European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available online at: www.oapub.org/edu

DOI: 10.46827/ejes.v11i11.5588 Volume 11 | Issue 11 | 2024

A CRITICAL ANALYSIS OF THE SCIENCE, TECHNOLOGY, AND INNOVATION POLICY IN THE UNITED ARAB EMIRATES, WITH A PARTICULAR FOCUS ON HIGHER EDUCATION

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Abstract:
This paper critically analyzes the Science, Technology, and Innovation (STI) policy in the United Arab Emirates (UAE), with a particular focus on its implications for higher education. The study explores how the UAE's STI policy, driven by a shift towards a knowledge-based economy, emphasizes human capital development, economic growth, and global competitiveness. It examines the role of higher education in fostering innovation and entrepreneurship and the alignment of the UAE's policies with global standards, such as those of the OECD. The analysis highlights key challenges, including the need for greater integration of STEM education, the underrepresentation of Emiratis in STEM fields, and the reliance on expatriate talent. Furthermore, the study critiques the STI policy's neoliberal underpinnings, which prioritize economic outcomes over social and cultural considerations, particularly in a collectivist society like the UAE. The paper concludes with suggestions for future policy revisions, emphasizing the need for more inclusive and context-sensitive approaches to innovation and education.

Keywords: science, technology, knowledge-based economy, human capital development, higher education, neoliberalism, economic growth

1. Introduction

The release of the Science, Technology, and Innovation (STI) policy and the National Innovation Strategy (NIS) coincide with the UAE's declaration of 2015 as the Year of Innovation, which recognizes innovation as a cornerstone of a knowledge-based, highly productive, and competitive economy. (UAE National Strategy, 2015). It is important to remember that the strategy and policy cover all of the UAE's seven Emirates, not just one. My analysis will concentrate on the STI policy initiation stage, employing the Basic Layered Model (Ed. D 2022, online) in combination with Archer's (1979) "*structural elaboration*" model, which will provide three perspectives through which this study will

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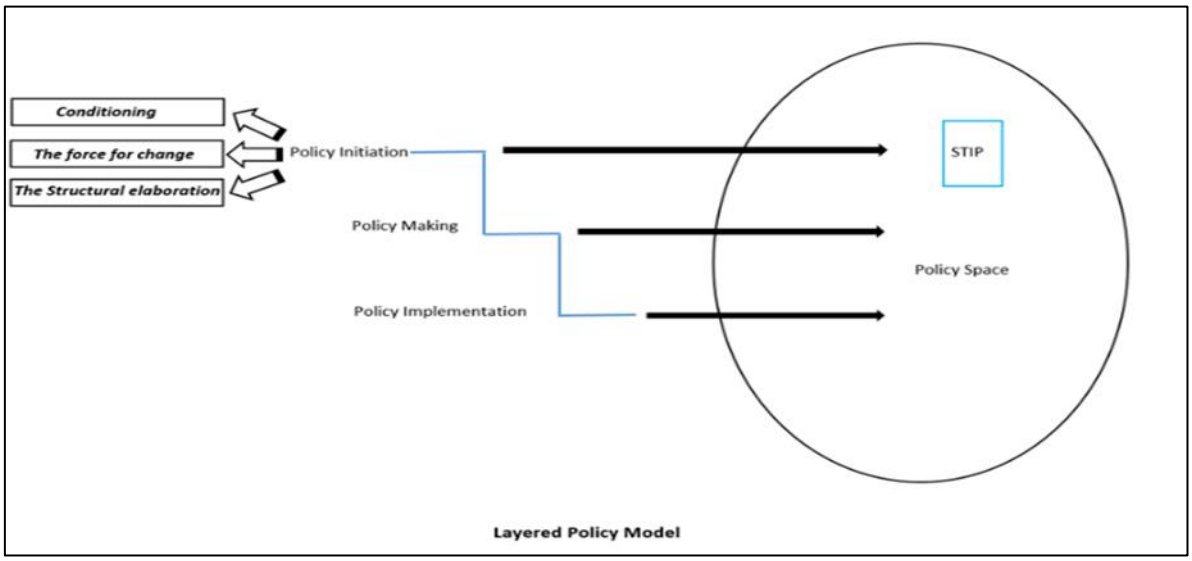
be framed. The first stage will be ***conditioning,*** which will review STI Awareness and Needs, focusing on the UAE's shift to a knowledge-based strategy and vision. In the second stage, I will examine ***the forces for change*** in this policy, which come from globalization, international organizations (IO), and social and economic factors. Finally, ***the structural elaboration lens***, or what I can call a suggestion to modify the policy, will be used to highlight the policy limitations as well as some points to take into account in the next version of STI policies.

The figure below shows the structure of this analysis.



The mechanism by which technology spreads across nations is crucial to the generation and distribution of global growth across nations. Therefore, international organizations such as the Organisation for Economic Cooperation and Development (OECD) play a significant role in fostering growth, which requires cross-government policies. In this paper, I will highlight the various areas of OECD educational research that seem to be influencing policy initiation, particularly in higher education in terms of the Science, Technology, and Innovation (STI) policy in the UAE.

The UAE's shift from oil to knowledge prompted policymakers to prioritize education. Knowledge is currently an important commodity (Ball, 2008, p.46) and can be viewed as an asset that can strengthen and improve economies around the world. In recent years, international education policies and governance have influenced UAE policymakers. In this essay, I will analyze the importance of *human capital* (HC) and *critical political economy* (CPE) theories. The *knowledge economy's* (KE) impact on STI policy is also discussed.

2. Literature Review

Many centuries of discussion and experimentation have resulted in a worldwide consensus that universities can play a variety of crucial roles in innovation and

entrepreneurship. Universities contribute to economic growth through new findings and academic spin-offs. Universities can update the technical knowledge and skills of the workforce at all levels via informal channels of university-industry engagement, such as research publications, conferences and networking, and training (Kaloudis, 2019, p.38). Today, project-based programs and approaches are seen as crucial elements of broader transformation and modernization policies of higher education institutions, which are also essential elements of "*national research and innovation systems*." This trend, which could be regarded as an "*innovation turn*," has implications for the entirety of higher education (Ruano-Borbalan, 2019, p.493).

