

GENDER ENROLMENT FACTORS IN ICT STUDIES

SHAHRYAN ABD. ALSERRI,
NOR AZAN MAT ZIN
TENGKU SITI MERIAM TENGKU WOOK

Research Center for Software Technology and Management
Faculty of Information Science & Technology
Universiti Kebangsaan Malaysia
43600 Bangi
Malaysia

shahryanalserri@gmail.com

ABSTRACT

Information and Communication Technology (ICT) has a direct impact on STEM education development, specifically in Computer Science and Information Technology studies, which are offered by most universities worldwide due to their importance for a country's development. The female workforce in ICT fields is an important asset for the development of a country. However, many universities in different countries still lack enrolled female students in ICT fields compared to male students. Many factors affect the enrollment of undergraduate female in ICT courses. Researchers in developed countries reported most of these factors, however there are only few studies done in the Middle East countries to identify these factors. This paper reviewed female students' engagement with STEM or computer technology (CT) courses, and factors that affect their enrolments are discussed.

Keywords: ICT education, gender, factors, serious games, enrolment

INTRODUCTION

Information and Communication Technologies (ICT) is a set of technological elements and resources used to communicate, build, distribute, save, and handle information (UNESCO, 1999). It is an umbrella term that includes any communication device or application such as Electronic learning (E-learning), cellular phones, computers and network, hardware and software, and referred to in different contexts such as ICTs in education, health care, or libraries (Rouse, 2005). Computer Technologies (CT) is a field under ICT. According to Dictionary.com, CT is the activity of designing, constructing and programming of computers. CT includes developing many different software platforms and devices. It has a direct relation with information technology (IT) and computer science (CS). ICT has become an important tool in STEM (Science, Technology, Engineering, and Math) education since it make the process more effective and modern (Kazimzade, 2016).

Researches conducted over the last decade show continuing lack of female involvement in STEM studies (Moreno et al., 2014). In addition, talented females miss out the professional job positions offered by STEM careers, so the number of females in STEM carriers is still low (Brandt, 2015).

Furthermore, globally, the United States, Europe, Austria, and some countries in the Middle East face a lack of females' enrolment in CT. Although many efforts have been made to solve the problem, up until now there is still a lack of females in CT fields. In developed countries, many researchers have tried to address this issue by studying the engagement factors that motivate females to enrol in ICT studies. However, there are only a few studies in the Middle Eastern countries to identify females' enrollment factors.

This paper presents a review of related research on the factors that affect the enrollment of females in ICT courses and related fields in developed countries. The paper organisation is divided into four sections. The introduction is the first section. Section two presents related work. Section three discusses the factors of women's enrolment in CT and its related fields, and the conclusion is presented in the last section.

RELATED STUDIES

The literature review covers five elements related to this study. These elements are the importance of ICT in general and its related fields (CT, CS, IT), the lack of female enrollment in ICT, and efforts to motivate females to enrol in ICT fields.

IMPORTANCE OF ICT AND ITS RELATED FIELDS

ICT is important because it increases access to information, and it provides a new way of communication. In addition, it offers several online facilities in the field of education, culture, commerce, and entertainment (Livingstone, 2012). Moreover, using ICT in education can enhance learning opportunities (Sarkar, 2012). ICT increases the quality of learning and enhances outcomes while making the management of learning system easier (Sarkar, 2012), and has an important impact on economy in many regions such as the USA, Europe, Asia and the Pacific Region.

The term ICT is more commonly used outside the USA, (Rouse, 2005) which uses the term CT. There are many reasons for increasing the gender equality in the community, which is believed can be achieved through CT education (Appianing & Eck, 2015). The CT industry offers a variety of desirable and well-paying jobs (UNESCO, 1999). Recruiting more females into the CT industry will create significant financial opportunities for a large number of people (Appianing & Eck, 2015; Barker & Aspray, 2006). Additionally, according to the National Centre for Women in Information Technology, in 2015 women held 25% of professional computing occupations in the U.S. (National Center for Women in Information Technology (NCWIT), 2016). By 2022, the forecast is that 1.2 million jobs related to CT will be created in the U.S. CT sector (UNESCO, 1999).

