Research Article

Section: Literature, Linguistics & Criticism

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Digital initiative, literacy and gender equality: Empowering education and language for sustainable development

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Abstract
Quality education and gender equality are paramount in the global socioeconomic landscape, as highlighted by Sustainable Development Goals 4 and 5. This paper investigates the role of technological integration in advancing education quality and gender parity in Saudi Arabia, aligning with Vision 2030. The study explored how online learning, digital literacy, and artificial intelligence systems can help solve the problem of poor education quality and remove barriers that are associated with gender differences in Saudi Arabia in connection with achieving the Kingdom's Vision 2030. Through a quantitative survey involving 950 participants from various sectors, including students, gender advocates, and policy analysts, insights were gathered on the impact of online learning, and artificial intelligence on educational outcomes. Results reveal a significant proportion (55.68%) enjoying access to quality education (56.73%) utilizing digital tools for learning enhancement. Encouragingly, 84.95% acknowledge the importance of digital literacy and online education in expanding educational opportunities. However, 75.89% recognize prevalent gender disparities, with limited access to digital tools hindering equality. Nonetheless, nearly all respondents (95%) agree on the potential of online learning to address gender gaps. Stakeholders affirm technology's pivotal role in realizing SDGs 4 and 5, emphasizing its capacity to elevate education quality, eradicate gender inequalities.

Keywords: gender equality, online learning, quality education, saudi vision, technology

Public Interest Statement

Access to quality education and gender equality are fundamental pillars for societal progress and development. In line with the Sustainable Development Goals (SDGs) 4 and 5, which emphasize these crucial aspects, this study delves into the transformative potential of technological integration in advancing education quality and gender parity in Saudi Arabia, aligning with the ambitious Vision 2030. The findings underscore the critical role that online learning, digital literacy, and artificial intelligence systems can play in addressing the challenges of poor education quality and gender disparities in Saudi Arabia. By examining the perspectives of diverse stakeholders, including students, gender advocates, and policy analysts, this research sheds light on the impact of technology-driven educational initiatives. One of the key revelations of this study is the significant proportion of individuals who have access to quality education through digital tools. Moreover, the recognition of the importance of digital literacy and online education in expanding educational opportunities is encouraging. However, the acknowledgment of prevalent gender disparities, particularly in access to digital tools, highlights an area of concern that needs urgent attention.

1. **Study Background and Context**

The search for sustainable development is intertwined in the fine-strands sewn within Vision 2030, which seeks diversified as well as knowledge-based economy. The innovation of this study is the incorporation of technology to address problems pertaining the SDG 4 and SDG5, a digital empowerment agenda emanating from Vision 2030. However, numerous challenges prevent the realization of this goal. First, the quality education in marginalized communities not only remote villages but also other areas which reduce personal growth and decrease socio-economic advancement was noted by Abdulmughni et al. (2023). Additionally, digital literacy programmes and mobile apps suggested by Alarjani et al. (2023) can be a perfect answer to the problem of improving reading level and numeric skills in rural areas. As Saleh and Adly (2024) point out, educational institutions should embrace technology skills development as per SDG 4. In general, technology use in education in Saudi Arabia does not only solve challenges but also meets Vision 2030 that seeks to build a knowledge-driven society as it rises above innovation and inclusiveness.

Saudi Arabia's route to gender equality is complicated by numerous obstacles originating from religious customs, social standards, and societal traditions that threaten women's full perception. This perpetuates the disparity since women are not represented in decision-making positions, according to Syed et al. (2018), which is a societal norm. Secondly, as Alessa et al. (2021) observe, economic aspects of gender inequality are highlighted, and there is a thrust to change attitudes towards the functioning of women in the labour force environment. Religion matters, as evidenced by Eum's (2019) interpretation, leading to the norms that often and consequentially create barriers to women's movement and activity within public spaces. Al-Nasrallah's (2023) corporate disclosures analysis highlights the continued gender inequalities, which contribute to the multiple processes involved in female empowerment within a corporative frame. Furthermore, Alshehry's (2023) study shows that women have a significant role in higher learning institutions as they help to achieve Vision 2030. In this new paradigm, technology serves as a catalyst for addressing the challenges mentioned. According to the study by El Hassan (2024), digital empowerment initiatives can ensure access to information, education, and economic opportunities for women, which will reduce gender-based use. According to Alshuwaikhat and Mohammed (2017), technology has the opportunity to unveil societal norms regarding gender, whereby women get a chance to engage in entrepreneurship activities as well as the remote position. Therefore, initiatives such as online support groups by Singh and Blessinger (2023) could serve as a communication platform for Saudi women to interact with each other, comment on the issues they face, and find references that empower them. The use of technology in the innovative nature

of gender equality becomes a strong method to eliminate social prejudices, promote inclusion, and align with Saudi Vision 2030.

The government-led Vision 2030, which aims to change the economy through business diversification and social reform activities throughout society (Alarjani et al., 2021), constitutes a transformational plan for Saudi Arabia's future. Based on the recognition of economic and social change, Vision 2030 is aligned with the SDGs at the international level, especially SDG 4 (quality education) and SDG 5 (gender equality). The Vision also regards education as the basis for all development, reaffirming SDG 4 as a guarantee of quality teaching and learning opportunities for every individual (Mitchell & Alfuraih, 2018). The concept of educational excellence as the key to developing a skilled labour force resonates with SDG 4, which addresses improving relevant skills and a sustainable learning environment (United Nations, 2015). At the same time, there is an emphasis in Vision about the gender equation that echoes SDG 5, which aims at women's empowerment and their full and effective participation across all sectors (Albassam, 2021). The link between the goals within Vision 2030 and the SDGs is high, as evidenced by Alharbi (2017) who notes that women's empowerment plays a key role in realising vision. Vision 2030 can therefore be viewed as a catalyst for SDG4 and SDG5 that points to the country's aspiration towards sustainable development and equitable growth.