In the last decade, economists and politicians realized that innovation promotes economic growth and raises living standards (Freeman *et al.*, 2019). This insight has caused global competition for innovative advantages. With the increase of competition between nations, the goal of quality and the creation of the world's best institutions are becoming more significant in the policy agenda in both emerging and wealthy countries. Several excellence programs have been created to achieve world-class campuses. However, Excellence initiatives seek the effective transformation and upgrading of universities, which demands a bold vision and the ability to alter the mindset of the academic community in pursuit of academic excellence (Salmi, 2016, p.18)

Innovation relies on science and technology, and integrating STEM/STI into university curricula encourages graduates to be market or enterprise-ready (Mok, 2022). STEM education was first introduced in the USA in 1957 and defined as "*a curriculum focused on science, technology, engineering, and math*." STEM education is interdisciplinary and hands-on, affecting practically every facet of daily life. The 1980s saw significant advances in science and technology, including the first artificial heart, cell phone, and space shuttle as well as the first personal computer (Soomro, 2019, p.158).

In the UAE context, before the 1950s oil boom, the UAE lacked the resources to build an effective educational system (Al-Dahri 2002 in Al-Ali 2014, p11). Since 1971, the UAE's government has expanded higher education. Egyptian, Jordanian, and Lebanese support helped found the first university in 1976 (Findlow, 2005, p.290). Today, in terms of student numbers and technological influence, the country's higher education system is the fastest growing in the Gulf (Findlow, 2005, p. 289) (Appendix 1).

In 2015, the Department of Education and Knowledge (ADEK-Abu Dhabi) introduced STEM education in the UAE. The government's STI policy was announced in November 2015. Think tanks, policy consultancies, government agencies, and commercial enterprises provided most of the public response and promoted the initiative. However, the Emirates Centre for Strategic Studies and Research identified some challenges to educational system reform. They found that, often, missions and goals are unclear or conflicting. These are connected to study programs and curriculum difficulties. Teaching and learning mistakes along with inflexible programs and curricula cause high dropout rates (Tabari, 2014, p.4). STEM educators also agree that STEM requires educators to plan and prepare more before entering a classroom (Gourgey *et al.* 2011 in Malaka 2018, p.26).

In the R&D sector, while there are no official structures and regulations to channel academic research from local institutions into policymaking, entities may hire individual researchers or institutions for research they deem necessary. Although there are no formal guidelines to incorporate academic research into policymaking, the government is more cognizant of the need for evidence-based policymaking and academic engagement (Mohammed Bin Rashid School of Government, 2015).

2.1 Policy Analyses

An analysis of the STI policy considers both the policy's "*text and action, words and deeds*" (Ball 1994, p.10). Much attention is paid to what the policy initiates and what it intends to accomplish within a larger corpus of relevant official releases.

At first observation, I noticed that the policy is associated with neoliberalism, as it intends to apply rational, technical, and knowledge-based approaches to most life domains (Patrick 2013, p.2), particularly focusing on the future generation and considering the global indices. According to most conventional interpretations, globalization promotes convergence because states have come to embody capital's values by accepting neoliberal policies (Painter 2009, p.591).

The policy mentioned "*talent*" repeatedly, but the main meaning is associated with the human capital theory, which emphasizes that skilled people will achieve economic growth, which is a clearly stated goal of the policy. To wit: "*STI opens up opportunities for faster economic growth*" (STI 2015, p.17). This demonstrates that the policy prioritizes highly skilled facilitators. This goal was also mentioned directly in the NIS, which implies that the UAE has a strong belief that "*human capital is more essential than urban development*" (NIS 2015, p.6).

The NIS connects science, technology, and innovation to economic growth, which is congruent with the human capital assumption that links economic growth to individuals' skill levels. Becker *et al.* (2016, p.24) explained that the reason for some countries' continuous progress is due to scientific and technological knowledge, which enhances labour productivity and other inputs in production.

From this perspective, the OECD's emphasis on skilled employees in developing countries and economic growth cannot be overlooked:

> *"Skills have become the global currency of the 21st century. Without proper investment in skills, people languish on the margins of society, technological progress does not translate into economic growth, and countries can no longer compete in an increasingly knowledge-based global society"* (OECD, 2012, p.10)

On the social side, the STI policy and NIS policy combine to promote and incubate youth entrepreneurship and start-up businesses that emerge from universities to support and assist innovators in turning their ideas into tangible projects. The goal here is twofold: to create job opportunities for skilled people and encourage collaboration across the government, the private sector, and media organizations (NIS; STI, 2015). Here also,

the human capital theory is elemental as it favours people skills. The education and training involved helps people increase their abilities, resulting in higher salaries and more money for society. Human capital theory states that skills determine production. Production for the STI is not limited to the government sector; rather, the policy emphasizes the role of corporations and partnerships with the private sector, particularly in fostering entrepreneurship for youth. Privatization and deregulation are important neoliberal components because they foster capitalist market processes and competitiveness. Further, human capital in a neoliberal society promotes competition. An individual must "*select*" to gain knowledge and skills. This doesn't end after college rather, it is life-long learning. Each person should continue to learn, whether informal or official. Neoliberalism defines an individual as a failure if they don't perform well in competition.

The UAE society is a collectivist community. Emirati students in higher education are less likely to accept entrepreneurship because of their collectivist culture, educational background, and lack of formal entrepreneurial instruction when compared to business students in the United States and Europe, for example, Hameed *et al.* (2016, p.5). Research on entrepreneurship suggests that more entrepreneurs originate from individualist cultures than from collectivist cultures. Even though the UAE's higher education system is among the best in the GCC (Gulf Cooperation Council) countries, it still needs to be bolstered in many areas, including entrepreneurial education. Within this context, let me elaborate on the political-economic assumption that the connection between the market, individuals, and the state influences production and society as a whole. While the STI policy declared its intention to promote and encourage entrepreneurship among youth in their collectivist community, it omitted a strategy on how to achieve this goal in a collectivist community. In a diverse community like the UAE, a "one-size-fits-all" approach would backfire. Any intervention would have to be sensitive to the social and cultural specificities of the local context.

