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"Current Issues, Trends, and New Ideas in Education"

Optimizing STEM Education via e-Learning: Addressing Challenges and Strategic Planning for Graduate Employment Outcomes

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Abstract

This study fills a significant vacuum in the literature and offers insightful information, especially pertinent to the Arabic and Gulf areas. In support of the socioeconomic development and diversification initiatives in these areas, it encourages the creation of educational policies and practices that can improve student job chances. Educators and policymakers play a crucial role in implementing these recommendations, ensuring that effective STEM education equips future generations with the knowledge and skills to navigate and secure digital environments, mitigating risks posed by cyber threats. By preparing students to excel in STEM disciplines, they ensure that the future workforce is ready to contribute to and shape a safer, more innovative future. Today's STEM workforce requires continuous education to stay abreast of advancements in STEM fields. Online delivery of STEM courses enables higher education institutions to collaborate effectively with industry partners, minimizing disruptions to productivity. This study aims to evaluate the enhancement of students' STEM knowledge and skills through e-learning platforms using Structural Equation Modeling (SEM). The dataset comprises 212 participants and 15 indicators, analyzed using measurement and structural models. Results indicate significant findings supporting hypotheses: E-Learning (E.L.) improving Student employment opportunities (SEO) ($B=0.539$, $t=8.884$, $p=0.000$) and E.L. improving STEM ($B=0.465$, $t=8.849$, $p=0.000$), validating H1 and H2, respectively. H3 explores how possessing STEM knowledge mediates E-Learning's impact on SEO, revealing a notable indirect relationship ($B=0.082$, $t=2.303$, $p=0.021$). Integrating E-Learning with STEM fosters a robust digital infrastructure, addressing talent shortages and improving human resource management amidst global technological advances. Online STEM courses are increasingly recognized as a viable solution to national STEM challenges, overcoming traditional adoption barriers.

Keywords:

Student Employment Opportunities (SEO);
E-Learning;
STEM;
Higher Education.

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1- Introduction

The distribution of education has been completely transformed due to the fast development of technology, particularly in science, technology, engineering, and mathematics (STEM). As a result of providing students with learning experiences that are both interactive and adaptable, e-learning platforms are revolutionizing how students engage with STEM courses [1]. Using these platforms presents a chance to overcome conventional educational hurdles, particularly in countries where professions in STEM fields are essential to the growth of the economically developing region. The urgent need to strengthen STEM education is a direct result of Oman and other Gulf nations needing more graduates who are competent in STEM fields. Utilizing e-learning in conjunction with STEM topics has the potential to assist in bridging this gap by increasing the employability of students, which is a significant problem in these areas. However, despite the growing popularity of online education, there are still a lot of obstacles to overcome, particularly when it

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comes to bringing educational outcomes in line with the requirements of the job market [2]. The education of students in the STEM fields, which is essential for the development of analytical thinking, problem-solving, and technical abilities, is of critical importance in fulfilling the demands of the workforce in the 21st century. Even though digital education is becoming increasingly popular worldwide, there is a lack of study on how these learning methods influence student employment in the Gulf and Arab countries [3]. This study aims to assess the efficacy of e-learning in strengthening the career opportunities available to students by increasing their knowledge of STEM subjects. Today's students increasingly engage with interactive platforms as technology advances, transforming learning methods [4]. Educators embracing eLearning in classrooms cater to these tech-savvy generations, providing hands-on, interactive experiences that demystify complex STEM concepts traditionally seen as abstract [5]. This approach enhances understanding and boosts learning outcomes significantly [6].

Moreover, eLearning levels the educational playing field, offering accessibility from any location with internet access [7]. It inspires independent study and prepares students for future STEM careers, addressing a significant gap between available jobs and qualified candidates [8]. STEM education integrates diverse subjects like science and mathematics, fostering problem-solving skills, analytical thinking, creativity, and teamwork—essential for thriving in collaborative workplaces and tackling pressing issues like cybersecurity [9]. Several barriers seen to hamper its effectiveness and success globally beset e-learning, which is under growing scrutiny. Even with exponential technological advances, academic groups face many challenges, particularly in the effective and efficient use of e-learning to facilitate STEM education. STEM is an acronym used to illustrate science, technology, engineering, and mathematics classes. Each of these categories has many subcategories and disciplines. STEM is used primarily to address a concern for the lack of qualified graduates for STEM careers, including Gulf regions, the need to enhance curriculums in the Gulf regions, and, in particular, Oman, as well as the demand for qualified instructors in these fields.

In recent years, with the advancement of computer technology, the e-learning movement has received an unprecedented boost [10]. Using the computer and the internet, e-learning has made learning resources convenient and flexible [11]. E-learning is often used in open and flexible learning disclosures, particularly about new information technology (NIT) or information and communication technology (ICT) appeal. E-learning or electronic education refers to the use of communications and information technologies to create, deliver, and use learning results, generally referring to using open, distance, or network technologies as the media to complete a series of learning goals and relevant learning services [12]. Manufacturers, teachers, learners, management personnel, and even education institutions use the technology to establish teaching, learning, curriculum, and support services [13].

This work addresses a significant gap in the literature by integrating three variables: E-Learning (E.L.) as an independent variable, Science, Technology, Engineering, and Mathematics (STEM) as both an independent variable and a mediator, and Student Employment Opportunities (SEO) as a dependent variable. The relationship between these variables, with STEM acting as a mediator has not been discussed in existing literature. Previous studies have primarily focused on educational performance using either E-Learning or STEM independently without exploring their combined impact on student employment opportunities through a mediating framework.

1-1- Why the Arabic and Gulf Areas Might Benefit Significantly from this Study

- Technology Advancement at a Rapid Pace: The Arabic and Gulf areas are experiencing a major digital transition and technological breakthroughs. In these areas, e-learning is becoming increasingly important in improving the quality and accessibility of education. Effective educational policies and practices must consider STEM education when analyzing how E-Learning affects student career chances.
- Economic Diversification: Several Gulf nations are actively working to move away from economies that rely heavily on oil. One of the most essential strategies in these endeavors is to encourage STEM education to develop a workforce capable of fostering innovation and launching new businesses. Through an analysis of the relationship between STEM, employment, and e-learning, this study offers insights that can help these national goals.
- Youth Unemployment: Youth unemployment is a severe problem in many Arab and Gulf nations. This study tackles a significant socioeconomic issue by investigating how STEM education and e-learning might improve student job chances. To lower unemployment rates, politicians and educational institutions should use this data as a guide for creating programs that better prepare students for the workforce.
- Cultural Relevance: Studies that consider the particular educational dynamics of the Arabic and Gulf areas are required due to their distinct cultural environment. The study closes a significant vacuum in the literature by concentrating on these areas. It provides culturally relevant insights that students may use to better their educational performance and job prospects.
- Future Workforce Requirements: The need for STEM abilities increases as the global labor market changes. To ensure that educational practices align with the labor market's future demands, this study looks at STEM's mediating function in the link between career chances and e-learning. Sustaining the competitive advantage of the Gulf economies in the global arena requires this alignment.

1-2- Statement of the Problem

The need for more skilled graduates in STEM subjects, essential for economic diversification and technical growth, is a significant worry in Oman and many other Gulf nations. This is because STEM fields are vital in driving technological advancement. The traditional methods of instruction are frequently insufficient to fulfill the ever-changing requirements of the job market, even though STEM education is widely acknowledged as a potential answer. However, the influence that e-learning has on students' employability in these locations is still poorly understood, even though it has emerged as a promising instrument to improve STEM education. This study investigates how e-learning might enhance STEM education and, as a result, the career prospects available to graduates to address this issue.

1-3- Research Gap

Studies that concentrate on the Arab and Gulf areas, particularly regarding STEM education, are few. This is even though there is substantial research on using e-learning to enhance educational results worldwide. In the past, researchers have investigated the role of either e-learning or STEM education on its own. Still, they have seldom investigated the intersection of the two concerning career chances. Furthermore, an absence of research uses a Structural Equation Modeling (SEM) methodology to comprehend STEM education's role as a mediator between e-learning and student employment.