This paper analyses Saudi Arabia's Vision 2030 and its formulation in terms of education, sustainable development goals related to quality education (SDG-4), and gender equality (SDG-5). This research draws from Saudi Arabia's vigorous reform programmes to understand the challenges and opportunities regarding quality education as well as gender equality. The innovation lies in the promotion of a comprehensive digital empowerment and learning programme that uses technology to alleviate these conditions. The paper aims to contribute practical insights and solutions relevant for the Saudi Arabian context by aligning with particular indicators of SDG 4 (quality education) and SDG 5 (gender equality). The importance of this research is in its usefulness to inform policymakers, educators, and stakeholders on the complicated links between Vision 2030, including targeted SDGs, through providing practical measures for enabling inclusive education wherein women are duly empowered, thus supporting global sustainability objectives.

2. Review of related Studies

Different studies have been carried out, both in Saudi Arabia and globally, to analyse and evaluate the indicators of Sustainable Development Goals 4 and 5. These studies have focused on the correlation between quality education and gender equality, particularly in rural communities where gender norms seem to significantly influence the educational opportunities available to women. Therefore, it is important to further investigate the results of these studies in order to identify the deficiencies in the existing body of literature and determine the major research topics that are pertinent to this publication. The review is divided into segments based on the results of prior investigations.

2.1. Quality Education in Saudi Arabia; A Review of Key Findings

Education quality does not only mean being literate and numerate but something much more comprehensive. It includes development of critical thinking ability, problem-solving, and the ability to change with a changing environment. The nature of subsequent holistic development acts as a starting point to the concerted well-being of every individual and society that leads to integration, economic growth converging into sustainable development program further supported by UN-SDG (2023). Acknowledging this transformative force, the international community adopted Sustainable Development Goal 4 (SDG 4) as one of its intrinsic building blocks in achieving the 2030 Agenda. In view of the commonly understood idea that "everyone gets equally high-quality education," SDG 4 promotes the notions of "inclusive and equitable" learning opportunities to

all, without regard for gender, economic standing or geographical distance. This education equality search finds a harmonious reverb in the ambitious Vision 2030 compassed by Saudi Arabia. Due to the importance of education in changing the face of Kingdom's economy and strengthening its future competitiveness, Vision 2030 encompasses a transformative plan for this sector. Its goal is to 'transform education' through instinctive innovation, creativity, and critical thinking in a comfortable digitalized climate (Vision 2030). And towards this end, Saudi Arabia aspires to transform her economy from a concentration on minerals resources to an emphasis of knowledge-driven society that the people will become empowered through education which is made to be a national strength rather than oil alone.

Quality education in Saudi Arabia is characterized by several complex issues, especially in the rural setting where traditionally oriented educational systems maintain imbalances. Aldegether (2023) notes how Saudi Arabian representations of family education curriculum reinforce gender stereotypes, thus limiting educational opportunities. Moreover, in accordance with what Alotaibi (2022) argues that female academic leaders of higher learning have a significant role to play when aiming at meeting Vision 2030 this implies that gender differences significantly impacted the quality of education. However, it is clear from the work of Allmnakrah and Evers (2020) that there is inadequate technological integration concerning the need for a fundamental revolution in the educational system in Saudi Arabia. However, despite the emphases from Barry (2021), challenges seem to continue in fixing broader significant gaps that include access to human capital and resources. Additionally, Mitchell and Alfuraih (2018) provide the agenda of National Transformation Program 2020 and Vision 2030 through education as well as stress that the gaps should be mitigated to achieve utmost goals by both parties. Omar and El-Bastawissi (2023) discuss missing data on SDG 4 in the Arab Region as the final focus, noting that an accurate assessment of education difficulties can ensure sustainable development goals' attainment. In other words, these studies altogether highlight the major issues in sufficient quality education within remote regions of Saudi Arabia: from gender imbalances and traditional educational systems to technological format and complete informational data.

In spite of the efforts to meet SDG4 within Saudi Arabian remote communities, some challenges remain on how best to train teachers; increase the number of both male and female educators; integrate technology successfully; and see that quality education is available widely enough. However, technological integration still remains a great challenge in scaling up the implementation of technology-enabled learning platforms to remote or rural areas as discussed by Ahmed et al. (2024). The work of Akhlag and Sabha (2023) on Saudi early childhood female teachers highlights the need to pay more attention to gender gap in teacher development and representation. The idea that increasing female teacher supply is paramount to the role of Vision 2030 in helping Saudi women develop in multiple areas, including education, as proposed in Alaffef (2024) assumes a significant level of importance. Further, Alkhayyat et al. (2021) analyze SDGs in Saudi Arabia referring to a holistic perspective first and last not least to the teacher training program implementation. The contribution of higher education to sustainable development goals, including quality education, is revealed by Saleh and Adly (2024) in their analysis of the performance levels among Arab universities. On the other hand, the scope of quality education poses challenges and addressing these issues is critical in realizing SDG 4 in Saudi Arabian rural areas.

The Vision 2030 has a major role in transforming the country from being oil based to one that is knowledge based and as such it relies much on quality education. In this regard, Alharbi (2022) studies the impact of female academic leaders on realizing Vision 2030, emphasizing the crucial role that women play in determining the outcomes of education. Alessa, Shalhoob, and Almugarry's (2022) article on Saudi women's economic empowerment highlights the support for women in non-traditional roles through education in accordance with Vision 2030 vision on focusing the economy providing diversified fields. According to Mitchell and Alfuraih (2018), education is very vital in the attainment of the National Transformation

Program 2020 and Saudi Vision 2030. As indicated by Langworthy and Naguib (2023), the study on women's empowerment and public policy provides information regarding gender, education, and policy changes. As shown by Barry's (2021) assessment of equal opportunities in education in Saudi Arabia, several issues have been identified that need to be addressed to facilitate the successful implementation of Vision 2030. However, the imperative of this approach is in the holistic vision of quality education encompassing gender inclusiveness, skill development and moving away from the old paradigms, are also important elements that would help us to successfully transit into knowledge economy.

