suggested to be adapted to student personality (M= 4.64, SD= 0.49), project state progress (M= 4.52, SD= 0.51) and skill (M= 4, SD= 0.63) as shown in Figure 9 . All the means are greater than 3.5 as revealed in. Therefore, the hypothesis H7 has been supported.



**Figure 7: Recommending group members**



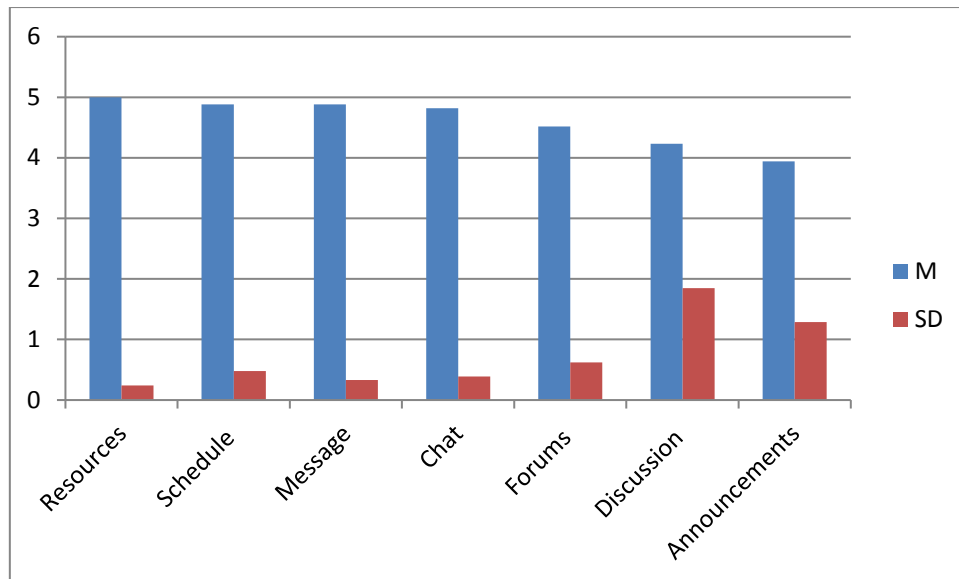
**Figure 8: Recommending Communication tools**



**Figure 9: Recommending Tasks**

Furthermore, T-tests showed that the student *self-defined virtual project group membership* from learners' profiles (e.g., skills, interests, knowledge and gender) is *preferable* ( $M= 4.76$ ,  $SD= 0.43$ ), when compared to the system-organised virtual project group membership based on learners' profiles ( $M= 2$ ,  $SD=0.61$ )  $t(16) = 17.162$ ,  $p \leq .05$ . Therefore, the hypothesis H8 has been supported. Moreover, students were asked to rate the usefulness of various features using a 5-point Likert scale from 1="Not useful at all" to 5="Very useful". When defining the 'Closest Interpretation' for each question, the mean is used. Hence, mean response of from 3.41 to 4.20, have as closest interpretation 'Useful'; 2.61 to 3.40 is 'Neither'; and if the mean is 2.60 or below then the interpretation is set to 'Not Useful'. The results from the questionnaire showed that the highest rated tools students desired were *resources* ( $M=5$ ,  $SD=0.24$ ), *schedule* (project management) ( $M=4.88$ ,  $SD=0.48$ ), *message* ( $M=4.88$ ,  $SD=0.33$ ), *chat* ( $M=4.82$ ,  $SD=0.39$ ), *forums* ( $M= 4.52$ ,  $SD=0.62$ ) *discussion* ( $M=4.23$ ,  $SD=1.85$ ). The lowest rated tool was *announcements* ( $M= 3.94$ ,  $SD=1.29$ ) as shown in Figure 10. All the means are greater than 3.5. Hence, hypothesis H9 has been confirmed. Moreover, I found that from the questionnaire all students daily use the Facebook and Twitter social network platforms. They can be used for a data collection tool. Therefore, the hypothesis H10 has been supported.





**Figure 10: Web 2.0 tools to activate in group projects**

### **5.6 A model for the Recommendation Process**

The proposed processing framework (Figure 1) was established based on previous literature [83, 157] and the results reported. Hypotheses 1-7 require that several data are collected about the users: knowledge, skills, interests, preferences, gender, and collaborative behaviour. As a result, a *data collection* layer has been proposed, to unobtrusively obtain some of these student characteristics from social networks (SN) (e.g., first name, last name, email and gender) and the other relevant personal characteristics from an existing adaptive social e-learning system (e.g., students' collaborative behavior (asking, answering and commenting), students' knowledge (from prior learning achievements or test results) and skills). This user information is used to build the user model. The user model can be updated, according to the user's further activities. As students in the experiment preferred to have recommendations, instead of automatic processing, a *recommendation layer* was introduced, which represents a set of recommendation rules. It is the layer that performs the personalisation and adaptation, by considering the information collected from both the adaptive social e-learning process and social networks. The *presentation layer* is responsible for displaying the recommended content to users or user groups.

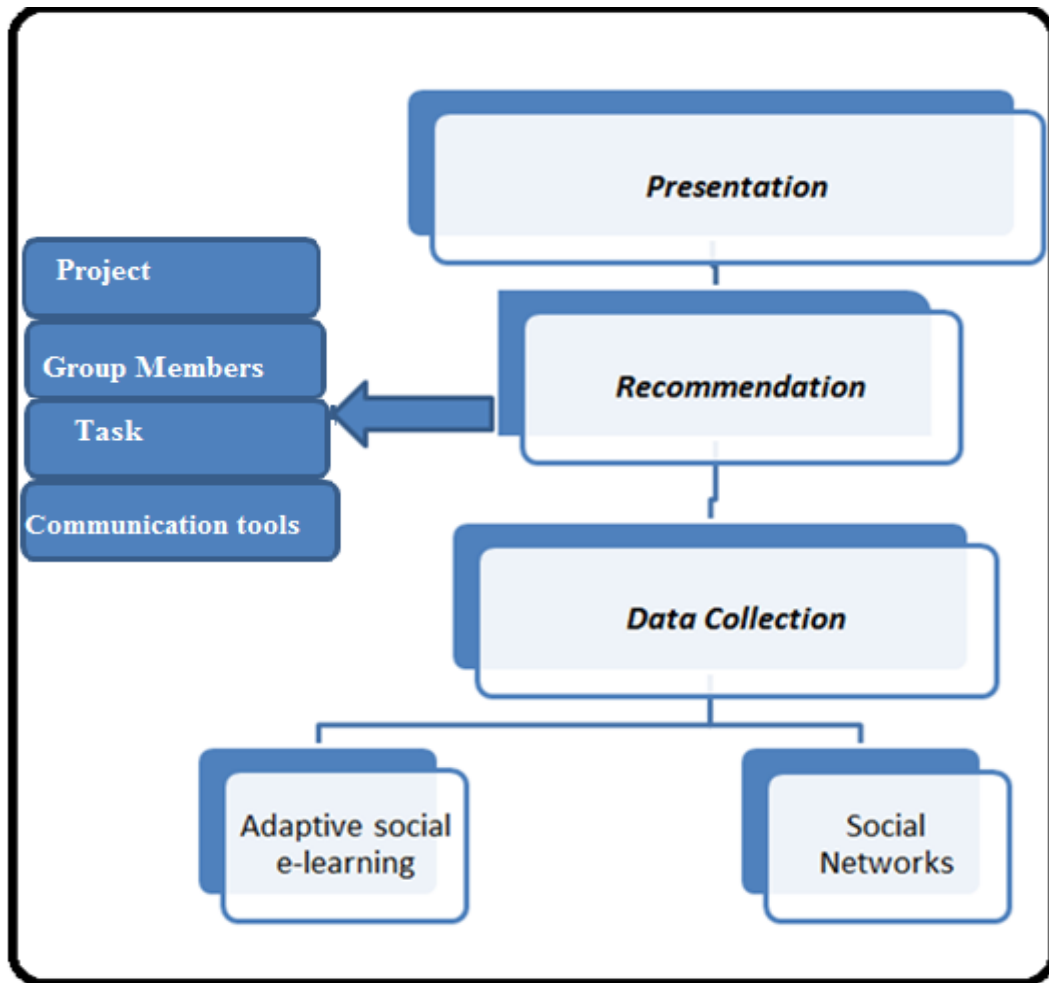


Figure 11: Topolor 3 Framework

### 5.7 The System Architecture of Topolor 3

Based on this framework, the architecture of the Topolor 3 system was defined (Figure 11). The Topolor 2 system was selected as a basis for development, as it already supports some of the desired general features. Topolor 2 is an e-learning system, which allows for a modicum of adaptation, as well as social interaction. It has been developed at the University of Warwick. [152]. However, it does not support group formation, project recommendation, tasks recommendation and communication tools recommendation. Therefore, it was decided to extend its features to Topolor 3, so that it can allow the building of groups with appropriate membership, and allow for wider application to collaborative learning, specifically the type based on projects. Moreover, the Topolor 3 system has been additionally integrated with the Facebook system (the most popular social network worldwide), in

order to obtain the student profile data. In this chapter, it focuses only on the features related to recommendations of project, group members, and task and communication tools in project-based e-learning.

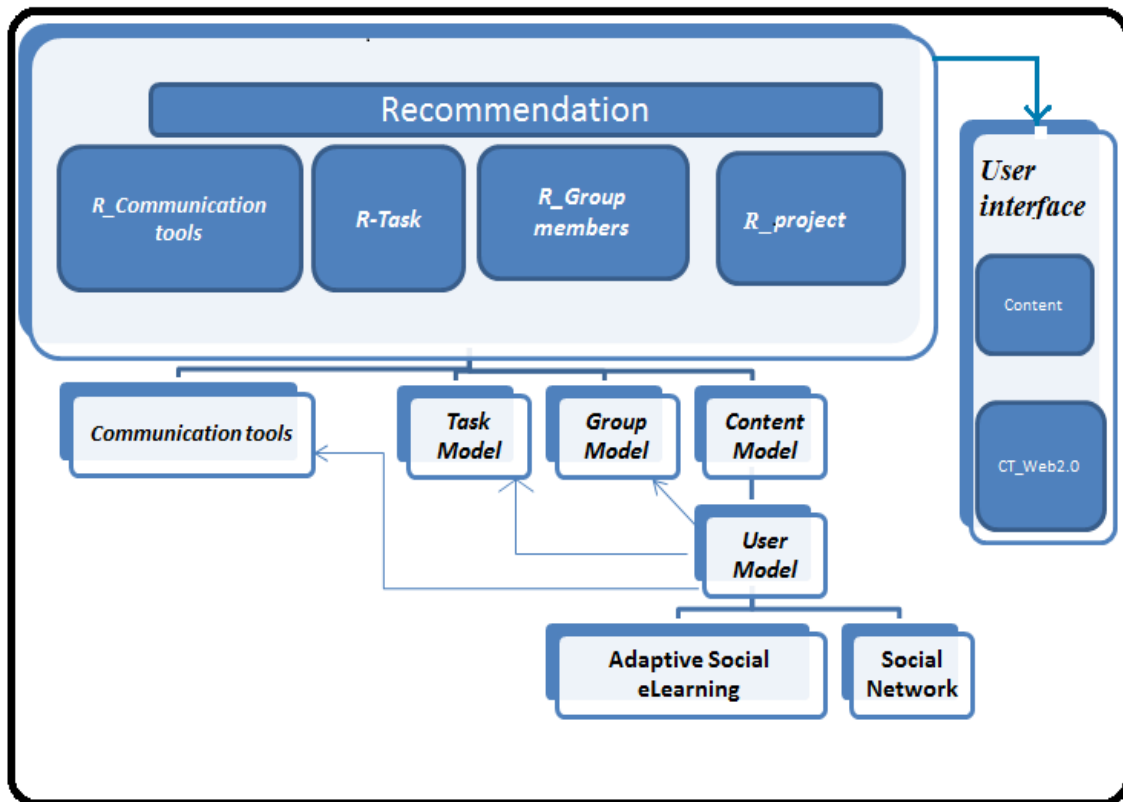


Figure 12: The System Architecture of Topolor 3

The system architecture of Topolor 3 (**Figure 12**) offers all the features for *the Recommendation of Project, Group members, tasks within project management, and communication tools*, supporting collaborative group project-based learning. The architecture of the Topolor 3 system is described in the following.

**Project Model (PM):** This describes the topic of the project. It is also linked to the course model (CM), to connect the learning process with the relevant projects (as below). Each project item in the project model contains some data about it.

**User Model (UM):** The user model retrieves students' information from Facebook and from the Topolor adaptive social e-learning environment.

**Group Model (GM):** This model represents a set of students having matching group characteristics and project goals. They have same skill knowledge and interest.

**Task Model (TM):** This describes activities that students have to perform, in order to fulfil the goals of the project. It is also linked to project model. Each task item of a project contains some data about it, such as student's name, start/end date task.

**Communication tools Model (CM):** This model is linked to a project model. It can be instantiated to chat, comments, and questions. This mechanism can help group learners easily interact with each other.

**The recommendation model (RM):** This is a set of recommendation rules for (what should be recommended, when a recommendation should be provided, how a recommendation should be presented) referring to projects (RP), tasks (RT), group members (RGM) and communication tools (RCT).

**User interface:** It contains presentation content and communication tools. Communication tools (CT) allow students to communicate with each other about the project.

## **5.8 Implementation**

Topolor 3 is implemented by applying PHP, HTML, CSS, SQL and JavaScript and is built on the Yii Framework (<http://yiiframework.com>) as Topolor 2 was. Topolor 3 has been implemented in order to meet the system requirements proposed by the learners, as defined in section 5.3. Table 20 presents the extent of the modifications made to Topolor 2 to arrive at Topolor 3, specifically concentrating on collaborative learning aspects.

Table 20: Overview of Topolor 2 and Topolor 3 systems

Course Tool	Description	Topolor2	Topolor3
1. Take tests	<ul style="list-style-type: none"> <li>Take tests after learning a topic.</li> </ul>	X	X
2. Learning progress	<ul style="list-style-type: none"> <li>View learning progress in percentage.</li> </ul>	X	X
3. Learning path.	<ul style="list-style-type: none"> <li>Choose to view the whole or partial learning path.</li> </ul>	X	X
4. Create groups	<ul style="list-style-type: none"> <li>Create groups that are registered for the same topic.</li> <li>Create groups that share common learning interests.</li> </ul>	X	X
5. Discuss	<ul style="list-style-type: none"> <li>Discuss the current learning topic with other students.</li> </ul>	X	X
6. Ask/answer	<ul style="list-style-type: none"> <li>Ask and answer questions of other students.</li> </ul>	X	X
7. Feedback	<ul style="list-style-type: none"> <li>Use the feedback &amp; questions forum at the end of each lesson.</li> </ul>	X	X
8. Share materials	<ul style="list-style-type: none"> <li>Share and/or recommend learning materials.</li> </ul>	X	X
9. Communication tools	<ul style="list-style-type: none"> <li>Use communication tools to chat and leave messages.</li> </ul>	X	X
10. Comments	<ul style="list-style-type: none"> <li>Write comments/notions wherever and whenever wanted.</li> </ul>	X	X
11. View history	<ul style="list-style-type: none"> <li>View history discussion when selecting a particular topic.</li> </ul>	X	X

12. Recommend topics	<ul style="list-style-type: none"> <li>Recommend other topics according to current learning topic.</li> <li>Recommend topics according to student's knowledge level.</li> </ul>	X	X
13. Adapt learning path	<ul style="list-style-type: none"> <li>Adapt learning path according to learning progress.</li> </ul>	X	X
14. Recommend students	<ul style="list-style-type: none"> <li>Recommend other students according to the current topic.</li> </ul>	X	X
15. Project instance	<ul style="list-style-type: none"> <li>It is composed of multiple ideas for projects related to Java Script, with defines skills for each idea that enables personalised matching between students and ideas. Each project idea has one or more resources, to help in improving the students' knowledge about the project. A project is recommended to students according to their skills, knowledge level and interested.</li> </ul>		X
16. Taking a Test for project topic	<ul style="list-style-type: none"> <li>Each project has a quiz to assess students' knowledge,</li> </ul>		X

	<p>in order to recommend a project topic according to the student's knowledge level. If a student's knowledge is less than 40%, it is recommended to them to study the resources related to the project and repeat the quiz afterwards, to ensure that the knowledge has been updated, prior to joining the group or selecting another project that has enables skills.</p>		
17. Recommended Students	<ul style="list-style-type: none"> <li>Group members are recommended for a given project, from among registered students, based on their profile. Students can easily select the members of their group that is relevant to them, according to their characteristics from their learner profiles.</li> </ul>		X
18. Start Group	<ul style="list-style-type: none"> <li>Students self-define group membership based on recommendations about the students' characteristics from the learners' profiles. Group members can be added by inviting them with a</li> </ul>		X

	<p>description related to the project and then the invitee can accept or reject the invite.</p>		
19. Task Project Management	<ul style="list-style-type: none"> <li>It contains different featured tasks that allow for students to create tasks, edit, delete and view list of student tasks. Tasks are recommended to students according to the task style: whether the students are verbal or visual - as obtained from a personality test. a task project management tool has been implemented, to help students plan and organise project groups.</li> </ul>		X
20. Chat group	<ul style="list-style-type: none"> <li>This is a communication tool privately used by a group project and any member of the group can check the history of the discussions at any time.</li> </ul> <p>Recommendations for the communication tools are provided in Topolor 3, to improve communication among the group members and other groups. The system</p>		X



	<p>monitors user contribution and updates user models.</p> <p>Then, student participation can be identified.</p>		
21. Translation	<ul style="list-style-type: none"> <li>• Translation from English to other languages such as Arabic.</li> </ul>		X

As shown in Figure 13, a **Project** instance is composed of multiple ideas for projects related to Java Script, with defined skills for each idea that enable personalised matching between students and ideas. Each project idea has one or more resources, to help in improving the students' knowledge about the project. A project is recommended to students according to their skills, knowledge level and interested.

**Taking a Test:** Each project has a quiz to assess students' knowledge, in order to recommend a project topic according to the student's knowledge level. If a student's knowledge is less than 40%, it is recommended to them to study the resources related to the project and repeat the quiz afterwards, to ensure that the knowledge has been updated, prior to joining the group or selecting another project that has different skills (see Figure 13).

The screenshot shows a web application interface for a project titled "First topic: Java script a calculator". The interface includes a navigation menu with options like "JS Reserved Words", "JS JSON", "Project", "Second topic: Java script Tic Tac Toe", and "Third topic: JavaScript Form Validation". The main content area displays the project title, a description of the calculator's functionality, and a list of project ideas. Below the project ideas, there are four buttons: "Learning Path", "My Performance", "My Contribution", and "Start Project". At the bottom, there are tabs for "Recommended Resources", "Questions", "Recommended Students", and "Comments", along with a "Sort by" dropdown menu and a "featured" button.

**Figure 13: Project Ideas and Taking a Test**

**Recommended Students:** Group members are recommended according to registered students in the same project with their profile (e.g., first name, last name, email, gender, question asked, question answered, and comment). A student can easily select their members group that relevant to characteristics by learner's profile (see Figure 14).