1-4- Contribution and Significance of the Study

This study makes several significant contributions. This article addresses a vacuum in the existing body of research by concentrating on the role that e-learning plays in improving STEM education and its influence on student employment in the Gulf area, notably in Kuwait. The second contribution is that it offers empirical data through structural equation modeling (SEM) to establish the mediating influence of STEM knowledge in enhancing job chances through e-learning. In conclusion, the research provides valuable information for decision-makers and educators in the region, indicating that incorporating e-learning into STEM curricula can dramatically improve graduates' employability. This effort is essential for solving skill shortages in the area and for shaping future educational policy by providing valuable information.

To summarize, this research addresses a significant gap in the existing body of knowledge and provides valuable insights particularly relevant to the Arabic and Gulf regions. It promotes the development of educational practices and policies to enhance students' job prospects, thereby supporting socioeconomic growth and diversification efforts in these areas. The proposed framework offers strategic guidance for integrating E-Learning and STEM education to improve graduate employment rates.

2- Literature Review

To maintain resources and avoid depletion, collective effort is required to address sustainability, a worldwide concern. Traditional educational practices put pressure on resources in developing nations, notably in colleges located in Arab countries. However, the transition to e-learning, as investigated in this study, presents a promising step toward digital transformation. It addresses issues and provides a strategic roadmap to promote sustainability by aligning educational practices with technology developments and protecting university and national resources [14]. Action research was used to construct a blended faculty learning community that supports professional growth and community building for STEM professors and graduate students. The program taught STEM-specific online pedagogy, answering requests for better course design and faculty assistance. Participants developed confidence in online teaching, valued community interaction, and improved their student engagement tactics [15]. This study developed a STEM-based e-learning module on sound waves to enhance collaboration skills in high school physics. Tested with 30 students, it achieved 100% feasibility and acceptability, showing it is effective and suitable for improving collaboration in physics learning [16]. Traditional teaching techniques in MENA have changed to include ICT resources such as LMS, particularly during COVID-19. This chapter investigates the transition from social media as a networking tool to an educational resource, examining the benefits and drawbacks of learning objectives [17]. The global economy feeds on information and creativity in the twenty-first century, necessitating new educational paradigms. This study investigates the relevance of 21st-century skills in Gulf Cooperation Council (GCC) nations, focusing on difficulties such as curriculum alignment, teacher training, and flexible educational policies for skill development [18].

A Ministerial Committee for Higher Education, a pivotal entity created in 1996 to supervise educational cooperation, plays a crucial role in developing the educational sector after most GCC nations had established Ministries of Higher Education. Each country made its requirements based on its academic objectives [19]. The GCC Charter promotes collaboration in several areas, including education, the economy, trade, culture, and health, by strongly emphasizing coordination, integration, and unity among the six nations. By partnering with the corporate sector and forming joint enterprises, it also seeks to promote scientific and technical advancement. The GCC nations have seen substantial social and economic transformations, including increased investment in the education sector, promotion of gender equality, and economic diversification. The 2021 report from the Regional Center for Educational Planning describes how education has developed in the GCC States [20-22]. With a CAGR of over 11%, the e-learning market in the GCC nations is expected to expand by $569.04 million between 2021 and 2025. The main forces behind this expansion include gamification, changing teaching strategies, and educational institutions' growing use of the I.B. curriculum. The industry is helped by the increasing use of cloud computing, favorable government regulations, and the vital need for skill-based training [23, 24].

The study thoroughly examines the market's size, trends, growth factors, obstacles, and vendor landscape. It covers around 25 companies, such as Pearson Plc, Administrate Ltd., and Coursera Inc. It provides information on impending trends and difficulties to assist businesses in planning and grabbing expansion chances [19]. The Gulf Cooperation Council (GCC) region is anticipated to see economic growth of 2.8% in 2024, rising to 4.7% in 2025, according to the spring 2024 Gulf Economic Update (GEU) [25]. This growth is bolstered by expected increases in oil production as OPEC+ eases production limits and by the substantial expansion of the non-oil economy. Despite these positive prospects, hydrocarbon revenues will continue to significantly influence fiscal and external balances, with a projected budgetary surplus of 0.1% of GDP and a current account surplus of 7.5% in 2024.

The GEU underscores the critical role of education quality in sustaining long-term economic growth across GCC countries. The report's Special Focus, "Unlocking Prosperity: Transforming Education for Economic Breakthrough in the GCC," examines learning outcomes and suggests strategies to enhance educational effectiveness. Optimizing human capital's potential emphasizes developing fundamental skills early, improving instructional strategies, and making well-informed policy decisions based on thorough learning assessments [21, 22].

Bahrain: The country's economy is expected to grow by 3.5% in 2024, driven by increased oil production and ongoing structural changes. The non-oil sector, fueled by recovery in tourism, services, and infrastructure projects, is expected to grow by nearly 4%, overshadowing the hydrocarbon sector's modest 1.3% expansion.

Kuwait: Kuwait's economy is set to recover with a growth rate of 2.8% in 2024, driven by expansive fiscal policies, increased oil production, and output from the Al Zour refinery. Despite a projected 2.1% growth in the non-oil sector, elevated interest rates may limit domestic consumption. Political uncertainties could further delay infrastructure projects and reform initiatives.

Oman: anticipates favorable economic growth of 1.5% in 2024, supported by rising gas production and diversification efforts, including investments in renewable energy and SMEs. Further acceleration is expected over the medium term, with inflation converging to 2%.

Qatar: Qatar's real GDP growth is expected to modestly strengthen to 2.1% in 2024, driven by robust 2.4% growth in the non-oil sector, particularly in tourism. The hydrocarbon sector, however, faces constraints, with anticipated growth of 1.6% until a significant boost from the North Field expansion project in late 2025.

Saudi Arabia: After a contraction in 2023, Saudi Arabia forecasts 2.5% GDP growth in 2024, led by a robust 4.8% expansion in non-oil private sectors. Despite an expected 0.8% contraction in oil GDP due to production cuts, the aggressive ramp-up in oil output in 2025 projects 5.9% overall GDP growth.

United Arab Emirates: The UAE projects accelerated GDP growth of 3.9% in 2024, driven by OPEC+'s planned oil production hike and global economic recovery. Oil output is expected to rise by 5.8%, while a resilient non-oil sector, including tourism, real estate, construction, transportation, and manufacturing, is set to expand by 3.2%.

Despite the GCC governments' attempts, the education sector faces formidable obstacles. This section examines the GCC nations' results in the three primary international assessments—PISA, TIMSS, and PIRLS [26, 28].

2-1- .International Student Assessment Program (PISA)

The OECD administers PISA, an assessment program that gauges 15-year-old pupils' academic achievement in reading, science, and arithmetic. Established in 2000, PISA has assisted nations in improving their approaches to education every three years. Out of the six GCC nations, only Saudi Arabia, the United Arab Emirates, and Qatar have participated in PISA. Saudi Arabia placed 74th in math, 72nd in science, and 66th in reading on the PISA 2018 results. Up to science, the UAE came up at fifty-ninth, 47th in reading, and 51st in math. Qatar came in at 61st, 58th, and 61st in reading, science, and math, respectively. Since 2009, the UAE's performance in mathematics has been on the rise despite a bit of a fall in science and reading ratings. Conversely, Qatar has steadily improved in all three subjects since 2006, as demonstrated in Table 1.