Transformative change at the cultural system level requires that STI policy embrace a broad spectrum of technological, social, cultural, and organizational advancements, ranging from low-tech to high-tech. The World Investment Report (UNCATAD 2019, p.5) asserted that entrepreneurs and businesses are at the heart of the innovation system. They play a pivotal role in bringing innovative technology, products, and services to market by connecting diverse types of knowledge. They must increase their participation in learning and innovation networks and invest in establishing connections with other businesses and STI players. In the context of the UAE, a short glance at the entrepreneurs' activities (Appendix 2) reveals that STI and technology development in enterprises must enhance their capacity to adapt to innovation policies. Observers criticize start-up enterprises for being money-oriented, focused on short-term success, and lacking long-term technology support.

In addition, human capital theory aligns with the need to create job opportunities for trained future generations. However, the policy assumes that young people would earn new (knowledge-based) opportunities by increasing their personal skills;

disregarding the OECD's concern about the Emiratis irregular attendance and school dropout rates (OECD 2015, p.10) and agreeing with the statement in question that R&D will create new job opportunities for nationals, "*Employ and retain UAE nationals in R&D work fields*" (STI 215, p.25). The impediment comes from a lack of student interest. Studies show that the majority of national university students prefer to major in the humanities. For example, in 2014, only 21% of students at federal universities were enrolled in STEM majors. Among these, 61% were studying natural sciences, and only 31% were studying engineering. Most of the aforementioned 21% were men, with only 16% being women (ElSayary 2018; Moonesar *et al.* 2015, cited in Khreibi 2020, p.36).

Moreover, the policy opened doors for highly skilled individuals from around the world to "attract and retain the best STEM minds and talents from all over the world" (STI 2015, p.25). The UAE's attractive work environment and its ability to create opportunities in the science and technology sectors enable talented foreigners to have a better chance of getting jobs. As a sequence of this mismatch between supply (national students) and demand in the market, it leaves Emiratis unemployed and causes social anxiety and inequality. Here, the STI responds to the political economy theory by creating job opportunities that may solve the unemployment problem for expats. However, this circumstance will reduce Emiratis' competitiveness.

In the UAE employment strategy, nationals are prioritized for high-level posts when competence is not the primary criterion. However, in the globalization index, internal competition is crucial. The STI policy neglected to note the methodology in this area. "*Low skills equilibrium*" was one of the problems of the political economy, which necessitated the improvement of people's skills. Finegold and Soskice contended that the majority of businesses that are conducted by poorly-trained managers and employees generate low-quality goods and services. (Finegold and Soskice 1988, p.22). The UNCTAD 2019 report concluded that innovation must be driven by civil society and citizens in order to reach STI goals.

In regard to job opportunities in R&D for nationals, the UAE's infrastructure is considered suitable for conducting research, and the UAE maintains close relationships with many leading science and technology countries and organizations. However, the UAE is missing some of the most important components of innovation such as financial opportunities, bureaucratic challenges, and country limits on survey data collection. The limits on data collection hinder representative surveys of existing universities from being conducted. Such data is crucial to conduct a thorough multilevel analysis of the causal link between individual and institutional factors. (Karabchuk *et al.* 2021, p.5). Also, due to the low participation of nationals in the R&D (Appendix 3), the UAE's academic context is heavily reliant on expatriates while also being globally market-oriented (Kirk & Napier, 2009; Wilkins, 2010, 2021 in Karabchuk*et al.* 2021, p.5). With expats heavily contributing to R&D, there is a lower output locally between science and industry. The quality of the education system and the postgraduate graduates have also been criticized, and the country does not produce enough technical people and engineers in a place that sorely needs them. The role of universities in research support is also unclear, especially

given that the STI intends to develop this knowledge for businesses, particularly entrepreneurial firms. On the social front, UAE nationals make up a smaller proportion of the UAE population than expats (UAE nationals make up only about 11% of the population (UAE's Government Portal, 2019). Without technical know-hows, UAE nationals are expected to play the role of entrepreneurs in economic development.

2.2 Globalization Index

The standpoint of the policy's ambition is to initiate a "*national policy with a global perspective*" (STI, 2015). Globalization involves economic, social, technological, and political changes that cross national boundaries (Godwin, p.4). According to Verger *et al.* (2018), globalization defines educational challenges that were previously unaddressed.

The globalization of education is seen as a result of the development of a "*world culture*" or "*world polity*," a global transnational cultural environment, and this common symbolic universe explains how educational ideas appear to be coming together across the globe (Robertson and Dale 2014, p.157). This idea of student productivity as a state capital is neoliberal. Competition for an interstate market share encourages state participation. For example, the international comparison (e.g, PISA and TIMSS).

The STI policy addresses the demand for competence and the globally competitive knowledge-based economy. The presence of the word "global" thirteen times in the STI policy and twenty-three times in the NIS demonstrates the significance of the global impact and the desire to be among the top countries, to the extent that globalization statistics were a driving force behind the initiation of the STI policy (UAE ranking) (Dutta and Wunsch-Vincent, 2017, p.40).

Globalization's impact on the UAE is mixed. The UAE has targeted development by importing international branch campuses in order to be globally competitive in the knowledge economy and to become a regional hub for higher education (Ahmad and Hussain 2017, p.1329); this embodies an "*untested educational model*" (Wilkins, 2010, p.390) for example, Abu Dhabi has enticed Paris-Sorbonne, INSEAD, and New York University, rapidly improving its tertiary education offerings. However, this has had an impact on social and cultural life. Foreign colleges in the UAE provide courses that have nothing to do with the culture of the country. They do not support Emirati culture, identity, or education (Al Ali, 2014).

From a different angle, Robertson and Dale (2015, p.158) contend that there is a need to recognize that the "*parts*" cannot be comprehended without an awareness of the whole and that this is a response to the larger ideology of development and modernization. This suggests that integrating global branches into the UAE benefits the quality of national graduates.

The STI stressed universities' important roles in R&D and infrastructure development and set universities the following goals:

- To improve university science and technology education and research;
- To provide universities with world-class labs, equipment, and computers;
- To increase R&D facilities for key innovative sectors;

- To support technology transfer and innovation incubators. (p.25)

The UAE education system has been attacked in literature, with companies highlighting poor graduate qualifications in a variety of areas, primarily technical. More specifically, a critical flaw in the UAE education system is its isolation from the market and industries. As a result, the UAE's employment rate in the private sector is far below the rate in the public sector. Abdelkarim and Haan (2002, in Al-Abd *et al.* 2012, p.2096) emphasized the importance of allocating funds for technical and soft skills training courses, pointing out the public sector's lack of involvement in such training. They also criticized the UAE's un-training-led culture, claiming that most training is focused on new technologies rather than economic development.