First topic: Java script a calculator

الأسئلة/Questions Recommended Students تعليقات/Comments

resources shared/مشاركة مصادر questions asked/الأسئلة المطروحة questions answered

is learning/يدرس has learnt/درست

**FatmiaAlberkany**  
 Email: fatimaalbrkany@gmail.com  
 last activity 08/10 01:13 PM

0 tutorial learnt 0 topic learnt  
 0 resource shared 0 question asked  
 0 question answered 0 answer  
 0 comment 0 like

message profile

**Afaf**  
 Email: alamrimoon@gmail.com  
 last activity 04/02 02:23 PM

0 tutorial learnt 44 topics learnt  
 1 resource shared 0 question asked  
 0 question answered 0 answer  
 0 comment 0 like

message profile

**Figure 14: Recommended Students**

**Start Group:** Students self-define group membership based on recommendations about the students' characteristics from the learners' profiles. Group members can be added by inviting them with a description related to the project and then the invitee can accept or reject the invite (see Figure 15).

JavaScript Tutorial & Project Project Ideas

java script a calculator  
 Estimated time: 15 Days. From May 10, 2015 To May 25, 2015  
 Mark percentage of the course: 30 %  
 It is recommend you to take test before you start with group

Groups/المجموعات

+ Start a group/انشاء مجموعة

**Start Group**

Initial Plan \*

Write down your initial project plan to attract other students

Invite People

Students Profile

Emails:

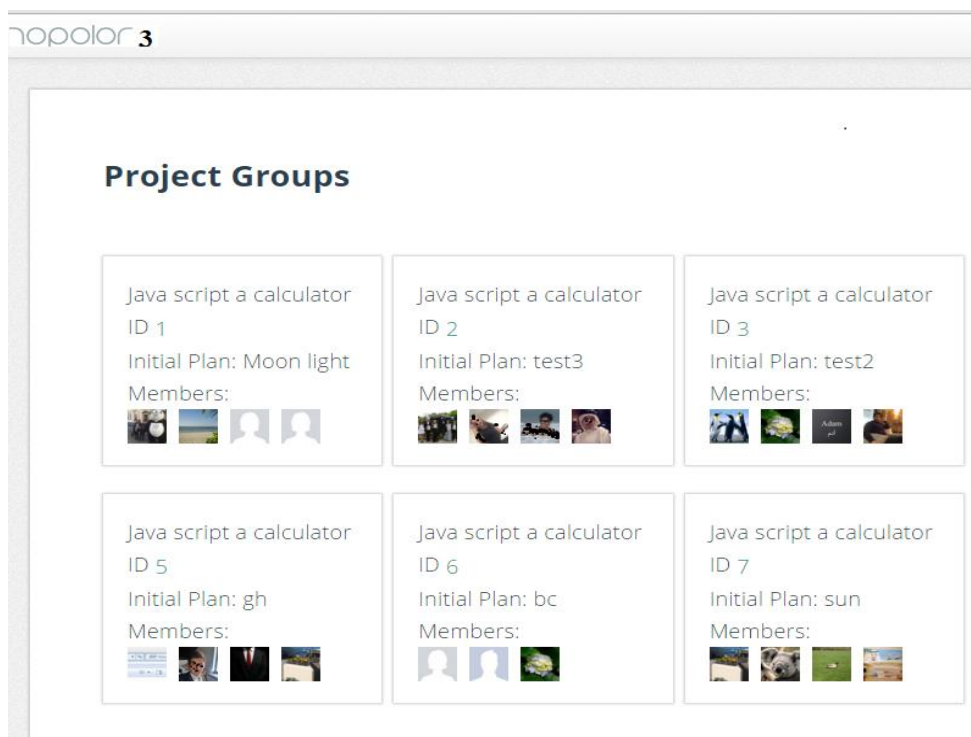
Enter comma separated list of invited emails.

Description

Save

**Figure 15: Starting a Group**

**Task Project Management:** It contains different featured tasks that allow for students to create tasks, edit, delete and view list of students' tasks (see Figure 17, Figure 18 and Figure 19). Tasks are recommended to students according to the *task style*: whether the students are verbal or visual as obtained from a personality Test. There are many measures of learning styles, but the one applied here is the Felder and Soloman's "Index of Learning Styles" (ILS) [158] . FLSM has been named the most suitable for learning styles model in technology-enhanced learning [10, 11]. Moreover, it is freely provided, and has been integrated in Topolor 3 as an external link that allows student to test their personality, to select appropriate tasks for them (see Figure 17). Example tasks in a project are: creating the interface, coding, testing and fixing bugs, writing report and other tasks. Moreover, a task project management tool has been implemented, to help students plan and organise project groups. For example, it can give an overview about how long tasks will take to complete, early warnings of any risks to the project, recommended daily progress to complete the tasks before the deadline, and historical information on other projects.



**Figure 16: Groups**

**nopolar 3**

**Create Project**  
Fields with \* are required.

User Id  
All

Topic Id  
Collaborative Filtering

Project\_Name \*

Project Idea Group Id \*  
Moon light

Project Idea Id  
All

• Test personality»

Task  
Codir Go to test your personality!

Description \*

Create Time

Status  
Not Yet Started

**Figure 17: Creating Project Tasks**

**nopolar 3**

Select Language

- Create Project
- Update Project
- Delete Project
- Manage Project
- List Project

**View Projectlist #33**  
undefined

14 days 13 hours 16 minutes 9 seconds left to submit your project

ID	33
User	elham
Topic	0000-00-00 00:00:00
Project Idea	Not set
Group	java.cw
Name Project	Not set
Task	Coding
Description	designing interface for calculator
Start Time	Not set
End Time	Not set
Update User	Not set
Status	Started

**Figure 18: Viewing Tasks**

**nopolar 3**

**List of Tasks**

Display

**ID:** 33  
**Project\_Name:** java script a calculator  
**Project Idea Group id:** Moon light  
**User:** elham  
**Task:** Coding  
**Description:** designing interface for calculator  
**Start Time:** 2015-04-23 00:00:00  
**Status:** Started  
**End Time:** 0000-00-00 00:00:00  
**Update User:**

**ID:** 35  
**Project\_Name:** java script a calculator  
**Project Idea Group id:** Moon light  
**User:** SaimaAlharbi  
**Task:** Writing report  
**Description:** I will write report that explains the techniques that we used in building this  
**Start Time:** 2015-04-21 00:00:00  
**Status:** Not Yet Started  
**End Time:** 0000-00-00 00:00:00  
**Update User:**

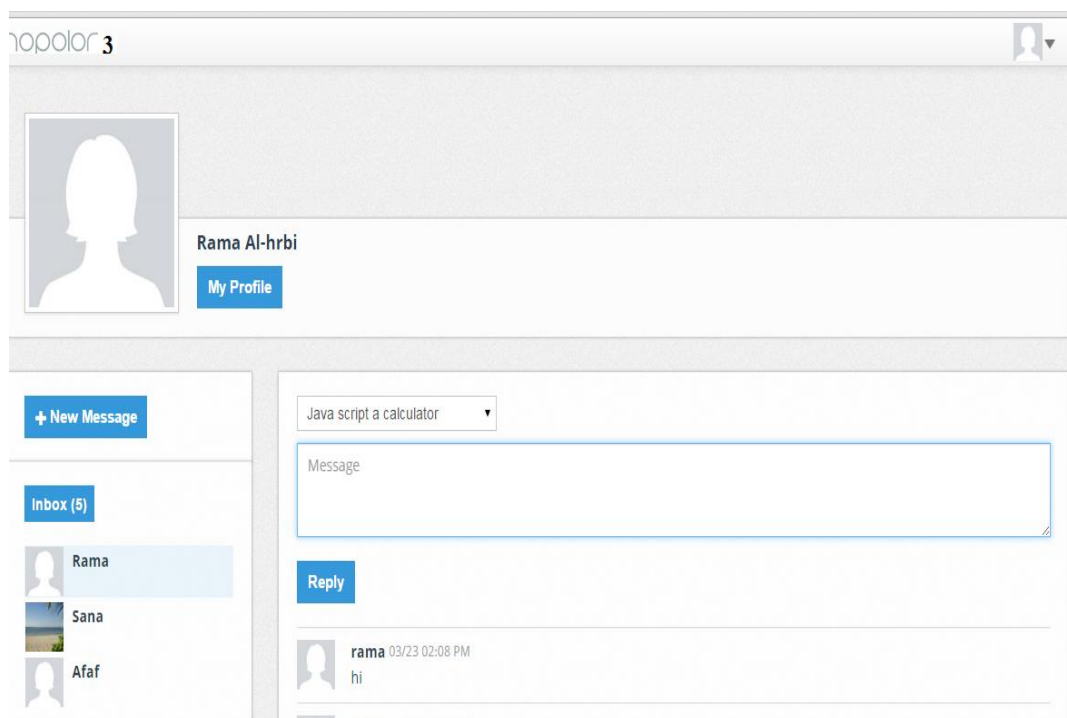
**ID:** 37  
**Project\_Name:** java script a calculator  
**Project Idea Group id:** Moon light

**ID:** 38  
**Project\_Name:** java script a calculator  
**Project Idea Group id:** Moon light

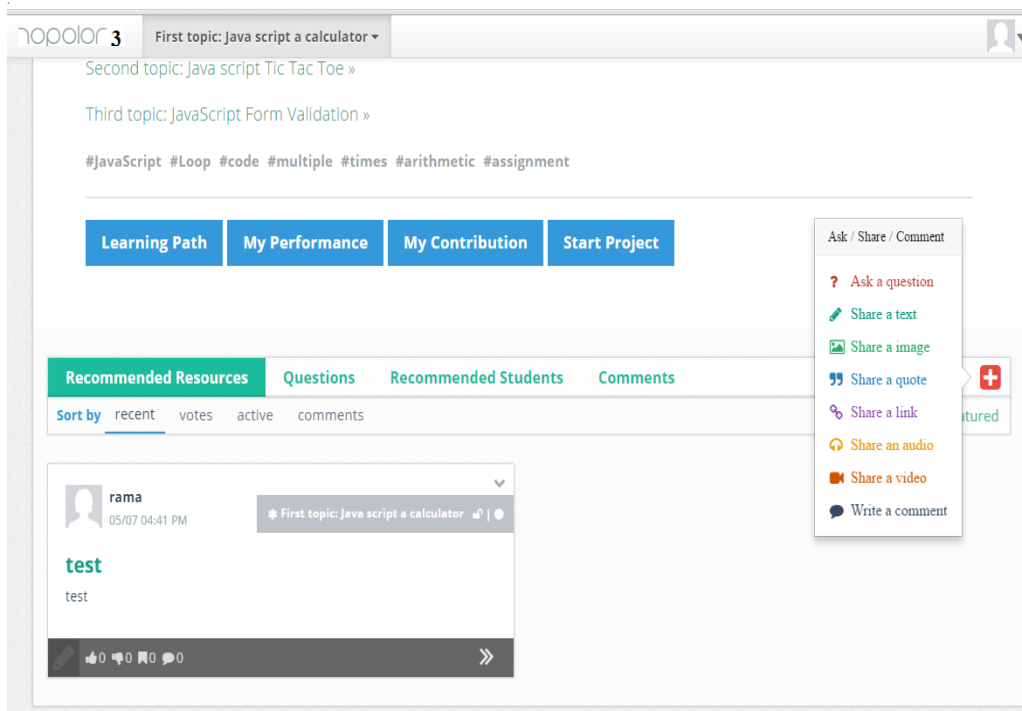
**Figure 19: List of Tasks**

**Chat group:** This is communication tool privately used by a group project and any member group can check the history of the discussions at any time. As was earlier mentioned, one reason for problems with communication is that some students are struggling with communication skills, and that this can influence the outcome of a project. Therefore, recommendations for the communication tools are provided in Topolor 3 (see Figure 20), to improve communication among the group members and other groups. The system monitors user contribution and updates user models. Then, student participation can be identified.

Topolor 3 has also some other features, of social, personalisation and adaptation nature that existed in the previous version, Topolor 2. For example, tools for sending private messages, for asking questions, for sharing text content, images and links, to further support students (see Figure 21: Social toolset).



**Figure 20: Chat group**



**Figure 21: Social toolset**

### Culture

1. Saudi Arabian culture is high *uncertainty avoidance*. Thus, Topolor 3 system is designed to reduce uncertainty by providing clear structure and familiar descriptions. The forecasting of results is available before students act (e.g., “if you take test, you will be allowed to create group and access task project”). Facilitate the e-learning navigation, by means of alerts, messages, and guidelines.
2. Saudi Arabian Culture has a *high power distance dimension*, students need more support and guidance from teachers/leaders or e-learning system. Students can get assessment and feedback from lecturers by toolsets and comments on the learning pages in Topolor 3 system. High Power Distance includes similar features to high uncertainty avoidant sites. Topolor 3 system supports assisting with navigation via alerts and guidelines.
3. Saudi Arabian Culture is a *collectivist culture*. Saudi Arabia students desire to study or work collaboratively in a group rather than work individually. Thus, Topolor 3 system is designed to supports social interaction. For example, group chat and group project management. Additionally, Topolor 3 has also some other features, of social that existed in the version, Topolor 2. For example, tools messages, for asking questions, for comments from students or

lecturer, for discussion forums, for sharing text content, images and links, to further support students and teamwork in project to provide online learning with sense of community.

4. Saudi Arabian Culture is a *masculine society*. Saudi Arabian society is very sensitive to display pictures of females in e-learning. Thus Topolor 3 system is designed to not forcing sign of female photographs. Students' photographs are generated from the Facebook website, but in Facebook, most of Saudi women do not put their pictures but often put fake photos such as photo flowers. Moreover, the Topolor 3 system is designed to facilitate creating *group projects* that offer social interaction, with separation of the genders.

Moreover, Topolor 3 system supports translation to Arabic or other languages as well as supporting the direction of writing. For example, in the Arabic language the direction of writing is from right.

## **5.9 Discussions**

In this chapter two experiments have been conducted. The first experiment was carried out to *explore the cultural factors of the Saudi Arabian students*. An online questionnaire survey (Appendix B) has been applied. The online questionnaire received replies by 175 students from several Saudi Arabian universities. The study adopted the Hofstede cultural value dimensions as a theoretical framework. Hofstede's national culture dimensions were considered as a base for understanding the influence of national culture on people's behaviour. In this study, the findings showed that *Saudi Arabian students' cultural characteristics* are similar to Hofstede's 1980 [16] analysis for the Arab world and can be applied to Saudi Arabia e-learning. This research has contributed to the understanding of the link between culture and education in Saudi Arabia and issues linked to the acceptance of a learning system. Its findings encourage an understanding of what factors might help an effective web-based education implementation.

The second experiment was conducted *to explore the needs of the students for the recommended project membership, tasks and communication tools for group projects in e-learning*. The participants were 17 Saudi Arabian students from two universities, the School of Computer Science at the



University of Nottingham and the Department of Computer Science from the Nottingham Trent University, in the UK.

However, the results indicate the following points that development of *group project in e-learning* intended for Saudi Arabian students should be aware of as following.

- Saudi Arabian Culture has a *high power distance dimension*, students respect their teachers and they prefer to listen and get feedback from their instructors. That means that students need more support and guidance from teachers/leaders or the e-learning system.
- Saudi Arabian Culture is a *collectivist culture*. This implies that Saudi Arabia students desire to study collaboratively in a group rather than work individually, and they accept the recommendations from their peers to enhance their education. This result indicates that if e-learning system supports social interaction and teamwork in coursework such as discussion forums, chat and email, the student is more likely to have positive intentions towards using it.
- Saudi Arabian Culture is a *masculine society*. Indeed, Saudi Arabia is strongly affected by cultural traditions and religious Islam. The separation of the genders is obligatory in Saudi Arabian cultures and societal norms impact on all sides of life, including the educational environment. The classes for each gender are in separate buildings. Communication between females and males is not allowed, except for close relatives and in special situations. These points to creating *group projects* in e-Learning system that offer social interaction, with separation of the genders. If this is provided, the Saudi Arabian student is more likely to have positive intentions towards using such a system.
- Saudi Arabian culture shows *high uncertainty avoidance*. Thus uncertainty and ambiguity are not acceptable for the majority of students. This might be because students' experience with the internet is limited, especially with regards to *group projects* in e-learning. They need more guidance with help in the lessons, simple designs with clear descriptions and limited an amount of data, to decrease ambiguity and uncertainty.

- The outcome gives indications about what parameters can be considered for the recommendation of project topic, group members, communication tools and project task which were shown to be statistically significant.
  - a) Recommendations of the project topic are according to the student's knowledge level, skill, interests and personality.
  - b) Recommendations of group members could be according to student's knowledge level, skill, collaborative behaviour, and gender.
  - c) Recommendations of communication tools could be according to student's personality and collaborative behaviour.
  - d) The recommendations of project tasks could be according to student's personality, skill and project state progress.
- Although most research has used system-organised group formation, the results revealed that students' self-defined virtual project group allocation based on system-recommendations from learners' profiles (e.g., skills, interests, knowledge and gender) is preferable to them, when compared to system-organised virtual project group member allocation.
- The result also showed that all participants use daily the Facebook and Twitter social network platforms. The main reasons for using Facebook and Twitter were that they are a place to share users' interests and discover the latest news. Also, Facebook provides users with a place to interact with their friends and family. This indicates that Facebook can be used to build the user model and profile.
- The results from the questionnaire showed that the highest rated tool was resources, schedule, message, chat and forums discussion and that the lowest rated tools were announcements.

Based on these results, a model for recommendation of group projects in an existing e-Learning system has been developed. It was further implemented on top of the Topolor 3 system architecture. It is integrated with a Facebook system and social personalised adaptive e-learning system, in order to build student profile data (e.g., students' skill, knowledge and students' collaborative behaviour). The system architecture of Topolor 3 (Figure 12) presents

the features for *the Recommendation of project, group members, tasks within project management, and communication tools*, supporting collaborative group project-based learning.

## **5.10 Conclusion**

This chapter identifies *Saudi Arabian users' cultural* characteristics, by analysing Hofstede's cultural value dimensions, and their appropriateness for Saudi Arabian e-learning. The quantitative data from the students was collected by using an online questionnaire. In this study, the findings demonstrate that Saudi Arabian users' cultural characteristics are *similar to Hofstede's 1980 analysis for the Arab world and can be specifically applied for Saudi Arabian personalised e-learning*. Hence, implementers of e-learning in Saudi Arabia need to be aware of these strongly influential factors and implement them in their learning solution.

The main aim of the second experiment was to investigate the needs of the students for the recommended project and communication tools for the group project. The outcome illustrated the parameters which can be considered for the recommendation of group project topics, group members, communication tools and project tasks.

Moreover, this chapter explores the needs of the students for the recommended project and tools communication for group project. Both qualitative and quantitative data have been collected and analysed. The outcome showed the parameters which can be considered for recommendation of group project topics, group members, communication tools and project tasks.

In addition, this chapter has shown the process of design and implementation of the Topolor 3 system.

In conclusion, this chapter aims to address the research objectives **O4** *'explore the cultural characteristics of Saudi Arabian students using Hofstede's cultural value dimensions* and **O5**: *explore the needs of the students in relation to the recommended project group membership, the recommended task and the recommended communication tools for the group project, with the aim of determining*

*what is necessary for implementation of the recommendation environment*'. Based on the hypotheses and results from **O4** and **O5**, a framework was constructed, as per objective **O6** "*proposing a framework for recommendation of collaborative projects within e-Learning*". Based on this framework, the architecture of the Topolor 3 system was defined, and the system implemented.

The process of addressing these research objectives, together with the result from the work that is described in chapter 6, contributes to answering research question **R3**: "*Are personalised virtual project and team formation methods for e-learning more acceptable to Saudi students than traditional project and team formation methods for e-learning?*"

In the next chapter, the system evaluation with students is described, to investigate the learners' perceived acceptance of the recommended project, group membership, task, and communication tools.