Table 1. PISA 2018 Results of Selected Countries (Source: PISA 2018 Insights and Interpretations (Schleicher, 2019))

Country	Mathematics Score	Mathematics Rank	Science Score	Science Rank	Reading Score	Reading Rank
China	591	1	590	1	555	1
United Kingdom	502	17	505	15	504	15
Germany	500	20	503	16	498	21
United States	478	38	502	19	505	13
France	495	26	493	25	493	23
OECD Average	489		489		487	
Turkey	454	43	468	40	466	40
United Arab Emirates	435	51	434	50	432	47
Jordan	400	65	429	52	419	56
Qatar	414	61	419	58	407	61
Saudi Arabia	373	74	386	72	399	66
Lebanon	393	69	384	73	353	75
Morocco	368	75	377	75	359	74

2-2- Trends in International Mathematics and Science Study (TIMSS)

The International Association for the Evaluation of Educational Achievement (IEA) administers the TIMSS, an assessment tool designed to gauge fourth- and eighth-grade students' mathematical and scientific proficiency every four years. Unlike PISA, all six GCC nations participated in the most recent 2019 cycle. All GCC nations, meanwhile, performed worse than the global average (Mullis et al., 2019). The GCC nations' mean scores and ranks are shown in Table 2, together with the worldwide average and Singapore, Chinese Taipei, Russia, the U.S., and England. The trends in the assessed categories for the GCC nations over time are shown in Graphs 5-8.

Table 2. TIMSS 2019 Results of Selected Countries (Source: PISA 2018 Insights and Interpretations (Schleicher, 2019))

Country	Fourth Grade Mathematics Score	Fourth Grade Mathematics Rank	Fourth Grade Science Score	Fourth Grade Science Rank	Eighth Grade Mathematics Score	Eighth Grade Mathematics Rank	Eighth Grade Science Score	Eighth Grade Science Rank
Singapore	625	1	595	1	616	1	608	1
Chinese Taipei	559	4	558	5	612	2	574	2
Russia	567	6	567	3	543	6	543	5
United States	535	15	539	8	515	12	522	11
England	556	8	537	11	515	12	517	14
International Average	500		500		500		500	
Bahrain	480	44	493	48	481	24	486	22
United Arab Emirates	481	43	473	56	473	26	473	26
Qatar	449	48	439	56	403	50	475	25
Oman	431	52	457	43	403	50	457	30
Kuwait	383	54	392	54	404	35	444	34
Saudi Arabia	398	53	402	53	394	37	431	35

2-3- Progress in International Reading Literacy Study (PIRLS)

The IEA uses PIRLS to assess fourth graders' reading comprehension and achievement every five years. As with TIMSS, the scores of the six GCC nations were below the global average. Table 3 shows the average scores of the GCC nations throughout several PIRLS cycles.

This study systematically reviews STEM education in the GCC, a previously unexplored topic. Amid declining aspirations and underachievement of GCC youth in STEM fields, as evidenced by TIMSS and PISA assessments, the focus on STEM education for sustainable development is growing [29]. Research in this area is vital for informing educational policies in GCC countries, aligning with their strategic plans to build a skilled workforce essential for a knowledge-based economy. Globally, the demand for a creative, innovative, and highly trained workforce is increasing, with STEM professions crucial to sustainable growth and prosperity. This study identifies challenges in recruiting and retaining students in STEM disciplines, highlighting key barriers that need addressing. The findings can inform public policy and professional practices related to STEM education. Motivated by the GCC region's emphasis on STEM despite generally poor international test performance, this study contributes to research on STEM education in the GCC (Figure

1). While Western research on STEM is extensive, the topic remains under-studied in the Arab world, particularly in the GCC. By reviewing STEM education research in the GCC, this paper offers a non-Western perspective, providing insights into general trends and barriers in the region and comparing them with factors influencing STEM participation in the U.S. and Western Europe.

Table 3. PIRLS Results of GCC Countries

Country	2001	2006	2011	2016
International Average	500	500	500	500
United Arab Emirates	N/A	N/A	439	450
Bahrain	N/A	N/A	N/A	446
Qatar	N/A	353	425	442
Saudi Arabia	N/A	N/A	430	430
Oman	N/A	N/A	391	418
Kuwait	396	330	N/A	393

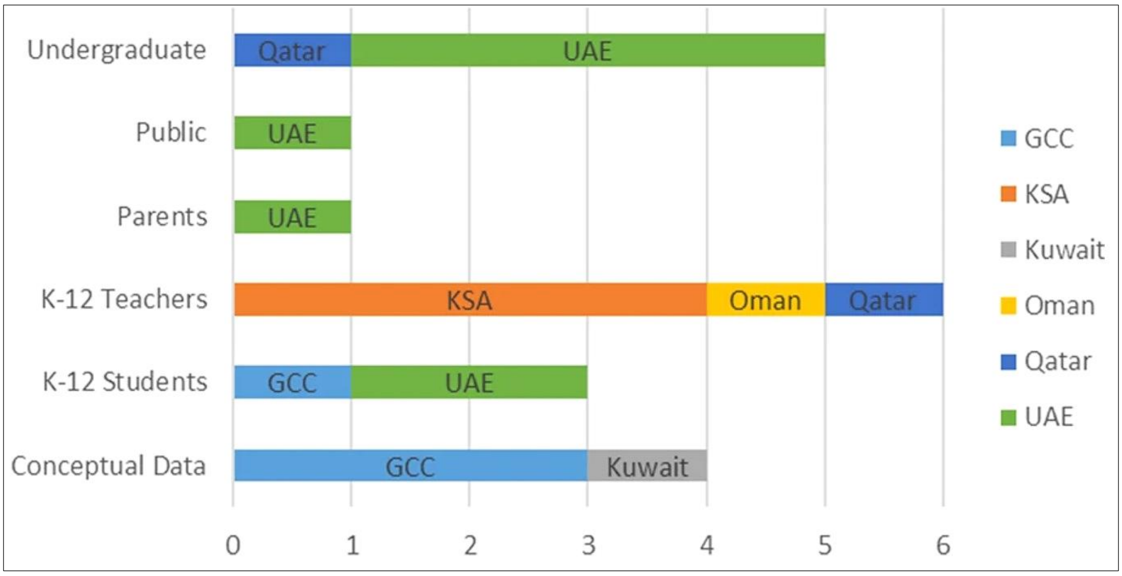

Figure 1. Statistics for STEM education in the GCC [29]

The research reviewed in this study provides valuable insights into STEM education in the GCC, but several areas require further investigation. Critical shortcomings identified include the underrepresentation of women, significant gender disparities, and methodological issues, such as a lack of comparative or longitudinal studies. Research shows that constructive teaching methods positively influence teachers' attitudes toward science, highlighting the need for targeted professional development. Gender disparities and stereotypes are prominent in the reviewed studies, with significant cross-gender effects on students' perceptions. Addressing gender influences on STEM education enrollment and achievement is critical for improving student recruitment in the GCC. Studies also show that non-cognitive factors are more important than cognitive factors in predicting academic success, emphasizing the need for a holistic approach to STEM education. Relationships between citizenship status, education, and labor force participation in the GCC also indicate broader socioeconomic factors influencing STEM education outcomes.

Online STEM courses also impact global scalability by removing geographical constraints to in-person instruction [30]. With its 26th-place ranking in STEM education, the United States struggles to differentiate itself in the global economy, where innovation mainly determines success. Employers estimate that fewer than 50% of STEM graduates graduate with the abilities necessary to obtain employment in the market, even though today's educators believe their graduates possess 70% of those competencies (Figures 2 and 3). Industry and higher education concur that there is a significant shortage in our workforce, notwithstanding differing numbers [31].

The COVID-19 pandemic catalyzed a shift in education to virtual learning, impacting active student engagement. We implemented five online STEM programs involving 140 students, 16 undergraduate mentors, and 8 STEM professionals. Our study highlights an effective interactive model using digital tools for student engagement, retention, and STEM innovation [7]. The U.N.'s 2030 agenda prioritizes inclusive, equitable, quality education. Digital technologies detect emissions, enhance energy efficiency, and reduce pollution. The COVID-19 pandemic has institutionalized their role, transforming education into active learning through tools like software, iPads, and E-books, fostering research interest [33].