The UAE's neoliberal reforms aim to increase access to higher education while shifting expenses to the private sector and consumers. Ball (2012, p.26) considered neoliberalism as the most popular political-economic ideology in the world nowadays. It influences global education policies. Ideas like introducing market mechanisms and logic (like products and competition), liberalizing and privatizing the education sector, and bringing corporate management techniques and styles of leadership into public education are very popular, Verger *et al.* (2018). Globalization must be understood as a new "context of contexts" for education policies (cf. Peck and Theodore 2010, as cited in Verger *et al.* 2018, p.6). It outlines problems and modifies state autonomy. It helps develop international actors and transnational policy networks. However, a quality assurance mechanism or how the higher education curricula would bridge the gap in skill level has not been determined in the policy. Even the methodology of improving the university's sector as a whole has not been discussed. In the UAE, globalization of higher education is seen as a business model that allows for the exchange of cultural knowledge and values, an overall improvement in the quality of national education, the spread of technology, and the development of a workforce that is skilled in working with people from other countries. Thus, the result of this globalization is uncertain.

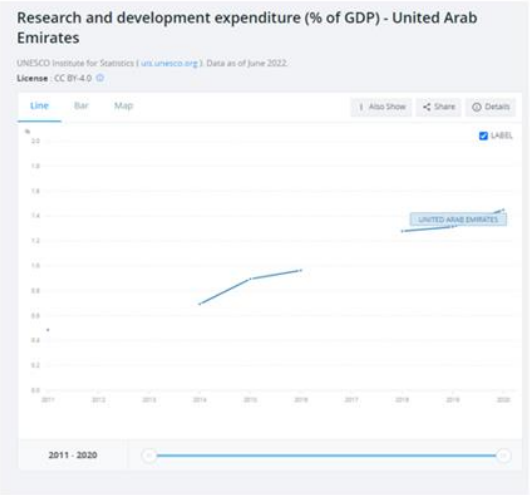
Despite the fact that the connection between the development of human capital through higher education and economic growth can be viewed two ways, it is not always straightforward, and the results for local cultures and national objectives in an internationalized context may be detrimental. If national ambitions and traditions are not to be absorbed by globalization's restructuring of the world based on Western interests and models, globalization and neoliberalism have resulted in having higher education institutions that promote global and not local markets, establishing a centre-periphery relationship. Knowledge producers are the new centre because a knowledge-based economy requires research and industry linkages. Governments adopt externally imposed curricula and standards like clients and consumers but have little control over them. Thus, the UAE's higher education system is at a critical juncture. A globalizing and diversified economy is demanding that it be more efficient, more effective, and more responsive (Ashour and Fatima, 2016, p.577). The UAE's higher education sector is confronted with several problems, such as increased competition among domestic and international institutions. In fact, the globalization of higher education has produced a

mature market (Hemsley-Brown and Oplatka, 2006, in AlSharari 2019, p.373). To achieve a competitive advantage in higher worldwide rankings with a global emphasis on capacity building and long-term sustainability, the UAE must balance idealistic aims with concrete realities. Building a viable higher educational system remains a significant challenge in the UAE, which has economic resources but lacks the human capital needed for global competition other than outsourcing or expatriate consultants (Mahani and Molki 2011 in Alsharari 2018, p.376).

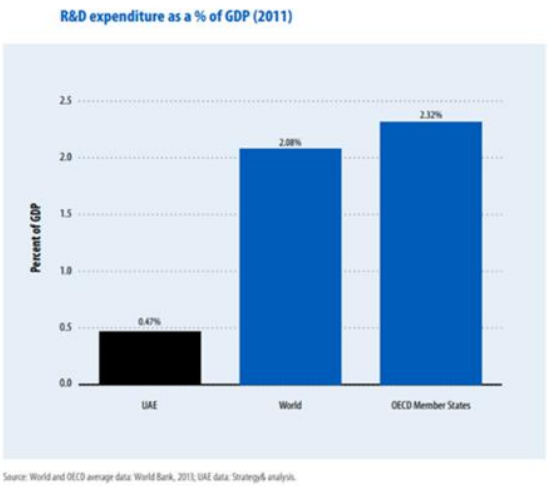
In regards to research and development, it is crucial to advanced economies' economic growth and job creation. Businesses, governments, colleges, and non-profit organizations around the world have made enormous investments in research and development. Since 2000, worldwide R&D spending has more than tripled, from $677 billion in 2000 dollars to $2.2 trillion in 2019 values (Sargent, 2021, p.1).

Developing R&D policies is challenging in countries with poor research capacity. The government has led efforts (New R&D Policy-Appendix 4) while the private sector has contributed little. The OECD 2015 report for the UAE stated that investment in research and development in the UAE is low, at.001% of GDP, and highlighted that increasing R&D in the UAE is another approach to boost the knowledge-based economy (OECD, 2015, p.88).

The policy prioritized R&D in various industries, aiming that universal education and R&D will help the UAE build a knowledge economy. According to the World Bank, research and development expenditure (% of GDP) in the United Arab Emirates is still low, at 1.245% in 2020, compared to 1.28% in 2018 (UNESCO Institute for Statistics, 2021) (GII 2014, p.106):



Reference: *World Bank data 2022*
https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=AE UIS



Reference: *The Global Innovation Index 2014-(GII 2014, p.106).*

The OECD's 2015 report to the UAE suggested that investing in information exchange and research from a global perspective will increase the country's talent pool. The country needs to network and collaborate with worldwide institutions and organizations. This report seems to be one of the main features of the STI policy,

enhancing scale and cross-fertilization, assuring a robust innovation system, and hastening institutional capacity development (STI, p.26). Neoliberalism, quality assurance, and imported internationalization are significant globalization approaches. In parallel, human capital suggests importing skills and expertise to meet national skill shortages. In response, the Emirates Research and Development Council has been established. R&D cooperation has extended with the construction of international collaborative facilities such as the UAE-Korea Joint R&D Technical Centre, a partnership between Khalifa University and the Korea Basic Science Institute (KBSI). As of 2020, R&D was given 1.3% of GDP. The industrial sector's R&D expenditures are predicted to more than double from AED 21 billion in 2020 to AED 57 billion in 2031. R&D (investemirates.ae, 2022).

