

Gender-Based Perspectives of eLearning Systems: An Empirical Study of Social Sustainability

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Abstract

Digital technologies have an increasing impact on our everyday life. A large impact of software engineering on society also means that socio-cultural factors are becoming crucial for software systems. The gender and cultural diversity have significant impact not only on the software development process but also on the overall sustainability of the software as well as on the society where the software is used. Thus, these diversity aspects should be analysed while developing a software system. This paper presents an empirical study that investigates the gender and cultural differences in needs and usage of system features. Our focus is on eLearning systems used in Australia and Saudi Arabia, but the results of the study might be expanded to other application domains. To explore the differences, we applied a combination of qualitative and quantitative methods on the data collected from 177 participants. The results demonstrated the cultural and gender diversity may have a significant impact on user needs and preferences.

Keywords: Social Sustainability, Requirements Engineering, Society, Gender, Culture, eLearning Systems

1. Introduction

Software is having an increasing impact on everyday life, with tasks such as communication, banking and shopping being performed on devices such as mobile phones and laptops. Modern societies are relying more and more in their daily routines on software and software systems in the education, transportation, health, entertainment domains [32]. This large impact of software engineering on society and culture also means that the socio-cultural factors have to be taken into account while developing software systems, especially when their longevity is required.

Social sustainability aspects refer to the quality of life, human rights and equality including the equal distribution of resources and opportunities and economic conditions, etc. [23]. Software systems provide a means of increasing social sustainability, as they make many kinds of resources more accessible. For example, eLearning systems provide a platform for accessible teaching and learning, but also include online access to learning materials and online support

for learning and teaching. In developing countries such as Bangladesh, particularly in rural areas, eLearning systems allow educational equity for people who cannot afford to pay for private tutors [21].

From a software engineering perspective, social sustainability is defined as the equitable, diverse, connected, maintained and democratic relationships among people within society [18]. One principle of social sustainability is gender equality. Almost 66% of the world's illiterate adults in 2015 were women who even do not have rudimentary literacy skills [30]. Access to education in developing countries is still an issue. Besides, males dominated particular subjects or areas in education. For example, females rarely have access to civil engineering in the higher education in Saudi Arabia. We cannot radically change this situation immediately, however, software engineering solutions might help to overcome inequality by increasing the level of interconnection and access to resources, services, and opportunities, which will lead to changes in society over time in an evolutionary rather than revolutionary way.

In previous work, we analysed individual and social sustainability requirements on software systems [4, 5]. In this paper, we research the gender and cultural diversity aspects more in depth for the example of eLearning systems. For our analysis, we selected two countries with widely different cultures and gender-related laws: Australia and Saudi Arabia. Also according to Hofstede's culture theory [16], which has been widely adopted by researchers in many disciplines as well as in software engineering research over the past few decades [11, 20], the cultural context of these two countries differs by many dimensions.

In the current study, we investigated the gender and cultural differences in needs and usage of system features, focusing on eLearning systems in (1) Australia, having mixed-gender education and left-to-right text direction, and (2) Saudi Arabia, having a single-gender education and right-to-left text direction. We applied thematic coding method (a mix of qualitative and quantitative methods) to analyse the data collected from 177 female and male participants. The results of our study could be expanded and applied to other application domains.

Outline: We organized the paper as follows. Sections 2 and 3 introduce the related work and the basic ideas of Hofstede's culture theory. In Section 4, we discuss the research questions. Section 5 explains the methodology including data collection and analysis. We present the results in Section 6, and the discussion and conclusions in Section 7.

2. Related Work

Sustainability became one of the emerging topics in software engineering only over the last decade. In this section, we discuss the related work on socio-cultural aspects of sustainability in software engineering as well as on cultural aspects within requirements engineering.

Willis et al. [33] analysed how education systems can help to create social sustainability. The authors defined social sustainability as 'a positive and long-term condition within communities and a process within communities that can achieve and maintain that condition' highlighting that this concept focuses attention on the mid-to-long-term future.

Al Hinai and Chitchyan [2] conducted a systematic literature review on social sustainability, and identified over 600 indicators of social sustainability, which they aggregated into 12 groups: employment, health, education, security, services and facilities, equality, human rights, social networks, social acceptance, resilience, cultural and political. Al Hinai [1] also introduced a number of metrics and an accompanying method for analysing social sustainability requirements of software systems.