In Europe, the enrollment of females in the ICT sectors is also expected to generate economic benefits. If females are given the same opportunities as males are to work in the ICT sectors, this would contribute 9 billion euros annually to the European Gross domestic product (GDP) (Puzzles, 2015). Commenting on this trend, in 2013, I.S.L. said: *“The industry itself would profit from more balanced participation rates: organisations that are more inclusive of women in management achieve 35% higher ROE and 34% better total return to shareholders than other comparable organisations”* (Iclaves, 2013). Addressing this issue in the context of Asia and Pacific Region, Tandon (2012) estimated that restricting female job opportunities in ICT would incur 42 to 46 billion USD in costs to this region. In her report, Tandon further observed, *“World Bank findings demonstrate that similar restrictions have imposed massive costs throughout the Arab States Region, where the gender gap in economic opportunity remains the widest in the world today”* (Tandon, 2012).

Existing gender inequality will not be changed by specific intervention (Bartilla & Köppe, 2015). However, more efforts are needed to solve this problem.

GENDER INEQUALITY IN ICT ENROLMENT

Computer Science (CS) is one field in the ICT sector. Studies of the CS field are lacking in many regions such as the U.S, Europe, Australia, and some countries in the Middle East (Bartilla & Köppe, 2015; BUREAU 2013; Bureau, 2014; Al Humoud et al., 2014; Ministry of

Higher Education, 2013; Moreno et al., 2014; Zweben & Bisot, 2016; Strong, 2014). According to the Taulbee Survey conducted in the U.S. (2014), female students enrolled in CS fields comprised only 14.1% of the overall student population (Zweben & Bisot, 2016). This represented a small decrease from 14.2% reported by Taulbee's survey in 2013 (Strong, 2014). Moreover, in 2010, the Taulbee Survey reported the results for 2001 up to 2010, where the number of female graduated in the CS field decreased from 19% in 2001 to 14% in 2010 (Moreno et al., 2014).

In term of ICT, European women are inadequately represented in the sector. In particular, the number of female students enrolled in STEM courses is low, contributing to their absence from most ICT companies, especially in highly technical and executive positions. Furthermore, in ICT sector, males still outnumber females; for example, among 1000 bachelor degree graduates, there are only 29 females with a degree in ICT, compared to 95 males (Bureau, 2014). Netherlands has only 4% to 5% of females enrolled in CS (Bartilla & Köppe, 2015). Australia experiences the same issue, as most females in high school did not like to study IT courses (Appianing & Eck, 2015). This is in contrast to Spain where female students perform much better than males in technology studies. Still, they prefer not to choose technical subjects (Appianing & Eck, 2015). In addition, similar findings apply to other European countries (Moreno et al., 2014).

Furthermore, some developing countries in the Middle East such as Kuwait faced the same issue of a low number of females' enrolment in CT fields in 2014 (State of Kuwait Central Statistical Bureau, 2014) whereby the number of female students enrolled in Technology Studies is 37.7% of the total. Besides that, in 2013 the percentage was 26.4% over the average (State of Kuwait Central Statistical Bureau, 2013). Saudi Arabia has the same problem of a lack of females enrolled in the IT courses; where in 2013-2014, the rate of females enrolled in the IT field was 11.2% (Ministry of Higher Education, 2013). Furthermore, many pre-college students avoided taking CS studies, due to misconception about the CS field. They think that CS mainly concerns repairing computers or office applications (Al Humoud et al., 2014).