2.3 OECD

The OECD is a leader in education research, international assessment, and data analysis. It has become the global standard (OECD, 2004, p.4). According to Martens (2007, cited in Grek 2009, p.24), the OECD's "*scientific approach to political decision-making*" has made the organization an active global policy actor. Additionally, Ball (2013, p.39) believes that the OECD operational method played a big role in making it one of the global policy actors. "*Rational peer pressure*" is used.

Despite the absence of the OECD name in NIS and STI, they appear to be aligned with the OECD's thinking and activities. The UAE is an OECD member; in the report "Better Skills, Better Jobs, Better Lives, 2015", three policy levers were advised to convert skills and knowledge into jobs:

a) creating appropriate skills,
b) activating skill supply, and
c) putting skills to effective use.

The document's impact on the STI policy appears in several areas that the STI highlighted. I have shown this influence above, yet the OECD's publications discuss globalization as an economic factor of competition and comparability, and policymakers have accepted the social vision of a knowledge economy that "*perceives all human activity to be based on the individual acting in free competitive markets*" (Rizvi and Lingard 2009, p.446). This marketized vision does not always mesh with education. For example, the OECD report suggested that the UAE's demography and economic elements should be included, yet the UAE's shift towards the knowledge economy raises the demand to generate higher-level skills to aid in that transition for all society members (OECD, 2015). However, the STI policy does not imply that everyone would be provided with equally good educational standards. For instance, how can students with disabilities have equal opportunity? How will the socioeconomic variance be taken into account? The expansion of knowledge in society is not obtained equally across all members (Sharma *et al.*, 2013, p.347). In this domain, the political economy's perspective appears to criticize policy by emphasizing that investment in the training and education of highly educated workers will not result in market demands. Employers do not improve working conditions or

change their industrial methods in response to the availability of more capable personnel, necessitating the establishment of a comprehensive welfare state to assist the unemployed and their families through difficult times (Brown, 1999, p.240).

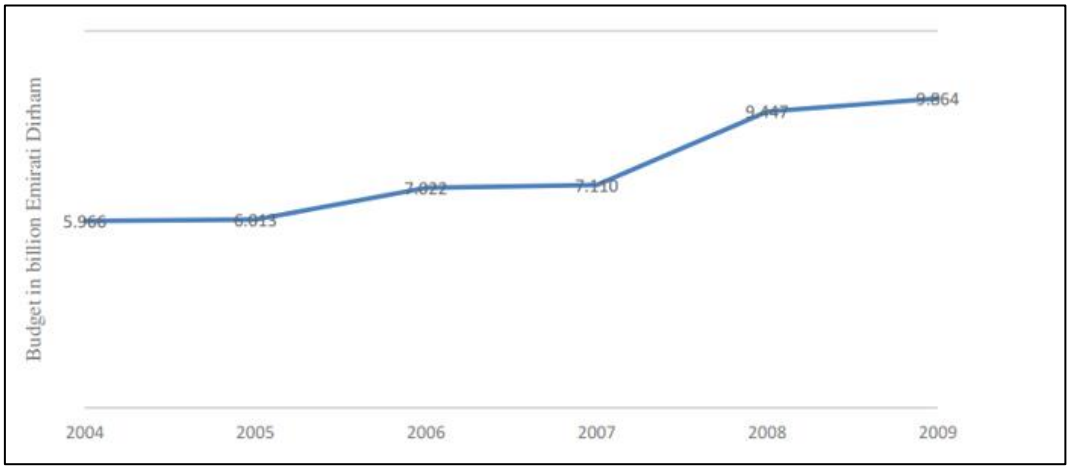
2.4 Knowledge Economy

The UAE was founded in 1971 as the seven sheikh-ruled emirates came together to maintain local autonomy. The post-formation of the UAE was self-aware, considered what it meant to be "*indigenous*," and expanded supranational networks. Since oil discoveries, the UAE state has played a crucial role in preserving partnerships and agreements that go beyond government responsibilities. Olssen *et al.* (2004, p.60) noted that if the policy is a state discourse, it is, by definition, political. On the economic and social front, the UAE is an oil producer. The country ranks among the top 31 in the most recent Human Development Index (Nations, 2022). The economy's progress appears to be consistent with oil income (a commodity-based economy), which restricts job opportunities to one industry. However, the UAE has recently started making real efforts to diversify its economy in order to become less dependent on hydrocarbons and make the transition to a Knowledge Economy (KE).

The term (KE) refers to an information-based economy, not one based on production. This relates to R&D. Since oil was discovered in 1982, the UAE has grown at breakneck speed, with a per capita GDP equivalent to that of most developed countries. While the economy is still strongly dependent on oil and gas, diversification towards knowledge-based industries is underway (Abu Dhabi Council for Economic Development 2030 vision) (Data.abudhabi, 2022). However, a number of challenges continue to arise in terms of human capital. For example, only 7.66% of UAE nationals are employed as a percentage of the total workforce (UAE's Government Portal, 2019). Female labour force participation remains low, at roughly 15.87%. (UAE Ministry of Economy, 2008). Furthermore, Knowledge expansion has been reliant on foreign employees. Emirati intellectual capital development in STI domains is crucial to facilitating a successful and long-term transformation strategy. The foundations of a knowledge economy cannot exist without a knowledge society. (Sharma *et al.*2013, p.347) A lack of national high-calibre science, technology, and engineering graduates is a hurdle in the economic transition process, making it more difficult for both the government and private enterprises to locate and employ local talent in an era when a country's competitive edge depends more so than ever on technical innovation.

Moreover, the scarcity of data and absence of contemporary analysis of the UAE research productivity define the need to organize open-access statistics information and fragmented research (Karabchuk *et al.,* 2021, p.3). In the absence of in-depth data and analytics, as well as strong government buy-in to use tech-enabled data and analytics capabilities in promoting the knowledge-based economy, it is challenging to build a knowledge economy that works. Also, the need to remove negative perceptions of engineering, adopt steps to increase family participation at the higher education level, and guarantee a broader availability of STI university programs across the UAE.