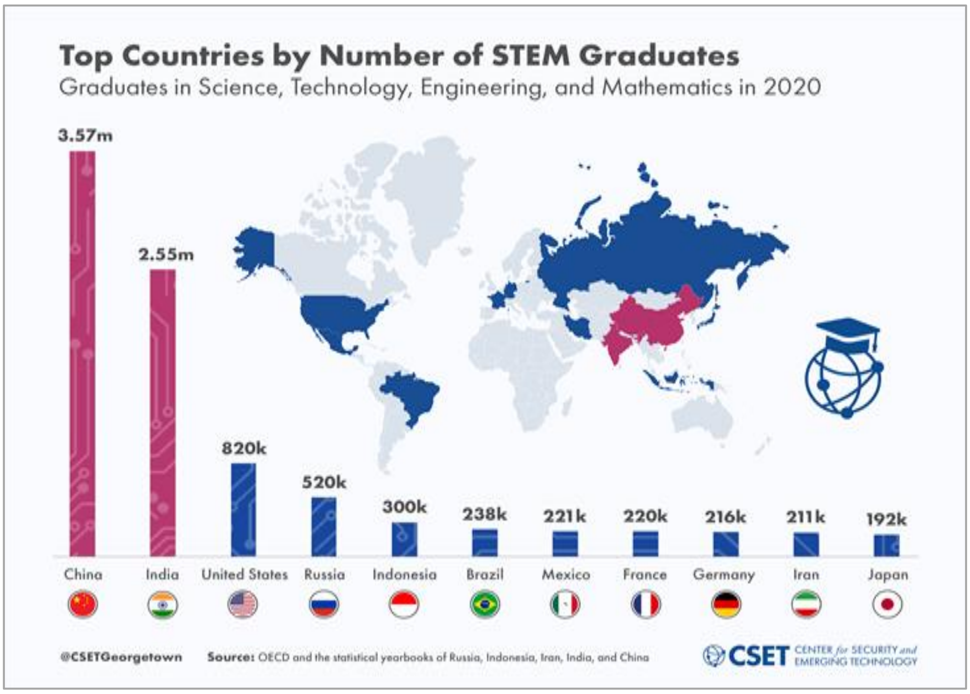

Figure 2. **Top nations with the most STEM graduates in 2020 (The original graph was made by [32])**

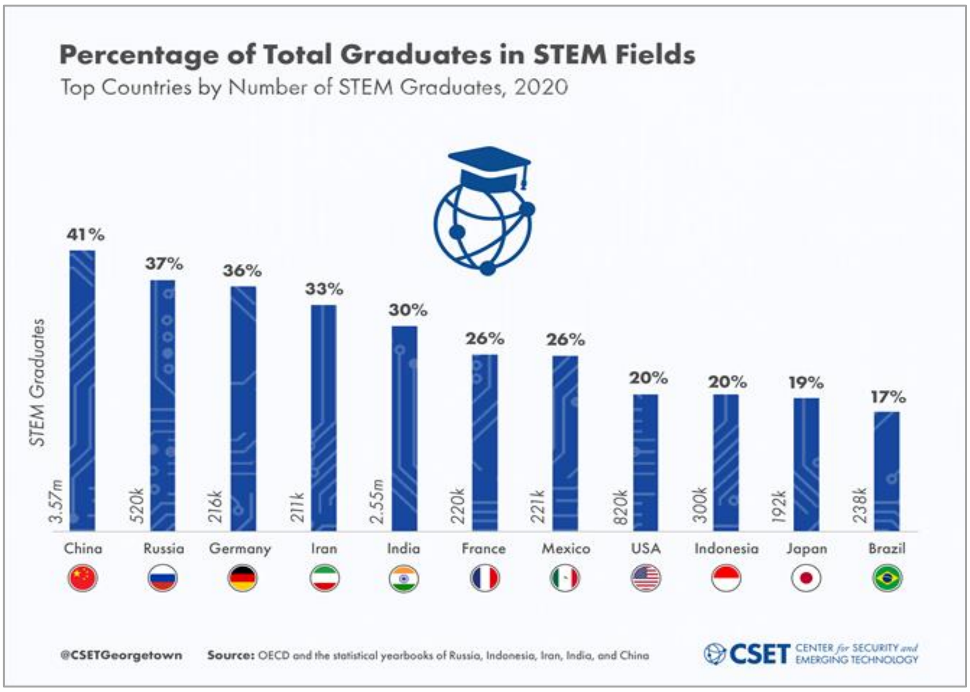

Figure 3. **The proportion of all graduates in STEM fields (The original graph was made by [32])**

This systematic literature review examines research on STEM education in the GCC, highlighting demographic, geographic, methodological, and thematic variations across studies. Despite these differences, the review identifies critical gaps, such as the underrepresentation of women, institutional barriers to STEM enrollment, and the influence of high school education on students' aspirations. Addressing these gaps is crucial for policy-making and human capacity building in the GCC, supporting the transition to a knowledge-based economy. The review also underscores the need for more research on the cultural, contextual, and school-level factors that impact STEM participation, aligning with international findings on STEM education challenges.

Over the years, TIMSS and PISA, two international evaluations, have come under heavy fire. Critics contend that the assessments emphasize economic rather than educational criteria and that the research's restricted measuring scopes lead to its limited findings [34]. Furthermore, they draw attention to the fact that these studies frequently undervalue the significance of student participation and optimistic learning attitudes for future performance. All six GCC states, however, are actively attempting to raise their ratings in these evaluations.

In summary, the GCC nations have seen tremendous development in the education sector, recovering well from the COVID-19 epidemic and forecasting 5.9% growth in the entire economy in 2022. They consistently devote significant amounts of their government budgets to improving education, which raises student enrollment and yields educational advantages. The GCC governments work to promote technology, international standing, and academic standards as part of their national aspirations.

Existing research has focused on either E-Learning or STEM in isolation, neglecting their combined effect on employment opportunities. The proposed framework is especially relevant for the Arabic and Gulf regions undergoing rapid technological advancement and economic diversification. It offers crucial insights for developing educational policies to enhance job prospects, address youth unemployment, and align education with future workforce demands.

3- Research Methodology

The proposed work utilizes the 'PLS-Sem' Methodology to achieve the main objective proposed in this work and to evaluate the developed hypothesis. In this study, we address the effect of E-Learning on utilizing STEM attributes and skills. The research aims to answer the following question:

3-1- Research Questions

How does e-learning improve students' acquisition of the knowledge and skills required for STEM education?

Objectives:

To analyze the effectiveness of e-learning platforms in enhancing students' STEM knowledge and skills.

Hypotheses:

H1: The effectiveness of strategic planning in educational institutions is significantly enhanced by E-Learning.

H2: In higher education, using E-Learning improves students' STEM knowledge and skills, leading to better employment opportunities.

H3: Possessing STEM knowledge has a significant positive relationship with E-Learning and partially mediates its impact on strategic planning, thereby increasing graduate employment rates.

Figure 4 demonstrates the proposed conceptual framework based on the objective and hypothesis developed in this work.

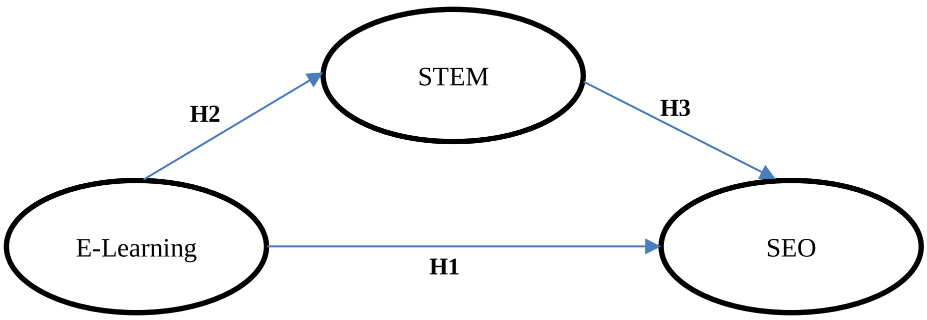

Figure 4. The proposed conceptual framework

In Figure 4:

E.L.: E-Learning (E.L.) (Independent Variables (I.V.s).

STEM: Science, Technology, Engineering, and Mathematics (STEM) (Independent Variables (I.V.s) & Mediator).