Based on a generic model for sustainability introduced by Penzenstadler and Femmer [24], Al Hinai and Chitchyan [3] analysed equality as a social sustainability aspect and studied how it can be engineered through software systems. The authors identified three values to achieve equality requirements: socio-cultural equality, fairness, and social equality for accessing services and resources. Their study suggests extra-functional requirements for equality, i.e., reporting, tracking, and alerts features for citizen's complaints, and quality functionality such as accessibility and integration.

Betz et al. [10] introduced a concept of *sustainability debt* to assist the discovery, documentation, and communication of sustainability issues in requirements engineering. The authors defined this concept as the hidden impact of past decisions about software-intensive systems that negatively affects economic, technical, environmental, social and individual sustainability on the systems under design. Analysis of correlation between digital longevity and sustainability was introduced by Becker in [8]. Becker et al. [9] presented a cross-disciplinary initiative to create a common ground and develop a focal point of reference for the global community of re- search and practice in software and sustainability: The Karlskrona Manifesto on Sustainability Design and Software, cf. also [31].

Chitchyan et al. [12] presented the results of a qualitative study, which goal was to explore perceptions and attitudes towards sustainability, of requirements engineering practitioners. The authors identified barriers to the engagement with sustainability design in RE practice, as well as proposed possible solutions to overcome these barriers.

Gibson et al. [14] analysed the perception of sustainable software engineering among UK students enrolled on computing degree programs and junior software developers in industry. The authors conducted an interview study with respect to sustainability, sustainability requirements, and the relationship of these concepts to software engineering principles and practices. The results of their study was that while sustainability is not a primary focus for the study participants, but the concept of sustainability is valued highly by them.

Several works analysed cultural aspects in Requirements Engineering (RE). However, none of these studies investigated/measured the correlation of culture and sustainability during the RE phase. For example, Tuunanen and Kuo [29] analysed the effect of culture on prioritizing and selecting users' requirements during the development of information systems project. Three different cultures were included in this study Finland, China, and the U.S. The authors argue that the impact of culture on requirement prioritization, as part of the overall requirements engineering process, has been insufficiently investigated. The findings show that there are no differences between the values of groups of individuals (in the case of the study context). However, the research confirmed that culture does influence user's requirements.

Thanasankit [28] investigated the implication of Thai culture and hierarchical decision-making on RE process. According to the author, the concept of power contributes towards bureaucratic decision-making, so there is need to explore the implication of culture and gender differences in software development.

3. Cultural Dimensions

Many attempts have been carried out to define and model culture. Hofstede's model is one of the most accepted and adopted cultural model in software engineering cultural studies [11, 19, 7, 6]. Hofstede's model allows researchers to analyse the impact of national culture on the process between cultures. Hofstede et al. [16] defined “*culture*” as “*the collective programming of the mind which distinguishes the members of one group or category of people from another*”. He introduced the cultural dimensions based on his survey conducted on IBM employees in more than 70 countries. Based on the survey result, Hofstede concluded that culture can be indicated by the following six dimensions:

- **Power Distance Index (PDI)**: concerns about inequalities of the distribution of power among society members;
- **INDividualism versus collectivism (IDV)**: the extent to which people are attached to the community, society, or family;

- **MASculinity versus femininity (MAS):** the extent of how distinct the social gender roles are (in a masculine society the gender roles are clearly distinct, in contrast to a feminine society in which social gender roles overlap);
- **Uncertainty Avoidance Index (UAI):** the extent of how people feel either tolerance or intolerance in unstructured situations and unknown future;
- **Long-Term versus short-term Orientation (LTO):** the extent to which the society maintains and links the challenges of the present and the future with its own past; and
- **Indulgence Versus Restraint (IVR):** the extent to which society appeals for gratification ranging from between enjoyment to restriction.

Understanding the culture of various stakeholders could assist in understanding their needs and preferences, i.e., in order to elicit the correct requirements. For instance, in countries like Saudi Arabia, female opinions and needs might be ignored during requirements' elicitation. To resolve this issue, engineers would need to determine which differences in software system requirements may be due to gender to fill the gap and to consider prosperity when including special functions or providing intensive resources and information. Thus, engineers should be educated about genders and cultural background of stakeholders as well as understanding software domains. We adopted Hofstede's cultural theory when analysing participants' responses to understand gender-based and cultural background. According to Hofstede's theory, each country has been allocated a numerical score run from 0-100 with 50 as an average for each dimension. If a country score is above the average, the culture rate relatively highly in that dimension.