2.2. Gender Equality Concerns in the Saudi Arabian Remote Area

The topic of gender equality in Saudi Arabia has undergone significant transformation that is characterized by marked changes in education and the labour market. To that end, Alshuwaikhat and Mohammed (2017) note that even though the nation's Vision 2030 emphasis on sustainability, sustainable gender still remains to be a major issue. Akhlag and Sabha (2023) focus on the perceptions of ECE Saudi female teachers regarding gender stereotype in STEM activities and how this can affect the educational setting. Alharbi's (2022) empirical inquiry sheds light on how Vision 2030 was responsible for women empowerment, which necessitates a paradigmatical shift. Nevertheless, Al-Nasrallah's (2023) study of gender equality and women empowerment over ten years still exhibits a case study on corporate disclosures that reveals the path of ongoing gender balance. The research led by Qwaider et al. (2023) uses GIS-based progress tracking to assess Saudi Arabia's success in meeting the SDGs, including gender-related targets. Since El Hassan (2024) focuses on the absence of missing data concerning SDG on education in the Arab region, it is evident that this may raise the question of gender equality in education there. Gök and Gök's (2023) empirical analysis of gender inequality in human development across G20 countries offers a comparative perspective. In totality, these studies enhance our understanding of the changing nature of gender equality in Saudi Arabia and also highlight the need for continued actions to close any existing gaps and, in line with Vision 2030.

Gender equality is closely connected with issues of quality education and sustainable development, the focus of SDG 4 and SDG 5 respectively (Alharbi (2022)). Nevertheless, in Saudi Arabia the entrenched patriarchal practices and discriminatory practices pose a huge threat to succeeding in efforts to establish equity both in education and opportunity (Alessa et al. 2022).

Probably the most salient impediment to gender equality in Saudi Arabia is the male guardianship system because it grants wide control over a woman's life to her male guardian – father, husband or brother (Peng et al., 2024; OECD, 2020; EUM, 2019; Alrajih & Zahid, 2018). This arrangement limits the level of freedom to roam around, travels, and employment for women and therefore creating numerous barriers in accessing education, especially at higher levels. Reforms have alleviated some restraints for example women can now drive; however, major restrictions still prevail (Human Rights Watch, 2019). Discriminatory social norms and gendered assumptions are not only entrenched in society but are also reflected in the system of formal education (Peng et al., 2024; A;shery, 2023; Alessa, 2022). Additionally, curriculums often promote traditional gender stereotypes, which limit what girls hope for in life and the types of careers they pursue (UNESCO, 2012). This goes a long way in creating the imbalance of women in STEM and other leadership positions (Aldegether, 2023; OECD, 2020; Human Rights Watch, 2019).

2.3. Gap in the Literature

Gender equality and quality education in Saudi Arabia are affected by the situation's growing complexity, which is revealed through numerous systemic research publications (Syed et al., 2018; Saleh & Malibari, 2021; Barry, 2021; Abdulmughni & Al-Abyadh, 2023). Prominent discoveries reveal general issues caused by the patriarchal fatherhood system, discriminatory gender social norms, and segregated education from

the perspective of gender (Ahmed et al. 2024; Parveen 2013 Sadan Aljehani Zahra Kedan & Khan Fernandez 2016). These factors constrain access to higher education for women, reduce career options, and reinforce traditional gender roles in the curriculum (OECD, 2020; Peng et al., 2024; Ahmed et al., 2024; Parveen, 2023). Although recent reforms are a sign of such progress, considerable gaps are noted, which do not allow fully achieving SDGs 4 and 5 (Peng et al., 2024). However, it is worth noting that the literature pinpoints a clear gap in an examination of the subtle dynamics between technological advancements, high-quality education, and gender equality in the Saudi case. Most studies tend to regard technology as a neutral instrument; however, it can aggravate or help minimize the educational injustice (Ahmed et al., 2024; Syed et al., 2018). This overlooks a significant point, as developments in fields such as AI, online learning systems, and EdTech can redefine the educational world. By looking at these developments from the perspective of gender equality, it is significant to ensure that they do not inadvertently reinscribe existing prejudices or constrain female participation.

The first challenge in the formula is the gender gap that is already there when it comes to digital literacy and technology access. The privileged communities stand the chance of achieving more in technological advancements over time, thus reducing technology and skills gaps and further marginalizing disadvantaged groups such as girls and women in the rural areas. This calls for further research to determine the current status of digital literacy that is available in Saudi Arabia and how it differs across gender and demographic groups. This would guide targeted interventions to reduce the digital divide and have fair use of technology-based learning. In addition, the creation and roll out of EdTech products necessitate a certain element of gender bias consideration. AI-assisted learning tools should run on algorithms that are free of bias; this is fundamental in the fact that stereotypes can be perpetuated and girls' learning experiences would be limited by such. Further research is required to uncover and counteract such biases that EdTech tools and algorithms present, as they are supposed to create inclusive environments responsive to gender practices.

In addition, technology is a huge asset through which society can use to break down gender barriers that are related to education. By using online learning platforms, mobility restrictions of females in terms of time and place can be taken into consideration as well as the issues with other traditional academic institutions. Studies on the efficacy of these platforms towards reaching the female population who remain marginalised in terms of accessing education are pertinent to inform strategies for enhancing educational access and gender equity. Closing the gap in literature on technology, gender equality, and quality education in Saudi Arabia is imperative for harnessing the true transformative nature of technology. Through critical analysis of this interplay as well as the development of evidence-based policies, stakeholders can ensure that technology becomes a means through which knowledge and education are inclusive and equitable, thus empowering all men and women to achieve their potential.