# Chapter 6: Evaluation of Collaborative Recommender System for online Group Projects

## 6.1 Overview

In the previous chapter, *Topolor2* system has been extended, in order to provide **adaptive recommendations** to support students' decisions about; *project selection*, based on students' knowledge and skills; *group membership*, based on student's profile characteristics; *project tasks*, based on students' personality; and *communication tools*. The aim of these recommendations is to offer performance monitoring and dynamic support to the user, to increase the acceptance of the virtual group project.

The current chapter provides the systematic evaluation of the newly developed, as described below.

### Case Study Objectives:

Experiment 1. *To explore a student's perceived usability (effectiveness, efficiency and satisfaction of using) towards the Topolor 3 system.*

Experiment 2. a) *To explore if the functionalities offered in the Topolor 3 system are acceptable to Saudi students if they are matched to their own cultural characteristics.*

Experiment 2. b) *To investigate Saudi Arabian higher education students' acceptance of a recommended virtual project and recommended group formation for e-learning versus traditional project- and team-formation methods for e-learning.*

The key objective of the work presented in this chapter is to answer the research question **R3**:

*“Are personalised virtual project and team formation methods for e-learning more acceptable to Saudi students than traditional project and team formation methods for e-learning?”*

### **Sub- questions:**

**R3.1** “*Is the recommended project that is personalised to students’ characteristics (users’ skill, interests and knowledge) within a social personalised e-learning more acceptable to Saudi students than current/traditional e-learning methods?*”

**R3.2** “*Is adaptive task recommendation within a group project-based Learning System more acceptable to Saudi students when compared to current/traditional e-learning methods?*”

**R3.3** “*Is a self-defined virtual project teamwork (group activities), which is personalised to the student’s characteristics, based on the learners’ profiles within social personalised e-learning, more acceptable to Saudi students than team formation methods in current/traditional e-learning?*”

**R3.4** “*Is an adaptive communication mechanism within a group project-based Learning System more acceptable to Saudi students than current/traditional e-learning methods?*”

A case study followed by a questionnaire and focus group was used to evaluate these hypotheses. Topolor 3 was used with students from three universities: the University of Nottingham, and Nottingham Trent University in the UK, and Taibah University, the city of Madinah, Saudi Arabia.

## **6.2 Experimental Setup**

Data were collected through two experiments, described below.

**Experiment 1:** The experiment was carried out in February 2015 to explore *the usability of the Topolor 3*. The undergraduates participated from the School of Computer Science at the University of Nottingham and the Department of Computer Science from the Nottingham Trent University, in the UK. The students were invited to access Topolor 3 at their preferred time and location and were asked to complete an optional online survey (Appendix D). Out of the 20 students who were invited to participate in the online course, seventeen completed the online survey.

The usability questionnaire consisted of 10 questions to measure the usability of the Topolor 3 system. Each question was rated on a 5-point Likert scale, where 1 = strongly disagree, 3 = neutral and 5 = strongly agree. This questionnaire was based on the *System Usability Scale (SUS)* [125].

Usability questionnaire items (statements) are as follows:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn many things before I could get going with this system.

### **6.3 Data Analysis Usability of the Topolor 3**

The System Usability Scale SUS items are alternately positive and negative; the responses that agree with Statements 1, 3, 5, 7, and 9 should be given a high score:

- Strongly Agree—4 points
- Agree—3 points
- Neither—2 points
- Disagree—1 point
- Strongly Disagree—0 points

On other hand, the responses that disagree with Statements 2, 4, 6, 8, and 10 should be given a high score:

- Strongly Agree—0 points
- Agree—1 point
- Neither—2 points
- Disagree—3 points
- Strongly Disagree—4 points

To calculate the total SUS score, multiply the sum of the item score by 2.5. Therefore, SUS scores range from 0 to 100. However, if the overall score is higher than 90, this indicates an exceptional system, and if the overall score is between 70 and 80, it indicates a good system [125].

**Experiment 2:** The second experiment was conducted in June 2015 to *investigate the acceptance of Saudi Arabian Higher Education students of a recommended virtual project and recommended group formation for e-learning versus traditional project- and team-formation methods for e-learning.*

For the initial data, during this experiment, a questionnaire was delivered to 45 students at the Taibah University. Participants were volunteer students from the Department of Computer Science.

The evaluation setup consisted of evaluating two versions of a system against each other, whilst studying JavaScript. To support this, a course on the topic of JavaScript was created, which was run for all students on a social personalised e-learning system (Topolor 2) versus the same course, with the addition of a personalised virtual project team recommender (Topolor 3). The students were asked to study and complete a coursework/project in the two different systems over the period of three weeks. In order to remove bias potentially introduced by the order in which systems are presented to students, the students were divided into two groups, Group A and Group B. The JavaScript topics were also divided into two independent parts, Part X and Part Y, and taught to students, as follows:

1. Students in Group A were taught Part X of the JavaScript course with Topolor 2 (based on social personalised e-learning). Student in Group B were taught Part Y of the JavaScript course with Topolor 3 (adding personalised virtual project teams to Topolor 2). After finishing this stage of the experiment, each student was asked to fill-in a questionnaire (Appendix E and F) (on a Likert scale[159]), to evaluate the introduced systems.

2. Students in Group A then moved on to learning Part Y of the JavaScript course with Topolor 3, and students in group B moved on to learn part X of the JavaScript course with Topolor 2. After finishing this last stage of the experiment, each student was asked to fill-in a questionnaire (also on a Likert scale), to evaluate the introduced systems.



The reason for teaching each student the same part of a subject with the same tool was to ensure that comparison between the groups was comparing like for like. To ensure further non-biasing, the students were not told at any stage of the evaluation which version of the system was the one extended by the thesis author. Both systems were new to the students. Moreover, it was ensured that Part X and Part Y for the JavaScript course could be taught independently, and in any order required,

The questionnaire for the second experiment has generated quantitative and qualitative data. The questionnaire was developed based on measures that have been validated by prior researchers: the TAM measures of perceived usefulness, perceived ease of use, and behavioural intention from Davis [7] and adopted the Hofstede cultural value dimensions [21]. Resulting questionnaire items are thus mapped on these measures. Some questions were taken from previous questionnaires that have been validated by prior researchers [8], [7], [160], and [154] (e.g., the TAM questionnaire [7]). However, the questionnaire was also altered in order to be suitable for the target audience as present in Table 21. All questionnaire items were firstly published in English and then were translated into Arabic.

Additional to the questionnaires, qualitative methods were utilised to gain richer data, to facilitate a better understanding of the participant's experience. Interviews were done with a focus group (with 1-2 students from each sub-group) after the running of the experiment.

Furthermore, the event logs were analysed, in order to understand how different students within project teams used the extended Topolor 3 system. The Topolor 3 system tracks every action done by users. These are recorded in a database. The reason for analysing only the data from Topolor 3 was that only the usage of the new features was of interest for the current thesis.

The final step was to use statistical tests and analysis of the feedback and the event logs, to draw the conclusions.

**Table 21 Development of the questionnaire**

#	Original Statement	Modified Statement Topolor 2	Modified Statement Topolor 3	Hypothesis
1	I find the e-learning system to be useful in my learning [6].	I find the system useful to select my topic project.	I find the system useful to select my topic project.	H13.1.1: A Saudi student's <i>perceived usefulness</i> of a test-based project recommendation method is higher than that of other project choosing methods in social personalised e-learning.
2	Electronic mail enables me to accomplish tasks more quickly [5].	This system has allowed me to find my topic project more quickly.	The Topolor 3 system has allowed me to find my topic project more quickly.	
3	Using the e-learning system improves my learning performance [6].	Using this system would improve my project performance.	Using the Topolor 3 would improve my project performance.	
4	It was easy to recognise the content recommended by the system. [160].	It was easy to recognise the content coursework/project by this system.	It was easy to recognise the content coursework/project by the Topolor 3 system.	H13.1.2: A Saudi student's <i>perceived ease of use</i> towards a test-based project recommendation method within social personalised e-learning is higher than choosing project methods in social personalised e-learning.
5	I find the electronic mail system easy to use [5].	I find it easy to select my project by this system.	I find it easy to select my project.	
6	I will use the system again [160].	I will use the system again to select my topic project.	I will use the system again to select my topic project.	H13.1.3: Saudi students' <i>intention of further use</i> of a recommending tool for projects within a social personalised e-learning is stronger, when compared to social personalised e-learning methods.
7	I intend to use e-learning to accomplish a learning task whenever it has a feature to help me perform it [154].	I intend to use this system related projects/assignments to accomplish a selected project whenever it has a features to help me perform it.	I intend to use this system related projects/assignments to accomplish a selected project whenever it has a features to help me perform it.	
8	Electronic mail enables me to accomplish tasks more quickly [5].	This system has allowed me to find my team members more quickly.	The Topolor 3 system has allowed me to find my team members more quickly.	H13.2.1: A Saudi student's <i>perceived usefulness</i> toward self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is higher than current/traditional methods e-learning.
9	I find the e-learning system to be useful in my learning [5].	I find this system useful to select my team members.	I find the Topolor 3 system useful to select my team members.	

11	It is easy for me to remember how to perform tasks using the electronic mail system [5].	It is easy for me to remember how to perform selecting my team members using this system (non-recommended team members).	It is easy for me to remember how to perform selecting my team members using the Topolor 3 system (recommended team members).	H13.2.2: A Saudi student's <i>perceived ease of use</i> towards self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is higher than current/traditional methods e-learning.
12	I find it easy to get the electronic mail system to do what I want it to do [5].	I find it easy to get this system to select my team members.	I find it easy to get the Topolor 3 system to select my team members.	
13	I will use the system again [160].	I will use this e-learning system to find my team members.	I will use Topolor 3 system to find my team members.	
14	I will tell my friends about this system [160].	I will tell my friends about this system to find members for academic team projects.	I will tell my friends about Topolor 3 system to find members for academic team projects.	H13.2.3: Saudi students' <i>intentions of further use</i> of the self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is stronger, when compared to current/social personalised e-learning methods.
15	Using electronic mail gives me greater control over my work [5].	Using this system is useful, and gives team members greater control over their work (manage group project).	Using the Topolor 3 system is useful, and gives team members greater control over their work (manage group project).	H13.3.1: A Saudi student's <i>perceived usefulness</i> toward an adaptive task within group project-based Learning System is higher than a non-recommended task in current/social personalised e-learning.
16	I find the e-learning system to be useful in my learning [6].	I find the e-learning system useful to select my task project.	I find the Topolor 3 system useful to select my task project.	
17	It is easy for me to remember how to perform tasks using the electronic mail system [5].	It is easy for me to remember how to perform tasks project using this system.	It is easy for me to remember how to perform task project using the Topolor 3 system.	H13.3.2: A Saudi student's <i>perceived ease of use</i> toward an adaptive task within group project-based Learning System is higher, when compared to a non-recommended task in current/social personalised e-learning methods.
18	Overall, I find the electronic mail system easy to use [5].	Overall, I find the project management in this system was easy to use.	Overall, I find the project management in this system was easy to use.	
19	I will tell my friends about the system [160].	I will tell my friends about task project management in this e-	I will tell my friends about task project management in the	H13.3.3: Saudi students' <i>continuance intention</i> of an adaptive task within group project-based Learning System is higher than a

		learning system.	Topolor 3 system.	non-recommended task in current/social personalised e-learning methods.
20	I find the e-learning system to be useful in my learning [6].	In e-learning, the communication toolset in the system was useful to talk with my group project.	The communication toolset in the system was useful to talk with my group project.	H13.4.1: A Saudi student's <i>perceived usefulness</i> toward an adaptive communication mechanism within a project-based Learning System is higher than that of the current communication mechanisms in social personalised e-learning.  H13.4.2: A Saudi student's <i>perceived ease of use</i> toward an adaptive communication mechanism within a project-based Learning System is higher than that of the current social personalised e-learning methods.  H13.4.3: Saudi <i>students' continuance intentions</i> with an adaptive communication mechanism within a project-based Learning System is higher than that for the current social personalised e-learning methods.
21	Using the e-learning system increases my learning productivity [6].	In this e-learning, using the communication tools increased cooperation in my group project.	Using the communication tools increased cooperation in my group project.	
22	It was easy to discuss with the peers [160].	It was easy to discuss with my group members.	It was easy to discuss with my group members.	
23	It was easy to access the content shared by peers [160].	It was easy to access the resources shared by peers.	It was easy to access the resources shared by peers.	
24	The system helped me engage in interacting with peers [160].	The system helped me engage in interacting with my group.	The system helped me engage in interacting with my group.	
25	I will use the system frequently [160].	I would like to use this system frequently to chat with my group members.	I will use this system frequently to chat with my group members.	
26	I will use the system again [160].	I will use the system again to communicate with my group project.	I will use the system again to communicate with my group project.	
27	I will tell my friends about the system [160].	I will tell my friends about the task project management in this e-learning system.	I will tell my friends about the communication toolset in this system.	

Moreover, the quantitative results of the second case study in chapter 5 show that Saudi Arabian participants represent high-context cultures (see more discussion in Chapter 5). Therefore, there are more statements to evaluate Topolor 3 design features using high cultural dimensions. The reason for

analysing only the data from Topolor 3 was that only the utilisation of the novel features related to culture was of interest for this thesis. The questionnaire items (Appendix F) (collectivism, high power distance, high uncertainty avoidance, and masculinity) were also measured on a five-point Likert scale anchored [159] at both extremes to 1 (strongly disagree) and 5 (strongly agree). Cultural items are as follows:

- 28 The help link was useful (H12.4).
- 29 The help link has a clear structure and directions for a lesson and working within the project, preventing uncertainty or mistakes (H12.3).
- 30 Using this system has enabled more interactive communication between the lecturers and students (H12.3).
- 31 The Topolor 3 system facilitates suitable interaction and collaboration between lecturer and students (H12.3).
- 32 This system facilitates suitable interaction and collaboration among groups of students (H12.1).
- 33 Using this system has enabled more interactive communications among groups of students (H12.1).
- 34 I find this system useful to create unmixed member teamwork (H12.2).
- 35 Using this system has enabled me to select my member's teamwork similar to my gender (male/female) (H12.2).

### **6.2.2 Data Analysis: Topolor 2 versus Topolor 3**

To evaluate the normality in this study, all items were assessed by applying the SPSS Kolmogorov-Smirnov test [138]. Additionally, in the study, the collected data were analysed by inferential statistics (*t*-test and Wilcoxon signed-scores [140]) and descriptive statistics (frequency distribution, mean, and standard deviation) to confirm or reject the following hypotheses H11, H12 and H13 .

## 6.3 Results

### 6.3.1 Usability of the Topolor 3 system

#### Hypothesis

**H11** Students perceive high *effectiveness*, *efficiency* and *satisfaction* of using the Topolor 3 system.

If the SUS score is higher than 70 would be confirmed the hypothesis (H11), whereas if the SUS score is less than 70 would be confirmed null hypothesis for **H11**.

Table 22 presents SUS's items and the results from the questionnaires. The SUS score for Topolor 3 is 74.85 out of 100 which mean Topolor 3 system at a 'good' level of usability. Moreover, *Cronbach's Alpha* of the SUS scores is 0.73 (>0.7), meaning the results of SUS questionnaires were at a 'good' level of reliability [125]. Therefore, the hypothesis related to learners' *effectiveness* and *efficiency* at the 'system as a whole' level, i.e., 0 H11 has been supported.

**Table 22: Usability of the Topolor 3 (H11)**

Statement	Mean	Median	SD
1. I think that I would like to use Topolor 3 frequently	3.70	4	.46
2. I found the Topolor 3 system unnecessarily complex	3.76	4	.43
3. I thought the Topolor 3 system was easy to use	3.64	4	.49
4. I think that I would need the support of a technical person to be able to use this system	2.17	2	.39
5. I found the various functions in this system were well integrated	3.52	4	.51
6. I thought there was too much inconsistency in this system	2.32	2	.33
7. I would imagine that most people would learn to use this system very quickly	3.58	4	.71
8. I found the Topolor 3 system very difficult to use	1.94	2	.42
9. I felt very confident using this system	3.58	4	.50
10. I needed to learn a lot of things before I could get going with this system	1.88	2	.48

### 6.3.2 Testing Normality

To evaluate the normality in this study, all items were assessed by applying SPSS Kolmogorov - Smirnov Test [138]. If the P value is greater than 0.05, the data originate from a normally-distributed population. If the P value is less than or equal to 0.05, the data originate from a non-normal distributed population (see Chapter 3). It was found that, the p-values of analysis all items were less than 0.05 (see Table 23 and Table 24). This does not indicate a weakness in the measure but rather reveals the underlying nature of the measured construct.

**Table 23: Normality Test for Topolor 2**

Topolor 2	K.S			K.S			K.S		
	students' perceived usefulness			students' perceived ease of use			students' intention of further use		
Feature	Statistic	N	Sig	Statistic	N	Sig	Statistic	N	Sig
Tool for selecting project	.264	30	.000	.347	30	.000	.324	30	.000
Tool for selecting task project	.433	30	.000	.317	30	.000	.438	30	.000
Team formation	.328	30	.000	.167	30	.000	.367	30	.000
Tool communication for group project	.259	30	.000	.240	30	.000	.315	30	.000

**Table 24 : Normality Test for Topolor 3**

Topolor 3	K-S			K-S			K-S		
	students' perceived usefulness			students' perceived ease of use			students' intention of further use		
Feature	Statistic	N	Sig	Statistic	N	Sig	Statistic	N	Sig
Recommending tool for project	.279	30	.000	.288	30	.000	.282	30	.000
Team formation	.378	30	.000	.378	30	.000	.304	30	.000
Recommending tool for task	.357	30	.000	.398	30	.000	.322	30	.000
Adaptive tool communication	.285	30	.000	.360	30	.000	.330	30	.000

### 6.3.3 Results of evaluating Topolor 3 Design Features Using Cultural Dimensions

#### Hypothesis

**H12** The functionalities offered in the Topolor 3 system are acceptable to Saudi Arabian students, if they are matched to their own cultural characteristics.

**H12.1** The Topolor 3 system matches the expectations of the *collectivism dimension*.

**H12.2** The Topolor 3 system matches the expectations of *masculinity*.

**H12.3** The Topolor 3 system matches the expectations of the *high power distance dimension*.

**H12.4** The Topolor 3 system matches the expectations of the *high uncertainty avoidance dimension*.



If the score is higher than 3.5, this would confirm the hypothesis H12, whereas if the score is less than 3.5, it would confirmed the null hypothesis for H12.

Cultural characteristics are shown in Table 25. The score that is greater than 3.5 would support the hypothesis (H12), whilst the confirming null hypothesis for 0 would be supported if the score is less than 3.5.

In terms of **collectivism dimension**, the *mean* range is 4.35, the *median* is 4, and the *standard deviation (SD) of the result* is .57 and the *mean* is greater than 3.5. Moreover, *Cronbach's Alpha* of the scores is 0.77 (>0.7), showing a 'good' level of reliability [147]. Therefore, the hypothesis H12.1 is supported within the constraints of the experimental sample (by the students involved in the experiment).

For the **masculinity dimension**, the *mean* range is 3.88, the *median* is 4, and the *standard deviation (SD) of the result* is .80 and the *mean* is greater than 3.5. Moreover, *Cronbach's Alpha* of the scores is 0.83 (>0.8), showing a 'good' level of reliability [147] . Therefore, the hypothesis H12.4 is supported by the students.

For the **high power distance dimension**, the *mean* is 2.88, the *median* is 3, and the *standard deviation (SD) of the result* is .59 and the *mean* is less than 3.5. Moreover, *Cronbach's Alpha* of the scores is 0.80 (>0.8), showing a 'good' level of reliability [147]. Therefore, the hypothesis H12.3 is not supported by the students.