In Jordan and Yemen, undergraduate female students' enrolment in some CS fields such as computer network is still low. For example, in Jordan, the percentage of enrolled undergraduate female students in computer networking in 2014 -2015 was 8.3 % (Ministry of Higher Education and Scientific, Jordan, 2015; Ministry of Higher Education and Scientific Research, Jordan, 2014). However, in Yemen, at Sana'a University, the percentage of enrolled female students in 2014 is 6.7% (Sana'a University 2014). In 2013-2014, at Sana'a Community College, the number of undergraduate females' enrolment in computer networking field was 34.7% (Sana'a Community College, 2015). Although many countries have low female engagement with ICT courses, some other countries such as Malaysia do not face this problem, as undergraduate females in universities and within CT are not under represented. Othman and Latih (2006) stated, "The percentage of female students often exceeds the number of male students" (Othman & Latih, 2006). As previously discussed, there is a lack of women enrolment in ICT in some developed and developing countries. One of the solutions to overcome this problem is to motivate females to choose their career in ICT at the early school age (Appianing & Eck, 2015).

EFFORTS TO MOTIVATE FEMALES TO ENROL IN ICT COURSES

Many initiatives over the previous decade tried to encourage more females to enrol in ICT. In Netherlands, there is a program named "Girls Day", which was established to close the gap of gender imbalance within CS studies. Even though this program has contributed to improving the percentage of women's enrolment within CS, the improvement is still not much (Bartilla & Köppe, 2015). Continuing similar efforts to close the females' enrolment gaps

within ICT, Google Company has funded a program to support Women in technology (Bartilla & Köppe, 2015). Additionally, the European Union started a project named "Women in Research and Innovation" to help females to do research improvement, and participate in ICT design and invention, during the period from 2011-2020 (Tandon, 2012). Furthermore, some international companies established programs to help females by narrowing the gap in CT, such as "Women at Microsoft" and "Google women" (Moreno et al., 2014). Likewise, companies like Facebook and LinkedIn have also established programs to assist females in Technologies (Bartilla & Köppe, 2015; Mendoza, 2015).

In developing countries, many organisations have established programs to enhance female enrolment within ICT. They have proposed solutions to encourage females to increase their access to ICT, but those solutions have not been verified empirically. Therefore, more research is still needed in this area (Antonio & Tuffley, 2014). One example of the companies that started a project to help females in developing countries is CISCO, which offers a training program to support talented females to use ICT. This program is helping females to get equality in the IT sector in Egypt, Lebanon, and Jordan, where females at universities have been trained to design, create, maintain computer networks and other software. However, this program focuses only on talented females, not on any ordinary one (Antonio & Tuffley, 2014).

Few attempts were made in the Middle East to narrow the gap of a low number of females in CT, such as in Saudi Arabia, as reported by Al Humoud et.al. (2014). They have attempted to change the misconception of CS field by organising a two weeks summer camp for high school girls. However, this summer camp was for a few number of girls in the Saudi educational community who were lucky to get that chance to participate in the camp (Al Humoud et al., 2014).

Many initiatives have been established to close the female gap within CT. However, there is still limited achievement in the math, physical sciences, engineering, and CS which show a progress or positive impact (Brandt, 2015). Therefore, new and innovative ways need to be explored, as not all solutions can fit different cultures or societies (Carmichael, 2008). Factors that influence females enrolment in ICT courses need to be identified before a solution can be formulated.

FEMALE ENROLMENTS FACTORS

There are many factors affecting the females enrolment in ICT. These factors were identified from many previous studies using a systematic literature review (SLR). The keywords used for searching were gender, ICT, factors, STEM, Enrolment, Engagement, CT, and CS. The databases involved in this search were IEEE, Google, Google scholar, Science Direct and ACM. Moreover, the period of the published journals and reports ranges from 2010 to 2016.

There are many factors that influence women enrolment in computing (Schimpf, Andronicos & Main, 2015). El-Bahey and Zeid (2013) mentioned that, many researchers globally have discovered a number of related factors, which cause a low representation of females in CS sectors. However, Arab countries are not yet included in those studies (El-Bahey & Zeid, 2013). The types of factors are pedagogical, socio-cultural, psychological, and cognitive. The factors of work and interaction may be different between different societies (El-Bahey & Zeid 2013; Frieze et al., 2012). Some of those factors exist because of cultural stereotypes of females in society. Those factors have a relationship with a male-dominated environment, for example, the absence of female role models in the technological sectors, and difficulties with life balance between private and professional life (Moreno et al., 2014).