2.4. Study Objectives

The general objective of this paper is to assess the achievement of SDGs 4 and 5 in the context of Saudi Arabian remote communities, focusing on how technology can assist in achieving the goals in the Kingdom. the following specific objectives are pursued:

i. To explore the extent to which the integration of technological advancements, including online learning, Artificial Intelligence systems and digital literacy systems, can increase the access and quality of education in Saudi Arabia.

ii. To analyse how technological enhancements such as online learning, digital literacy, and AI-models can help in reducing gender inequality in Saudi Arabia, and help in achieving SDG 5, mainly in equal access to education and employment opportunities.

iii.   To interrogate how technological integration in achieving quality education and gender equality can enhance the realization of Vision 2030

2.5. Research Questions

Based on the study objectives and the gaps identified from the reviewed studies, the following research questions are pursued:

a.   To what extent can the integration of technological advancements, including online learning, Artificial Intelligence systems and digital literacy systems, increase the access and quality of education in Saudi Arabia?

b.   How can technological enhancements such as online learning, digital literacy, and AI-models help in reducing gender inequality in Saudi Arabia, and help in achieving SDG 5, mainly in equal access to education and employment opportunities?

c.   In what ways can the interrogate technological integration in achieving quality education and gender equality enhance the realization of Vision 2030 in Saudi Arabia?

These research questions form the basis for the development of measuring items in the data collection, and also form the stand on which the analysis was conducted.

3.   Research Methodology and Materials

Various methods were implemented to guarantee the originality and eliciting primary data for the study. The methodological processes are designed to mainly generate required data for the analysis of technological impacts in reaching SDG 4 (quality education), and SDG 5 (gender equality) in the Kingdom of Saudi Arabia.

3.1. Research Approach

To attain to the objectives set out in this paper, the quantitative survey method was adopted as the most suitable approach. The adoption of quantitative survey in a study requires gathering of numerical data from a poll of larger study population to answer survey questions related to the research questions. The rationale for adopting the quantitative method in this paper is motivated by the need to use numerical data to establish the views of a group considered key stakeholders in the discission of quality education and gender equality in Saudi Arabia.

3.2. Research Design

The survey design is the most suitable approach for this research study. The utilization of a quantitative research methodology coincides with its implementation, enabling researchers to engage as many participants as possible. Additionally, using a survey design assists in constructing data collection tools that predominantly collect numerical information utilized in statistical analysis.

3.3. Study Community

Women and the youth population are considered a group that are most affected by issues in quality education and gender equality in Saudi Arabia. They face different limitations and restrictions. As such, they were considered the most appropriate members of the Saudi community to provide requite data that suits the objectives of this research. As such, the study community in this research include male and female students drawn from King Saud University and King Abdulaziz University. Other members include women drawn

from different ministries, agencies and business. The choice of larger spectrum of participants is to ensure that the stakeholder emanated from different areas in life to be able to discuss issues of quality education and gender inequality in Saudi Arabia.

3.4. Study Tools and Materials

Digitally designed survey questionnaire was used in the collection of the appropriate primary data for this study. The questionnaires contain the materials that are used as measuring items in the study, as listed below:

a) The first part of the questionnaire contains relevant demographic data that form the analysis of the core personal information of the participants, including gender, age, academic qualification, group, and level in digital literacy.

b) The second part of the questionnaire contains five study questions developed from the first research question, which explores the extent the integration of technological advancements, including online learning, Artificial Intelligence systems and digital literacy systems, can increase the access and quality of education in Saudi Arabia.

c) The third part of the questionnaire also focused on the second research question, wherein five survey questions were developed and included. The aim was to unveil how technological enhancements such as online learning, digital literacy, and AI-models can help in reducing gender inequality in Saudi Arabia, and help in achieving SDG 5, mainly in equal access to education and employment opportunities.

d) The last part of the questionnaire was directed at selected stakeholders who are knowledgeable in the critical issues in Vision 2030. Four survey items were included in this section, aimed at understanding ways wherein the technological integration in achieving quality education and gender equality can enhance the realization of Vision 2030 in Saudi Arabia.

Sections 2-4 in the survey was developed based on the 3-points Likert scale of accept, neutral, reject. The choice of 3-points Likert scale is mainly to gain specific direction of the opinions of the stakeholders on critical issues in connection to the study questions.

3.5. Study Sampling

In order to determine the appropriate sample size of study stakeholders, we utilised the expert sampling technique. This methodology is commonly employed when researching a topic that requires individuals with exceptional knowledge in a specific area, as stated by Dayn (2013). By selecting experts who possess ample experience and expertise concerning quality education and gender equality, our intention was to gain insight from diverse viewpoints on this subject matter. Ultimately, 270 students in the education departments knowledgeable in quality education and 389 active promoters in the campaign for gender equality in Saudi Arabia were chosen through careful selection utilising this method. Other participants include economic and educational policy experts in the Kingdom of Saudi Arabia

3.6. Measures of Validity and Reliability

There are various methods for assessing the soundness of research inquiries and the consistency of study instruments. In order to determine the reliability of the questionnaire used in this particular study, a pilot test was carried out that involved six education and women affairs experts who were excluded from the main sample group. Based on responses obtained from this survey, an evaluation was conducted regarding how reliable our instrument is. Additionally, we utilised expert review techniques to validate inquiry items;

three specialists each in education policy, economic policy and women affairs were enlisted for this purpose, whose suggestions and inputs aided us completely while measuring validity parameters.

3.7. The Procedure for Analysis

After collecting the data, we used appropriate statistical measures to analyse it. We calculated the percentile values of the Likert scales and created descriptive tables that included mean scores, standard deviations, and standard errors. In each analysis section corresponding to our research questions, we carefully scrutinised the statistical findings by referencing relevant literature.