For the **high uncertainty avoidance dimension**, the *mean* is of 4.20 the *median* is 4, and the *standard deviation (SD) of the result* is .68 and the *mean* is greater than 3.5. Moreover, *Cronbach's Alpha* of the scores is 0.877 (>0.8), showing a 'good' level of reliability [147]. Therefore, hypothesis H12.4 is supported by the students.

**Table 25: Results of Hypothesis 2**

Item	Mean	Median	Std. Deviation	Cronbach's Alpha
Masculinity	3.88	4	.80	0.83
collectivism dimension	4.35	4	.57	0.77
power index	2.83	3	.51	0.80
uncertainty avoidance	4.20	4	.68	0.87

### 6.3.5 Results of the Acceptance of Topolor 2 versus Topolor 3

#### Hypothesis

**H 13** Personalised virtual project and team formation methods for e-learning are more *acceptable* to Saudi students than traditional project and team formation methods for e-learning.

Therefore, the Null-hypothesis that needs refuting is: if the score of the acceptance students of traditional project- and team-formation methods for e-learning is higher than the score of the acceptance students of personalised virtual project and team formation methods for e-learning or there is no difference between the score of the acceptance students of traditional project and personalised virtual project and team formation methods for e-learning.

Sub-hypotheses:

**H13.1** A recommended coursework/project that is personalised to users' skills, interests and knowledge within a social personalised e-learning is more *acceptable* to Saudi students than project selection methods in current/social personalised e-learning.

- H13.1.1** A Saudi student's *perceived usefulness* of a test-based project recommendation method is higher than that of other project choosing methods in social personalised e-learning.
- H13.1.2** A Saudi student's *perceived ease of use* towards a test-based project recommendation method within social personalised e-learning is higher than choosing project methods in social personalised e-learning.
- H13.1.3** Saudi students' *intention of further use* of a recommending tool for projects within a social personalised e-learning is stronger, when compared to social personalised e-learning methods.
- H13.2** A self-defined virtual project teamwork (group activities) that is personalised to the student's characteristics based on the learners' profiles in a social personalised e-learning is more *acceptable* to Saudi students than team formation methods in current/social personalised e-learning.
- H13.2.1** A Saudi student's *perceived usefulness* toward self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is higher than current/traditional methods e-learning.
- H13.2.2** A Saudi student's *perceived ease of use* towards self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is higher than current/traditional methods e-learning.
- H13.2.3** Saudi students' *intentions of further use* of the self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is stronger, when compared to current/social personalised e-learning methods.
- H13.3** An adaptive task recommendation within a project-based Learning System is more *acceptable* to Saudi students than a non-recommended task (selected by themselves) in current/social personalised e-learning.
- H13.3.1.** A Saudi student's *perceived usefulness* toward an adaptive task within group project-based Learning System is higher than a non-recommended task in current/social personalised e-learning.

**H13.3.2.** A Saudi student's *perceived ease of use* toward an adaptive task within group project-based Learning System is higher, when compared to a non-recommended task in current/social personalised e-learning methods.

**H13.3.3.** Saudi students' *continuance intention* of an adaptive task within group project-based Learning System is higher than a non-recommended task in current/social personalised e-learning methods.

**H13.4** An adaptive communication mechanism within project-based Learning System is more *acceptable* to Saudi students than current/social personalised e-learning methods.

**H13.4.1** A Saudi student's *perceived usefulness* toward an adaptive communication mechanism within a project-based Learning System is higher than that of the current communication mechanisms in social personalised e-learning.

**H13.4.2** A Saudi student's *perceived ease of use* toward an adaptive communication mechanism within a project-based Learning System is higher than that of the current social personalised e-learning methods.

**H13.4.3** Saudi students' *continuance intentions* with an adaptive communication mechanism within a project-based Learning System is higher than that for the current social personalised e-learning methods.

The questionnaire (Appendix E and F) results corresponding to students' perceived usefulness, ease of use and students' intention for Topolor 3 and Topolor 2 (the social personalised e-learning system) are shown in Table 26. Paired sample t-test was used for analysing data (see Table 27). Additionally, Wilcoxon Signed-Scores Test was used for analysing data, due to the fact that the data were not normally distributed (see Table 28).

#### **6.3.4.1 Results of recommending a project**

The T-test showed that the students' *perceived usefulness* toward the test-based recommender method for project selection is *higher* (M= 4.36, SD= .41) than the students' *perceived usefulness* toward current practice, based on no automatic recommendation of coursework/project (M=1.95, SD=.49;  $t(29) = 17575$ ;  $p \leq .05$ ) (see Table 26 and Table 27). Additionally, Wilcoxon Signed-Scores Test

indicated that the median the students' *perceived usefulness* toward the test-based recommender method for project selection ranks,  $Mdn = 4.33$ , was statistically significantly higher than the median students' *perceived usefulness* toward current practice, based on no automatic recommendation of coursework/project scores,  $Mdn = 2$ ,  $Z = 4.79$ ,  $p < .000$  (see Table 28). Furthermore, Cronbach's *Alpha* has scores of  $0.80 (\geq 0.8)$  for students' *perceived usefulness* towards the recommended project; and scores of  $0.79 (>0.7)$  for students' *perceived usefulness* toward the current methods of project selection (see Table 26), indicating a 'good' level of reliability of the questions used [147]. Therefore, the hypothesis H13.1.1 is supported.

Moreover, the results revealed that student's *perceived ease of use* towards the test-based recommender method for project is *more* ( $M = 4.50$ ,  $SD = .47$ ) compared to non-recommending tool for project ( $M = 2$ ,  $SD = .52$ ),  $t(29) = 18.018$ ,  $p \leq .05$  as shown in Table 26 Table 27 . Furthermore, Wilcoxon Signed-Scores Test indicated that the median the students' *perceived ease of use* towards the test-based recommender method for project scores,  $Mdn = 4.50$ , was statistically significantly *stronger* than the median students' *perceived ease of use* toward non-recommending tool for project,  $Mdn = 2$ ,  $Z = 4.831$ ,  $p < .000$  (see Table 28). Additionally, *Cronbach's Alpha* has scores of  $0.84 (\geq 0.8)$  in student's *perceived ease of use* toward test-based recommender method for project *and* scores of  $0.84 (>0.8)$  in student's *perceived ease of use* toward test-based recommender method for project in social personalised e-learning (see Table 26), indicating a 'good' level of reliability [147]. Therefore, the hypothesis H13.1.2 is supported.

Additionally, Table 26 shown that students' *intention of further use* of the test-based recommender method for project is *stronger* ( $M = 4.53$ ,  $SD = .45$ ) compared to non-test-based recommender method for project ( $M = 2$ ,  $SD = .57$ ),  $t(29) = 18.551$ ,  $p \leq .05$  (see Table 27). In addition, Wilcoxon Signed-Scores Test indicated that the median the students' *intention of further use* of the test-based recommender method for project scores,  $Mdn = 4.50$ , was statistically significantly more than the median students' *intention of further use* of non-recommending tool for project,  $Mdn = 2$ ,  $Z = 4.818$ ,  $p < .000$  (see Table 28). Moreover, *Cronbach's Alpha* has scores of  $0.84 (\geq 0.8)$  in students' *intention of further use of a recommended tool for project and* scores of  $0.83 (>0.8)$  in students' *intention of*

*further use of a non-recommended tool for project in social personalised e-learning methods* (see Table 26), indicating a ‘good’ level of reliability [147].

Therefore, the hypothesis H13.1.3 is supported. These results were further supported by the qualitative feedback. For example (the student remarks are translated from Arabic), one of student mentioned that “*It gives me an opportunity to test my knowledge and to expand my knowledge through related resources before I select my project*”. Another student commented that “*The resources related to the project are a useful to develop my knowledge and skills*”. Another said “*A test about the student’s knowledge related to a project is a very useful way to find a project that is fit for that student*”.

#### **6.3.4.2 Results of self-defined virtual project team formation based on learners’ profiles**

Table 26 shows that Saudi students’ *perceived usefulness* toward self-defined virtual project team formation based on learners’ profiles is *higher* (M= 4.33, SD= .45) than students’ *perceived usefulness* toward team formation based on social personalised e-learning methods (M= 1.88, SD= .48),  $t(29) = 21.486$ ,  $p \leq .05$  as shown Table 26 and Table 27. In addition, Wilcoxon Signed-Scores Test indicated that the median students’ *perceived usefulness* toward self-defined virtual project team formation based on learners’ profiles scores, Mdn = 4, was statistically significantly more than the median students’ *perceived usefulness* toward team formation based on social personalised e-learning methods, Mdn =2,  $Z = 4.863$ ,  $p < .000$  (see Table 28). Furthermore, *Cronbach’s Alpha* has scores of 0.87 (>0.8) in students’ *perceived usefulness* toward team formation based on learners’ profiles and scores of 0.82 (>0.8) in students’ *perceived usefulness* toward team formation in social personalised e-learning, indicating a ‘good’ level of reliability [147] (see Table 26). Therefore, the hypothesis H13.2.1 is supported.

Table 26 and Table 27 reveal that students’ *perceived ease of use* towards team formation based on learners’ profiles is *higher* (M= 4.35, SD= .45) compared to team formation methods in social personalised e-learning (M= 1.88, SD= .66),  $t(29) = 20.796$ ,  $p \leq .05$ . In addition, Wilcoxon Signed-Scores Test indicated that the median students’ *perceived ease of use* toward self-defined virtual

project team formation based on learners' profiles scores, Mdn = 4, was statistically significantly *stronger* than the median students' *perceived ease of use* toward team formation based on social personalised e-learning methods, Mdn =2, Z = 4.816, p < .000 (see Table 28). Moreover, *Cronbach's Alpha* has scores of 0.87(>0.8) in students' *perceived ease of use* toward team formation based on learners' profiles and scores of 0.80 (>0.8) in *students' perceived ease of use* toward team formation methods in social personalised e-learning , indicating a 'good' level of reliability [147] (see Table 26). Therefore, the hypothesis H13.2.2 is supported.

The students' *intention of further use* of the self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is *stronger* (M= 4.50, SD= .50) compared to team formation based on social personalised e-learning (M= 2, SD= .45), t (29) =19.708, p ≤ .05 as revealed in Table 26 Table 27. Furthermore, Wilcoxon Signed-Scores Test indicated that the median students' *intention of further use* of the self-defined virtual project team formation based on learners' profiles scores, Mdn = 4.50, was statistically significantly *stronger* than the median students' *intention of further use* of the team formation based on social personalised e-learning methods, Mdn =2, Z = 4.833, p < .000 (see Table 28). Additionally, *Cronbach's Alpha* has scores of 0.83 (>0.8) in *students' intention* toward team formation based on learners' profiles and scores of 0.88 (>0.8) in *students' intention* toward team formation in Social personalised e-learning , indicating a 'good' level of reliability [147] as presented in Table 26. Therefore, the hypothesis H13.2.3 is supported. These results were further supported by the qualitative feedback. For example (the students' remarks were translated from Arabic), one student explained that, "*I was very happy to use the Topolor 3 system. I would like to continue to use it to find my group members and I expect this will become a very interesting type of online collaborative project, the more you work with it.*" Another student commented that "*The Topolor 3 system recommended to me some students which are interested in the same project. Also it has allowed me to access their profiles before I invite them to work with me.*" Another student mentioned that "*The Topolor 3 system encourages self-reliance to select group members.*"

#### 6.3.4.3 Results of adaptive task recommendation

Table 26 and Table 27 show that Saudi students' *perceived* usefulness toward adaptive task within group project-based Learning System is *higher* ( $M= 4.34$ ,  $SD= .44$ ) than students' *perceived usefulness* toward non-recommended task on social personalised e-learning ( $M= 2$ ,  $SD= .35$ ),  $t(28) = 27.161$ ,  $p \leq .05$ . In addition, Wilcoxon Signed-Scores Test revealed that the median Saudi students' *perceived usefulness* toward adaptive task within group project-based Learning System scores,  $Mdn = 4$ , was statistically significantly *higher* than the median students' *perceived usefulness* toward non-recommended task on social personalised e-learning,  $Mdn = 2$ ,  $Z = 4.797$ ,  $p < .000$  (see Table 28). Moreover, *Cronbach's Alpha* has scores of 0.83 ( $> 0.8$ ) in students' *perceived usefulness* toward recommended tool for project's task and scores of 0.86 ( $> 0.8$ ) in students' *perceived usefulness* toward non-recommended tool for project's task in social personalised e-learning, indicating a 'good' level of reliability [147] (see Table 26). Therefore, the hypothesis H13.3.1 is supported.

Table 26 demonstrates that *students' perceived ease of use* towards recommended tool for task is *higher* ( $M= 4.33$ ,  $SD= .46$ ) compared to non-recommended task ( $M= 1.80$ ,  $SD= .51$ ),  $t(29) = 19.994$ ,  $p \leq .05$  as revealed in Table 27. Moreover, Wilcoxon Signed-Scores Test indicated that the median Saudi *students' perceived ease of use* toward recommended tool for task scores,  $Mdn = 4$ , was statistically significantly higher than the median *students' perceived ease of use* toward non-recommended task on social personalised e-learning,  $Mdn = 2$ ,  $Z = 4.841$ ,  $p < .000$  (see Table 28).

Additionally, *Cronbach's Alpha* has scores of 0.77 ( $> 0.7$ ) in students' *perceived ease of use* toward recommended tool for project's task and scores of 0.87 ( $> 0.8$ ) in students' *perceived ease of use* toward *non-recommended* tool for project's task in social personalised e-learning, indicating a 'good' level of reliability [147] (see Table 26). Therefore, the hypothesis H13.3.2 is supported.

Moreover, the results revealed that *students' intention of further use* of a recommended tool for task is *stronger* ( $M= 4.43$ ,  $SD= .46$ ) compared to non-recommended task ( $M= 1.96$ ,  $SD= .34$ ),  $t(29) = 21.970$ ,  $p \leq .05$  as presented in Table 26 and Table 27. In addition, Wilcoxon Signed-Scores Test shown that the median Saudi *students' intention of further use* of a recommended tool for task scores,



Mdn = 4.25, was statistically significantly *higher* than the median students' *perceived usefulness* toward non-recommended task on social personalised e-learning, Mdn =2, Z = 4.847, p < .000 (see Table 28). Furthermore, *Cronbach's Alpha* has scores of 0.84 (> 0.8) in students' *intention of further use* of a recommended tool for project's task and 0.86 (>0.8) in students' *intention of further use* of a non-recommended tool for project's task in *social personalised e-learning*, indicating a 'good' level of reliability [147] (see Table 26). Therefore, the hypothesis H13.3.3 is supported. These results were consistent with the qualitative feedback. For example (translated from Arabic), one student said that, "The personality test is a useful way to find a task fit for me." Another student mentioned that "I like using the Topolor 3 system. It helped us to plan our project better and arrange our time." Another student explained that, "I would like to use the Topolor 3 system again. It has many advantages for group projects, such as tracking the time to complete the project tasks and recommending us daily progress, to complete the tasks before the deadline."

#### **6.3.4.4 Results of the adaptive communication mechanism**

*Saudi students' perceived usefulness* toward adaptive communication mechanism is more (M= 4.51, SD= .46) than students' *perceived usefulness* toward communication mechanism in current/social personalised e-learning methods (M= 2.10, SD= .67), t (29) = 16.13, p ≤ .05 as revealed in Table 26 and Table 27. In addition, Wilcoxon Signed-Scores Test revealed that the median *Saudi students' perceived usefulness* toward adaptive communication mechanism scores, Mdn = 4.50, was statistically significantly *higher* than the median students' *perceived usefulness* toward communication mechanism in current/social personalised e-learning methods, Mdn =2, Z = 4.846, p < .000 (see Table 28). Moreover, *Cronbach's Alpha* has scores of 0.80 (>0.8) in *students' perceived usefulness* toward adaptive communication mechanism and scores of 0.81 (>0.8) in *students' perceived usefulness* toward communication mechanism in social personalised e-learning methods, indicating a 'good' level of reliability [147] (see Table 26). Therefore, the hypothesis H13.4.1 is supported.

Table 26 and Table 27 displays that *Saudi students' perceived ease of use* toward adaptive communication mechanism is more (M= 4.38, SD= .46) than students' *perceived ease of use* toward

communication mechanism in current/social personalised e-learning methods ( $M= 2.18$ ,  $SD= .67$ ),  $t(29) = 16.59$ ,  $p \leq .05$ . Moreover, Wilcoxon Signed-Scores Test shown that the median *Saudi students' perceived ease of use* toward adaptive communication mechanism scores,  $Mdn = 4$ , was statistically significantly *more* than the median students' *perceived ease of use* toward communication mechanism in current/social personalised e-learning methods,  $Mdn = 2$ ,  $Z = 4.847$ ,  $p < .000$  (see Table 28). Furthermore, *Cronbach's Alpha* has scores of 0.89 ( $>0.8$ ) in *students' perceived ease of use* toward adaptive communication mechanism and scores of 0.84 ( $>0.8$ ) in *students' perceived ease of use* toward communication mechanism in social personalised e-learning methods, indicating a 'good' level of reliability [147] (see Table 26). Therefore, the hypothesis H13.4.2 is supported.

*Saudi students' continuance intention* of adaptive communication mechanism is *more* ( $M= 4.34$ ,  $SD= .41$ ) than students' *continuance intention* of communication mechanism in current/social personalised e-learning methods ( $M= 1.97$ ,  $SD= .49$ ),  $t(29) = 22.76$ ,  $p \leq .05$  as shown in Table 26 and Table 27. Additionally, Wilcoxon Signed-Scores Test presented that the median *Saudi students' continuance intention* of adaptive communication mechanism scores,  $Mdn = 4$ , was statistically significantly *greater* than the median students' *continuance intention* of communication mechanism in current/social personalised e-learning methods,  $Mdn = 2$ ,  $Z = 4.827$ ,  $p < .000$  (see Table 28).

Additionally, *Cronbach's Alpha* has scores of 0.89 ( $>0.8$ ) in *students' intention* toward adaptive communication mechanism and scores of 0.82 ( $>0.8$ ) in *students' intention* toward communication mechanism in social personalised e-learning methods, indicating a 'good' level of reliability [147] (see Table 26). Therefore, the hypothesis H13.4.3 is supported. These results were further confirmed by the qualitative feedback. For example (as translated from Arabic), one of student mentioned that "*I like using the chat in Topolor 3. It helped me connect with my group members easily.*" Another student commented that "*Topolor 3 is useful to improve the communication process in a project. It enables me to be in touch with my group colleagues and arranging schedules.*" Another respondent said that, "*I would like to use Topolor 3 system again. It offered opportunity that group members can work together on assignments*".