SEO: Student employment opportunities (SEO), Dependent Variable (DV).

3-2- Data Collection

A total of 411 email requests were sent out with a survey of 4 demographics and 15 structured questions. A non-probability sampling approach was employed, using convenience sampling to gather data from professors. The questionnaire was developed with two independent variables, encompassing ten questions, and one dependent variable with five questions, based on a thorough review of relevant literature and establishing study objectives. Experts reviewed the questions to ensure clarity. The e-questionnaire was distributed via Google Drive. By June 23, 2024, 214 out of the 411 participants had responded. Based on prior research, this sample size was deemed appropriate for analysis considering the information in previous studies [35-38].

3-3- Cleaning Data

First, we verified that the dataset's minimum and maximum values on the five-point Likert scale (1 to 5) were accurate. Next, we examined missing data from the required fields and searched for anomalies but found none. Finally, we used standard deviation (S.D.) to assess unusual responses. There were two records with an SD of 0, which we removed from the collected data. The dataset now consists of 212 records. According to Figure 5, the descriptive statistics indicate that the data is appropriate for analysis based on previous research, with SD-Min = 0.258 and SD-Max = 1.740 [35-38]. The suggested threshold for the standard deviation (STDEV) is over 0.25.

Name	No.	Type	Missing	Mean	Median	Scale min	Scale max	Observed	Observed	Standard (	Excess kur	Skewness	Cramér-vc
Major	1	TEXT	0	3	3	3	3	3	3	0	NaN	NaN	0.004
Nationality	2	TEXT	0	0	0	3	3	3	3	0	0	0	0
Age	3	MET	0	39.099	37	3	78	3	78	14.999	-0.047	0.414	0
Experince	4	TEXT	0	0	0	3	3	3	3	0	0	0	0
1.E-Learning(EL-1)	5	MET	0	3.646	4	1	5	1	5	1.304	-0.48	-0.774	0
2.E-Learning(EL-2)	6	MET	0	3.675	4	1	5	1	5	1.252	-0.464	-0.742	0
3.E-Learning(EL-3)	7	MET	0	3.637	4	1	5	1	5	1.298	-0.83	-0.591	0
4.E-Learning(EL-4)	8	MET	0	3.396	4	1	5	1	5	1.207	-0.711	-0.46	0
5.E-Learning(EL-5)	9	MET	0	3.618	4	1	5	1	5	1.095	0.028	-0.76	0
STEM(S-2)	10	MET	0	3.92	4	1	5	1	5	1.018	-0.215	-0.73	0
7.STEM(S-1)	11	MET	0	3.731	4	1	5	1	5	0.999	-0.096	-0.61	0
8.STEM(S-3)	12	MET	0	3.939	4	1	5	1	5	0.864	0.399	-0.677	0
9.STEM(S-4)	13	MET	0	3.745	4	1	5	1	5	1.056	-0.326	-0.565	0
10.STEM(S-5)	14	MET	0	3.939	4	1	5	1	5	1.033	0.09	-0.833	0
11.(1-SEO)	15	MET	0	3.505	4	1	5	1	5	1.312	-0.804	-0.566	0
12.(2-SEO)	16	MET	0	3.585	4	1	5	1	5	1.152	-0.131	-0.721	0
13.(3-SEO)	17	MET	0	3.736	4	1	5	1	5	1.035	-0.381	-0.505	0
14.(4-SEO)	18	MET	0	3.741	4	1	5	1	5	1.083	-0.44	-0.59	0
15.(5-SEO)	19	MET	0	3.703	4	1	5	1	5	1.133	-0.232	-0.629	0

Figure 5. Descriptive Statistics

Skewness and kurtosis were assessed using descriptive statistics. Values of skewness between -3 and +3 and kurtosis between -10 and +10 are considered suitable for Structural Equation Modeling (SEM) [35-38].

4- Data Analysis and Results

4-1- Assessment Model: Validity and Reliability

Composite Reliability (C.R.) and Cronbach's Alpha were used to evaluate validity and reliability. Items with factor loadings below 0.700 were removed from the dataset. Figure 6 displays the data before removal, while Figure 7 shows the data after removing the other items.

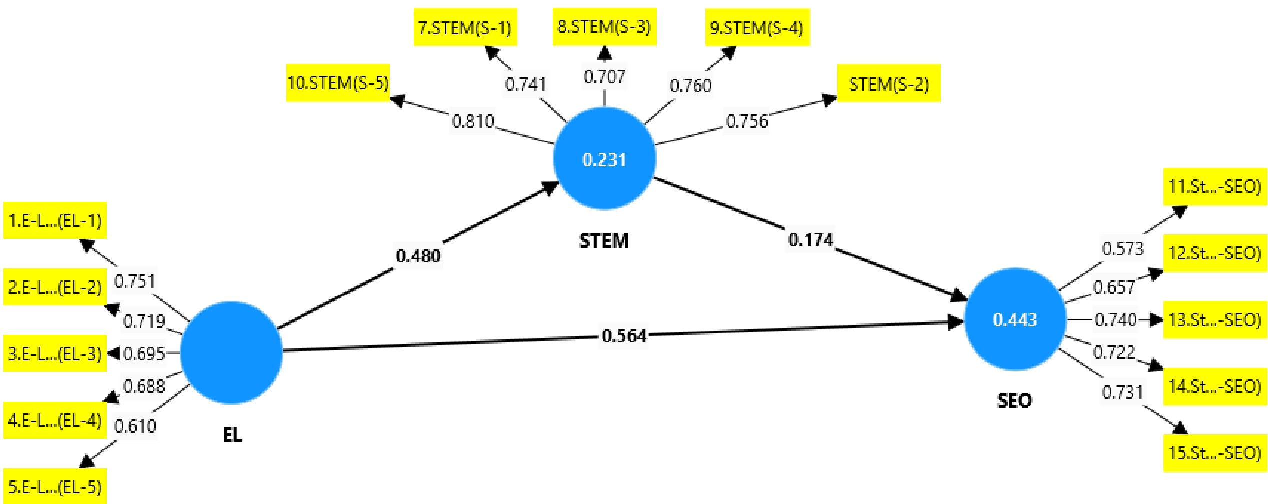

Figure 6. Conceptual Model before removing indicators below 0.7

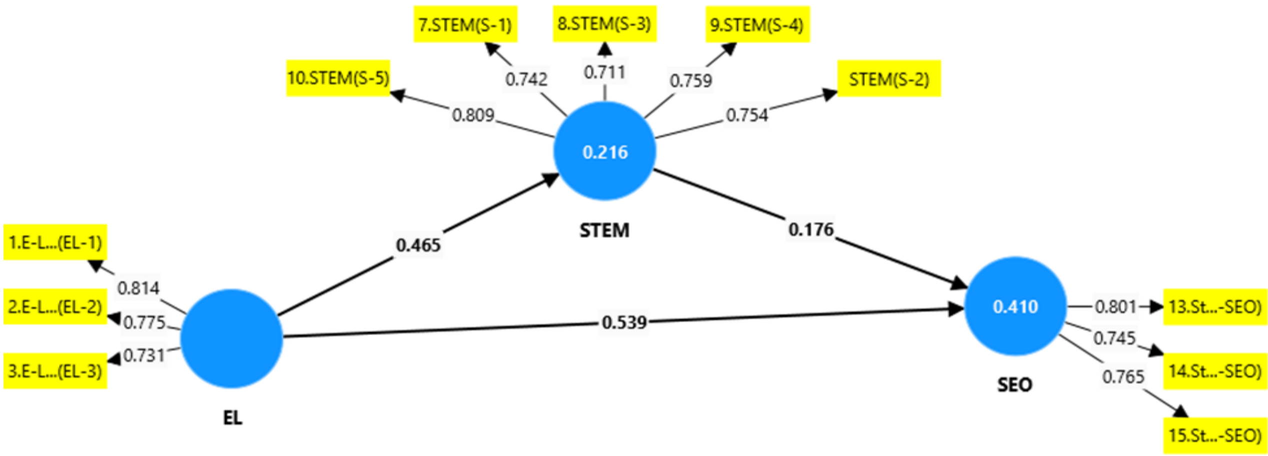

Figure 7. Conceptual Model after removing indicators below 0.7

This conclusion was reached after thorough testing, including AVE and HTMT. Table 4 presents the validity and reliability of the remaining items, along with their factor loadings. Robust reliability is indicated by all alpha values and C.R. exceeding the suggested threshold of 0.700. Convergent validity was confirmed with AVE values equal to or above 0.500 and C.R. values of 0.700 or higher. Discriminant validity was demonstrated as the factor loadings for each item were higher than their cross-loadings.

