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Barriers and Potential Solutions to Women in Studying Computer Programming in Saudi Arabia: A Discussion Paper

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ABSTRACT

The teaching and learning of computer programming courses by Saudi female students are affected by the country's background and culture. In this discussion paper, we: (1) present the challenges faces by women in computer science education in Saudi Arabia ; (2) provide insights into the factors involved in computer programming teaching and learning ; and (3) focus on potential solutions using mobile teaching and learning approaches in female computer science education.

Keywords: Culture, female, mobile learning, programming, Saudi Arabia.

OVERVIEW OF THE KINGDOM OF SAUDI ARABIA

The Background of Saudi Arabia

Saudi Arabia is the biggest country in the Middle East and is located inWestern Asia. The predominant spoken and written language in the country is Arabic, which is also its official language. Due to its monarchical system of government, Saudi Arabia is frequently referred to as the Kingdom of Saudi Arabia.

In 1932, the monarchy was created after the successful amalgamation of numerous Saudi tribes into one state. The unified state was established with the help of King Abdul-Aziz Al-Saud [1]. As a result of the country housing Al-Masjid Al-Haram in Mecca and Al-Masjid An-Nabawi in Medina, the kingdom is known as "The Land of the Two Holy Mosques". The king is responsible for looking after the two holy mosques. Furthermore, theocracy is practised in Saudi Arabia, where the Islamic faith is the source of law and order for its monarchical administration. The state is governed by Islamic Sharia law, with the Quran serving as its constitution.

Saudi ArabianCulture

The distinctiveness of each culture is a result of the diversity of the underlying ideas, customs and attitudes that form the basis of each community. As a result, societies around the world are unique. Philosophy is a fundamental component of society and has an unmistakable impact on the type of educational system implemented when combined with underlying theories [1]. This may also be observed in Saudi Arabia.

Islamic and Arab traditions are deeply ingrained in this country's cultural milieu [2,3]. The dynamics of Saudi culture include religious devotion, family values, traditions and conservatism.

[1] https://www.mofa.gov.sa/sites/mofaen/Minister/Pages/Default.aspx

Islamic traditions predominate the entire kingdom because it is where Islam originated, and this includes education. For instance, the monarchy has put into place a system of education where different genders are educated on different platforms. Interactions between men and women at educational institutions are expressly forbidden. Typically, only

women manage institutes of higher learning for girls. When men are required to educate women, strict regulations are put into place. Attempts to achieve equality for women in the state continue to be thwarted by the cultural influence of gender segregation.

The government can no longer disregard social and religious ideas in the kingdom,because they are so strong and difficult to change. The predominance of social standards has an underlying effect on numerous fields, particularly education. Global education has undergone a technological revolution, and Saudi Arabia has not lagged. However, questions are raised about whether its cultural climate allows for the incorporation of technologies in its educational setting. As a result, how the Saudi government handles the current obstacles will determine whether the country ever transitions to a contemporary educational system.

Islamic countries' social and religious norms are constantly at odds with contemporary technology. Islamic beliefs and traditions serve as the foundation for the conservative nature of Saudi culture. Social networking is, therefore, viewed negatively. Technology that is said to violate Saudi society's fundamental social values is undesirable unless it is handled with extreme caution [4]. The usage of technology with cameras may be seen as a violation of Saudi society's restrictions on interactions between men and women. In Islamic contexts, social networking is a particularly delicate subject that calls for suitable cultural adaptations to be completely welcomed.

Computer Education in Saudi Arabia

Women in Saudi Arabia who study computer science in female institutions employ traditional methods of learning, such as taking paper notes in class, which is less interesting than using technology for engagement. As a result, studying programming at the university level might be difficult for most women. Concerns about women's privacy and the misuse of mobile devices' cameras served as the foundation for Saudi colleges' conservatism regarding mobile use [5]. Female institutions across the nation have recently started allowing female students to bring in their devices to facilitate better classroom arrangements [2]. One important effect is that female-only universities will implement the 'Bring Your Own Device' policy, allowing students to use their own mobile devices, computers and tablets in the classroom [6]. As a result, female students will find it more fascinating and engaging to pursue subjects like computer science and programming.