In developed countries, many types of research studied the female enrolment factors in ICT, as shown in Table 1. These factors include societal stereotypes, role models, family and peer influences, cultural environment, girls perceptions that ICT is a male domain or culture,

interest in the subject matter, and career opportunities (Appianing & Eck, 2015; Ashcraft et al., 2012; El-Bahey & Zeid 2013; Moreno et al., 2014; Schimpf et al., 2015).

Table 1: The Factors That Affects Female Enrolments And Engagement With ICT

NO	Author, year	Factors	
1	(Appianing & Eck, 2015)	<ul style="list-style-type: none"> • The stereotypical gender. • Lack of female role models/mentors. • Male domain/culture. • Computer self-efficacy and computer anxiety. 	<ul style="list-style-type: none"> • Family influence. • Students' relationships with teachers. • The impact of computing experience.
2	(Ashcraft et al., 2012)	<ul style="list-style-type: none"> • Formal/informal education. • Peer influences. • Families, communities, and role models. • Media and popular culture. 	<ul style="list-style-type: none"> • Girls' perceptions. • Interests, confidence, and career decisions.
3	(Moreno et al., 2014)	<ul style="list-style-type: none"> • Career opportunities. • cultural stereotypes • The role of women in society (Female model). <ul style="list-style-type: none"> ○ Its association with a strong male environment. 	<ul style="list-style-type: none"> ○ Feminine referents to follow in the technological field. ○ The complex balance between personal, and professional life among others.
4	(Brandt, 2015)	<ul style="list-style-type: none"> • Academic preparation • self confidence • Cultural factors 	<ul style="list-style-type: none"> • Career/life balance • Self-assessment of capability.
5	(Ogan, Herring & Robinson, 2015)	<ul style="list-style-type: none"> • Flexible work schedule. • inherent challenges. 	<ul style="list-style-type: none"> • interest in the subject matter • role model
6	(Iclaves, 2013)	<ul style="list-style-type: none"> • Cultural traditions and stereotypes about women's role in society and about the sector. • Self-confidence. • Bargaining skills. • Risk-aversion. 	<ul style="list-style-type: none"> • Competition. • male dominated environment • reconciliation between personal and professional life • Role models in the sector.
7	(Plan UK, 2013)	<ul style="list-style-type: none"> • Lack of female teachers • Teachers' attitudes Girls' progress 	<ul style="list-style-type: none"> • Traditional teaching methods • Curricula and assessment Curricula
8	(El-Bahey & Zeid 2013)	<ul style="list-style-type: none"> • Intrinsic interest in computers • Promising career • Government scholarships 	<ul style="list-style-type: none"> • Parent advise • Interaction with role models • Introductory Classes

All identified factors from previous studies are based on Western societies; hence, there is a need to discover whether those same factors have an impact on Middle Eastern societies. This study will focus on Yemen, as a case study for the Middle East society. The identified factors will be studied and validated for undergraduate Yemeni females. Furthermore, the study will explore different approaches to motivate students to take up ICT courses.

CONCLUSIONS AND FUTURE WORK

In this paper, we have discussed factors affecting women's enrolment in ICT, based on findings from the literature review. ICT fields are still a male domain. Many developed and developing countries still face a lack of female engagement with ICT fields. For example, Yemen is a Middle Eastern country, which has a lack of females enrolling in computer network field in universities.

Many factors affect female engagement with ICT technologies, and most of them were reported in Europe, U.S. and Australian studies. However, few studies in the Middle East have been done on females' enrolment factors. Therefore, further research on identifying the factors that influence the enrolment of Yemenis undergraduate females will be studied. Future work will also consider the design of serious games as a tool for motivating students in education.

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