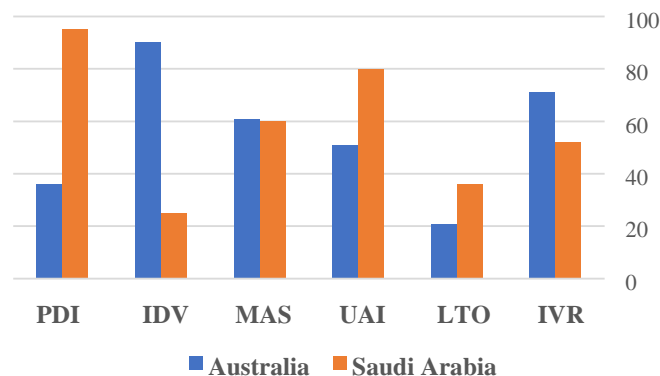


Figure 1. Comparison of Australia and Saudi Arabia using Hofstede's cultural dimensions and data [16]

Figure 1 presents the differences of the six cultural dimensions for Australia and Saudi Arabia according to Hofstede et al. [16]. The power distance of Australia was lower than Saudi Arabia. This indicator in the educational context means that Australian instructors expect initiatives from learners in the class, whereas in Saudi instructors take all initiatives. Australia had a higher individualism percentage than Saudi Arabia that indicates Saudi Arabia was higher in collectivism than Australia. This demonstrates, the goal of the Australian education process is to encourage learners to discover their own abilities. In contrast, Saudi education is more about passive learning where learners depend on the instructor. Saudi Arabia with a score of 80 is a high uncertainty avoidance culture where instructors are supposed to have all the answers. In contrast to this, Australia instructors in a low uncertainty avoidance culture may say "I do not know".

Both Australia and Saudi Arabia had a 60 percent masculinity index value which determines they both had low femininity value. In education, this indicator means that men and women study different subjects. The societies in both Australia and Saudi Arabia had a long-term orientation. Where is in education, learners associate their academic success with effort and have worked hard, as the Australian culture was more indulgent while Saudi Arabia rated midway between enjoyment and restriction.

The education systems of these two countries are extremely different. In Australia, as in Europe and the US, women and men attend the same campuses and classes, i.e., women are not excluded from any learning activities and have access to exactly the same tutorials, labs and presentations, and resources. In contrast, Saudi Arabia has single-gender education that means that women and men attend different campuses that are physically disconnected. All classes and learning activities (including eLearning) are separated, which implies the need to duplicate them.

4. The Research Problem

The literature reflects increased interest in determining the social sustainability of software systems, especially for cultural diversity and gender equality. Nevertheless, this issue requires further investigation from both psychological experts and software engineers on the cutting edge of social sustainability for the longevity of software systems. The broad research problem that guided this study was ‘How can we address cultural diversity and genders equality in sustainability requirements of eLearning systems?’ In order to ensure the social sustainability of software, we have to ensure that:

- There are equal opportunity and access to functionalities provided with high-quality across all cultures and genders;
- All functionalities and information which are tailored to meet the needs and interests are identified and provided; and
- A range of functionalities for systematic risk assessment and monitoring processes are implemented and specified for gender-based and society cultural changes over time.

These points lead to the following research questions:

RQ1 What are the gender and cultural differences in the use of the features provided by the system?

RQ2 What are the gender and cultural differences in the needs of the system features?

We address both questions in the context of eLearning systems in Australia and Saudi Arabia.

5. Research Methodology

To address the research problem, we applied the thematic coding approach [26], which was a combination of qualitative and quantitative methods. We followed the sequential exploratory model of the mixed approach that was presented in [13]. Firstly, the qualitative method was employed during the data collection stage to conduct an open-ended questionnaire. Then, the results were converted to quantitative data through coding themes to perform statistical analysis. This combined process is a common strategy used in empirical software engineering studies to explore and understand the research problem [27, 26].

5.1. Data Collection

An online questionnaire with open-ended questions was emailed to learners and instructors who use eLearning systems in Australia and Saudi Arabia. The aim was to explore the differences in

needs and usage of system features of end-users who have different cultural backgrounds, also covering the gender aspects.