**Table 26: Scores of learner perceived usefulness, ease of use and students' intention for Topolor 2 and Topolor 3**

<i>Feature</i>	<i>students' perceived usefulness</i>			<i>students' perceived ease of use</i>			<i>students' intention of further use</i>		
	<i>mean</i>	<i>SD</i>	<i>C-Alpha</i>	<i>mean</i>	<i>SD</i>	<i>C-Alpha</i>	<i>mean</i>	<i>SD</i>	<i>C-Alpha</i>
H13.1: test-based recommender method for project selection in Topolor 3	4.36	.41	.80	4.50	.47	.84	4.53	.45	.84
H13.1: current project choosing methods in Topolor 2	1.95	.49	.79	2	.57	.84	2.08	.57	.83
H13.2: A recommending tool for task in Topolor 3	4.34	.45	.83	4.33	.46	.77	4.43	.46	.84
H13.2: Non-recommending tool for task in Topolor 2	2	.35	.86	1.80	.51	.87	1.96	.34	.86
H13.3: Team formation on Topolor 3	4.35	.46	.87	4.35	.45	.87	4.50	.50	.88
H13.3: Team formation in Topolor 2	1.88	.48	.82	1.83	.66	.80	2	.45	.83
H13.4: Adaptive communication tool in Topolor 3	4.51	.46	.80	4.38	.46	0.89	4.34	.41	.89
H13.4: communication tool in Topolor 2	2.10	.67	.81	2.18	.67	0.84	1.97	.49	.82

**Table 27: T-test for Topolor2 and Topolor3**

	<i>students' perceived usefulness</i>			<i>students' perceived ease of use</i>			<i>students' intention</i>		
<b>Feature</b>	<i>t</i>	<i>df</i>	<i>Sig.</i>	<i>t</i>	<i>df</i>	<i>Sig.</i>	<i>t</i>	<i>df</i>	<i>Sig.</i>
H13.1:A recommending tool for project (Toplor 3)and non-recommending project (Toplor 2)	17.58	29	.00	18.02	29	.00	18.55	29	.00
H13.2:A recommending tool for task ((Toplor 3)) and non-recommending task (Toplor 2)	27.16	28	.00	19.99	29	.00	21.97	29	.00
H13.3:Team formation on Topolor 3 system and Topolor 2 system	21,49	29	.00	20.80	29	.00	19.71	29	.00
H13.4: Adaptive communication tool (Toplor 3)and traditional communication tool (Toplor 3)	16.13	29	.00	16.59	29	.00	22.76	29	.00

**Table 28: Wilcoxon Signed-Scores Test for Topolor 2 and Topolor 3**

	<b>students' perceived usefulness</b>		<b>students' perceived ease of use</b>		<b>students' intention</b>	
<b>Feature</b>	<b>Z</b>	<b>Sig.</b>	<b>Z</b>	<b>Sig.</b>	<b>Z</b>	<b>Sig.</b>
H13.1: test-based recommender method for project selection (Toplor 3) and non-recommending project (Toplor 2)	4.79	000	4.83	000	4.81	000
H1.2:A recommending tool for task ((Toplor 3)) and non-recommending task	4.79	000	4.84	000	4.84	000

(Toplor 2)						
H13.3:Team formation on Topolor 3 system and Topolor 2 system	4.86	000	4.81	000	4.83	000
H13.4: Adaptive communication tool (Toplor 3)and traditional communication tool (Toplor 3)	4.74	000	4.74	000	4.81	000

### 6.3.5 Log-files Results

Each student action within the Topolor 3 system, designated as “meaningful” by the designers, is recorded quantitatively in a searchable database. For example, when a student posts comments or views comments, posts a new announcement, creates or deletes a task, a chat message, each action is recorded in the database, along with the user ID.

For this research, I have analysed event logs related to group projects, in order to understand how students used the Topolor 3 system. The record data tuple is:

```
<user_id, controller, action, request,create_at>.
```

For example, on possible value would be as:

```
<132, "project", "view", "id=42", "2015-07-24 10:02:30">.
```

It means that at 10:02:30 on July 24th 2015, the student (id=132) accessed a project page (id=43).

The total number of actions that were recorded during the study on the Topolor 3 system was of 4528 actions from the 45 students who used the system.

11 students (24%) invited group members from the students recommended by the Topolor 3 system and 32 out of 45 students accepted the invitation, a percentage of 71.11% of the students. 36 out of 45 students select the project topic from the recommended projects by the Topolor 3 system. 22 different kinds of activities were determined from the record data, as revealed in Table 29.

As can be seen from Table 29, the most frequent actions were of Message/chat (i.e., sending a message, viewing a message/ chat etc.), followed by project task actions (i.e., creating/viewing a project task page). Submitting quizzes, selecting project topics and inviting group members and

accepting or rejecting invitation actions were used just at the start of the group project. This was to be expected, due to the fact that students did not need to perform these actions, after selecting their project and the members of their group. Not all the students performed announcements actions (e.g., creating announcements). This could be because these were not considered to be important feature for group projects or perhaps because not all students had important announcements to make for all students.

Table 29: Actions recorded

<b>Tool Event</b>	<b>Actions possible</b>	<b>Number of actions</b>
<i>Quiz_topic project</i>	Submit/view quiz	73
<i>Select topic_project</i>	View/select	45
<i>Members group invitation</i>	Accept/reject	45
<i>Comment</i>	Create / view	34
<i>Tasks</i>	Create / view / update / delete	1469
<i>Announcements</i>	Create / view	3
<i>Resources / a question/answer</i>	Create / view/ create question / view / an answer to a question / view;	93
<i>Message/chat</i>	Create message / view/	2800

## 6.4 Discussion

Chapter 5 introduces Topolor 3 that can allow the building of project teams with appropriate membership and may allow for an enhanced level of collaboration within collaborative learning. Moreover, the Topolor 3 system is integrated with the Facebook system, in order to obtain student profile data.

The current chapter 6 describes various evaluations performed on the newly introduced system in chapter 5, based on the theory developed previously, in order to answer to the research questions. For the evaluation of Topolor 3, two experiments have been conducted. The first experiment was carried out to explore the usability of Topolor 3 in terms of effectiveness, efficiency and satisfaction of using the Topolor 3 functionalities. The System Usability Scale (SUS) questionnaire survey (Appendix D) has been applied, for evaluating the system at the ‘system as a whole’ level (see table 20). The results confirmed that students perceive high effectiveness, efficiency and satisfaction in using the Topolor 3 system. This indicates that students generally perceive the Topolor 3 system to be usable.

The next experiment was conducted to investigate Saudi Arabian higher education students’ acceptance of a recommended virtual project and recommended group formation for e-learning versus traditional project- and team-formation methods for e-learning. In terms of data collection, a survey questionnaire and an interview were conducted. The qualitative feedback was consistent with the outcomes of the questionnaire.

With regard to students’ *perceived usefulness, ease of use, intention of further use* in using the Topolor 2 and Topolor 3 systems, these three perceptions were evaluated at four levels of the functionality of the systems: ‘recommended tool for project’, ‘student self-defined virtual project team formation’, ‘adaptive tasks’ and ‘adaptive communication mechanism’.

Moreover, students’ *perceived* collectivism, power distance, uncertainty avoidance, and masculinity were evaluated at the system level, as a whole, *to investigate if the functionality offered in the Topolor 3 system matches their own cultural characteristics* (see table 30). The study adopted the Hofstede cultural value dimensions as a theoretical framework (see more on this framework in chapter 2 section

2.6.1). Hofstede’s national culture dimensions were considered as a base for understanding the influence of national culture on people’s behaviour.

Table 30: Cultural features in Topolor3

High Uncertainty avoidance	Providing clear structure and facilitate the e-learning navigation, by means of alerts, messages, and guidelines, preventing uncertainty or mistakes.
High Power Distance dimension	Providing toolsets for feedback from lecturers (e.g., comments) and navigation via alerts and guidelines.
Collectivist culture	social interaction tools (e.g., group chat and group project management)
Masculine society	Providing toolsets for creating <i>group projects</i> with separation of the genders.

All the results presented here inherit the limits created by the size and scale of the experiment (as discussed in Chapter 3, section 3.3.4).

In terms of *recommendations for the project*, the questionnaire results indicate that Saudi students’ *perceived usefulness* toward the recommendation of a project within social personalised e-learning was higher than choosing project methods in social personalised e-learning themselves. Additionally, Saudi students’ perceived ease of use towards the recommendation tool of a project within social personalised e-learning was higher than choosing project methods in social personalised e-learning. Furthermore, Saudi students’ *intention of further use* of the recommendation of a project within a social personalised e-learning was stronger, when compared to social personalised e-learning methods. The overall results of the case study have indicated that the *recommended project* that is



personalised to students' characteristics (users' skill, interests and knowledge) within a social personalised e-learning is more *acceptable* to Saudi students than current/social personalised e-learning methods. Thus, it can be concluded that this process has its advantages. It is acceptable that identifying skills related to the project and using knowledge tests has a positive influence on the project selection process, as it supports: 1) providing recommendations for students before the project selection, and 2) checking if the students have understood the project task or not.

With regards to *self-defined virtual project team formation* based on learners' profiles, the questionnaire results indicate that Saudi students' *perceived usefulness* toward self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is higher than current/traditional methods in e-learning. In addition, Saudi students' *perceived ease of use* towards self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is higher than current/traditional methods e-learning. Moreover, Saudi students' *intention of further use* of the self-defined virtual project team formation based on learners' profiles in a social personalised e-learning is stronger, when compared to current/social personalised e-learning methods. The overall outcomes of this research have showed that a self-defined virtual project teamwork (group activities) that is personalised to the students' characteristics based on the learners' profiles in a social personalised e-learning is more *acceptable* to Saudi students than team formation methods in social personalised e-learning.

In the context of adaptive recommended tasks, the questionnaire outcomes show that Saudi students' *perceived usefulness* toward adaptive tasks within a project-based learning system is higher than non-recommended tasks in current/social personalised e-learning. Additionally, the students' *perceived ease of use* toward adaptive tasks is higher, when compared to non-recommended tasks in current/social personalised e-learning methods. Moreover, Saudi students' *continuance intention* of the recommended tasks within a project-based Learning System is higher than non-recommended task in current/social personalised e-learning. The overall findings of this research have shown that an adaptive task recommendation within a project-based Learning System is more *acceptable* to Saudi students than non-recommended tasks in current/social personalised e-learning. The Topolor 3 system

supports: 1) checking available project tasks; 2) providing recommendation for students, according to the *task style* based on whether the students are verbal or visual, before task selection; 3) helping students to plan and organise project teams. For example, it can give an overview about how long tasks will take to complete, early warnings of any risks to the project, recommended daily progress to complete the tasks before the deadline, and historical information on other projects.

With regard to *adaptive communication mechanisms*, the questionnaire results indicates that Saudi students' perceived usefulness toward an adaptive communication mechanism within a project-based Learning system is higher than that of the communication mechanism in social personalised e-learning. Furthermore, Saudi students' perceived ease of use toward adaptive communication mechanisms within a project-based learning system is higher than that in other social personalised e-learning environments. Additionally, Saudi students' continuance intention with adaptive communication mechanisms within a group project-based learning system is higher than that within other social personalised e-learning systems. The overall results of the case study have indicated that an adaptive communication mechanism within a project-based learning system is more acceptable to Saudi students than current/social personalised e-learning methods.

In terms of evaluating the Topolor 3 design features using cultural dimensions, the results of this study revealed that Topolor 3 is *not matched with the expectations about the high power distance dimension*. Although teachers can check the progress of student collaboration and give them feedback via interaction toolsets and comments on the learning pages, students reported that there is a lack of lecturer guidance. They were not able to interact with the teacher directly and get feedback regarding the project. This occurrence links with culture hierarchy and structure, which implies the need of some type of external support for their actions. Saudi students can be described as dependent students, who request the teachers' aid and reinforcement to finish a given task. Therefore, they need to see such a system's guidance clearly marked as 'teacher approved'.

Moreover, Saudi students desire to work collaboratively in a group to achieve their goals, rather than focussing on personal study. They like to discuss about issues together, which they find much more

attractive and efficient than forming an individual view. It can be concluded that Topolor 3 is *matched with the expectations of the collectivism dimension*. Students are allowed to work in small teams.

Furthermore, students found the system attractive, because of the communicating and collective nature of the activities. In addition, it can be noticed on the Topolor 3 site that each group can display all the pictures of all the members in that team, which further supports the collectivism culture. However, it is essential to cater for the separation of the genders in teaching in Saudi Arabia. The results of this study revealed that Topolor 3 is *matched with the expectations of the perceived masculinity dimension*. The Topolor 3 system enables creating collaborative project teams with separation of the genders. In addition, during the experiments, it was noticed that there was no sign of a female photograph on the Topolor 3 system; female students uploaded pseudo-photos instead of their real photos, such as photos about nature or animals. Saudi Arabian culture becomes very sensitive to photographs of women when they are used on any websites and this is linked to the culture and religion of the country.

The outcomes of this study revealed that Topolor 3 is *matched with the expectations of the perceived high-uncertainty-avoidance dimension*. The system aims at being straightforward for the students. To reduce student concerns that may raise uncertainty, the predicted results are presented to the students (e.g., “if you take test, you will be allowed to start a group project”). The system attempts to make the project structure clear, by setting clear expectations for participation and setting up times and deadlines for project submission.

A similar work on adaptive group formation based on to learning styles, which are determined systematically based on the students’ profile, has been proposed in [83, 93, 157]. The main difference between these works and the one in this thesis is using a student-centered method in project-based e-learning, to support the student in decisions regarding: the *project definition*, based on students’ knowledge and skills; *group membership*, based on student profile characteristics; *project tasks*, based on students’ personality; and *communication tools*, by providing adaptive recommendations. Moreover, these systems do not automatically use characteristics of learning and collaborative

behaviour in an existing e-learning system and social network to support students in decisions about project selection, group formation, etc. As an alternative, they apply independent means for supporting group formation. In this work, the users' characteristics are collected automatically from social networks and from a social adaptive e-learning system, which allows for frequent updates and includes collaborative aspects. This represents a novel and flexible method to the group formation process. Furthermore, these researches focused on virtual open online communities, which are then grouped by relating them to students' interests; these communities have no access - or exit limitations. On the contrary, the work presented in the current thesis focuses on virtual teams, which are linked based on task-related results and time restraints, often using the method of deadlines [161]. The form of the virtual team is organised as the task requests. This holds the teams together, and these teams are not divided until the tasks are achieved. Moreover, each member in the team has one or more task roles, as based on recommendation in [162].

A similar work focuses on virtual teams, which allocates students to specific tasks, based on learning styles and preferences, but with mobile learning, is described in [163]. The main difference between this work and the one described in this thesis is that they are using two heuristic algorithms: a genetic algorithm and a simulated annealing method. The algorithmic methods are complex for non-experts, and thus the link between cause and effect might be obstructed or impossible to extract and reuse is thus diminished. Other research focused on improving two main features in collaborative learning, communication and project management, by offering adaptive recommendations [91]. Unlike the work presented in this thesis, the methods adopted for creating group tasks do not tailor to individual students' characteristics, because students sign up to group tasks manually. Also, their system does not offer means for supporting collaborative communication and project management environments.

## **6.5 Summary**

This chapter has described the investigation about the acceptance of the proposed Topolor 3 system versus traditional project- and team-formation methods for e-learning, from the perspectives of learner usefulness, perceived ease of use, and behavioural intention. The Topolor 3 *design features using cultural dimensions* were evaluated from the perspectives of learner collectivism, power distance,

uncertainty avoidance, and masculinity. Moreover, the Topolor 3 system combines group formation adaptation and project management recommendations with social learning domain adaptation. The qualitative and quantitative data have been extracted. A questionnaire was developed, based on measures that have been validated by prior researchers: the TAM measures of perceived usefulness, perceived ease of use, and behavioural intention from Davis [7], as well as the Hofstede cultural value dimensions [21] and the System Usability Scale (SUS)[150].

In conclusion, the main objectives of the studies presented in this chapter are to answer the research questions, as follows:

**R3** Are personalised virtual project and team formation methods for e-learning more acceptable to Saudi students than traditional project and team formation methods for e-learning?

**R3.1** *Is the recommended project that is personalised to students' characteristics (skills, interests and knowledge) within social personalised e-learning more acceptable to Saudi students than current/traditional e-learning methods?*

The answer is that **the recommended project that is personalised to students' characteristics (skills, interests and knowledge) within social personalised e-learning is statistically significantly more acceptable to Saudi students than current/social personalised e-learning methods.**

**R3.2** *Is adaptive task recommendation within a group project-based e-learning system more acceptable to Saudi students than current/traditional e-learning methods?*

The answer is that **an adaptive task recommendation within a project-based learning system is statistically significantly more acceptable to Saudi students than non-recommended tasks in current/social personalised e-learning.**

**R3.3** *Is a self-defined virtual team project (group activity) that is personalised to the student's characteristics (based on the learner's profile within a social personalised e-learning system) more acceptable to Saudi students than team formation methods in current/traditional e-learning?*

The answer is that a **self-defined virtual team project that is personalised to the students' characteristics (based on the learners' profiles in a social personalised e-learning system) is statistically significantly more acceptable to Saudi students than team formation methods in current/traditional e-learning.**

*R3.4 Is an adaptive communication mechanism within a group project-based e-learning system more acceptable to Saudi students than current/traditional e-learning methods?*

The answer is that an **adaptive communication mechanism within a project-based e-learning system is statistically significantly more acceptable to Saudi students than current/traditional e-learning methods.**

# Chapter 7: Conclusions

## 7.1 Reviewing the thesis' aims

This thesis has investigated the acceptance of *social personalised* as opposed to static e-learning and classroom learning for Saudi university students, and how a more *personalised and social* system can benefit Saudi education, rather than employing identical delivery for all students, regardless of their interests, preferences, backgrounds, and knowledge. Moreover, the thesis has investigated Saudi students' acceptance of the traditional collaborative learning system (the widely used Jusur system) for group project work. It has also explored Saudi Arabian students' cultural characteristics, through Hofstede's cultural value dimensions, and the appropriateness of Saudi Arabian e-learning, based on these characteristics. Furthermore, it has explored the needs of students with regards to *project membership, tasks* and the *communication tools* used for group projects in e-learning.

Additionally, the work presented in this thesis eventually led to the investigation of a *novel technique for merging, balancing the extent of adaptation, collaborating virtually and forming teams in Saudi Arabian e-learning*. Specifically, this research has explored a novel combination of the following: *traditional adaptation based on user modelling, virtual collaborative projects, and team formation methods*, with the aim of increasing the acceptance of virtual team projects in social personalised adaptive e-learning systems. The *Topolor2* system has been extended, to provide adaptive recommendations to support students' decisions about the following: *project selection*, based on the students' knowledge and skills; *group membership* based on the students' profile characteristics; *project tasks*, based on students' personality; and *communication tools*. The aim of these recommendations is to offer performance monitoring and dynamic support to the user, to increase the acceptance of virtual group projects.

**Topolor 2** and **Topolor 3** were evaluated. The comparison was based on the well-known *technology acceptance model (TAM)*, a theoretical framework that was used in this thesis to design the method of data collection from the students. Specifically, Topolor 3's *design features, cultural dimensions* and

*usability* were evaluated. The results indicate that students generally perceived the Topolor 3 system to be usable. The evaluation outcomes have been useful in obtaining new insights on the effect of the new approaches presented in this thesis.

This chapter aims to conclude the thesis with a review of the study's general achievements and contributions, as well as considerations of the study's limitations, and directions for future research.

For the remainder of this chapter, Section 7.2 summarises the research procedure by which the study questions have been answered, and discusses how well the individual study objectives have been met, and what the answer to the research questions posed at the start of the thesis are. Secondly, Section 7.3 presents the main contributions of this research. Finally, Section 7.4 discusses the limitations of the research and presents possibilities for future research, both for the author of the thesis, as well as for other researchers in the field.

## **7.2 Answer to Research Questions and Implementation of Objectives**

This thesis has explored several methods and technologies, in order to answer the following research questions.

**R1:** *Is Saudi students' acceptance of social personalised e-learning systems (Topolor) higher than their acceptance of the traditional e-learning and classroom learning?*

**R2:** *Do Saudi students demonstrate acceptance of the traditional collaborative learning system for group project work?*

**R3:** *Are personalised virtual project and team formation methods for e-learning more acceptable to Saudi students than traditional project and team formation methods for e-learning?*

Further, more detailed research questions were the following.