4. Results and Discussions

4.1. Results of the Demographic Features

Various demographic characteristics were presented to the study participants, and the results are further summarised in the table below:

Table 1: Summary of Demographic Characteristics

Groups	Categories	Repetition	Percentage
Gender	Male	136	13.19%
	Female	814	86.81%
Age	20-24	87	9.21%
	25-29	177	18.75%
	30-34	163	17.26%
	35-39	169	17.87%
	40-44	224	23.70%
	45 and above	130	13.76%
Group	Students	270	28.53%
	Gender Equality Promoters	389	41.16%
	Educational Policy Experts	173	18.30%
	Economic Policy Experts	118	12.49%

The following table provides a number of important demographic characteristics among the participants, which allows one to analyse their gender and age peculiarities within different groups. It is worth mentioning that females had dominated the study with 86.81% of the total sample while males formed only little less than one-third at 13.19%. The age group of the participants revealed a diverse representation, ranging from 20 to 45 years and above. The figure with the highest percentage within age categories was the 40-44 rated category where the total participants were 23.70%. Regarding categories, Gender Inequality Promoters had the highest incidence at 41.16%, overtaking Students with the figure of 28.53%. Educational Policy experts and Economic policy experts were 18.30% and 12.49%, respectively, in their contribution to this field of knowledge. This demographic trait is very essential to the study because it gives a configuration into the participants structures from diverse backgrounds and age groups. It is also important to know how the findings of this study has been witnessed among Gender Equality Promoters, Students, and Policy Experts because diverse experiences and expertise through wide spectrums needs an in-depth analysis around gender equality issues associated with Saudi Arabia.

4.2. Results of the Data Connected to the Research Questions

To properly analyse the impact of technology in achieving quality education and gender equality in Saudi Arabia, the survey items distributed to the study population were developed only from the research questions. The results are thus presented in accordance with the research questions.

4.2.1. Results of the Survey Items from Research Question One

In the first research question, the focus was to ascertain the extent to which the integration of technological advancements, including online learning, Artificial Intelligence systems and digital literacy systems, can increase the access and quality of education in Saudi Arabia. The results of the survey items derived from this question are contained in the graphs and table below:

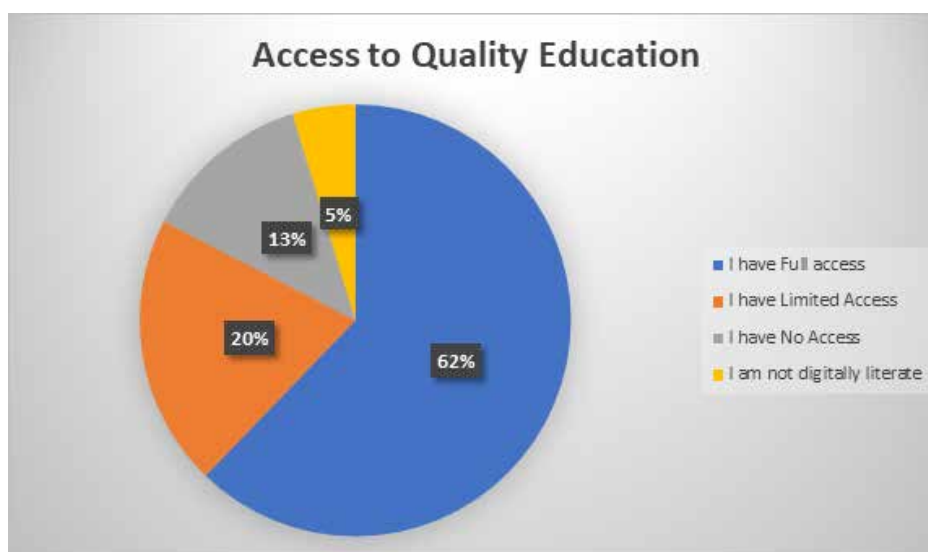Figure 1: Participants' **Access to Quality Education**

Figure 1 shows the results that reflect diverse access to quality education for participants in this study. It emerges that a relatively large percentage 55.68% indicated availability of quality education implying a considerable proportion of the society enjoying quality education services. In contrast, only 18.21% mentioned limited access, which implies constraints or limitations on this group to utilize educative resources completely and recounted as difficulties or restrictions faced by this faction in fully utilizing the educative assets. The findings also showed that 11.37% said they had no access to quality education, which highlighted a worrying number of the population who never receive an offering in terms of education at all. In addition to that, a shortage of digital literacy was pointed out by 4.21% of respondents suggesting another obstacle for accessing educational materials provided through the digital platforms. Altogether, these findings highlight the need for action-oriented approaches to eliminate disparities in educational accessibility and suggested whether referring to quality, digital literacy or overall availability, this will serve as a significant contribution towards achieving SDG 4 goals and securing equal opportunities for education.

Fig 2: Usage of Digital Tools to Enhance Educational Activities (Teaching or Learning)
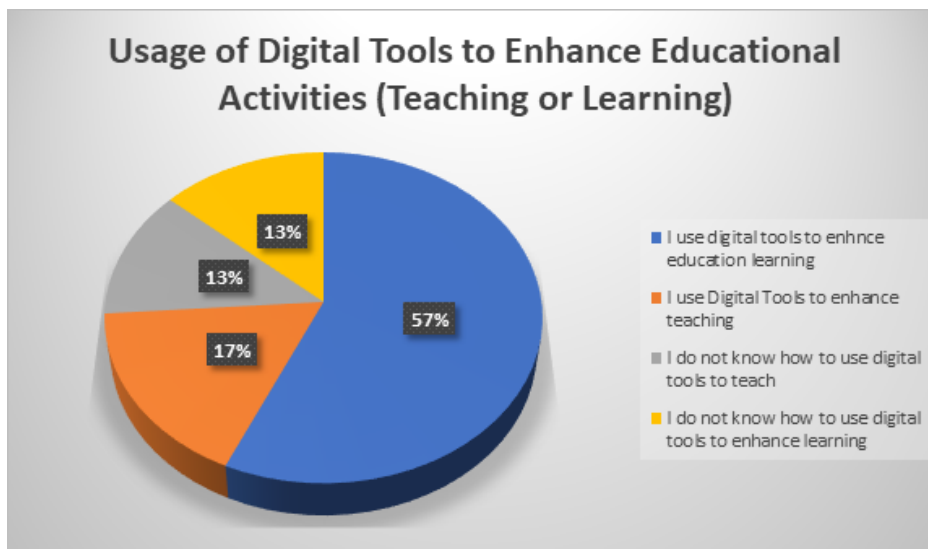