The questionnaire consisted of two sections. The first section had demographic questions about country, university, role, and eLearning systems. In the second section, learners and instructors had to answer three open-ended questions:

Q1: *What kind of functionality are you using, such as chat, discussion board, etc.?*

Q2: *Which functionality do you request which is not provided in your system?*

Q3: *What would you change to improve features in the current system and how important is this?*

5.2. Data Analysis

We performed coding themes (pre-defined themes) to extract the free description of short-answers based on gender from those who were in learner and instructor roles. The themes included five characteristic categories of eLearning systems. Four characteristics including *content*, *communication*, *assessment* and *explicit learner support* were identified by Goldsworthy and Rankine [15]. We added a new category, *quality functionality*, to cover both functional and non-functional characteristics of eLearning systems during the analysis. We also believe the quality functionality is a crucial characteristic, so the five categories are defined as follows:

- **Content functionality:** including course content resources such as lecture notes, slides, and media recording, reading materials, and interactive resources;
- **Communication functionality:** having email, discussion board, social media, announcements, text and video chats;
- **Assessment functionality:** consisting of tests and quizzes, assignment management, grade books, practice activities, past exams, feedback and surveys;
- **Explicit learner support functionality:** involving calendar and schedule, Turnitin for plagiarism reporting, checklist task, and external supported software; and
- **Quality functionality:** involving all software quality such as availability, performance, integrability, usability, and portability.

Each answer to the three open-ended questions was transformed from variables to values against the five categories. For example, one participant responded to

‘What kind of functionality are you using?’

with the statement ‘Discussion board and assignments page, as well as coursework page (lectures and tutorials/labs)’, so we annotated 1 against *content functionality*, *communication functionality*, and *assessment functionality*. Notably, we annotated 1 if a participant's answer included more than one of each category. For instance, if participant responded with ‘Discussion board, email and text chat’, we assigned 1 in front of *communication functionality*. After interpreting the responses, we carried out a statistical analysis to examine the data and to determine meaningful relationships as well as to visualize the representation of results.

To validate the transformation, the first author interpreted the answers from variables to values and the other authors individually inspected the responses within assigned codes and categories. They randomly selected participants and then checked if the values assigned were categorized according to the participant's response.

6. Results and Discussion

The questionnaire was sent via email to two different universities in Australia and Saudi Arabia. A total of 177 male and female participants, who used eLearning systems either as learners or instructors, completed and returned their responses. There were 12% female and 39% male participants from Australia. In Saudi Arabia, there were 6% female and 43% male participants (cf. Figure 2 and Table 1). In what follows, we discuss the major findings of the study, in connection with research questions.

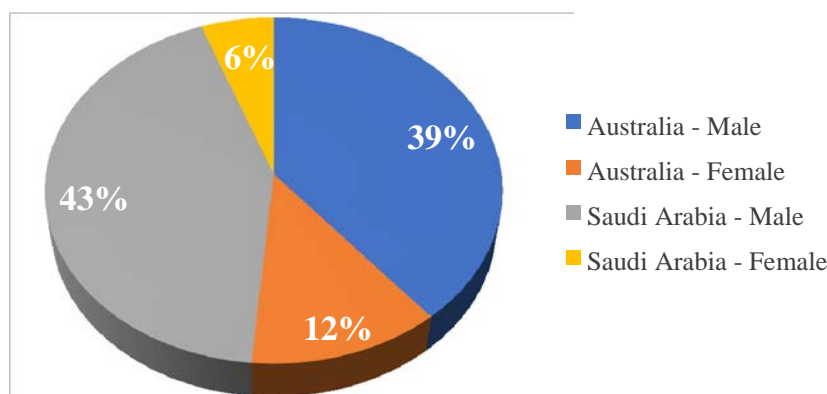


Figure 2. The gender percentage of participants from Australia and Saudi Arabia

Table 1. Participants: Statistics by gender and country

Country \ Gender	Australia	Saudi Arabia	Total
Male	69	76	145
Female	22	10	32
Total	91	86	177

RQ1: What are the gender and cultural differences in the use of the features provided by the system?

Saudi Arabian females, as shown in Figure 3, provided the highest number of all participants who use the content and assessment functionalities of eLearning systems, with 30% and 40%, respectively. In Australia, male participants were higher than females in using the communication and explicit learning support features. Males in Saudi Arabia had the lowest percentages for both content and communication functionalities of eLearning systems, but they used the assessment feature more than Australian males.

The presented in Figure 3 results indicate that females' and males' preferences for usage of eLearning system features are different differ in Saudi Arabia. While in Australia both genders had no significant differences in the functionalities they used. This finding correlates with results of Pan and Jordan-Marsh [22] as well as of Jones et al. [17], who analysed gender and cultural differences in Internet use. Similarly, Rovai [25] reported culture and gender influence on communication and understanding during the online discussions in eLearning systems.