4-2- Predictive Validity

The criteria put out by "Heterotrait-monotrait ratio (HTMT)" is presented in Table 5, "Fornell & Larcker" is presented in Table 6, and Cross Loading is presented in Table 7. Additional confirmation of discriminant validity was obtained**,** presenting the specific findings.

Table 4. Item loadings, reliability, and validity

	"Factor Loading"	"Cronbach's alpha"	"Composite reliability (rho_a)"	"Composite reliability (rho_c)"	"Average variance extracted (AVE)"
E-Learning(EL)		**0.664**	**0.664**	**0.817**	**0.599**
1.E-Learning(EL-1)	0.814				
2.E-Learning(EL-2)	0.775				
3.E-Learning(EL-3)	0.731				
STEM		**0.813**	**0.819**	**0.869**	**0.571**
7.STEM(S-1)	0.742				
8.STEM(S-3)	0.711				
9.STEM(S-4)	0.759				
STEM(S-2)	0.754				
Student employment opportunities (SEO)		**0.658**	**0.661**	**0.814**	**0.594**
(3-SEO)	0.801				
(4-SEO)	0.745				
(5-SEO)	0.765				

The factor loadings, reliability, and validity metrics for three different constructs are presented in Table 4. These constructions are described as E-Learning (E.L.), STEM, and Student Employment Opportunities (SEO). The factor loadings for e-learning are as follows: EL-1 (0.814), EL-2 (0.775), and EL-3 (0.731). Additionally, the Cronbach's Alpha value is 0.664, the composite reliability (rho_a) value is 0.664, the composite reliability (rho_c) value is 0.817, and the average variance extracted (AVE) value is 0.599. S-1 (0.742), S-2 (0.754), S-3 (0.711), and S-4 (0.759) are the factor loadings that are associated with the STEM construct. Additionally, the Cronbach's Alpha value is 0.813, the composite reliability (rho_a) value is 0.819, the composite reliability (rho_c) value is 0.869, and the average variance extracted (AVE) value is 0.571. The factor loadings for Student Employment Opportunities are as follows: SEO-3 (0.801), SEO-4 (0.745), and SEO-5 (0.765). Additionally, the Cronbach's Alpha value is 0.658, the composite reliability (rho_a) value is 0.661, the composite reliability (rho_c) value is 0.814, and the average variance extracted (AVE) value is 0.594. The table provides a concise summary of the factor loadings for each item, as well as the overall reliability measures, composite reliability scores, and average variance retrieved for each construct.

Table 5. Heterotrait-monotrait ratio (HTMT)

	EL	SEO	STEM
EL			
SEO	0.937		
STEM	0.618	0.570	

Table 6. Fornell-Larcker criterion.

	EL	SEO	STEM
EL	0.774		
SEO	0.621	0.771	
STEM	0.465	0.427	0.756

Table 7. Cross loadings

1.E-Learning(EL-1)	0.814	0.418	0.457
10.STEM(S-5)	0.343	0.285	0.809
13. Student employment opportunities(3-SEO)	0.506	0.801	0.378
14. Student employment opportunities(4-SEO)	0.463	0.745	0.323
15. Student employment opportunities(5-SEO)	0.464	0.765	0.280
2.E-Learning(EL-2)	0.775	0.467	0.332
3.E-Learning(EL-3)	0.731	0.552	0.288
7.STEM(S-1)	0.382	0.356	0.742
8.STEM(S-3)	0.291	0.275	0.711
9.STEM(S-4)	0.423	0.371	0.759
STEM(S-2)	0.280	0.299	0.754

4-3- Structural Model

The next stage of our research was assessing the structural models to investigate our proposed hypotheses, as presented in Table 8.

Table 8 . Testing Hypotheses Directly

	"Original sample (O)"	"Sample mean (M)"	"Standard deviation (STDEV)"	"T statistics (|O/STDEV|)"	"P values"
EL → SEO	0.539	0.541	0.061	8.884	0.000
EL → STEM	0.465	0.472	0.053	8.849	0.000
STEM → SEO	0.176	0.178	0.073	2.426	0.015

4-4- The Findings

The finding of the hypothesis testing are shown in Table 8, with a particular emphasis on the direct effects between the constructs. In terms of the correlation between E-Learning (E.L.) and Student Employment Opportunities (SEO), the initial estimate of the sample size is 0.539, with a sample mean of 0.541, a standard deviation of 0.061, a t-statistic of 8.884, and a p-value of 0.000, which indicates that there is a statistically significant impact. The direct effect of e-learning (E.L.) on STEM is shown by an initial sample estimate of 0.465, a sample mean of 0.472, a standard deviation of 0.053, a t-statistic of 8.849, and a p-value of 0.000, all of which point to the presence of a significant effect. Finally, yet importantly, the relationship between STEM and Student Employment Opportunities (SEO) has a sample mean of 0.178, an original sample estimate of 0.176, a standard deviation of 0.073, a t-statistic of 2.426, and a p-value of 0.015. These values indicate that the effect is statistically significant but smaller than the effect of the other relationships.

4-5- Testing Hypotheses Directly

It was decided to do a two-tailed test with a t-value of -1.96 and a 95% significance level. This decision was influenced by the data reported by Hair et al. [38]. Table 8 shows that the hypothesis findings revealed a substantial influence of E.L. -> SEO (B=0.539, t=8.884, p=0.000). Consequently, h1 was supported. E.L. → STEM: STEM was significantly impacted by E.L. (B=0.465, t=8.849, p=0.000), supporting hypothesis h2. The testing of H3 is presented in the next section.

4-6- Results of the Mediation Analysis

Figure 8 and Table 9 illustrate the Mediation analysis "Bootstrapping" implementation.

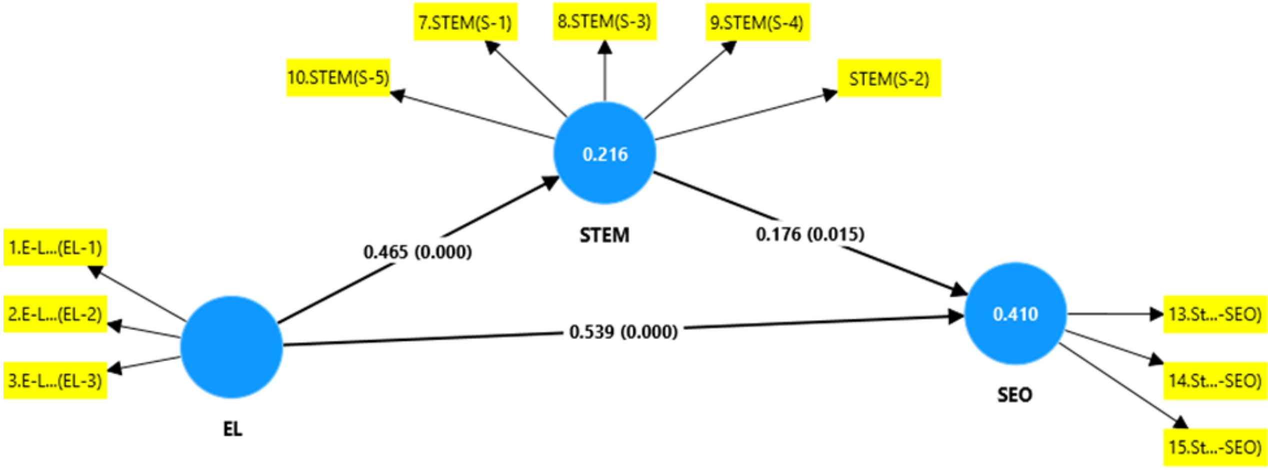

Figure 8. Bootstrapping implementation for Mediation analysis

Table 9. Result Summary

Total effect		Direct Effect		Specific indirect effect							
B	**P**	**B**	**P**	**Hypothesis**	**B**	**t**	**UL**	**LL**	**P**	**Results**	
0.621	0.000	0.539	0.000	H3 EL → STEM → SEO	0.082	2.303	0.013	0.152	0.021	Partial Mediation	**H3:Accepted**

5- Results and Discussion

Our research findings provide essential insights into how e-learning influences students' STEM knowledge and abilities acquisition. These findings allow us to answer the research questions, objectives, and hypotheses. The results of our research indicate that students' learning and skills in STEM fields are greatly improved via the use of e-learning, which is in line with the evaluation of the efficacy of e-learning in this category.