R&D has dominated the policy space. R&D is mentioned seventeen times in relation to economic growth. Since the Second World War, the UAE has supported scientific research and modern industries through its functions (Schot & Steinmueller, 2018, p.1555). Universities and research institutes receive most of the public R&D funds directly. The UAE's Education Ministry aims to spend 1.5% on R&D by 2021. Key objectives of policymakers for funding higher education include the cost-effectiveness of programs and the production of more academic outputs, which are frequently measured in terms of publications or citations. From 2000 to 2010, the UAE was not a top research performer (Haq & Tanveer 2020, cited in Karabchuk *et al.* 2021, p.3). Few studies on UAE research productivity have been published. However, the STI policy has addressed alternative approaches resulting from research and development by giving businesses with low-cost space for expansion. The political leaders of the UAE are attempting to close the 'development gap' by transforming the UAE's academic community from an information recipient to a knowledge producer (Olcott, 2010 in Ashour and Fatima, 2016, p.585). The UAE's education funding has risen steadily since 2004. The education budget (including higher education) increased by more than 90% from 2004 to 2009 and 2010. (Emirate Competitiveness Council, 2014) (UAE's Government Portal, 2022). However, the private sector R&D investment is low (Parcero *et al.* 2017, p.1156).

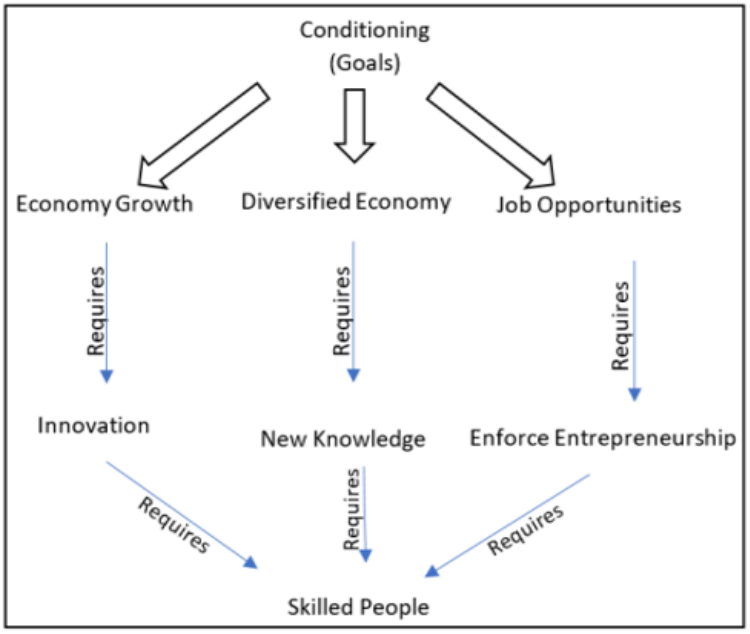


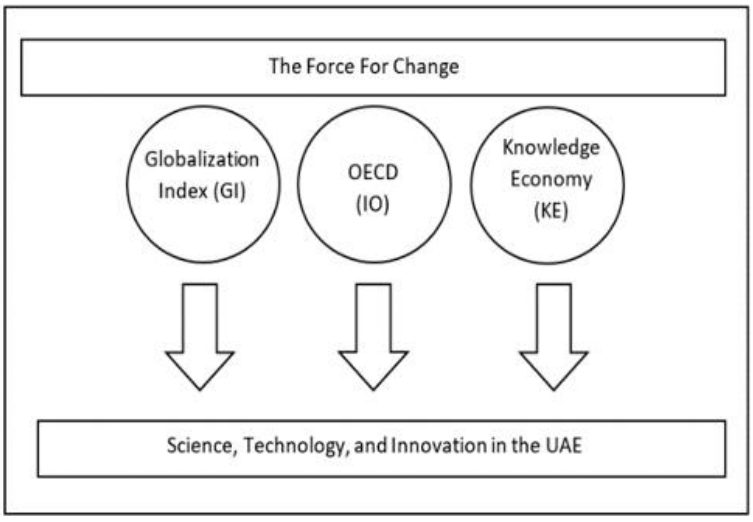
The UAE's industrial sector has not yet reached its height. The fact that the country is wealthy in capital is insufficient to explain the current status quo; several variables considerably reduce the size of the market and increase its risk and issues, including a big expatriate population that is more inclined to leave the country at any time (Toledo, 2013 in Parcero *et al.* 2017, p.1160).

Previous paragraphs focused on R&D, especially expenditure. However, macro-level strategic debates on the UAE's industrial diversification and shifting to KE would be misguided without a more in-depth examination of the underlying variables (institutional, cultural, social, economic, etc.) that influence the country's human capital development. Obviously, diversification entails an economic structure shift; structural change refers to significant shifts in the mix of employment and the relative contribution

of the primary, secondary, and tertiary sectors to the overall economic growth (Schilir 2012, cited in Schiliro 2013, p.233). Therefore, to have a more diverse economy, investing in areas with high productivity and innovative technology helps sustain long-term economic growth.

Before addressing the structural elaboration, the figures below summarize the policy initiation from two perspectives: conditioning and the force for change:



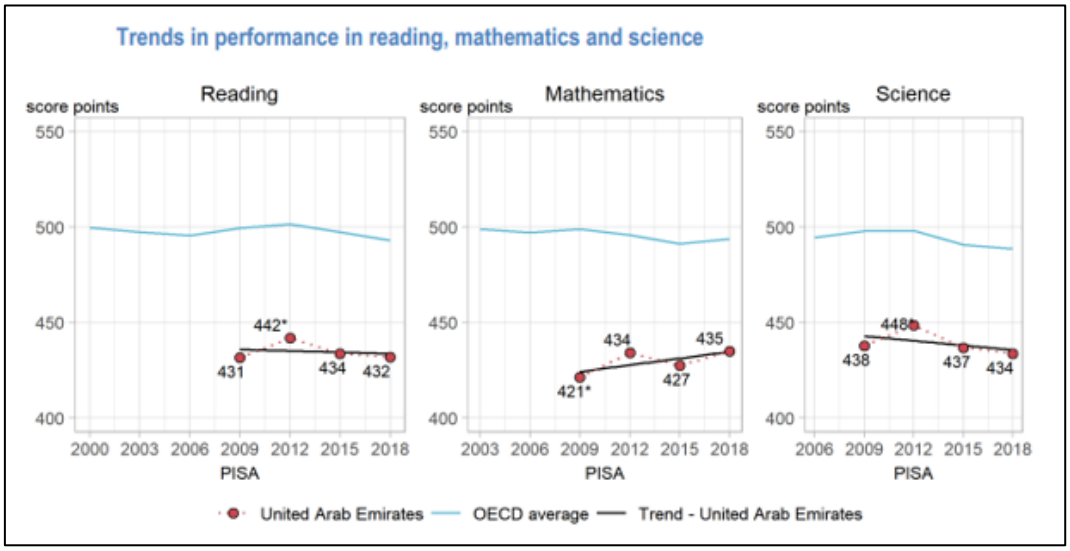


2.5 Policy: Future Possibilities

In this part, I will highlight some general policy points that may be considered in the next version:

This policy has neglected the need for a solid education system for young children to develop innovative ideas. It limited schools' ability to digitize content and offer online platforms. (STI 2015, p.19). UAE school students' international performance cannot be

ignored in this context. The UAE students perform below the worldwide average on the 2018 PISA test. (OECD-PISA, 2019).



The mismatch between R&D and education systems and policies may lead to disappointment. Bevan (2019, p.53) explained that, without alignment between Human Capital development and education systems, it would be incapable of meeting industry demands when constructing a high-tech industry. Al-Khateeb *et al.* (2007) confirmed that a good education is required before new technology can generate economic benefits. NIS suggested a few programs to encourage students of all ages to be more creative, but none are school-based.

- The policy did not include the UAE's poor areas. The study of poverty and uncontrolled urban growth is the foundation of technical innovations and engineering solutions, Alabi *et al.* (2018, p.3).
- The STI policy did not mention the role of vocational education in this shift. In vocational education, technology has opened up new learning opportunities by enabling access to the global market. (Owais *et al.* 2020, p.265).
- Developing and retaining national talent in academics, the government must target "domestic" human resources through high-caliber PhD programs.
- Encourage graduates to enter academia and research.

3. Conclusion

The policy's focus on research in a vital field raises the question of whether transformative change is too ambitious for academics and practitioners in science, technology, and innovation policy today. STI policies are needed to handle important issues and promote development (Wyckoff, 2013, p.304). STI interventions alone will not be enough; additional policies will be needed. Human resources and infrastructure are supply-side. The OECD added entrepreneurship, government regulation, and procurement to the demand side for successful STI policies. It is important to recognize

that revolutionary change will not be the consequence of new policies but of a bigger historical process in which many people are already engaged. Thus, transformative innovation policy should be understood as a response to what is occurring in and to the transitioning contemporary world. Policymakers and academics in this field must create a new conceptual framework to handle social and environmental concerns and establish new socio-technical systems. All these are possible when one considers the strength of the UAE, that its education system and state economy are amongst the fastest expanding in the world, and that the UAE's efficiency in overcoming problems is remarkable (3rd in IMD world competitiveness in 2022, Ministry of Cabinet Affairs, 2022). Other positive factors are the availability of capital, its robust IT infrastructure, and its significant ties to leading nations and organizations in STI domains.

Conflict of Interest Statement
There are no conflicts of interest to declare.

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Appendix 1: UAE Educational System in the Education Global Indicators

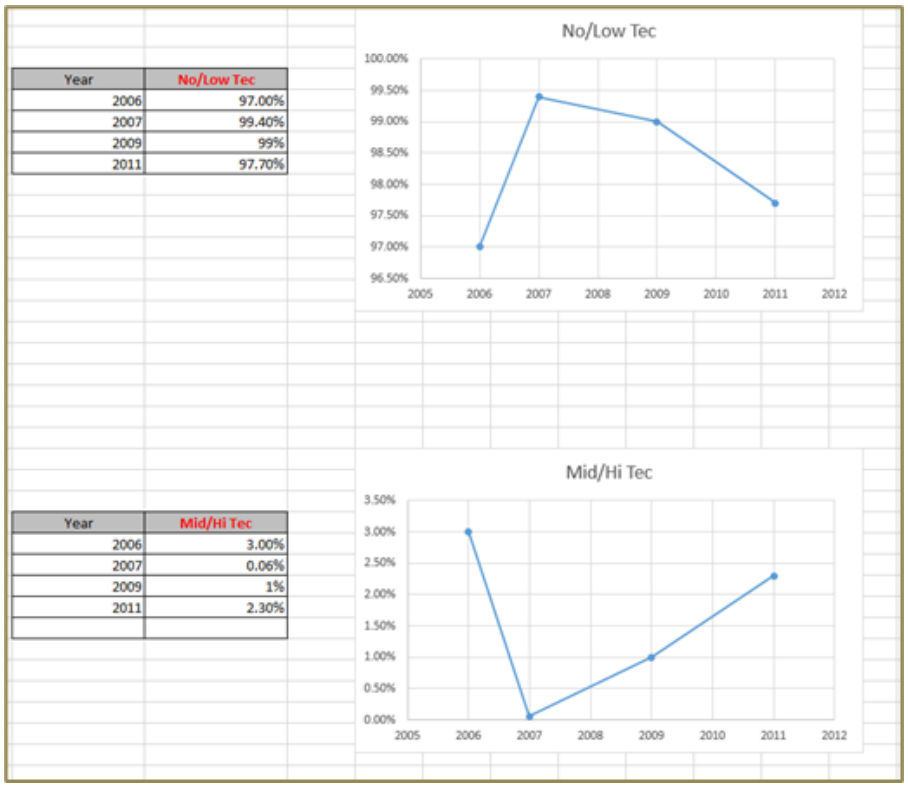
Comparison of the UAE's education indicators with those of the top 10 countries in the Global Competitiveness Report 2015–2016.

