

Towards a Knowledge-Based Economy: Empowering Higher Education in Oman with AI for Vision 2040 Achievement

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Abstract. Artificial intelligence has emerged as a transformative technology with the potential to revolutionize various industries, including higher education. By incorporating artificial intelligence in Omani higher education, institutions can enhance the learning experience for students, improve teaching methods, and streamline administrative processes. Furthermore, AI can play a crucial role in personalized learning by providing tailored educational content and adaptive learning platforms that cater to individual student needs. Additionally, AI can assist in automating administrative tasks, such as grading and data analysis, freeing up time for educators to focus on instruction and student interactions. Overall, the implementation of artificial intelligence in Omani higher education has the potential to lead to a more efficient and effective learning environment, empowering students, and educators to reach their full potential and contribute to Oman's vision of becoming a knowledge-based economy by 2040. By integrating artificial intelligence into the higher education system in Oman, students can benefit from personalized learning experiences tailored to their individual needs and learning styles. Using AI, institutions can analyse vast amounts of data to identify trends, enabling educators improve teaching strategies. AI cannot replace teachers in the education system, but studying and analysing certain parameters can help remove elements which could possibly have human bias e.g. performance evaluation. Tools based on AI can provide continuous inputs to the students which help them improve their performance. AI based access for remote location students helps in extending the outreach of HEI to a larger segment of population thus making the environment more inclusive.

Keywords: Artificial Intelligence, Higher education, Oman, knowledge economy

1 Introduction

The last few decades have witnessed tremendous changes in the overall computer architecture with inclusions such as Artificial Intelligence, Machine Learning, Big Data

and Robotics. While all these innovations have impacted human lives in multifarious ways including several aspects of daily lives, be it the use of facial recognition by several applications in mobile phones or conducting patient surveys to enhance the overall healthcare related experience or smart personal assistants like Alexa and Siri or even driving a vehicle. There has been a major spur in their application, manufacturing, banking, healthcare, entertainment, agriculture, possibly now a rare sector of the economy that remains untouched.

Another facet of these technologies is that they have been instrumental in the collection, curation and dissemination of large quantum of information and nations the world over are witnessing a change in their economies which are now science and technology based, the knowledge economy as it is commonly referred to as. Powell & Snellman, (2004) describe the knowledge economy as a production and services-based economy that has a great deal of reliance on knowledge-intensive actions and intellectual capabilities than inputs of natural resources. It is an economy that believes in building in improvement measures at each step of the process, starting at the designing stage right until the product is delivered to the customer and the solicited feedback is received. An economy that not only produces at an accelerated pace but also renders those products obsolete in no time due to newer innovations and upgrades. Abramovitz & David (1996) attribute the increase in wealth in the knowledge economy to an intangible capital that is developed owing to the inclusion of technology-based solutions in all forms of economic activity.

The third factor to be considered is that the world is gradually moving towards an AI enabled environment and the future generations of humans must be AI ready, to be successful in their careers, to be enabled in their lives, to be comfortable in an AI driven society, knowledge of AI will be paramount. Moreover, as may be witnessed already, several jobs will be passed on to AI based solutions making the humans involved redundant. Going forward businesses and other non-government organizations will need to adjust their senior leadership, workforce capability, and infrastructure to fully reap the benefits of AI. The premier source for skill enhancement and enablement, development of an appreciation of technology interfaced lives is education, at primary, secondary and tertiary levels. (Australian Government Department of Education, 2024).

Bearing in mind these aspects, this paper aims to study the role of Artificial Intelligence in education and specifically higher education to understand the inter-linkages and real time applications. The Sultanate of Oman is a progressive nation in the Middle East and has developed a master document, a blueprint called Vision 2040 which is designed as the guide the transformation of the oil dependant economy to a more diversified, sustainable, and prosperous knowledge focussed one based on the understanding that innovation and technology are essential to achieving the goals set forth by the motivating roadmap. This research article is divided into the following sections - a literature review on Artificial Intelligence, the knowledge economy, the impact of AI on higher education, study the present achievements that Oman has had in this direction through case applications and the possible technology inclusions in higher education that have already been planned.

2 Literature Review

2.1 Knowledge Economy

The society has been witnessing a dramatic change in the way goods and services are being produced, distributed and consumed. Knowledge, now, is a key factor of production. Knowledge is contributing to optimal utilization of natural and allied resources and is fast becoming the core distinguishing factor and a contributor towards gaining competitive advantage (Davood Behboudi et al., 2013). The knowledge economy is not only about amassing data and information, instead investing in research, development of higher education facilities, software development, creating contemporary information infrastructure, increasing the innovation potential (Kefela, 2010; Mortazavi & Bahrami, 2012). In short, the whole premise is based on developing ability amongst people and processes. These actions, as per the World bank, constitute the Knowledge Economy Framework. For a country to transition to the Knowledge Economy, it must have the following (Chen & Dahlman, 2006):

- 1) The establishment of governmental policies that provide apt economic policies that encourage efficient allocation of resources using existing knowledge.
- 2) The development of educated workers with the required skills who can innovate with their knowledge.
- 3) Development of incubation and research centres, institutions of higher education to tap into the ever-growing global stock of knowledge and adapt it to local needs.
- 4) A state-of-the-art information infrastructure capable of facilitating dissemination, and processing of information and knowledge.