OVERVIEW OF FEMALE EDUCATION IN SAUDI ARABIA

Female Education in Saudi Arabia

Women in Saudi Arabia were not permitted to attend school until 1959 [3]. They were informally educated at home because they were excluded from formal education and society. The education of girls was, at the time, heavily discouraged by the culture of society. Women attending schools was considered to be a violation of Islam and the Quran and was, therefore, unacceptable. Policies and attitudes about women in the kingdom have changed significantly since 1959, and despite difficulties and opposition, the Saudi government has been able to emphasise the value of women's education [7].

[2]https://english.pravda.ru/news/world/138816-saudiwomen/

[3]https://www.moe.gov.sa/en/aboutus/aboutministry/Pages/About.aspx

Princess Iffat Al-Thunayan and King Faisal founded Dar Al-Hanan, the first female-only school in Saudi Arabia, in 1955. It gave girls access to school for the first time. There were roughly 15 primary schools for girls in the kingdom in 1961. The government then established the first girls' intermediate school in 1964 [4]due to the push for girls' education. In that same year, the first secondary school for girls opened. Following this, the establishment of schools for girls in the kingdom accelerated [4].

The advancement of Saudi Arabia's society has been significantly influenced by the education of women. As men started to appreciate the benefits of women's participation in various spheres of employment, women started to have equal chances. Women have achieved significant advancements in a variety of sectors, including journalism, education, law and political participation. It is interesting to note that over 35% of women now work in technical sectors [8]. Furthermore, the expansion of female higher education opportunities has also encouraged more female students to pursue degrees in science, technology, engineering and mathematics [4].

Higher Education

The kingdom's economic transformation through the discovery of oil spurred improvements in education. To oversee education at all levels, the Ministry of Education was founded in 1954. The relevance of higher education as a key component of human development initiatives was also acknowledged by the government. As a result, a charter for education policy was unveiled in 1970. Initiating a long-term plan for creating a trained labour force through the educational system, the policy emphasised the value of education to society and the kingdom as a whole [9]. This goal complemented government initiatives to promote a sophisticated economy. As a result, a university was established; however, only male students could enrol. Separate schools and higher education institutions for women were first established as female education grew over time.

The basis for higher education in Saudi Arabia was built in 1957 with the founding of King Saud University (formerly known as Riyadh University). Initially, the institution had 9 employees and 21 pupils. The kingdom had seven universities by the end of 1982, with a combined student body of more than 60,000 and more than 6,500 staff members.

In 1970, the first women's college was founded. However, Riyadh, where girls received off-campus education, saw the start of women's higher education in 1962. Girls who had completed high school were admitted to women's colleges where they were instructedon how to become high school and intermediate school teachers. Twelve further institutions were founded using this approach by the year 1980. In Medina, Tabuk, Abha, Buraida and Jeddah, colleges that provide training in science and education were built. In Riyadh and Dammam, colleges of arts and education were founded at the same time. These colleges now offer courses in history, geography, English, Arabic, religion, education, psychology, home economics, physics, chemistry and biology.

One of the biggest female universities is Princess Noura bint Abdulrahman University, which has more than 50,000 female students. By making science courses available to female students when they were previously only for male students, this university made history. Since 2004, when King Abdullah assumed the throne, there have been more than 20 universities in Saudi Arabia, which was up from 8 in 2004 [2]. These academic institutions, along with others, offer certificates, bachelor's degrees, master's degreesand PhDs in a range of specialisations.

Education has become a top concern in Saudi Arabia during the past few decades. The main strategy used by the kingdom to safeguard the future of its people and advance nation-building is education.

[4]https://www.saudiembassy.net/about-saudi-arabia

The government's strategy includes reform of the educational sector as well. As a result, the industry has consistently received a sizable amount of funding. For instance, the government recently allotted education about 25% of its overall budget [10]. The kingdom is recognised as the top country in the world for the percentage of GDP spent on education due to this massive expenditure. By guaranteeing that students receive free education, the Saudi government supports all levels of education in the country. Additionally, the government offers stipends to students pursuing higher education and pays more than half of the tuition for students at private universities. Additionally, the government offers scholarships to help students who pursue studies overseas. It also offers full assistance to students from rural areas in terms of housing options and other costs.

Gender segregation in schools has been influenced by social standards and religious beliefs, resulting in separate campuses for men and women [10].

PROBLEMS FOR FEMALE SAUDI STUDENTS IN LEARNING PROGRAMMING

Many aspects influence the education of Saudi women. Hamdan [11] went into further detail about the geographical and cultural issues these women have when trying to learn computer programming.