**R3.1** *Is the recommended project that is personalised to students' characteristics (skills, interests and knowledge) within social personalised e-learning more acceptable to Saudi students than current/traditional e-learning methods?*



**R3.2** *Is adaptive task recommendation within a group project-based e-learning system more acceptable to Saudi students than current/traditional e-learning methods?*

**R3.3** *Is a self-defined virtual team project (group activity) that is personalised to the student's characteristics (based on the learner's profile within a social personalised e-learning system) more acceptable to Saudi students than team formation methods in current/traditional e-learning?*

**R3.4** *Is an adaptive communication mechanism within a group project-based learning system more acceptable to Saudi students than current/traditional e-learning methods?*

This research has been fulfilled through seven separate study objectives (as stated in Section 1.4), formulated in order to answer the above research questions.

**O1:** *Review the fields of adaptive social e-learning, adaptive collaborative learning environments, and cultural and virtual project and team formation, to investigate their effect on the e-learning process, and more specifically, on the virtual project process (project formation process and project completion process) for e-learning.*

This research objective has been achieved by carrying out a comprehensive literature review in the fields of adaptive social e-learning, adaptive collaborative learning environments, and cultural and virtual project and team formation, as summarised in the chapter on background and related work (Chapter 2). This review identified gaps in the existing research in these fields. Theories related to the topics of interest were also presented.

The research started from the belief that a 'one size fits all' approach is not particularly suitable for the Saudi culture. Although various studies [164], [3], [165], [166] have investigated the acceptance of the traditional e-learning, no known study has looked at the acceptance of social personalised e-learning in the Saudi context. Moreover, most of the existing literature has concentrated on opinions of faculty employees and administrators a gap that this thesis has attempted to rectify. This research has investigated the *acceptance of social personalised versus traditional e-learning in Saudi Arabia from the students' perspective* (Chapter 4), and has thus attempted to fill a gap in the e-learning

literature. It has focused, in particular, on the *acceptance of social personalised versus e-learning and classroom learning by Saudi university students*.

Addressing the first study objective provided the background knowledge to answer research questions R1, R2 and R3.

**O2:** Explore Saudi students' acceptance of a social personalised e-learning versus the traditional e-learning system and classroom learning.

**O3:** Explore Saudi students' acceptance of the traditional collaborative e-learning for group project work.

These research objectives were addressed through an experimental study evaluating the Topolor system in comparison to the traditional e-learning system (Jusur system) and classroom learning (Chapter 4).

The acceptance of the social personalised versus static e-learning and classroom learning by Saudi university students was explored. The comparison was based on the well-known *technology acceptance model* (TAM). Additionally, Saudi students' acceptance of the traditional collaborative e-learning system (Jusur system) for group project work was explored.

The achievement of research objectives **O2 and O3** aided in answering the first and second research questions:

**R1:** *Is Saudi students' acceptance of social personalised e-learning systems (Topolor) higher than their acceptance of the traditional e-learning system (Jusur system) and classroom learning?*

The answer is that the **Saudi students' acceptance of social personalised e-learning systems (Topolor) is statistically significantly higher than their acceptance of the traditional e-learning system (Jusur system) and classroom learning.**

**R2:** *Do Saudi students demonstrate acceptance towards the traditional collaborative learning system (Jusur system) for group project work?*

**Saudi students do not demonstrate acceptance towards the traditional collaborative learning system (Jusur system) for group project work. This clearly shows that other digital methods for group project work need to be explored.**

**O4:** *Explore the cultural characteristics of Saudi Arabian students using Hofstede's cultural value dimensions.*

An experiment was done to *explore* the *cultural factors* that influence acceptance of e-learning in the context of the more recently developed field of *group projects* in e-learning, from the students' perspective. The study adopted Hofstede's cultural value dimensions (*power distance, individualism versus collectivism, masculinity versus femininity, and uncertainty avoidance*) as a theoretical framework, for understanding the influence of the national culture on people's behaviour. The results revealed that *Saudi Arabian students' cultural characteristics* are similar to Hofstede's 1980 [16] analysis of the Arab world and can be applied to Saudi Arabian e-learning. This information aids in the understanding of which cultural factors might support an effective e-learning implementation.

**O5:** *Explore the needs of the students in relation to the recommended project group membership, the recommended task and the recommended communication tools for the group project, with the aim of determining what is necessary for implementation of the recommendation environment.*

Some recent studies have highlighted the need for the integration of a collaborative learning environment (virtual communities), methods and technologies, into adaptive systems. However, only a limited numbers of systems allowing virtual team projects for e-learning interaction have been suggested. The requirements for the Saudi Arabia students' virtual team tools in an adaptive e-learning setting have been determined, thus filling a gap in the e-learning literature (Chapter 5).

**O5** was thus completed through a case study of the system requirements (Chapter 5). Its results identified the needs of Saudi Arabian students with regard to the *project, group members, project task* and *communication tools* for the group project, to help designers implement the recommendation environment in the next research objective.

**O6:** *Propose a framework for recommendation of collaborative projects within an e-learning system. Based on this framework, the architecture of the (Topolor 3) system will be defined, and the system will be implemented.*

The proposed framework for recommendation of group projects was established, based on the previous literature [83, 157] and based on the hypotheses and conclusions from **O4** and **O5** (Chapter 5). This framework was implemented on top of the Topolor 2 system architecture. Topolor 3 was integrated with the Facebook system and the Topolor 2 social personalised adaptive e-learning system, in order to build student profile data (e.g., to be able to collect information about students' skills). The system architecture of Topolor 3 offers the *adaptive recommendation of project, group members, project management tasks, and communication tools, thus supporting collaborative project-based group learning.*

**O7:** *Investigate Saudi Arabian higher education students' acceptance of a recommended virtual project and recommended group formation for e-learning versus traditional project- and team-formation methods for e-learning.*

This research objective was completed through a case study investigating the acceptance of the proposed Topolor 3 system versus traditional project and team formation methods for e-learning, from the perspectives of learner usefulness, perceived ease of use, and behavioural intention (Chapter 6). Topolor 2 provides support for virtual *communities* in social personalised adaptive e-learning, whereas Topolor 3 provides support for *virtual project teams* in social personalised adaptive e-learning.

Topolor 3 offers *adaptive recommendations*, to support students' decisions about *project selection*, based on the students' knowledge and skills; *group membership recommendation*, based on the students' profile characteristics; *project tasks recommendation*, based on the students' personalities; and *communication tools*. The aim of these recommendations is to offer *performance monitoring* and *dynamic support to the students*, to increase their acceptance of virtual group projects. The outcomes

of the case study indicate that *Topolor 3* is more *acceptable* to Saudi students than *Topolor 2*, for virtual collaborative projects and team formation.

The achievement of research objective **O6** aided in answering the third research question and its sub-questions as following.

**R3:** *Are personalised virtual project and team formation methods for e-learning more acceptable to Saudi students than traditional project and team formation methods for e-learning?*

**R3.1** *Is the recommended project that is personalised to students' characteristics (skills, interests and knowledge) within social personalised e-learning more acceptable to Saudi students than current/traditional e-learning methods?*

The answer is that **the recommended project that is personalised to students' characteristics (skills, interests and knowledge) within social personalised e-learning is statistically significantly more acceptable to Saudi students than current/social personalised e-learning methods.**

**R3.2** *Is adaptive task recommendation within a group project-based e-learning system more acceptable to Saudi students than current/traditional e-learning methods?*

The answer is that **an adaptive task recommendation within a project-based learning system is statistically significantly more acceptable to Saudi students than non-recommended tasks in current/social personalised e-learning.**

**R3.3** *Is a self-defined virtual team project (group activity) that is personalised to the student's characteristics (based on the learner's profile within a social personalised e-learning system) more acceptable to Saudi students than team formation methods in current/traditional e-learning?*

The answer is that **a self-defined virtual team project that is personalised to the students' characteristics (based on the learners' profiles in a social personalised e-learning system) is**

**statistically significantly more acceptable to Saudi students than team formation methods in current/traditional e-learning.**

**R3.4** *Is an adaptive communication mechanism within a group project-based e-learning system more acceptable to Saudi students than current/traditional e-learning methods?*

The answer is that an **adaptive communication mechanism within a project-based e-learning system is statistically significantly more acceptable to Saudi students than current/traditional e-learning methods.**

### **7.3 Contributions**

The outcomes of the research described in this thesis present some important contributions to theory and practice, as follows.

1. This study is one of the few to have investigated the *acceptance of social personalisation e-learning versus traditional learning in Saudi Arabian universities* (classroom learning or traditional e-learning). Moreover, it has investigated *Saudi students' acceptance of the traditional collaborative learning system (Jusur system) for group project work* (Chapter 4). Saudi universities have purchased e-learning systems from commercial companies, such as Jusur, with their learning management system (LMS). However, this form of e-learning is not meant to offer personalised learning that helps the individual student and does not offer supporting functionalities for virtual teams. It is directly converted from English into Arabic, regardless of the student's interests, preferences, background (cultural), or knowledge [20]. The study's results indicate that Saudi students do not *perceive usefulness, ease of use, and intention for further use* for the traditional collaborative learning system (Jusur system) for group project work. Social personalisation seems to be needed, for the implementation of e-learning in Saudi Arabia.
2. The research *gives e-learning facilitators in Saudi Arabia the main principles with which to guide their introduction of e-learning, at the university level*. The results indicate the

following points to keep in mind, when developing e-learning *group projects* for Saudi Arabian students.

- Saudi Arabian culture has a *high power distance* dimension. Thus, students need more support and guidance from the e-learning system.
- Saudi Arabian culture is a *collectivist* culture. An e-learning system should support social interaction and teamwork within coursework, such as with discussion forums, chat, message and email. This is because Saudi Arabian students prefer to learn collaboratively in a group, rather than studying individually.
- Saudi Arabian culture is a *masculine society*. An e-learning system should support separation of the genders, when creating *group projects*, or in social interaction, such as in discussion forums or chat.
- Saudi Arabian culture shows *high uncertainty avoidance*. An e-learning system should provide guidance with help in the lessons, simple designs with clear descriptions, and a limited amount of data, so as to decrease ambiguity and uncertainty for students.

Additionally, the outcomes give some indications about which parameters can be considered for the recommendation of project topic, group members, communication tools and project task.

- a) Recommendations of the project topic could be made according to the student's knowledge level; skills, interests and personality (see Chapter 5 section 5.5.2).
- b) Recommendations of group members could be made according to a student's knowledge level, skills, collaborative behaviour, and gender (see Chapter 5 section 5.5.2).
- c) Recommendations of communication tools could be made according to a student's personality and collaborative behaviour (see Chapter 5 section 5.5.2).
- d) The recommendations of project tasks could be made according to a student's personality, skills and project progress (see Chapter 5 section 5.5.2).
- e) Students prefer self-defined virtual project group allocation, based on system recommendations based on learners' profiles (e.g., skills, interests, knowledge and

gender) compared to system-organised virtual project group member allocation (see Chapter 5 section 5.5.2).

f) The results also show that Facebook and Twitter can be used to build the user model and profile (see Chapter 5 section 5.5.2).

3. A main contribution of the research is the *design and implementation of a new personalised virtual team project system for e-learning* (Topolor 3). A comprehensive literature review summarised current development trends and the existing limitations of adaptive systems for collaborative learning support (ACLS) systems, especially for virtual team project and formation methods. The existing adaptive systems for collaborative learning support (ACLS) systems have only marginally investigated the merging of virtual team project features and adaptation techniques. Therefore, this thesis presents a new personalised virtual team project system for e-learning, the Topolor 3 system. Topolor 3 was created to address the limitations of the existing adaptive collaborative learning support systems. This was achieved by using the benefits of ‘traditional’ adaptation, based on user modelling, enhanced with features based on collaborative e-learning systems and virtual team project systems. The personalised virtual team project features presented in this thesis are defined, along with their implementation and evaluation, via two case studies (see Chapter 5). The research provides an approach for using a student-centred method in project-based e-learning, to support the student’s decisions regarding the following, by providing adaptive recommendations: *project definition*, based on the students’ knowledge and skills; group membership, based on student profile characteristics; *project task*, based on students’ personalities; and *communication tools*. The aim of these recommendations is to offer performance monitoring and dynamic support to the user, so as to increase the acceptance of the virtual group project. Current research has failed to propose such an approach in collaborative project-based e-learning environments. As shown in Chapter 2, there exist techniques and software for creating groups, such as [167], [87], [168]. The limitation with these techniques lie in the fact that they use either automatically formed groups or a difficult process to form groups. In addition, they were not



initially designed for use in virtual team project learning environments, and can be very time consuming.

4. A comparison between the new personalised virtual team project system for e-learning (Topolor 3) and the traditional team project system was done in this thesis. The results show that:
  - Saudi students' *perceived usefulness, perceived ease of use and intention of further use* of the *recommendation of a project* within social personalised e-learning was higher than for choosing project methods on their own in social personalised e-learning.
  - Furthermore, Saudi students' *perceived usefulness, perceived ease of use and intention of further use* of self-defined virtual project team formation based on learners' profiles in social personalised e-learning is higher than that for current/traditional methods of e-learning.
  - Moreover, Saudi students' *perceived usefulness, perceived ease of use and intention of further use* of adaptive tasks within a project-based learning system is higher than that for non-recommended tasks in current/social personalised e-learning.
  - Finally, Saudi students' *perceived usefulness, perceived ease of use and intention of further use* of adaptive communication mechanisms within a project-based learning system is also higher than that for the communication mechanisms in social personalised e-learning.
5. The research has contributed to the *methodology* for performing research in this area. The study adopted the *Technology Acceptance Model* and *Hofstede's cultural value dimensions* to explain Saudi Arabian universities students' acceptance of different approaches to education. The study indicates that TAM and Hofstede's cultural value dimensions are valid models for this purpose, adding to the empirical proof of the power of TAM and Hofstede's cultural value dimensions for explaining acceptance of technology.

#### **7.4 Study limitations and further studies**

The study has some limitations that require attention when considering its results. Firstly, the research population was limited to the students of Saudi Arabian universities. As a consequence, the outcome of the study may not reflect the general use of e-learning in higher education.

In addition, it investigated Saudi students' acceptance of a traditional collaborative learning system (Jusur system) for group project work (Chapter 4), against a specific social adaptive e-learning system (Topolor). The reasons for doing so were explained (Chapter 4 section 4.1). However, results with a different set of systems might have been different.

Furthermore, for the case study implemented in chapter 4 section 4.4, the student sample, whilst reasonably large and somewhat representative in terms of subject variety (English and Computer Science as being at different parts of the spectrum, as explain in Chapter 4.5) and years of study, was mainly from the University of Taibah only. The study could be extended to other student samples in other Saudi universities, as behaviour and expectations are similar. However, no such additional study or comparison data exists at present.

Furthermore, the study focused only on a few factors (*perceived usefulness, ease of use, attitude and intention of further use*), mainly derived from one theory (*TAM*). Whilst this thesis explains why this theory was chosen, as well as why these factors are chosen (see Chapter 2.6.2 ), future research can explore other variables that could have an impact on the intention to use a particular e-learning system. This can be done by testing or integrating other well-established theories, like the theory of planned behaviour (TPB) [169], to predict human behaviour.

In addition, the study explored Saudi Arabian users' cultural characteristics in terms of *Hofstede's cultural value dimensions* and their alignment with Saudi Arabian e-learning (Chapter 5). The study focused on four cultural factors derived from one theory (Hofstede's cultural value dimensions). Whilst the reason for doing so was explained (see Chapter 2 section 2.6.1), future research might further explore other cultural variables that could have an influence on the intent to use a particular e-learning system. This could be achieved by integrating other cultural model theories, such as those of Hall [95] and Trompenaars [96].

Finally, this work has explored a novel combination of traditional adaptation based on user modelling and virtual collaborative project and team formation methods, in order to increase the acceptance of personalised virtual team projects in social personalised adaptive e-learning systems (Chapter 6). It would also be useful to explore how students use personalised virtual teams to interact, collaborate, and construct knowledge within the context of a team project. Moreover, further research is needed, to identify the best kinds of support and the overall technological improvements needed to support virtual teams, such as personalised team performance visualisation.

## **7.5 Conclusion**

This thesis concludes with a review of the overall research achievement. It started this endeavour with 3 research questions, based on the different aspects of the research. All research questions were answered, and all objectives were reached. It also present research contributions, limitations and proposes future work that could be undertaken in this area.

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# APPENDIX A1:

## Social Personalised e-learning, vs Traditional e-learning and Classroom Learning

### The questionnaire items in English

This survey is linked to a thesis which is being written in the Department of Computer Science in University Of Warwick. The aim of the research is to investigate factors related to the usage of personalised web based education services, in order to develop the web based education services. We hope that you will take some time to answer the questions, which should take about 15 minutes. Answering is voluntary, and does not commit you to anything. This study's researcher is Afaf Alamri P.hD. ([A.Alamri@warwick.ac.uk](mailto:A.Alamri@warwick.ac.uk)). The data received will be kept confidential and will be stored in an anonymised manner. The data will be only be seen by myself and my supervisor.

Definitions used:

***Traditional ELearning*** is education delivered via an electronic medium such as the, internet, intranets, extranets, satellite transmission.

***Personalised eLearning*** uses on-line systems that measure your personal behaviour and preferences, store them and use these to alter the nature of the education given to you. The aim is to deliver a personalised and unique education, specially customised to you and your needs - and in so doing give you the best education you can receive.

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#### **1. What is your gender?**

- a) male
- b) female

#### **2. What is the name of your institution?**

University/ company name:

#### **3. If you study in a university, which year are you in:**

- a) First year b) Second year c) Third year d) Fourth year f) Fifth year.

4. **If you study in a university, which degree are you enrolled in:**  
 a) Bhs b) MSc c) PhD d) other.

5. **Please rate your usage of the internet:**

*I have used the Internet for:*

- a) Less than 1 year
- b) A year
- c) Two years
- d) 3 to 4 years
- e) 5 to 6 years
- f) More than 7 years.

6.	Strongly Disagree	Disagree	Neither	Agree	Strongly agree
a) Social personalisation e-learning (Topolor) is good idea. I like it more than classroom learning.					
b) Social personalisation e-learning (Topolor) is a bad idea. I dislike it. I prefer classroom learning'.					
c) Social personalisation e-					

learning (Topolor) is good idea. I like it more than classic e-learning (Jusur).					
d) I don't mind it either way (social personalised e-learning (Topolor) or classroom learning).					
e) I don't mind it either way (social personalised e-learning (Topolor) or classic e-learning (Jusur)).					
f) Social personalisation e-learning (Topolor) is a bad idea. I dislike it. I prefer classic e-learning (Jusur)'					
<b>7.</b>	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neither</b>	<b>Agree</b>	<b>Strongly agree</b>
a) Social personalisation e-					

<p>learning (Topolor) is easy to use. I find it easy to use or to learn to use, when compared to e-learning (Jusur).</p>					
<p>b) Social personalisation e-learning (Topolor) is easy to use. I find it easy to use or to learn to use, when compared to classroom learning.</p>					
<p>c) Social personalisation e-learning (Topolor) is similar in difficulty with classroom learning in both usage and learning to use it.</p>					
<p>d) Social personalisation e-learning (Topolor) is similar in difficulty with e-learning (Jusur) in both usage and learning to use it.</p>					
<p>e) I find traditional e-learning (Jusur) easy to</p>					

use or to learn to use, when compared to social personalisation e-learning (Topolor).					
f) I find classroom learning easy to use or to learn to use, when compared to social personalisation e- learning (Topolor).					
<b>8.</b>	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neither</b>	<b>Agree</b>	<b>Strongly agree</b>
a) Social personalisation e- learning (Topolor) is useful. It would improve my course performance, when compared to classroom learning.					
b) Social personalisation e- learning (Topolor) is useful. It would improve my course performance, when compared to e-					



learning (Jusur).					
c) Social personalisation e-learning (Topolor) will have no influence on my course performance, when compared to classroom learning.					
d) Social personalisation e-learning (Topolor) will have no influence on my course performance, when compared to e-learning (Jusur).					
e) Social personalisation e-learning (Topolor) is not useful. It would decrease my course performance, when compared to classroom learning.					
f) Social personalisation e-learning (Topolor) is not useful. It would decrease my course performance, when compared to e-learning (Jusur).					