Figure 2 also explains a number of critical facts regarding the usage of digital means for educational activities, showing the different levels of engagement among participants. Strikingly, more than half of the respondents (56.73%) confirmed that they rely on digital tools to improve their learning experiences and reflect a great tendency towards utilizing such tools for self enhancement. On the contrary, only a little proportion (17.15%) talked about utilizing digital tools for improvement in teaching, which perhaps indicate discrepancies in utilization of technology usage at different levels since both educators and learners use technologies differently. Additionally, 13.48% declared lack of knowledge on how to apply digital tools in their learning and the other percentage was 12.64% who did not know how to use these tools for teaching purposes. These results reinforce the necessity of a comprehensive approach to digital literacy, emphasizing both educators' and learners' skills needed to leverage the advantages of technology in education. In line with the bigger picture of SDG 4, this study highlights that these gaps should be addressed through strategically targeted interventions in order to create an inclusive and technologically-empowered environment.

Table 2: Summary of Varied Survey Questions Related to Research Question One

Survey Items	Accept	Neutral	Reject	Mean	Std. Dev
I consider digital literacy, AI models and online education as systems to be essential in increasing educational opportunities for individuals in Saudi Arabia	84.95%	4.03%	11.02%	4.85	0.96
Integrating various technological advancements can positively impact both the access to and quality of education in Saudi Arabia	91.64%	2.95%	5.41%	5.03	0.52
Considering the combined impact of online learning, Artificial Intelligence systems, and digital literacy, I believe it can significantly elevate the education landscape in Saudi Arabia	89.06%	3.74%	7.20%	4.93	0.75

Table 2 shows there is a strong homogeneity among the respondents that technology has played an important role in increasing educational opportunities in Saudi Arabia. Interestingly, 84.95% participants demonstrated a positive attitude towards the significance of digital literacy, AI models and online education systems for enhancing educational opportunities for people in the country. This highlights a collective understanding

of technologies as essential elements for broadening access to education. Additionally, 91.64% of the respondents acknowledged that merging numerous technological developments leads to benefitting from two aspects in Saudi Arabia i.e., access and quality of education. This large percentage underpins those widespread beliefs about the transformative attributes of technology in the education sector. Moreover, 89.06% of respondents reported the belief that online learning, together with Artificial Intelligence systems and digital literacy, can have a global impact on education in Saudi Arabia due to its boost for knowledge ranking procedures. Altogether, all these results support the core statement of this research as they clearly indicate that there is great value in technological development as it relates to the provision of quality education over and above what was intended by SDG 4 in the context of Saudi Arabia. The consistently high mean values also confirm the idea that there is a strong consensus among respondents towards positive impact of technological implementation on an initiative to achieve quality education in the Kingdom.

4.2.2. Results of Survey Items Related to the Second Research Question

The second research question directly eeks to unveil the impact of technology in reducing gender inequality in Saudi Arabia. The focus is to analyse how technological enhancements such as online learning, digital literacy, and AI-models can help in reducing gender inequality in Saudi Arabia, and help in achieving SDG 5, mainly in equal access to education and employment opportunities. The results are summarised in the charts and table below:

Fig 3: Prevalence of Gender Inequality Due to Limited Access to technological Tools

The results presented in Figure 3 shed a worrying light on gender discrimination especially concerning lower opportunities for accessing digital devices. A significant 75.89% of the respondents noted the high level of gender inequality in their country because of limited access to digital tools. This almost entire majority reflects a generally accepted awareness of the current gender difference, in terms of technological utilization in particular. Additionally, the low percentages in the neutral category (10.32%) and rejected category (13.78%) reinforce consensus regarding the issue. This data also correlates directly with this research focusing on SDG 5, which addresses gender equality. The results answered the fundamental need to work toward and, if possible, eliminate gender-specific limitations in accessing these digital tools in order to achieve a more inclusive education environment that ultimately benefits all participants by addressing SDG 5.

Figure 4: Access to Digital Will Facilitate the Elimination of Gender Inequalities, Mainly in Education and Leadership, in Saudi Arabia

The insights that emanate from Figure 4 begin to provide a remarkable perspective on the position of digital tools towards addressing gender bias in Saudi Arabia. An impressive 70.22% of respondents agreed to accept the idea that digital tools can help reduce gender inequalities within the country. This majority represents an overwhelming acceptance of the transformative force that technology provides in solving gender gap phenomena. The slightly lower percentages in the neutral (13.58%) and rejected (16.21%) groups further support prevailing recognition of a positive role played by digital tools availability in reducing gender gaps. This integrates most flawlessly with the core focus of the research, which examines interplay between innovativeness and gender parity, in particular concerning SDG number 5. These results tend to indicate the expanding perception of how technology can act as an instrumental resource for promoting a more gender-sensitive environment, leading towards transforming educational grounds within SDG 5 objectives on achieving gender equality.

Table 3: Summary of Results Related to Research Question Two

Survey Items	Accepted	Neutral	Rejected	Mean	Std Dev
Promoting online learning platforms can provide equal educational opportunities for both male and female students.	95.07%	2.73%	2.20%	5.37	0.42
Enhancing digital literacy programs can empower both genders, bridging the technological gap and promoting equality.	93.05%	1.26%	5.69%	5.08	0.54
Technology initiatives can encourage more women to pursue careers in STEM fields, promoting gender diversity.	96.84	1.05%	2.11%	5.53	0.32

The findings from Table 3 reveal a high consensus among the respondents about the positive effects of technological interventions on gender issues in Saudi Arabia, particularly education and leadership. It is also evident that nearly 95% of the respondents agreed to the fact that advocating for online learning channels can help eliminate gender inequality in terms of offering education to learners. And 93.05% also believe that raising digital literacy programs can make the women and men competence level high, in fact this will remove the technology gap and equalize both of them. Regarding the support of technology initiatives that correspond to attracting more women into STEM-related jobs, this is impressive with an astonishing figure of 96.84% indicating their approval. These results shed light on the wide perception of technology's ability to lessen involuntary gender disparities in higher studies by equalizing enhancement, increasing digital literacy and encouraging a women inclination towards STEM education. The consistently high mean scores across all items (5.37, 5.08, and 5.53) suggest a strong collective perception of technology to advance gender equality in Saudi Arabia.