The reason female learners in Saudi Arabia access and use eLearning systems more than male learners might be the single-gender education system: female learners communicate with male instructors online, as they might not be allowed face-to-face in the classrooms. In contrast, in Australia learners of both genders can meet their instructors face-to-face in the classrooms.

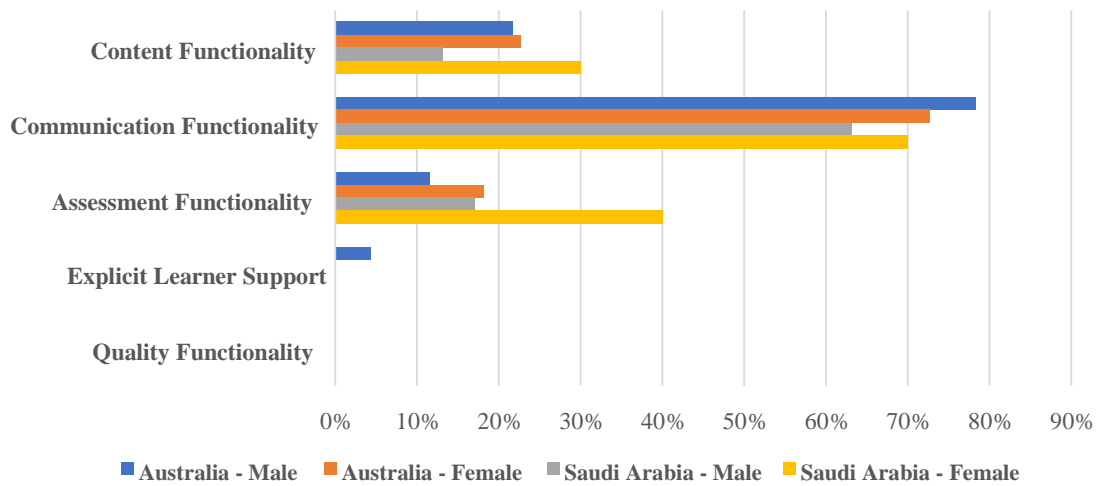


Figure 3. Functionality usage: Comparison by gender and country

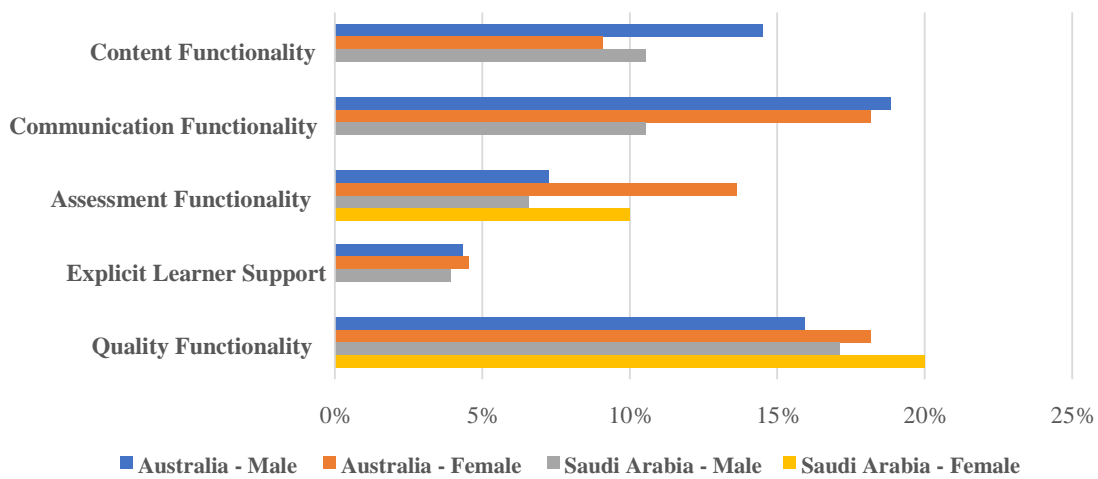


Figure 4. Functionalities requested: Comparison by gender and country

RQ2: What are the gender and cultural differences in the needs of the system features? Thus, what kind of functionalities of eLearning systems are in demand? What functionalities are not provided and what need to be improved from gender-based perspectives in Australia and Saudi Arabia?

Figure 4 illustrates the differences in requested functionalities of eLearning systems between Australia and Saudi Arabia for both genders. The quality and assessment functionalities were the most demanded by females in Australia and Saudi Arabia. Australian males requested more functionalities than did Saudi Arabian males. The communication functionality in Australian systems, also, was requested mostly by females.