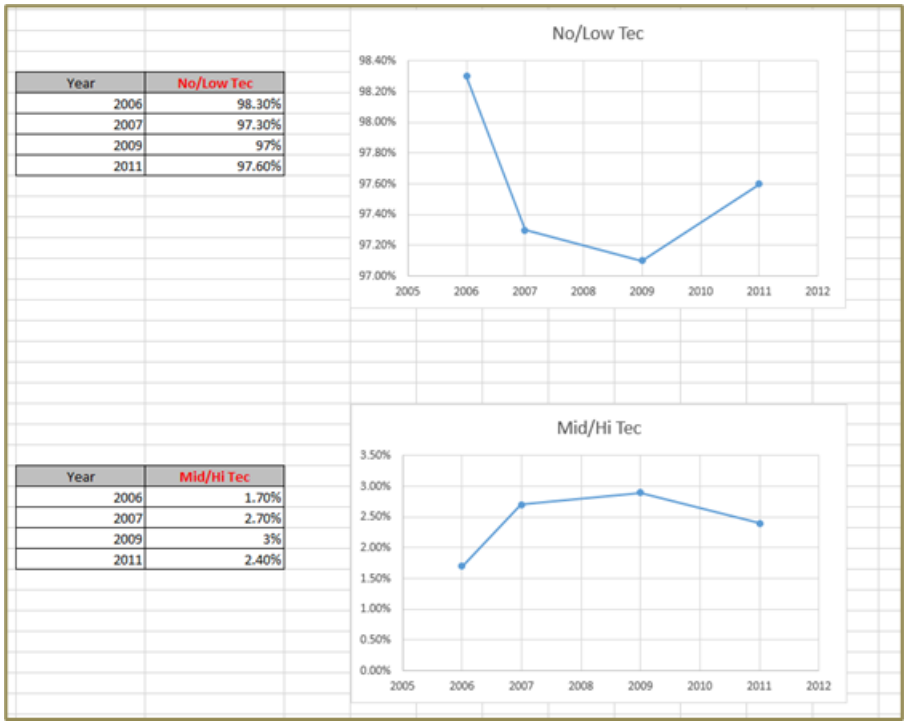
Country	Competitive Index Ranking	Quality of primary education	International ranking	Percentage of secondary education enrolment	Global ranking	University enrolment %	Global ranking	Quality of education system	Global ranking	Quality of science and math education	Global ranking	Quality of management schools	Global ranking	Access to internet	Global ranking	Availability of service and training	Global ranking	Staff training	Global ranking
UAE 2014	12	5.4	11	92.3	64	**	**	5.3	9	5.3	11	5.3	18	6	18	5.4	17	5.1	11
UAE 2015	17	5.4	12	92.3	67	16.8	99	5.3	12	5.3	11	5.3	20	6	9	5.4	20	5.4	12
Switzerland	1	6.1	1	96.3	51	55.6	46	6.1	1	5.9	4	6.3	1	5.9	16	6.5	1	5.7	1
Singapore	2	6.1	4	107.6	17	82.7	9	5.8	3	6.4	1	5.9	4	6.3	2	5.7	8	5.4	4
USA	3	4.9	14	93.7	61	94.3	3	4.9	18	4.5	44	5.7	9	5.9	17	5.6	11	5.1	14
Germany	4	5.2	13	101.3	27	61.7	38	5.4	10	5.2	16	5.2	25	5	39	5.9	5	5.1	13
Netherlands	5	5.8	9	129.9	3	77.3	16	5.4	8	5.5	7	5.7	8	6.1	5	6.2	2	5.2	9
Japan	6	5.8	19	101.8	24	61.5	40	4.5	20	5.3	9	4.4	51	5	37	5.4	19	5.4	19
Hong Kong	7	5.0	23	99.3	37	66.8	30	4.8	20	5.5	8	5.6	10	6.0	10	5.5	15	4.8	23
Finland	8	6.7	10	107.7	16	93.7	4	5.7	4	6.1	2	5.4	13	6.0	12	6.0	4	5.2	10
Sweden	9	4.7	8	98.3	7	98.4	41	4.6	25	4.5	43	5.4	16	6.3	4	5.6	14	5.3	8
UK	10	4.9	21	95.4	54	61.9	37	4.7	21	4.4	46	5.9	3	6.1	7	5.8	7	4.8	21

Reference: Ashour, S. and Fatima, S.K., 2016. Factors favouring or impeding building a stronger higher education system in the United Arab Emirates. *Journal of Higher Education Policy and Management*, *38*(5), pp.576-591

Appendix 2: Entrepreneurs' Technological Activities in the UAE over Time

The Early-stage Tech Entrepreneurs Established Entrepreneur's Tech





Reference: Hameed, I., Khan, M.B., Shahab, A., Hameed, I. and Qadeer, F., 2016. Science, technology and innovation through entrepreneurship education in the United Arab Emirates (UAE). *Sustainability*, *8*(12), p.1280.

Appendix 3: Number of Nationals Academic Staff in UAE Public and Private Higher Education Universities by Nationality, Gender, and Status, 2014-2017

Number of faculty members by nationality, gender and status in public and private higher education institutions in UAE, 2014-2017

	2014/2015					2016/2017				
	National		Non-national			National		Non-national		
Public HE institutions	Male	Female	Male	Female	Total	Male	Female	Male	Female	Total
Professor	8	2	154	24	188	7	4	143	19	173
Associate Professor	24	18	237	59	338	27	16	229	68	340
Assistant Professor	74	42	201	139	456	65	49	230	169	513
Lecturer/Faculty	33	69	774	567	1443	16	145	1029	744	1934
Total	139	131	1366	789	2425	115	214	1631	1000	2960
Private HE institutions										2014/2015
	National		Non-national		Total	National		Non-national		Total
	Male	Female	Male	Female		Male	Female	Male	Female	
Professor	2	0	417	46	465	5	3	342	53	403
Associate Professor	9	0	614	127	750	5	1	581	126	713
Assistant Professor	31	13	1318	543	1905	43	20	954	417	1434
Lecturer/Faculty	20	27	595	520	1162	37	15	603	522	1177
Total	62	40	2944	1236	4282	90	39	2480	1118	3727

Source: FCSA statistics online. http://data.bayanat.ae/en_GB/dataset/number-of-faculty-members-at-federal-higher-education-institutions/resource/40f5ab47-42f2-4ee0-85c9-efa39095a493 (retrieved on 10.05.2020).

Reference: Karabchuk, T., Shomotova, A. & Chmel, K. 2021, "Paradox of research productivity of higher education institutions in Arab Gulf countries: The case of the UAE", *Higher education quarterly*

Appendix 4: The New Research and Development policy in the UAE

Reference: The United Arab Emirates' Government Portal - The official guide to living, working, visiting and investing in the UAE. 2021. The Research and Development Governance Policy. [online] Available at: https://u.ae/en/about-the-uae/science-and-technology/the-research-and-development-governance-policy [Accessed 22 June 2022].

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