5-1- Questions for Further Research

The primary objective of this study was to investigate how students' acquisition of information and skills essential for STEM education might be improved via the use of e-learning. As demonstrated by the substantial direct effects and high t-statistics reported, the findings indicate that e-learning platforms influence students' STEM competency favorably. In particular, the findings suggest that students' understanding of STEM subjects is enhanced through e-learning (B=0.465, t=8.849, p=0.000), and their career chances are improved (B=0.539, t=8.884, p=0.000). These findings prove that e-learning platforms can effectively support the development of critical STEM abilities, hence addressing the demand for updated educational techniques in STEM subjects.

5-2- Aims and Objectives

The research aimed to investigate the efficacy of e-learning platforms in boosting the knowledge and abilities of students in the STEM fields. The findings demonstrate that e-learning is an essential component in improving this situation. The considerable direct benefits discovered in the investigation provide evidence that e-learning enhances knowledge in STEM fields and leads to more favorable employment opportunities. E-learning has been shown to positively influence the acquisition of skills and preparedness for a profession, which is compatible with these results and is consistent with the research.

5-3- Hypotheses Are as Follows

The hypothesis that e-learning improves strategic planning in educational institutions was found to be supported by the first hypothesis. In line with previous research highlighting the role of e-learning in enhancing institutional planning and efficiency, the findings suggest that e-learning contributes to more efficient strategic planning inside educational institutions. There is evidence to support the premise that students' STEM knowledge and abilities may be improved via the use of e-learning, which in turn leads to improved career chances. The strong direct effect of e-learning on STEM knowledge and career possibilities supports this hypothesis. This result is consistent with current work emphasizing e-learning's role in bridging the skills gap and improving employability.

The third hypothesis, which states that knowledge of STEM subjects has a favorable relationship with e-learning and partially mediates its influence on strategic planning, leading to an increase in the employment rates of graduates, was also validated. The findings indicated a noteworthy indirect impact of e-learning on the career options available to students with knowledge in STEM fields (B=0.082, t=2.303, p=0.021). The fact that this is the case suggests that although knowledge of STEM subjects acts as a mediator in the connection between e-learning and career prospects, the direct impact of e-learning on employment chances continues to be significant. Even though knowing STEM subjects makes e-learning more effective, this partial mediation does not fully explain the increased job results...

5-4- Comparative Analysis Concerning the Texts and Contributions

Our findings are consistent with previous research that emphasizes the effectiveness of e-learning in upgrading STEM education and promoting employability. It has been demonstrated in several studies, including those conducted by previous studies [15-18], that the use of e-learning platforms considerably enhances the employability of STEM skills and opportunities. Nevertheless, our study contributes to the existing body of work by establishing the mediating function that STEM knowledge plays in this connection. This is a unique contribution to the body of work that has been done previously.

5-4-1- Extending and Challenging Theoretical Models

Our work expands on current theoretical models by including region-specific variables and contextual aspects that are sometimes missed in larger models. Traditional e-learning strategies in STEM education tend to focus on global educational results and technology uptake rather than regional differences.

Model Adaptation: We modified and implemented recognized theoretical frameworks, such as the Technology Acceptance Model (TAM) and the Resource-Based View (RBV), to the Gulf and Arabic contexts. For example, our study considers elements such as physical restrictions and cultural features specific to these countries, which impact both the acceptance and efficacy of e-learning in STEM education.

Employment Effects: Traditional models frequently emphasize the direct educational impact of e-learning. Our research challenges this by clearly tying e-learning to job results, highlighting the importance of regional economic conditions, industry demands, and educational alignment. By integrating indicators like job placement rates and industry input, we present a more nuanced picture of how e-learning affects employment, expanding the theoretical knowledge of e-learning's role in workforce development.

5-4-2 Unique Factors in the Arabic and Gulf Regions

Several distinct variables particular to the Arabic and Gulf areas should be addressed for further research:

***Cultural And Social Context*:** Cultural views regarding e-learning and STEM education can substantially impact the technologies' implementation and efficacy. For example, conventional educational beliefs and gender norms may influence student involvement and achievements in specific locations.

***Infrastructure and Access*:** The variability in technical infrastructure among Gulf and Arabic nations impacts e-learning deployment. Understanding how these infrastructure variations affect e-learning efficacy is critical.

***Economic and Industry Needs*:** Gulf nations' economic diversification policies, such as Saudi Arabia's Vision 2030, encourage a concentration on STEM education to suit industry demands. Evaluating how e-learning matches these strategic aims and promotes economic growth might yield useful information.

Regional educational policies and laws impact the uptake and efficacy of e-learning. Examining how different policy frameworks influence e-learning deployment and outcomes might provide valuable insights for improving educational practices. Our research helps to close the gap by investigating these distinct characteristics and their consequences for theoretical models. It also proposes that future research should consider these region-specific characteristics to gain a more thorough knowledge of the influence of e-learning on STEM education and job outcomes in the Arab and Gulf areas. Our discoveries are especially pertinent when considered in the context of the Gulf area because they address the region's requirement for contemporary educational tools and tactics that are in line with the rapid economic advancements that are taking place. Furthermore, the findings provide educational officials and institutions in the Gulf region with valuable insights and a framework for efficiently incorporating e-learning into STEM education. Additionally, this research contributes to the larger educational landscape by highlighting the significance of STEM knowledge as a mediator in the link between e-learning and employment. It also offers valuable implications for improving educational practices and strategic planning.

The findings of the study, taken as a whole, lend support to the development of e-learning as an essential instrument for enhancing the efficiency of STEM education and employment outcomes, particularly in the Gulf area. The data that has been presented can serve as a guide for future study and the formulation of educational policy. This will ensure that electronic learning and STEM education initiatives can successfully meet the ever-changing needs of the global labor market.

5-5- Assessment of Employment Opportunities

In our study, changes in student employment opportunities (SEO) were examined using many methods:

Work Tracking: We used follow-up questionnaires and interviews with graduates to determine their work status after graduation. This includes gathering information about employment placements, industrial sectors, and STEM-related job roles. For example, we tracked how many graduates found jobs in technology or engineering within six months after finishing their studies.

Industry Collaboration**:** We collaborated with industry stakeholders to gain insights into hiring trends and match job needs with e-learning capabilities. The feedback from these partners gave concrete proof of how well-prepared students were for the labor market.

Internship And Placement Programs: We also assessed the effectiveness of internship and placement programs made possible by e-learning platforms. Data was gathered on the number of students who completed internships, the conversion rate of internships to full-time work, and employers' general satisfaction with e-learning-prepared graduates.

Measuring Stem Education Improvement**:** The improvement of STEM education through e-learning was quantified using numerous practical approaches. We examined academic performance measures before and after the use of e-learning technologies. This involved comparing test results, project grades, and overall course achievement in STEM disciplines.

Skills Assessments**:** Practical skills and competence examinations examined students' understanding of STEM topics and problem-solving abilities. This included delivering standardized examinations and practical assignments to assess the application of STEM knowledge.