Numerous issues Saudi students have when learning computer science and information technology (IT) have been studied. The lack of experience with programming software and applications, which is a barrier to grasping programming principles, is one of them, as addressed by Malik et al. [12]. Due to cultural and social taboos and Islamic religious regulations, female students are more negatively impacted than male students when using mobile devices. These limitations specifically apply to female photographers and recipients of their images. Women were not allowed to use smartphones in universities until recently [5] due to restrictions imposed by Sharia law in Saudi Arabia on certain photos. However, these traditional viewpoints that forbid women from using communication devices are still pervasive and may hurt women who want to study computer programming in college, especially when it comes to teacher–student interactions. Women's familiarity and proficiency with computers, like all other aspects of IT development,

require ongoing attention to technological advancements to keep women competitive and able to pick up the newest programming abilities.

Frequent software updates are needed to keep up with the demands of experienced programmers due to quick developments in IT. Alvis Live, for instance, is a helpful tool created by Hundhausen and Brown [13] that programming students can use for practical, inventive ways to design, explore, build and invent. If women want to receive the top-notch education necessary to be marketable after graduation, they must have equal access to new tools like these while in college.

The issues surrounding women's mobile device use have another facet. Mobile devices are not permitted to be used, even during programming classes, in Saudi universities that provide computer science and IT degrees to female students. Therefore, in programming classes, female students can only employ passive learning.

Female students are taught to code in the first year through conventional lectures that only make use of PowerPoint slides. The prerequisites for computer science courses are not met by the practice lab or the lectures. According to Fadel and Rajab's [14] assessment of female students at a Saudi institution, this problem is particularly challenging for female students whose studies are solely dependent on classroom instruction. Fadel and Rajab proposed goals for enhancing the students' coding skills based on their projected need to use mobile devices for their computer science courses.

[5]https://english.pravda.ru/news/world/138816-saudiwomen/

Although Saudi computer science teachers are content with their competency in the field and think highly of it, Alghamdi, Pears and Nyl'en [15] claim that there is still potential for improvement in their teaching strategies. This may indicate the difficulties female students have while studying computer programming because their teachers forbid them from using mobile devices.

Alghamdi [16] conducted research on the recent trend of more female students enrolling in computer science courses. Fun classes, parental influence and cultural fitness were the elements that encouraged more female students to enrol in computer science courses. Only ten female students from three Saudi colleges were interviewed for that study's findings. Adding to these findings, Alghamdi [17] noted that while women made up over 50% of computer science graduates in emerging nations like India, Malaysia and Saudi Arabia, only 14%–16% of those graduates came from the United States and other western nations. In Saudi Arabia, numerous colleges offer computer science courses, making it simple for women to enrol in these classes while adhering to social and cultural norms. The colleges provide secure, gender-specific learning spaces. Even though these aspects are encouraging female students to learn computer programming, the difficulties they face once they are enrolled in classes are still largely influenced by their academic standing and the professors' qualifications.

In conclusion, there are now significantly more Saudi women who learn programming than there were a few years ago. Despite this positive trend, questions about women's access to mobile devices and the impact of cultural factors on their learning still need to be answered. These issues must be resolved if Saudi Arabian women university students studying computer programming are to make meaningful use of their abilities and expertise.

COMPUTER PROGRAMMING AND LEARNING

An open and interconnected international era has resulted from easier access to the internet. This is consistent with the rise in demand for computer applications due to the widespread adoption of technologies related to computers. Therefore, a wide range of specialists is in great demand, including database managers, software programmers, network administrators, software engineers and creative designers. Computer programmers are essential in many different businesses, with software engineers being in great demand, according to research [18]. This is because many businesses and corporations rely on computers for their daily operations.

This dynamic has led to programming's growing significance in several new, non-IT-related sectors. The research sciences and other fields that did not at first use programming services have also discovered this rising significance [19]. Programming has grown in importance among students of all disciplines, including mathematics, physics and engineering, to satisfy their needs.

To ensure that students are computer literate and can successfully compete in the job market, an increasing number of schools and universities are offering computer science and IT programs. To provide learners with the necessary computer abilities, the first year of instruction covers the fundamentals of computer science and IT. Basic skills like

using computer software, comprehending operating systems, setting up primary networks and using the internet are typically covered in this course. Then, students are taught more sophisticated skills like graphic design, image processing and human–computer interactions.
The next part reviews earlier research on some of the elements of programming instruction.