4.2.3. Results of the Survey Items from Research Question Three

From the results connected to study questions one and two, it has been established that technological innovations play critical in achieving quality education and gender equality in Saudi Arabi. However, there is a need to further explore how technological integration in achieving quality education and gender equality can enhance the realization of Vision 2030 in Saudi Arabia. Only key stakeholders in the education and

economic policies and gender equality advocates in Saudi Arabia who participated in the study, received survey questions in this regard. The results of the four questions are summarised in the following table.

Table 4: Results of the Impacts of Technological Advancement for Achieving SDG 4 and 5 in Realizing Vision 2030

Survey Items	Accepted	Neutral	Rejected	Mean	Std Dev
The strategic integration of technology in educational policies and practices is imperative to foster a dynamic and globally competitive education system, supporting the overarching goals of Vision 2030.	88.46%	4.06%	7.48%	4.88	0.63
Implementing innovative teaching methods, facilitated by technological advancements, is crucial for preparing students with the skills needed for a knowledge-based economy as envisioned in Vision 2030.	79.85%	6.88%	13.27%	4.32	1.14
Encouraging women's participation in STEM fields through technology initiatives aligns with the vision of diversifying the workforce and promoting gender equality outlined in Vision 2030	94.06%	2.84%	3.10%	5.29	0.49
The incorporation of online learning platforms in education is an effective means to enhance accessibility and inclusivity, aligning with the goals of Vision 2030.	86.75%	4.06%	9.19%	4.75	0.72

The results in Table 4 highlight the importance of technological integration within the education system by aligning with the overall objectives as set out in Vision 2030 for Saudi Arabia. It is apparent that the majority of respondents are highly behind the idea that technology should be strategically embedded in every policy and practice being implemented in educational institutions if it has to figure as a new face for education, with an acceptance rate of 88.46 %. In addition, the acceptance of innovative teaching methods based on technological innovations reveals an understanding that students should be equipped with skills needed in the knowledge-based economy – which is inherent to Vision 2030 according to a 79.85% approval rate. The manifestation of support to encourage women's involvement in STEM disciplines through a technological initiative, with an astounding 94.06% acceptance rate, demonstrates the correspondence of such initiatives with Vision2023 agenda focused on diversifying the labor force and achieving gender equality. Secondly, the 86.75% acceptance rate for the incorporation of online learning platforms reflects a general agreement on the viability of such platforms in improving accessibility and inclusivity in education which is a critical part of Vision 2030 goals. These results collectively showcase the significant role of technological integration in attaining the end goals included in Vision 2030, i.e., achieving educational and gender equity objectives in Saudi Arabia.

4.3. Discussion of Key Findings and Answers to the Research Questions

. There are key findings in this study that are significant in answering the research questions. Figure 1 reveals a significant level of access to quality education in Saudi Arabia. The reported 55.68% of respondents with a full degree of access sets aside the focus on education requirements and the promise for their progress highlighted in Saudi Vision 2030 (Albassam, 2021). This is supported by the research findings of Mitchell and Alfuraih (2018), which claim that such positive development was provided for through education

towards achieving the aspiration in the national transformation programme. Nevertheless, the 18.21% that reported limited access shows that challenges persist, confirming concerns by Allmnakrah and Evers (2020) about the need for a paradigm shift in radically changing Saudi education. Figure 2 shows that many digital tools are used, with about 56.73% using them for teaching This aligns with the results of Akhlag and Sabha (2023) and Alessa et al. (2022), which emphasise the advantages of technology-mediated education in Saudi Arabia Moreover, 17.15% of teachers who used digital tools to promote learning indicate a great leaning towards adopting technology-enhanced education approaches as promoted by Vision 2030 (Al-Zohbi & Pilotti, 2023). Yet the 13.48% that are not sure of integrating digital tools into their teaching reflect educators' need to address influential challenges, such as those observed by Saleh and Adly (2024) regarding the role of higher education in promoting essential sustainable development goals.

Table 2 also confirms the positive reception of technology-based integration in education, with acceptance rates reported ranging from 84.95% to up to 91.64%. These high agreement percentages confirm the claims of Ahmed et al. (2024), who emphasise the importance of technological progress in attaining sustainable development goals. The correlation with the goals of Vision 2030 is clear, as highlighted by Alkhayyat et al. (2021) and Aldegether (2023), who talk about the SDGs' representation within Saudi Arabia's vision. Simply put, the aggregate results lead to a strong association between the findings of this present study and the main objectives that Saudi Vision 2030 possesses. The willingness among students and teachers for a positive attitude towards digital tools, particularly towards technological development, testifies to the general reform of education that is described in the vision (Gök & Gök, 2023). The findings, bolstered by different works by scholars, conclude an optimistic trend with a view to attaining the objectives of the vision on quality education and technological improvements in Saudi Arabia.

As illustrated in Figure 3, the respondents offer a subtle interpretation of the gender inequality that is evident in Saudi Arabia. From the data, it can be revealed that out of all participants, 75.89% agreed with the thought that limited access to digital tools leads to gender inequality. This is in line with the already published literature, as Syed, Ali, and Hennekam (2018) have adequately explained gender inequality when it comes to employment within the Saudi context. The rate of acceptance is high and represents the persistent challenges women face in different areas. Nevertheless, despite the 13.78% who rejected this idea, there remains a slice of society that does not conform to gender norms in the traditional sense. This dissenting opinion may reflect changing social attitudes, in concordance with Eum's (2019) considerations concerning the transformative nature of socio-cultural changes, especially in the age of Saudi Vision 2030.