However, the results in Figures 4 and 5 show that there are differences across-culture in the requested functionalities as well as improvements required of features in eLearning systems. These findings agree with Tuunanen and Kuo [29] in the point that culture affects user needs.

More than 40% of females and males in Australia requested the quality improvements of eLearning systems, which was the highest (cf. Figure 5). Almost 22% of female participants in Australia requested that the communication functionality of eLearning systems be improved

while 20% of female participants in Saudi Arabia requested the improvement of the assessment feature. The content functionality of eLearning systems was requested to be improved by only by $\sim 5\%$ of Australian male participants.

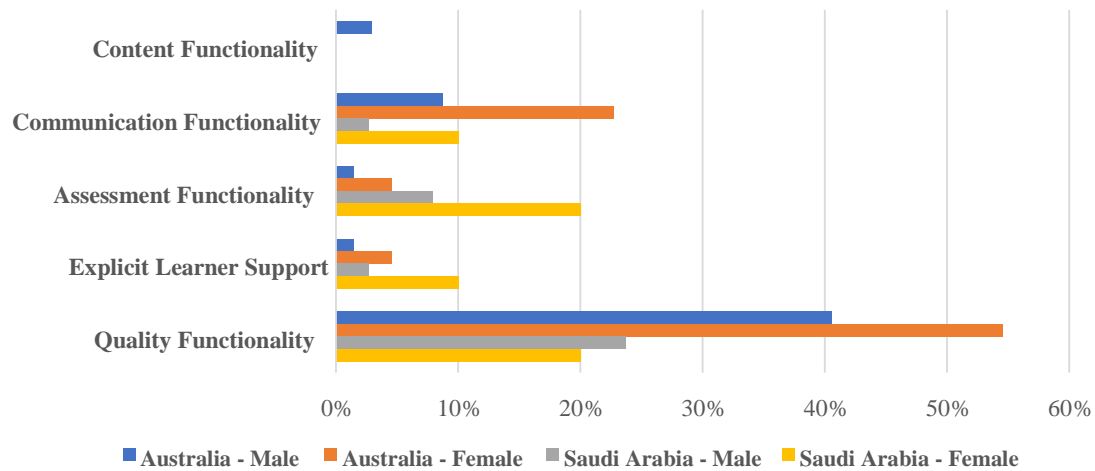


Figure 5. Comparison of deficient functionalities between female and male responses in Australia and Saudi Arabia

7. Conclusions

This study explored female and male perspectives on using eLearning systems in Australia and Saudi Arabia to analyse the used, requested and deficient functionalities. Participants of both genders were asked about the functionalities of eLearning systems that they use or would like to have, as well as that had defects and needed to be improved. Participant responses were collected and analysed using coding approach introduced in Section 5.

The study demonstrated that not only gender but also cultural background does influence the use and needs of stakeholders for systems and quality functionalities. If a female user deals with a certain function, and at the same time a male user in the same country deals with the same function, both genders will manage it differently. When a user of one gender may think the feature is hard to use, a user of the other gender may believe the functionality is amazing and easy to use. To fill this gap, software systems may provide the following:

- Monitoring and generating of reports providing culture- and gender-disaggregated data and cultural and gender-sensitive indicators over time;
- Involving gender and cultural diversity in user acceptance testing, especially to cover usability aspects; and
- Providing tailored and distinct features and functionalities to allow an appropriate customization to adapt the system to the user preferences, also taking into account cultural diversity.

The strengths of this study are the participants coming from different countries, Australia and Saudi Arabia, and all participants being part of either single-gender or mixed-gender educational systems. We have not achieved the gender balance in the responses: only 18% of participants were female. As the participation in the survey was completely voluntarily, and the invitations were disseminated to among learners and instructors in the same, gender independent, way, we may conclude that in both countries most female learners and instructors either prefer to

focus on compulsory activities or are not keen to express their opinion. We would encourage researchers to ensure gender equality of the participants by increasing their efforts in recruiting and inspiring females. For example, providing some discussion about the importance of taking part in gender equality studies before distributing the questionnaires may have resulted in involving more females.

This conclusion highlights the fact that gender and cultural background should be taken into account during requirements engineering activities and for eLearning software system operation to ensure social sustainability. Developing tailored and distinct needs analyses of stakeholders, providing resources and training, reporting gender-disaggregated data and gender-sensitive indicators are core social sustainability requirements for the longevity of software systems.

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