Attitude as a Factor of Acceptance of Computer Use

People's behaviours, emotions and responses to situations may be influenced by their attitudes, according to research [20, 21]. The adoption of mobile learning and teaching methods will be successful to a large extent if there is a positive attitude towards them. The term 'attitude' is typically used to describe a person's general psychological outlook towards a specific topic, which is based to some extent on favouritism or disfavour [22]. According to Ajzen and Fishbein [23], attitude refers to how a person reacts to or perceives an object.

This is a crucial research area because of the diversity of opinions that exist about computers and studying computer programming [24]. Technology perception, which can be either positive or negative, is crucial in determining attitudes. The use of technology in programming classrooms mostly depends on the attitudes, views and levels of support of the participating teachers for the technology. No matter how advanced or potent a given technology may be, its use and implementation in teaching and learning depend on how positively it is received and how it is taught [25].

There have been many technological developments in the 21st century, and there will be many more. Studies on the use of technologies in educational contexts have been launched as a result [26, 27]. One of the fields that has been impacted the most by technology and the resulting need for jobs is computer programming. The adoption and acceptance of m-learning technology depend on how teachers and students feel about the technology and how it should be used. An individual's attitude and aims are related. More specifically, attitude serves as an evaluative bias towards particular behaviours. The possibility that a person will have a favourable or negative attitude is also determined by how positively or negatively they perceive mobile-based learning and teaching practices. According to recent research by Teo, Huang and Hoi [28], a person's attitude can be used to predict whether they will use a specific technology. Al-Raimi et al. [29] suggest a theoretical framework for information systems based on the expectation confirmation model. This model focuses on variables that influence intentions to use mobile-based teaching and learning strategies going forward.

Even if m-learning is effectively incorporated into the teaching of computer programming to female students, other aspects of the learning environment and procedures must be considered if the ultimate objective is to make it simpler for Saudi female students to learn computer programming. The following sections go through these elements, the seven learning principles and the technology acceptance model (TAM).

The Seven Principles of Learning

Chickering and Gamson [30] outlined seven principles in their study 'Seven Principles for Successful Practice in Undergraduate Education' to further explain what constitutes good undergraduate education. These guiding principles are meant to help faculty, students and administration enhance teaching and learning. The following seven guidelines have been determined based on research on undergraduate education best practices and college learning and teaching.

Every tenet addresses a core idea in learning development [30]:
1. Encouraging contact between students and faculty members
2. Developing cooperation among students
3. Using active learning techniques
4. Giving prompt feedback
5. Emphasising time on task
6. Communicating high expectations
7. Respecting diverse talents

The Technology Acceptance Model

Many different sections of the world's educational systems have undergone significant changes due to the usage of technology and associated teaching methodologies. Today, a lot of educational institutions rely on technology to make sure children are well educated. To do this, teachers have tried to use technology tools to guarantee that learning activities are carried out effectively. In computer and programming sessions, teaching performance using contemporary means, like technology, coincides with formative evaluation [31, 32]. Because it enables students to use expert tools in their classes to assist them in overcoming the complexity of some courses, m-learning has consequently become a

typical paradigm of teaching for programming lectures [33]. Additionally, the employment of such tools enables the programming of technology in both educational and instructional contexts [43].

The elements of integrating technology into education have been the subject of a sizable body of literature, and the adoption of mobile learning has received a great deal of attention [32]. The TAM has continued to be the dominating approach in this area.

According to the TAM, users and consumers can use information systems to accept and implement technological practices. The basic argument contends that when customers have access to technology, they can find ways to benefit from it [35]. The TAM's theoretical soundness and simplicity are its strongest points, making it an important component of education. Its adoption and acceptance procedures are smooth, and this model was initially utilised in disciplines like computer science [36]. However, in recent years, educational institutions have used the TAM to determine how willing students are to use m-learning and teaching strategies [37, 38, 39]. Due to the impact of m-learning in many classes, including programming classes, teachers are using it as information and communication technologies advance. Tutors also employ a variety of m-learning activities and instructional strategies to assist students in their programming sessions.

Davis [40] uses two key concepts to characterise the TAM: perceived usefulness (PU), which the user might experience as performance improvement due to the usage of contemporary information and communication systems, and perceived usability. Using this method, it is possible to refer to how a person perceives the input necessary to operate a technology. One of the primary components of m-learning examined in relation to programming in this thesis is PU.