Looking into Figure 4, the data reveals a more positive picture as 70.22% of participants showed assurance in the ability of digital tools to eliminate gender disparities. This figure is echoed by the holistic approach proposed from the Qwaider et al. (2023) that highlights the role of using GIS in monitoring progress towards SDGs, including gender equality within Saudi Arabia It is in the light of this assessment that the rate of rejection, standing at 16.21%, highlights the doubt lingering among an element of society about the transformative tastefulness provided by technology around gender gaps. The emergence of such scepticism can be attributed to the complex challenges that are not well discussed by Shaqra (2024), accentuating the need for an intricate approach when using technology to address gender inequality.

Table 3 provides a more detailed picture of the items regarding gender equality and technology by including data from questionnaires focused on these two topics. The strong agreement values for all items, from 88.46% to 96.84%, show the consensus built in favour of a technological role in advancing gender equality. This data supports the perceptive findings of El Hassan (2024), who highlights the importance of addressing missing data in SDG 5 on the Arab Region. Additionally, the mean values above 5 for all items highlight the supportive aspect of technological initiatives in promoting gender diversity. This corresponds with Bastiana et al.'s (2023) research on gender equality and women's empowerment in the global sustainable

development goals.

Overall, the aggregate results from Fig. 3, Fig. 4, and Table 3 highlight the contradictory frame behind gender inequality in Saudi Arabia. As the acceptance rates presented in Fig. 3 show, most people are aware of the issues regarding gender inequality prevalent in different spheres of life. This reveals how this is corroborated with higher-level discussions of the critical need for structural shifts that are identified by Parveen (2023) in explaining Saudi women's participation and leadership. At the same time, the high correspondence with the positive effect of technology on gender equality in Fig. 4 and Table 3 combined creates a favourable forecast. This is in line with the overarching objectives of SDG 5 and echoes the aspirations set out by Saudi Vision 2030, as analysed in Alshuwaikhat & Mohammed (2017), which emphasise sustainability's central function within national development visions.

With regard to the strategic implementation of technology in educational policies and practices as a pre-requisite for building a dynamic education system capable of competing at the international level in accordance with Vision 2030, Table 4 details participants' views on this. The high acceptance score of 88.46% on this item clearly demonstrates the common awareness about how technology can transform education. This is in light of Mitchell and Alfuraih's (2018) views on how to reach the goals that are propounded in the National Transformation Programme 2020 aligned with Saudi Vision 2030 through education. The mean score of 4.88 denotes a high degree of consensus, which indicates how much technological integration is key to achieving the goals and objectives associated with Vision 2030.

This further emphasises the fact that participants believe that specific aspects of Vision 2030 can be realised through technology initiatives. The strongest support for this survey item was an affirmative response that there are efforts in STEM fields to encourage women's participation through technology initiatives, which are in line with and support the vision of workforce diversity and gender and have received a whopping 94.06% acceptance rate. This correlates with Alessa, Shalhoob, and Almugarry's (2022) analysis of Saudi women in the economy from a perspective of empowerment based on Saudi Vision 2030, pointing out the complex nature of initiatives that need to be implemented. The mean of 5.29 demonstrates considerable consensus suggesting a common vision regarding the integrated nature of technology and its enhancing role in promoting gender diversity and inclusive economic development, as highlighted by Saleh and Malibari (2021), which address gender disparities. The results, as summarised in Table 4, are extensively supported by a number of references such as AlArjani et al. (2021) which pertain to the idea that people collectively believe that technology is a saving force in achieving the intended goals of Vision 2030, whose dimensions include different aspects of education and social-economic development.

5. **Conclusions and Implications**

This research provides an insight into the transformative nature that technological advancements have in promoting quality education and ensuring gender equality in Saudi Arabia, intersecting with vision 2030 aspirations. Digital literacy, online learning, and Artificial Intelligence were identified as fundamental strategies aimed at improving learning opportunities and quality. The collective understanding that technology is important for the shaping of a globally competitive education system can be evidenced by the high acceptability inherent in all the survey items related to technological integration. The technological initiatives help to enhance the power of individuals and go a long way into breaking gender barriers, improving diversity along with supporting Vision 2030's objectives.

The results of the study provide insight into gender dynamics in Saudi Arabia, highlighting gendered inequalities and how tech interventions can potentially alleviate them. However, an important issue that the survey answers indicate is awareness that gender inequality exists due to technology acquisition. Nevertheless, the respondents appeared to be confident that if appropriate technology strategies were put

into use in an intelligent manner, those inequities could greatly be reduced. The findings imply that the Kingdom stands ready to use technological developments not only for educational improvements but also in terms of using technology as a mechanism for societal change tending towards more progressive gender depictions.

The study findings shed more light on the link between technology development and the achievement of Vision 2030. The participants commonly understood that the key role of technology in fulfilling the vision was to deliver measurable results, such as creating a competitive education system or ensuring gender diversity among STEM significantly. The high scores for survey items describing these facets reflect a common understanding of technology as an agent of systemic socioeconomic change envisioned by Vision 2030. These results correspond with a wider discussion on technology role in national development propositions, as appears in the Saudi Arabian Vision 2030.

The implications of this study go beyond academic literature to shape policy and practice. Upon identification of support for technology integration, policymakers can use the discovery to design and implement policies that promote quality education and viability in schools while attending to gender gaps. The research underlines the benefits of targeted interventions in digital literacy programmes, online learning spaces, and AI models. In addition, the results highlight the importance of ongoing investment in gender-sensitive technology innovations aimed at maintaining momentum toward Vision 2030's goals. With technological advancement, future research would be interested in identifying emerging trends and how they would impact education and gender equality, to keep Saudi Arabia at the zenith of using modern innovations for societal development. This research plays a pertinent role in the current debate on how technology determines the path that Saudi Arabia's education takes to shape gender features.

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Authorship and Level of Contribution

Both authors have participated substantially in the manuscript's conceptualization, drafting, revision, and final approval.

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