The Global Knowledge Index (GKI) is a useful instrument for evaluating and measuring the knowledge performance of countries across the globe at large. Developed by the United Nations Development Program in association with Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF), the GKI is a dynamic study tool around measuring knowledge and development in a nation. Initiated in 2017, it serves as a comprehensive framework for understanding and measuring knowledge-related performance globally. The tool investigates several aspects of information such as education, research and development, innovation, information communication and technology. The GKI gives an insight on where a country is doing well in terms of making use of knowledge for its own good and areas that it could be improved. Through consideration of parameters like quality in education, research outputs, technological readiness and digital connectivity among others, this index supports policy makers, researchers, and stakeholders to make informed decisions on how best to promote global competitiveness in knowledge-based growth.

The GKI considers 7 indices namely, Pre-university education, Technical and Vocational Education and Training, Information and Communications Technology, Enabling Environment, Research, Development and Innovation, Higher Education, Economy and Enabling Environment. Each of these indices are extremely relevant but studying each may not be feasible within the context of this research paper. An attempt is being made to build a more detailed understanding of the Higher Education sub-index. It is an established fact that higher education plays a pivotal role in creating the right

kind of human capital essential for a knowledge economy. To make the study in this arena comprehensive, valid sub-indices have been chosen namely, learning environment comprising of diversity, academic freedom, equity and inclusiveness; expenditure, enrolment, and resources; and measures the outputs via indices such as knowledge attainment, employment and social impact (UNDP and MBRF, 2023).

The 2023 GKI report studied 155 countries and Oman ranked 66, a moderate performer in terms of the existing knowledge infrastructure and interestingly, 57 out of 61 countries in terms of very high human development.

Presented below are some performance indices for the Sultanate of Oman as per the GKI report:

Table 1. GKI Indices Performance Indicator

	<i>Knowledge Capital</i>	<i>Educa- tion En- abling envi- ronment</i>	<i>Learning environ- ment</i>	<i>Infra- structure</i>	<i>Ac- cess</i>	<i>Us- age</i>	<i>Economic competi- tiveness</i>
<i>World Av.</i>	65	62	51.2	57.6	40.4	43	52.9
<i>Oman Av.</i>	68.7	75.2	28.9	59.1	53.1	46.8	52.4

Source: (UNDP & MBRF, n.d.)

The report indicates that on most parameters, Oman has showcased better performance in its bid to moving towards the Knowledge economy. Some of the strengths indicated by the GKI (2023) are an increase in the number of STEM graduates, an increase in the numbers of tertiary graduates from ICT programs, and an increase in the citable documents per R&D personnel clearly indicating Oman's focus on enduring research.

2.2 Artificial Intelligence

The origins of the term Artificial Intelligence dates to 1956 when John McCarthy referred to it as the "science and engineering of making intelligent machines". Work in these lines had commenced post the Turing Test which expected the computer to pass a human interrogator. For a IT system to be considered intelligent, it required to possess certain capabilities; the ability to communicate in English (NLP), to record and save all the information it receives, use this information to provide human like responses (automated reasoning), the ability to adapt to new situations and extrapolate its learnings to create patterns and provide solutions, vision to visualize objects and motor skills to move things around (Robotics). Simplistically, it includes the development of technology solutions that can understand the problem, perceive the prevailing circumstances, study the output environment, and undertake decision making thus providing conducive outputs, pretty much like human beings. An intelligent system that can handle complexities, infer, respond quickly, and learn on the go (Singh et al., 2013).

Artificial Intelligence is an interdisciplinary science which is causing a paradigm shift in virtually every sector of the technological development of industry and implementing AI into business environments. AI cuts down on time spent on repetitive tasks, improves employee productivity, and enhances the overall customer experience (Russell & Norvig, 2010).

Artificial intelligence has significantly impacted human lives – voice assistants, virtual assistants, chat bots, fingerprint and facial recognition, weather forecasts, live flight trackers, autonomous vehicles, diagnostic support and not to forget the navigational tools that are now a part of the everyday life. AI has already been useful in unconventional industries like agriculture where it can identify weeds, detect soil quality, nutrient deficiencies and provide technology-based aid to help yield better crops.

Education, like the other fields, has seen a great number of interventions through Artificial Intelligence. AI is very diverse in its capabilities and spectrum. As a support mechanism for teachers, AI can enhance the overall learning experience of students while improving learning outcomes as well (Verma, 2018). Proctored tests, online activity tracking of students to help personalize their learning experiences and align the academic inputs towards their learning styles. Education has a key role in developing digital literate humans that businesses will demand in its next generation employees on which is based economic prosperity (Abdelfattah et al., 2024; Cardona et al., 2023).