Student Comments**:** We received extensive comments from students on their learning experiences and perceived gains in STEM abilities. The input was acquired via standardized surveys and focus groups.

5-6- Examples From Our Work

Our study's SEM analysis revealed that e-learning considerably enhanced STEM knowledge (H2), as evidenced by a path coefficient of 0.465 and significant positive effects on student performance indicators and industry comments. For employment possibilities (H1), we found a path coefficient of 0.539, backed by data indicating higher job placements and successful industry engagement. Overall, these practical measurements supplemented our survey and SEM analysis, offering a more complete picture of how e-learning affects STEM education and career chances. This multifaceted approach guarantees that the outputs are robust and represent real-world scenarios.

5-7- E-Learning Prospects, Challenges, and the Innovative Experience of the University of Buraimi

E-learning has garnered significant attention due to its numerous advantages, enhancing educational processes with flexibility and accessibility. Rapid technological advancements, accelerated by the COVID-19 pandemic, have catalyzed a global shift towards e-learning, facilitated by widespread high-speed internet access. E-learning utilizes digital platforms like computers, smartphones, and tablets, fostering virtual education environments that transcend geographical boundaries. It encompasses asynchronous learning, where students engage at their own pace through forums and course materials, and synchronous learning, facilitating real-time interaction via chat rooms and virtual classrooms.

Even though the world is moving toward digital education, many top academic leaders in Arabic-speaking countries continue to doubt the efficacy of online learning. This doubt stems from several things:

Traditional Educational Values: Traditional classroom-based learning is frequently profoundly held in the minds of older academic leaders. They could consider in-person interaction essential to upholding the discipline and quality of education, so they consider e-learning a subpar alternative.

Technology Barriers: Robust technology infrastructure is necessary for adopting e-learning, yet it may be absent in some areas. Leaders who haven't witnessed successful e-learning installations could question the technology's viability and efficacy.

Quality Assurance Issues: There is a general worry over the caliber of online education. Many academic authorities are concerned that online education cannot meet the rigor and standards of conventional methods, especially in courses like STEM (Science, Technology, Engineering, and Mathematics) that demand practical experience.

Lack of Knowledge and Training: More senior academic administrators may be unaware of the newest e-learning technology and pedagogy developments. This ignorance may cause them to be averse to trying out novel approaches.

The delivery of STEM education is not exempt from these difficulties. Traditional teaching approaches may not correctly engage pupils or provide them with the transferable skills required in today's workforce. The dissemination of STEM information still needs to be improved in the presence of the integration of contemporary technologies and resources.

5-8- Proposed Solution

With an emphasis on K–12 children and the preparation of future generations for successful employment, a large portion of today's STEM programs strive to solve our country's STEM challenge. Nonetheless, this problem must be addressed immediately, impacting the "forgotten generation" in today's workforce. College students and continuing education professionals are the two groups that have the most significant immediate potential to bridge the present STEM gap in the workforce. Despite their differences, both groups deal with the same problems—a lack of money and time—that ask for an economical solution in terms of both logistics and finances. Online learning is the answer for 2014 and beyond to prepare the workforce better since it removes budgetary and time restrictions and can be just as effective as in-person training.

In the past, students' incapacity to finish the practical laboratories required for the experimental components of STEM courses posed a challenge to their online instruction. However, this barrier has vanished with the introduction of wet labs, which are given to students in addition to online training. Online STEM students, who are in charge of the entire experiment, also learn more since the group structure of in-person experiments is eliminated.

Higher education enrollment is not increasing due to our recovering economy, and institutions still have difficulty finding funding and staff. These organizations need to develop fresh ideas to make money outside the box. Furthermore, extremely few material and financial resources are available to schools to accommodate pupils. The university may increase tuition income without reducing personnel or resources by expanding the pool of students applying for admission and offering the first two years of compulsory STEM courses online.

Thus, by removing geographical obstacles to in-person instruction, online delivery of STEM courses also affects global scalability, which benefits Arabic higher education institutions in particular Gulf areas.

5-9- Future Work for Measuring the Long-Term Impact of E-Learning on Graduate Employment Rates

1. Longitudinal Tracking of Graduates: We advocate using a longitudinal research design to monitor graduates throughout their careers. This entails collecting data regularly after graduation to track employment status, career advancement, and work satisfaction. By following up with graduates, we can determine how e-learning affects their career paths and job outcomes.

2. Employment Surveys and Data Collection: Regular surveys with alums to acquire information on their employment status, job positions, and industrial sectors will yield important insights. These surveys may contain questions concerning the relevance of e-learning experiences to their present roles and any new skills or information obtained from e-learning programs. Our findings show that such surveys might provide direct evidence of the effects of e-learning on employment.

3. Collaborations with Employers: Forming collaborations with employers and industry partners can assist in tracking graduates' job results. Collaboration with enterprises that hire e-learning program graduates allows universities to get feedback on the e-learning curriculum's success in preparing students for the workforce. This partnership may also give information on employment rates and professional progression.

4. Data Integration with Alumni Networks: Another helpful technique is to track career advancement and job outcomes through alumni networks and databases. Institutions may use these networks to stay in touch with graduates while gathering information about their employment status and career growth. This strategy can help guarantee that the data collected is complete and up to date.

5. Evaluation of Employment Metrics: We recommend assessing employment rates, job placement rates, and time to employment. Analyzing these measures over time can assist in determining how e-learning affects graduates' ability to find work and grow in their jobs. Our findings underscore these indicators' significance in assessing e-learning initiatives' effectiveness.

By applying these measures, we want to give a complete assessment of e-learning's long-term influence on graduate employment rates and ensure that the efficacy of these programs can be correctly measured over time.

6- Conclusion

In conclusion, this study reveals that e-learning has the potential to improve STEM education and boost students' career chances dramatically. This makes e-learning particularly useful for the Gulf area, Arab nations, and women. Because of these findings, the revolutionary potential of e-learning in bridging the gap between education and industry demands is particularly highlighted. This research aims to urge Arabic academic leaders to include these innovative teaching approaches in their curricula by highlighting successful implementations. Not only does the incorporation of STEM courses with e-learning platforms provide students with the essential skills required for the modern workforce, but it also tackles economic concerns by supporting regional development. This strategy is especially relevant to the

Gulf area, which is experiencing fast economic growth and requires an education system that matches the requirements of new industries. In Oman, the pioneering efforts of the University of Buraimi serve as an example of how digital platforms may improve the accessibility and quality of education, therefore serving as a model for other institutions in the area. Even though e-learning brings several issues that need to be addressed, it does provide several significant benefits, such as enhanced accessibility and customization. To fully realize the potential of e-learning, the research highlights the necessity of continuing improvements in infrastructure, pedagogical tactics, and technical integration. By removing the usual adoption obstacles and providing a sustainable approach to education and human resource management, the online distribution of STEM courses appears as a feasible solution to the talent shortage situation that the Arab world is now experiencing. Significant is the fact that this study focuses on female participants. This research contributes to advancing gender parity in STEM areas, which continues to be a severe problem, by working to improve access to high-quality STEM education with e-learning. The findings endorse implementing policies and practices that guarantee equal opportunities for women, contributing to the region's overall socioeconomic growth and empowerment.

7- Declarations

7-1- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7-2- Funding

The author received no financial support for the research, authorship, and/or publication of this article.

7-3- Acknowledgements

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7-4- Institutional Review Board Statement

Not applicable.

7-5- Informed Consent Statement

All subjects gave their informed permission before beginning the research. They received an explanation of the study's goals, protocols, and participant rights. As participation in the study was voluntary, participants were free to leave at any moment without incurring any penalties. The research procedure preserved participant anonymity, and all acquired data were kept secret. Participants permitted their data to be used only for the study. Furthermore, no personally identifying information, such as email addresses or phone numbers, was gathered as part of the poll to respect confidentiality and ethical norms.

7-6- Conflicts of Interest

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the author.

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