9.	Strongly Disagree	Disagree	Neither	Agree	Strongly agree
a) I intend to use social personalised e-learning (Topolor) (e.g., during the semesters, from home, or for coursework).					
b) I intend to use a blend of social personalised e-learning (Topolor) and traditional Learning (Jusur).					
c) I intend to use a blend of social personalised e-learning (Topolor) and classroom learning.					
d) I intend to use a blend of traditional e-learning (Jusur) and traditional learning.					
e) I prefer non-personalised e-learning (Jusur) for					

courses, coursework, self-learning.					
f) I intend to use classroom learning (for courses, coursework, self-learning).					

**E-learning collaborative learning systems**

**Please rate to the extent to which you agree with each statement below.**

1= Strongly Disagree/ 2= Disagree/ 3= Neither / 4 = Agree/ 5= Strongly Agree

<b>Items</b>	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neither</b>	<b>Agree</b>	<b>Strongly agree</b>
10. Using the Jusur system for collaborative group project improves my academic performance.					
11. Using the Jusur system for collaborative group project system would enable me to accomplish tasks more quickly.					
12. I would find the Jusur system for					

collaborative group project useful in my work project.					
13. Using the Jusur system for collaborative group project increase my productivity.					
14. Using the Jusur system for collaborative group project would enhance my effectiveness on my study.					
15. Using the Jusur system for collaborative group project would make it easier to do my academic project.					
16. Learning to deal with the Jusur system for group projects is easy for me.					
17. I find the Jusur system to be flexible to interact with my group project.					
18. I find it easy to do what I want to do with my group project in the Jusur system.					
19. It is easy for me to become skilful at using the Jusur system for collaborative projects.					

20. I find the Jusur system easy to use for group projects.					
21. My interaction with the collaborative tool in the Jusur system is clear and understandable.					
22. I intend to use the Jusur system frequently with my group project.					
23. I intend to use the Jusur system in doing my academic tasks for group project.					

## APPENDIX A2: Social Personalised e-learning, vs Traditional e-learning and Classroom Learning

### The Questionnaire (Arabic version)

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

أخي الطالب/الطالبة:

بين أيديكم استبيان يتعلق ببحث لحصول على درجة الدكتوراه. والهدف من هذا البحث هو دراسة العوامل ذات الصلة باستخدام خدمات ويب التعليم القائم على شخصية المتعلم، من أجل تطوير خدمات الويب القائمة على التعليم. ارجو منكم الإجابة عن الأسئلة لعلم بأن أي معلومات ستبقي سرية ولن يطلع عليها احد سوى الباحثة. والإجابة عن الأسئلة هو طوعي ليس إجباري، ولا يؤثر لك أي شيء. أتمنى التأكد من الإجابة علي جميع الأسئلة لان الإجابات الناقصة سوف تؤدي إلى إلغاء الاستبيان بكامله .

أي استفسار :

[A.Alamri@warwick.ac.uk](mailto:A.Alamri@warwick.ac.uk)

ماذا يعنى التعليم الالكتروني و التعليم الشخصي الالكتروني؟

التعليم الالكتروني:

يقصد بالتعليم الالكتروني : تقديم المناهج التعليمية عبر الوسائط الكترونية مثل شبكة الانترنت أو شبكة محلية أو الخارجية و الأقمار الصناعية أو عبر الاسطوانات أو التلفزيون التفاعلي لوصول إلى المتعلمين

التعليم الالكتروني الشخصي :

هو نظام اكتروني الذي يسمح بقياس شخصية المستخدم و المفضل له و بعد ذلك يتم تخزينها واستخدامها لتغيير طبيعة تعليم المناسب لمستخدم. الهدف من ذلك هو تقديم التعليم المناسب لشخصيته المتعلم (مستوى التعليمي/ المفضل له) من أجل الحصول على أفضل تعليم.

وأخيرا شكرا لتعاونكم

الرجاء اختيار ما يناسبك:

1-الجنس

أ) ذكر ب) أنثى

الدرجة التعليمية :

أ) البكالوريوس

ب) الماجستير

ج)الدكتوراه

د) الدبلوم

ذ) أخرى

المرحلة التعليمية:

أ) في السنة الأولى ب) السنة الثانية ج) السنة الثالثة د) السنة الرابعة ذ) السنة الخامسة

3- معدل استخدامي للإنترنت

مدة استخدامي للإنترنت:

أ) لا استخدمه

ب) أقل من 1 سنة

ج) سنة

د) سنتين

ذ) 3 إلى 4 سنوات

ه) 5 إلى 6 سنوات

و) 7 سنوات و أكثر

الرجاء قراءة العبارات التالية بتمعن ثم اختيار الإجابة التي تمتلك بصدق

أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشد	Q6
					أ)التعليم الشخصي والاجتماعي الإلكتروني تبلور هو فكرة جيدة. أنا أفضله أكثر من التعليم التقليدي

					ب التعليم الشخصي والاجتماعي الإلكتروني تبلور هو فكرة سيئة. لم يعجبني ذلك. أنا أفضل التعليم التقليدي ( في القاعة
					ج) التعليم الشخصي والاجتماعي الإلكتروني هو فكرة جيدة. أنا أفضله أكثر من التعليم على شبكة الإنترنت التقليدي جسور
					د) لا مانع من إي من الاتجاهين التعليم الشخصي والاجتماعي الالكتروني تبلور أو التعليم التقليدي
					د) لا مانع من إي من الاتجاهين التعليم الشخصي والاجتماعي التعليم على الالكتروني تبلور أو شبكة الإنترنت التقليدي جسور
					ز) التعليم الشخصي والاجتماعي الإلكتروني تبلور هو فكرة سيئة. لم يعجبني ذلك. إننا أفضل لتعليم على شبكة الإنترنت التقليدي جسور
					<b>Q7</b>
					أ) التعليم الشخصي الاجتماعي الإلكتروني) تبلور) سهل الاستخدام. أجد



					أنه من السهل استخدامه أو تعلم كيفية استخدامه، بالمقارنة مع التعليم على شبكة الإنترنت (جسور)
					ب) التعليم الشخصي الاجتماعي الإلكتروني (تبلور) سهل الاستخدام. أجد أنه من السهل أن استخدامه أو لتعلم كيفية استخدامه، بالمقارنة مع التعليم في تقليدي (الجامعه)
					ج) التعليم الشخصي الاجتماعي الإلكتروني (تبلور) مشابه في صعوبته مع جسور في كل من التعليم وتعلم كيفية استخدامه.
					د) التعليم الشخصي الاجتماعي الإلكتروني (تبلور) مشابه في صعوبة مع التعلم الإلكتروني تقليدي (جسور) في كل من الاستخدام والتعلم لاستخدامها
					ذ) أجد التعلم الإلكتروني تقليدي (جسور) سهلة الاستخدام أو لتعلم كيفية استخدام، بالمقارنة مع التعليم الشخصي الاجتماعي الإلكتروني تبلور
					ز) أجد الفصول الدراسية التعليمية تقليديه سهلة الاستخدام أو لتعلم كيفية استخدام، بالمقارنة مع التعليم

					الشخصي الاجتماعي الإلكتروني تبلور
					<b>Q8</b>
					أ) التعليم الشخصي والاجتماعي الإلكتروني تبلور مفيد. فإنه له دور في تحسين أدائي في المنهج التعليمي، بالمقارنة مع التعليم التقليدي
					ب) التعليم الشخصي الاجتماعي الإلكتروني (تبلور) مفيد. يحسّن أدائي بالطبع، بالمقارنة مع التعليم على شبكة الإنترنت (جسور)
					ج) التعليم الشخصي الاجتماعي الإلكتروني تبلور لا يؤثر على تحسين الأداء في المنهج التعليمي، بالمقارنة مع التعليم التقليدي
					د) التعليم الشخصي الاجتماعي الإلكتروني تبلور لا يؤثر على تحسين الأداء في المنهج التعليمي، بالمقارنة مع التعليم على شبكة الإنترنت جسور
					ذ) التعليم الشخصي الاجتماعي الإلكتروني تبلور غير مفيد فإنه يخفض أدائي في الدراسة، بالمقارنة مع التعليم التقليدي

					<p>ز) التعليم الشخصي الاجتماعي الإلكتروني تبلور غير مفيد. فإنه يخفض أدائي الدراسي ، بالمقارنة مع التعليم على شبكة الإنترنت جسور</p>
					Q9
					<p>أ) أنوي استخدام التعليم الشخصي الاجتماعي الإلكتروني تبلور (على سبيل المثال، خلال فصول دراسية، من المنزل أو عن الدورات الدراسية</p>
					<p>ب) أنوي استخدام كلا التعليم الشخصي الاجتماعي الإلكتروني تبلور والتعلم على شبكة الإنترنت التقليدي جسور</p>
					<p>ج) أنوي استخدام كلا التعليم الشخصي الاجتماعي الإلكتروني تبلور والتعلم التقليدي ( الحضور لفاعه دراسيه</p>
					<p>د) أنوي استخدام كلا التعليم الشخصي الاجتماعي الإلكتروني تبلور والتعلم على شبكة الإنترنت جسور</p>

					(ذ) أنوي استخدام التعلم على شبكة الإنترنت <b>جسور</b> ، لتعلم الذاتي الدراسية الدورات
					(ز) أنوي استخدام <b>الفصول</b> الدراسية التقليدي (للدورات الدراسية، لتعلم الذاتي

#	لا أوافق بشدة	لا أوافق	محايد	أوافق	أوافق بشدة
استخدام نظام جسور لمجموعة العمل التعاوني لمشاريع سوف يؤدي الى تحسين الاداء الأكاديمي					
استخدام نظام جسور لمجموعة العمل التعاوني لمشاريع تمكيني من إنجاز المهام بسرعة أكبر					
انا اجد نظام جسور لمجموعة العمل التعاوني مفيد لاداء مهمتى فى المشروع					
استخدام نظام جسور للمشروع جماعي سوف يزيد إنتاجيتي					
استخدام نظام جسور لمجموعة العمل التعاوني سوف يحسن فعالية دراستي					
استخدام نظام جسور لمجموعة العمل التعاوني سوف يجعل من سهل القيام بالمهام المشروع الأكاديمي					

					سهل لي تعلم تعامل مع نظام جسور لمجموعة العمل التعاوني
					أجد نظام جسور مرن للتفاعل مع اعضاء مجموعة المشروع
					أجد من السهل القيام بعمل ما أريد القيام به مع مشروع مجموعتي في نظام جسور
					من السهل بالنسبة لي أن اصبح ماهر في استخدام نظام جسور لاداء مشروع تعاوني مع مجموعة طلاب
					أجد نظام جسور سهل الاستخدام لعمل التعاوني لمشاريع
					تفاعلي مع أدوات التعاونية في نظام جسور واضحة ومفهومة
					أنوي استخدام نظام جسور بشكل متكرر مع مشروع مجموعتي
					أنوي استخدام نظام جسور في القيام بالمهام الأكاديمية لمشاريع الجماعي

24q) أود مسار التعليم على شبكة الإنترنت إلى أن يأخذ في الاعتبار ما يلي:

أ. مستوى ألتعلمي(العرض يجب أن يكون من مستوى مماثل لما كنت درست من قبل)

ب. عمري (على سبيل المثال، يجب أن لا يكون عرض لأطفال ، أن يكون مناسب لسني).

ج -تعلمي / النمط المعرفي (على سبيل المثال، إذا كنت تحب الصورة القائمة على العرض، محتوى المنهج يجب أن يكون فيه الفيديو والرسوم البيانية والصور، أو إذا كنت تحب التدريب العملي على الوصول، المنهج يجب أن يحتوي على العروض والتدريب العملي على برامج، حيث كنت يمكن تغيير المتغيرات، الخ).

د- حالتى العاطفية (إذا اشعرا بالملل ينبغي أن يحاول ترفيهي ، وإذا أنا في عجلة ، فإنه ينبغي أن يكون الحصول بسرعة إلى المراد عمله.

ز- المفضل لي ط- حدد

25q) إذا كنت تواجه أي مشاكل مع تعليم الكتروني، هل يمكن أن أكتبها من فضلك؟

(قترح طرق لحل هذه المشاكل:

\* شكرا لملء هذه الاستبيان \*

# APPENDIX B1

## System Requirement Survey

### Investigation Saudi Arabia users' cultural characteristics

Dear student,

This survey is linked to a thesis which is being written in the Department of Computer Science in University Of Warwick. The aim of the research is to investigate *Saudi Arabia users' cultural characteristics*, in order to develop the web-based education services. We hope that you will take some time to answer the questions, which should take approximately ten minutes. Answering is voluntary, and does not commit you to anything. I am the study's main researcher and my name is Afaf Alamri P.hD. ([omrama2012@gmail.com](mailto:omrama2012@gmail.com)). The data received will be kept confidential and will be stored in an anonymised manner. The data will be only be seen by myself and my supervisor. Please circle your answers or give full names where appropriate

#### 1. What is your gender?

- a) male
- b) female

#### 2. If you currently study at university, which year are you in?

- a) First year
- b) Second year
- c) Third year
- d) Fourth year
- f) Fifth year.

If you do study at university, at what level are you enrolled

Bhs b) MSc c) PhD d) other.

**3. University Name?**

**4. Faculty?**

**Do you agree, or otherwise with the following?**

**5. When given educational information in a web-based system I prefer it presented in a tightly structured and regulated manner.**

1. Strongly Agree
2. Agree
3. Neither
4. Disagree
5. Strongly Disagree

**6. In web-based education, I need a lot of guidance from the leader / teacher/system to direct and limit my discoveries.**

1. Strongly Agree
2. Agree
3. Neither
4. Disagree
5. Strongly Disagree

**7. In web-based education, there should be as much structure and directions in a lesson as possible to ensure that there is no ambiguity.**

1. Strongly Agree
2. Agree
3. Neither



4. Disagree
5. Strongly Disagree

**8. In web-based education, I enjoy learning from my mistakes and dislike being 'protected' from making them.**

1. Strongly Agree
2. Agree
3. Neither
4. Disagree
5. Strongly Disagree

**9. In web-based education, I work best when members of the opposite gender are not present. Separation of the genders in education enables more effective teaching, with a teacher better able to target each group.**

1. Strongly Agree
2. Agree
3. Neither
4. Disagree
5. Strongly Disagree

**10. I prefer that a personal image for females is not displayed in e-Learning.**

1. Strongly Agree
2. Agree
3. Neither
4. Disagree
5. Strongly Disagree

**11. In web -based education, being accepted as a member of a group is better than being independent.**

1. Strongly Agree
2. Agree
3. Neither
4. Disagree
5. Strongly Disagree

**12. In web -based education, recommendations from peers (or chats with my peers) will have a positive influencing on my learning.**

1. Strongly Agree
2. Agree
3. Neither
4. Disagree
5. Strongly Disagree

## APPENDIX B2 Investigation Saudi Arabia users' cultural characteristics

### The Questionnaire (Arabic version)

آخى الطالب/الطالبة:

بسم الله الرحمن الرحيم

بين أيدكم استبيان يتعلق ببحث لحصول على درجة الدكتوراه. والهدف من هذا البحث هو دراسة العوامل ثقافيه ذات الصلة باستخدام خدمات ويب التعليم ، من أجل تطوير خدمات الويب القائمة على التعليم. ارجو منكم الإجابة عن الأسئلة لعلم بأن أي معلومات سنلقي سرية ولن يطلع عليها احد سوى الباحثة. والإجابة عن الأسئلة هو طوعي ليس إجباري، ولا يؤثر لك أي شيء. أ تمنى التأكد من الإجابة علي جميع الأسئلة لان الإجابات الناقصة سوف تؤدي إلى إلغاء الاستبيان بكامله .

أي استفسار :

[\(A.Alamri@warwick.ac.uk\)](mailto:A.Alamri@warwick.ac.uk)

#### 1-الجنس

(أ) ذكر (ب) أنثى

الدرجة التعليمية :

(أ) البكالوريوس

(ب) الماجستير

(ج)الدكتوراه

(د) الدبلوم

(ذ) أخرى

المرحلة التعليمية:

(أ) في السنة الأولى (ب) السنة الثانية (ج) السنة الثالثة (د) السنة الرابعة (ذ) السنة الخامسة

التخصص:

اسم الجامعة

الرجاء قراءة العبارات التالية بتمعن ثم اختيار الإجابة التي تمتلك بصدق

عندما يعرض التعليم في نظام قائم على شبكة الإنترنت فضله عرضه بطريقة منظمة بإحكام

أوافق بشدة

أوافق

محايد

لا أوافق

لا أوافق بشد

في التعلم الإلكتروني، احتاج الى الكثير من التوجيهات من زعيم / المعلم / نظام لإرشادي

أوافق بشدة

أوافق

محايد

لا أوافق

لا أوافق بشد

عندما يوفر ألتعليم الكتروني عدم الإختلاط بين الجنسين (الذكور والإناث) سوف يكون أنتاجي التعليمي أفضل  
الفصل بين الجنسين في التعليم يمكن تعليم أكثر فعالية

أوافق بشدة

أوافق

محايد

لا أوافق

لا أوافق بشد

ارغب عدم عرض الصور شخصيه لإناث في التعليم الالكتروني

أوافق بشدة

أوافق

محايد

لا أوافق

لا أوافق بشد

أفضل في ألتعليم الكتروني توفير تعليمات الإرشادية وشرح واضح في الدروس لتقليل من القلق و عدم الفهم أو حدوث الأخطاء

أوافق بشدة

أوافق

محايد

لا أوافق

لا أوافق بشد

أنا أستمتع التعلّم من أخطائي لذلك أفضل في ألتعليم الكتروني عدم توفير تعليمات الإرشادية

أوافق بشدة

أوافق

محايد

لا أوافق

لا أوافق بشد

في ألتعليم الكتروني، الدراسة ضمن مجموعة من الطلاب/الطالبات لتبادل المعرفة و الخبرة أفضل من الدراسة لوحد

أوافق بشدة

أوافق

محايد

لا أوافق

لا أوافق بشد

في التعليم الالكتروني، تبادل المعرفة و النصائح العلميه من أصدقائي الطلبة ( الدردشة بين الطلبة عن طريق شات) سوف يكون لها تأثير إيجابي في تعليمي

أوافق بشدة

أوافق

محايد

لا أوافق

لا أوافق بشد

وأخيرا شكرا لتعاونكم

# APPENDIX C

## System Requirement Survey

Dear students

This survey will help us with research and design next generation group project within e-learning *systems*. We hope that you will take some time to answer the questions, which should take about 15 minutes. Answering is voluntary, and does not commit you to anything. This study's researcher is Afaf Alamri (A.alamri@arwick.ac.uk). The data received will be kept confidential and will be stored in an anonymised manner. The data will be only be seen by myself and my supervisor.

**1. What is your gender?**

- a) male
- b) female

**2. If you study in a university, which year are you in:**

- a. First year
- b. Second year
- c. Third year
- d. Fourth year
- e. Fifth year.

**3. If you study in a university, which degree are you enrolled in:**

- 1. Bhs
- 2. MSc
- 3. PhD
- 4. Other

**4. College :**



Please rate to the extent to which you agree with each statement below.