Perceived Usefulness

People accept or reject IT for a variety of reasons, depending on several different circumstances. System usage mostly affects these variables. According to previous studies, people's willingness to use a particular application may depend on whether they think it will be useful in assisting them in resolving their difficulties. Consequently, PU can be defined as the degree to which a person thinks that using a specific technology solution can enhance their performance. However, utility is also the degree to which a technology can be put to good use [41, 42]. A system with a high PU is, therefore, thought to have a good association with user performance. This thesis, which examines user acceptance of m-learning, assumes that user performance acceptability has an impact on the use of mobile technology.

According to studies, PU is essential for determining how satisfied learners are with m-learning frameworks [43, 44]. The PU of mobile learning is also linked to student accomplishment, according to a study [45]. As a result, students who believe the m-learning model to be important are more likely to feel at ease using it compared with those who do not [46].

POTENTIAL SOLUTIONS

This review has so far gone into detail on the obstacles women must overcome to succeed in computer programming. To effectively address these problems, it is essential to comprehend them. The actions and solutions that have been effective in resolving some of these problems are highlighted in the following section.

Henne [47] wrote about his experiences instructing 225,000 pupils, half of whom were females, in computer science in Saudi Arabia. Henne provided an upgraded version of JavaScript for Visual Basic, which varies from most programming languages in that it comes with an integrated user interface. This makes it simpler for students to create aesthetically appealing applications. The process of developing mobile apps was intended to inspire pupils to pursue programming education. Henne instructed in English, and those who could understand it translated the courses into Arabic. Islamic prayer hours were accommodated in the class schedules, and the classroom climate was more laid-back than in the United States. Teachers and members of the curriculum committee were among the trainees, and they were free to raise questions without inhibition or fear. As a result, Henne was able to continually assess the degree of student comprehension and modify his instruction. There were practical lab sessions, and on the first day, every trainee was writing programs. Although students' cell phones rang nonstop while in class, this was not considered a distraction. Most trainees' queries were on how to connect the apps with Facebook, Twitter and WhatsApp. Henne learned from interactions with the trainees how quickly they made judgments and completed activities compared with western pupils, despite having a basic hierarchical structure.

Creating techniques to recognise promising candidates for computer science specialisations in high school was one of Henne's key objectives. The Visual Basic programming language was made available beyond Riyadh where it was first introduced. In five months, from January to May, the 150-page curriculum was created, and around 5,000 teachers

required training. To meet this goal in May, the course was done in phases, increasing the number of students at each level. September saw the start of classes. The first group of 225,000 students finished the course, and they found it enjoyable. Henne's experiences led to the discovery of a potential remedy for the difficulties female students had while studying computer programming. The answer is straightforward: user-friendly mobile programming programs (non-mobile applications are also possible). To assess the extent of this solution, some non-mobile application research is examined below, followed by a discussion of mobile solutions.

According to research, motivational strategies may not always work, and feelings like perplexity, boredom and annoyance may hinder students' ability to learn computer programming quickly and efficiently. A sophisticated learning environment for learning to code using machine learning methods was created by Ram'on et al. [48]. This system uses gamification techniques to motivate pupils while detecting and reacting to their emotions. According to experimental findings, the intention was influenced by reported enjoyment but not by perceived utility or attitudes towards the system. According to the study, this approach helped students' academic performance. Mobile phones were not used in this investigation. However, mobile technology could more advantageously use the gamification method to lower tension.

Using flipped classrooms is another technique to increase the efficiency of programming learning. In a study conducted in Taiwan, Chiang [49] created a system for online interactions between students and professors utilising mobile devices. There were 120 initial comments and 401 responses, resulting in a total of 521 comments. The problem-solving stage each of these comments represented was coded, such as asking questions, providing answers, discussing and sharing conclusions. Inter-rater reliability was used to validate the system's efficacy.

In conclusion, mobile platforms may offer a solution to the challenges Saudi female students encounter when learning computer programming.

CONCLUSION

This paper has sought to create familiarity with key aspects of the contexts of computer science courses and programming teaching and learning in Saudi Arabia. It briefly introduced Saudi Arabia's background, culture and computer education and included a general overview of female education in this country. It also discussed the barriers women face in studying computer programming and highlighted the factors involved in programming education. Finally, this paper emphasised the importance of the adoption of mobile teaching and learning as a solution for programming students.

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