Statement	Strongly Disagree	Disagree	Neither	Agree	Strongly agree
5. Recommend project topic according to student's skills level.					
6. Recommend project topic according to student's knowledge level.					
7. Recommend project topic according to student's interests.					
8. Recommend project topic according to student's personality.					
9. Recommend group members according to student's knowledge level.					

10. Recommend group members according to student's skills level.					
11. Recommend group members according to student's collaborative behaviour.					
12. Recommend group members according to gender (female/male).					
13. Recommend project tasks according to student's personality.					
14. Recommend project tasks according to student's skill					
15. Recommend project tasks according to project state progress					

**Please rate how helpful you think the following tools will be to support you collaborate with your fellow team participants.**

<b>Tools</b>	<b>Not Useful At All</b>	<b>Somewhat Not Useful</b>	<b>Neutral</b>	<b>Somewhat Useful</b>	<b>Very Useful</b>	<b>Have Not Used Before</b>
16. Announcements						
17. Discussion						
18. Chat Room						
19. Messages						
20. Forums						
21. Resources						
22. Schedule						

If you think other tools are useful writ them down please?

23. Do you use social network?

- Yes
- No

24. If yes, what social network (s) do you use?

- Facebook
- YouTube
- Twitter
- Google Plus
- LinkedIn
- Others: \_\_\_\_\_

# APPENDIX D

## Investigation the usability of Topolor 3 system

Dear students

This survey is linked to a thesis. The objective of the research is to investigate the usability of *Topolor 3 system*, in order to develop the web-based education services. We hope that you will take some time to answer the questions, which should take about 15 minutes. Answering is voluntary, and does not commit you to anything. This study's researcher is Afaf Alamri (A.alamri@arwick.ac.uk). The data received will be kept confidential and will be stored in an anonymised manner. The data will be only be seen by myself and my supervisor.

1. What is your gender?
  - a) male
  - b) female
  
2. If you study in a university, which year are you in:
  - a. First year
  - b. Second year
  - c. Third year
  - d. Fourth year
  - e. Fifth year.
  
3. If you study in a university, which degree are you enrolled in:
  - a) Bhs
  
  - b) MSc
  
  - c) PhD
  
  - d) Other

4. College :

Please rate to the extent to which you agree with each statement below.

Statement	Strongly Disagree	Disagree	Neither	Agree	Strongly agree
5. I think that I would like to use Topolor 3 frequently					
6. I found the Topolor 3 system unnecessarily complex					
7. I thought the Topolor 3 system was easy to use					
8. I think that I would need the support of a technical person to be able to use this system					
9. I found the various functions in this system were well integrated					
10. I thought there was too much inconsistency in this system					
11. I would imagine that most people would learn to use					

this system very quickly					
<b>12.</b> I found the Topolor 3 system very difficult to use					
<b>13.</b> I felt very confident using this system					
<b>14.</b> I needed to learn a lot of things before I could get going with this system					

**15.** List the most positive aspect(s) about this System.

- 1.
- 2.
- 3.

**16.** List the most negative aspect(s) about this System.

- 1.
- 2.
- 3.

*Thank you for taking our survey. Your response is very important to us.*

# APPENDIX E

## Investigation the acceptance of Topolor2 System

### Dear student

This survey is linked to a thesis which is being written in the Department of Computer Science in University Of Warwick. The aim of the research is to investigate the acceptance of virtual coursework/project and team project-based learning in traditional eLearning Topolor. We hope that you will take some time to answer the questions, which should take about 15 minutes. Answering is voluntary, and does not commit you to anything. This study's researcher is Afaf Alamri (A.alamri@arwick.ac.uk). The data received will be kept confidential and will be stored in an anonymised manner. The data will be only be seen by myself and my supervisor.

#### 1. What is your gender?

- Male
- Female

#### 2. Which degree are you enrolled in

- Bachelor's degree
- Post-graduate degree
- Other

Please enter an 'other' value for this selection.



### 3. College

**Please rate your agreement with the statements below:**

Statement					
4. I find the system useful to select my topic project.					
5. This system has allowed me to find my topic project more quickly.					
6. Using this system would improve my project performance.					
7. It was easy to recognise the content coursework/project by this system.					
8. I find it easy to select my project by this system.					
9. I will use the system again to select my topic project.					

<p><b>10.</b> I intend to use this system related projects/assignments to accomplish a selected project whenever it has a features to help me perform it.</p>					
<p><b>11.</b> This system has allowed me to find my team members more quickly.</p>					
<p><b>12.</b> I find this system useful to select my team members.</p>					
<p><b>13.</b> It is easy for me to remember how to perform selecting my team members using this system (non-recommended team members).</p>					
<p><b>14.</b> I find it easy to get this system to select my team members.</p>					
<p><b>15.</b> I will use this e-learning system to find my team members.</p>					
<p><b>16.</b> I will tell my friends about this system to find members for academic team projects.</p>					

<p><b>17.</b> Using this system is useful, and gives team members greater control over their work (manage group project).</p>					
<p><b>18.</b> I find the e-learning system useful to select my task project.</p>					
<p><b>19.</b> It is easy for me to remember how to perform tasks project using this system.</p>					
<p><b>20.</b> Overall, I find the project management in this system was easy to use.</p>					
<p><b>21.</b> I will tell my friends about task project management in this e-learning system.</p>					
<p><b>22.</b> In e-learning, the communication toolset in the system was useful to talk with my group project.</p>					
<p><b>23.</b> In this e-learning, using the communication tools increased cooperation in my group</p>					

project.					
<b>24.</b> It was easy to discuss with my group members.					
<b>25.</b> It was easy to access the resources shared by peers.					
<b>26.</b> The system helped me engage in interacting with my group.					
<b>27.</b> I would like to use this system frequently to chat with my group members.					
<b>28.</b> I will use the system again to communicate with my group project.					
<b>29.</b> I will tell my friends about the task project management in this e-learning system.					

**30.** List the most positive aspect(s) about this System.

- 1.
- 2.
- 3.

**31.** List the most negative aspect(s) about this System.

- 1.

2.

3.

*Thank you for taking our survey. Your response is very important to us.*

## The Questionnaire (Arabic version)

### Topolor2 eLearning system

عزيزي الطالب \الطالبة

يرتبط هذا المسح لأطروحة التي يتم كتابتها في قسم علوم الحاسوب في جامعة وارويك. الهدف من هذا البحث هو التحقيق في قبول اختيار المشروع، وبناء اعضاء المشروع بواسطة التعلم الإلكتروني (تبلور). نأمل أن سوف يستغرق بعض الوقت للرد على الأسئلة التي ينبغي أن يستغرق حوالي 15 دقيقة. الرد طوعي، ولا تلتزم لك أي شيء. الباحثة هذه الدراسة عفاف العمري ستبقى البيانات الواردة سرية وسيتم تخزينها بطريقة مجهول المصدر. سيتم النظر إلى البيانات إلا انا ومشرفتي

#### اختيار الإجابة

##### 1-الجنس

(أ) ذكر (ب) أنثى

##### الدرجة التعليمية :

(أ) البكالوريوس

(ب) الماجستير

(ذ) أخرى

##### المرحلة التعليمية:

(أ) في السنة الأولى (ب) السنة الثانية (ج) السنة الثالثة (د) السنة الرابعة (ذ) السنة الخامسة

##### :التخصص

الرجاء قراءة العبارات التالية بتمعن ثم اختيار الإجابة التي تمتلك بصدق

Statement	لا اوافق بشده	لا اوافق	محايد	اوافق	اوافق بشده	غير مطبق
أجد نظام مفيد لتحديد موضوع مشروع						
قد سمح نظام التعليم الإلكتروني لي للعثور على موضوع المشروع بسرعة أكبر.						
استخدام التعليم الإلكتروني سوف يحسن الأداء في مشروع						
كان من السهل لي التعرف على محتويات المشروع من قبل نظام التعليم الإلكتروني التقليدي						
أجد أنه من السهل اختيار موضوع مشروع						
سأستخدم النظام مرة أخرى لتحديد موضوع مشروع						
أنوي استخدام هذا النظام ذات الصلة لمشاريع لإنجاز اختيار المشروع في اي وقت لا لديه ميزات لمساعدتي في تنفيذ ذلك.						
قد سمح نظام التعليم الإلكتروني لي للعثور على أعضاء فريقي بسرعة						

أكبر.						
أجد نظام التعليم الإلكتروني مفيد لاختيار أعضاء فريقتي						
كان من السهل العثور على أعضاء فريقتي عن طريق نظام التعليم الإلكتروني						
من السهل بالنسبة لي أن أتذكر كيفية تنفيذ اختيار أعضاء فريقتي باستخدام هذا نظام						
سوف استخدم نظام التعليم الإلكتروني لإيجاد أعضاء فريقتي						
سأقول لأصدقائي عن هذا النظام لإيجاد أعضاء لمشاريع فرق الأكاديمية						
استخدام هذا نظام مفيدة، يعطي السيطرة لأعضاء الفريق أكثر على عملهم (إدارة مشروع جماعي)						
أجد نظام التعليم الإلكتروني مفيد لتحديد مهمني في المشروع						
عموماً، أجد إدارة المشاريع في هذا النظام سهل الاستخدام						
من السهل بالنسبة لي أن أتذكر كيفية تنفيذ مهام المشروع						



باستخدام هذا النظام						
سأقول لأصدقائي حول إدارة مهام المشاريع في نظام التعليم الالكتروني						
كانت مجموعة أدوات الاتصال الموصي مفيدة بها بواسطة هذا نظام						
استخدام مجموعة أدوات الاتصال بواسطة هذا نظام زادت تعاوني مع اعضاء مجموعتي						
كان من السهل لي النقاش مع اعضاء مجموعتي في هذا النظام						
كان من السهل لي الوصول إلى المصادر المشتركة من قبل الزملاء.						
يسر لي نظام المشاركة و التفاعل مع اعضاء مجموعتي						
أود أن استخدام هذا النظام دائما التواصل مع اعضاء المشروع.						

سوف استخدم النظام مرة أخرى من أجل التواصل مع اعضاء المشروع						
سأخبر أصدقائي حول مجموعة أدوات الاتصال في هذا النظام						

اكتب (ي) أكثر الجوانب الإيجابية في نظام

- 1.
- 2.
- 3.

اكتب (ي) أكثر الجوانب السلبية في نظام

- 1.
- 2.
- 3.

*Thank you for taking our survey. Your response is very important to us.*

# APPENDIX F

## Investigation the acceptance of Topolor3 System

Dear student

This survey is linked to a thesis which is being written in the Department of Computer Science in University Of Warwick. The aim of the research is to investigate the acceptance of virtual coursework/project and team project-based learning in Topolor3. We hope that you will take some time to answer the questions, which should take about 15 minutes. Answering is voluntary, and does not commit you to anything. This study's researcher is Afaf Alamri (A.alamri@warwick.ac.uk). The data received will be kept confidential and will be stored in an anonymised manner. The data will be only be seen by myself and my supervisor.

### 1. What is your gender?

- Male
- Female

### 2. Which degree are you enrolled in

- Bachelor's degree
- Post-graduate degree
- Other

Please enter an 'other' value for this selection.

### 3. College

***Q Please rate your agreement with the statements below:***

Statement					
4. I find the system useful to select my topic project.					
5. The Topolor 3 system has allowed me to find my topic project more quickly.					
6. Using the Topolor 3 would improve my project performance.					
7. It was easy to recognise the content coursework/project by the Topolor 3 system.					
8. I find it easy to					

select my project.					
9. I will use the system again to select my topic project.					
10. I intend to use this system related projects/assignments to accomplish a selected project whenever it has a features to help me perform it.					
11. The Topolor 3 system has allowed me to find my team members more quickly.					
12. I find the Topolor 3 system useful to select my team members.					

<p>13. It is easy for me to remember how to perform selecting my team members using the Topolor 3 system (recommended team members).</p>					
<p>14. I find it easy to get the Topolor 3 system to select my team members.</p>					
<p>15. I will use Topolor 3 system to find my team members.</p>					
<p>16. I will tell my friends about Topolor 3 system to find members for academic team projects.</p>					

<p>17. Using the Topolor 3 system is useful, and gives team members greater control over their work (manage group project).</p>					
<p>18. I find the Topolor 3 system useful to select my task project.</p>					
<p>19. It is easy for me to remember how to perform task project using the Topolor 3 system.</p>					
<p>20. Overall, I find the project management in this system was easy to use.</p>					

<p>21. I will tell my friends about task project management in the Topolor 3 system.</p>					
<p>22. The communication toolset in the system was useful to talk with my group project.</p>					
<p>23. Using the communication tools increased cooperation in my group project.</p>					
<p>24. It was easy to discuss with my group members.</p>					
<p>25. It was easy to access the resources shared</p>					



by peers.					
26. The system helped me engage in interacting with my group.					
27. I will use this system frequently to chat with my group members.					
28. I will use the system again to communicate with my group project.					
29. I will tell my friends about the communication toolset in this system.					
30. The help link was useful.					
31. The help link has a					

<p>clear structure and directions for a lesson and working within the project, preventing uncertainty or mistakes.</p>					
<p>32. Using this system has enabled more interactive communication between the lecturers and students.</p>					
<p>33. The Topolor 3 system facilitates suitable interaction and collaboration between lecturer and students.</p>					
<p>34. This system facilitates suitable</p>					

<p>interaction and collaboration among groups of students.</p>					
<p>35. Using this system has enabled more interactive communications among groups of students.</p>					
<p>36. I find this system useful to create unmixed member teamwork.</p>					
<p>37. Using this system has enabled me to select my member's teamwork similar to my gender (male/female).</p>					

38. List the most **positive** aspect(s) about this System.

- 1.
- 2.
- 3.

39. List the most **negative** aspect(s) about this System.

- 1.
- 2.
- 3.

*Thank you for taking our survey. Your response is very important to us.*

## The Questionnaire (Arabic version)

عزيزي الطالب \الطالبة

يرتبط هذا المسح لأطروحة التي يتم كتابتها في قسم علوم الحاسوب في جامعة وارويك. الهدف من هذا البحث هو التحقيق في قبول اختبار المشروع، وبناء اعضاء المشروع بواسطة التعلم الإلكتروني (تبلور ٣). نأمل أن سوف يستغرق بعض الوقت للرد على الأسئلة التي ينبغي أن يستغرق حوالي 15 دقيقة. الرد طوعي، ولا تلتزم لك أي شيء. الباحثة هذه الدراسة عفاف العمري ستبقى البيانات الواردة سرية وسيتم تخزينها بطريقة مجهول المصدر. سيتم النظر إلى البيانات إلا انا ومشرفتي

### اختيار الإجابة

#### 1-الجنس

(أ) ذكر (ب) أنثى

#### الدرجة التعليمية :

(أ) البكالوريوس

(ب) الماجستير

(ذ) أخرى

#### المرحلة التعليمية:

(أ) في السنة الأولى (ب) السنة الثانية (ج) السنة الثالثة (د) السنة الرابعة (ذ) السنة الخامسة

#### التخصص:

### الرجاء قراءة العبارات التالية بتمعن ثم اختيار الإجابة التي تمتلك بصدق

Statement	لا اوافق بشده	لا اوافق e	محايد	اوافق	اوافق بشده	غير مطبق
أجد نظام مفيد لتحديد موضوع مشروع						
قد سمح نظام تبلور ٣ لي للعثور على موضوع المشروع بسرعة						

أكبر.						
استخدام التعليم الإلكتروني تبلور ٣ سوف يحسن الأداء في مشروع						
كان من السهل لي التعرف على محتويات المشروع من قبل نظام تبلور ٣						
أجد أنه من السهل اختيار موضوع مشروع						
سأستخدم النظام مرة أخرى لتحديد موضوع مشروع						
أنوي استخدام هذا النظام ذات الصلة لمشاريع لإنجاز اختيار المشروع في اي وقت لا لديه ميزات لمساعدتي في تنفيذ ذلك.						
قد سمح نظام تبلور ٣ لي للعثور على أعضاء فريقي بسرعة أكبر.						
أجد نظام تبلور ٣ مفيد لاختيار أعضاء فريقي						
كان من السهل العثور على أعضاء						

فريقي عن طريق نظام تبلور ٣						
من السهل بالنسبة لي أن أتذكر كيفية تنفيذ اختيار أعضاء فريقي باستخدام نظام تبلور ٣						
سوف استخدم نظام تبلور ٣ مره اخرى لإيجاد أعضاء فريقي						
سأقول لأصدقائي عن هذا النظام لإيجاد أعضاء لمشاريع فرق الأكاديمية.						
استخدام هذا نظام مفيدة،يسمح السيطرة لأعضاء الفريق 'أكثر على عملهم (إدارة مشروع جماعي)						
أجد نظام تبلور ٣ التقليدي مفيد لتحديد مهمتي في المشروع						
عموما، أجد إدارة المشاريع في هذا النظام سهل الاستخدام						
من السهل بالنسبة لي أن أتذكر كيفية تنفيذ المهام المشروع باستخدام هذا النظام						
سأقول لأصدقائي حول إدارة مهام المشاريع في نظام تبلور ٣						

كانت مجموعة أدوات الاتصال الموصي بها مفيدة بواسطة هذا نظام						
استخدام مجموعة أدوات الاتصال بواسطة هذا نظام زادت تعاوني مع اعضاء مجموعتي						
كان من السهل لي النقاش مع اعضاء مجموعتي في هذا النظام.						
كان من السهل لي الوصول إلى المصادر المشتركة من قبل الزملاء.						
يسر لي نظام تشارك في التفاعل مع اعضاء مجموعتي						
أود أن استخدام هذا النظام دائما التواصل مع اعضاء المشروع.						



سوف استخدم النظام مرة أخرى من أجل التواصل مع أعضاء المشروع						
سأخبر أصدقائي حول مجموعة أدوات الاتصال في هذا النظام						
الروابط المساعدة مفيدة						
الروابط المساعدة لديها توجيهات واضحة لدرس ولعمل في المشروع، ومنع عدم اليقين أو الأخطاء						
باستخدام هذا النظام مكن من التواصل و تفاعل أكثر بين المحاضرين والطلاب						
تفاعل Topolor 3 يسهل نظام والتعاون المناسب بين المحاضر والطلاب						
يسهل هذا النظام على تفاعل مناسب والتعاون بين مجموعات من الطلاب						
باستخدام هذا النظام مكن من الاتصالات أكثر تفاعلية بين مجموعات من الطلاب						

أجد هذا النظام مفيد لإيجاد أعضاء العمل الجماعي الغير مختلط						
باستخدام هذا النظام قد مكنتني لاختيار أعضاء العمل الجماعي نفس جنسى ذكور / إناث						

2. List the most **negative** aspect(s) about Topolor 3 System.

اكتب (ي) أكثر الجوانب الإيجابية عن نظام تبلور ٣

- 1.
- 2.
- 3.

3. List the most **negative** aspect(s) about the Topolor 3.0 System.

اكتب (ي) أكثر الجوانب السلبية عن نظام تبلور ٣

- 1.
- 2.
- 3.

*Thank you for taking our survey.*

## **STUDENT FOCUS GROUP INTERVIEW**

1. What are some of the features about this tool that help you to find team and work together as a group?
  - i. Can you give me an example?
2. d. What are some of the features about this tool that make it harder to find team and work together as a group?
  - i. Can you give me an example?
3. Which tool(s) do you think was the most useful for virtual project team with group members?
4. How did this help you complete your assignment?
5. How do you think existing tools within virtual project team eLearning system could be improved to better facilitate team formation and collaboration?
6. How would you compare your experience between Topolor 3 eLearning and traditional team formation in eLearning?
7. Do you think that you would use Topolor 3 system again? Why / why not?
8. Is there anything else you'd like to say or discuss about project sites?