Covid-19 showed the potential of blended learning bringing academic institutions to pupils' homes breaking barriers of timetables, cohorts, and semesters (Amer jid Almahri et al., 2024). The availability of learning resources online or e-libraries as they are called have increased multiple folds. AI has helped improve teaching quality, AI driven student data analysis has provided insights to understanding what students want to learn, thus diversification, upgrading of curriculum and overall, student retention. Assessments have become easier using AI, newer learning methodologies have been introduced, timely student feedback are a few of the known interventions (Bhatnagar, 2020; Rahiman & Kodikal, 2023). Some authors identify the following 2 as main areas where AI has already shown considerable impact - availability of a diverse curriculum and in the overall enrolment numbers. AI driven courses offer accuracy and consistency in teaching courses that do not require high amounts of creativity and innovative teaching methodologies. From the enrolment perspective, there are two observations – the availability of courses and curriculum has become far reaching and is helping education reach even those who were bereft from it. The other observation is that with AI taking over jobs, either the people will upskill themselves to be more digitally adaptable or it might become too expensive for people to undertake education due to loss of employment and reduced purchasing power (Harry, 2023).

2.3 Vision 2040

The Sultanate of Oman has traditionally been a hydrocarbon dependent economy. Prior to the discovery of oil, the country has had a rich history and heritage of agriculture, maritime activities, trading, and fishing; all of which have continued to thrive in the modern times as well (Encyclopedia Britannica, n.d.). While oil for commercial processing was discovered in 1964 and its initial crude oil export happened in 1967, its

development as a modern state commenced in 1970 coinciding with commencement of modern methods of oil exploration, and ascension to the throne of H.M Sultan Qaboos bin Said, (Ministry of Transport, Communication & IT - Sultanate of Oman, 2019). H.M. Sultan Qaboos bin Said's tenure of rule extended from 1970 to 2020. Development of strong relations with the Western governments, and the Gulf Cooperation Council (GCC), of which Oman is a founding member (Britannica, 2019), resulted in establishing of oil exploration & processing companies controlled by the government like PDO and OmanOil etc, paved the way for overall improvement of GDP and quality of life of Omani citizens (Crystal & Peterson, 2019)

In 2021, Oman's GDP per capita was USD 19,479, with a high human development index rank of 54 (Unicef Country Office - Oman, 2022). With the objective of bringing together all aspects of development, prosperity, promotion of culture & values, global competitiveness and relevance in the developed world, and sustainability, the leadership of Oman developed the "Oman Vision 2040" as a beacon for various paths to be taken to achieve a large & diverse set of goals. It is the national reference for the next two decades of development and progress across multiple parameters. (Oman Vision 2040 Implementation Follow up unit, 2020)

The vision document has clearly highlighted one of the main priority areas as Education, learning, scientific research & national capabilities. This is to be achieved by improving educational outcomes, improving quality of curricula, alignment to international standards, accreditation to international bodies and using modern teaching techniques. Graduates from this enhanced education system should have competencies suitable for the global talent market and be the drivers of Oman as a knowledge-based economy. A national system is envisaged in this vision, which will nurture talent, creativity, and entrepreneurial potential (Oman Vision 2040 Implementation Follow up unit, 2021).

Vision 2040 of Oman states many points regarding education and skill development. It emphasises on the availability of Quality Education. The vision is to provide quality education at all levels from early childhood up to higher learning institutions to equip people with knowledge and skills necessary for future changes. With more and more young members of the population joining formal education and the need to migrate from the resource-based economy to a knowledge-based economy, Vision 2040 focuses clearly on Enhancing Skills. It aims at improving skills among Omani nationals with a special focus on critical thinking, problem solving, communication and digital literacy. This emphasis on skills is to keep themselves in line with the dynamics of a fast-changing global economy. Another important aspect of the Vision 2040 is that it vociferously promotes Lifelong Learning. Lifelong learning and continuous skill development are both critical elements for creating chances for individuals to learn new things throughout their lives so that they can adapt to the changing economic as well as technological terrain. It highlights the need for strong collaboration between industries & academia. Such collaborations help education programs align with industry needs thus promoting job-readiness of graduates and spurring economic growth. In addition, Vision 2040 places great emphasis on youth empowerment through education and skill

acquisition initiatives. Oman aims at having a skilled labour pool that can drive innovation, entrepreneurship, and sustainable development through investment in youth education and training.

Improvement achieved in the field of Education, learning, scientific research, and national capabilities are pegged to global indices, rankings or values which are released by neutral agencies and not controlled by any government. Oman has set its targets against the following parameters in the arena of education, research, and related development:

1. Global innovation index, current rank being 76, targeted rank by 2040 is Top 20.
2. Skills, global competitive index, current rank being 38, targeted rank by 2040 is Top 10.
3. Global talent competitiveness index GCTI, current rank being 48, targeted rank by 2040 is Top 20.
4. QS World university ranking, currently 1 Omani university features in the top 500, target is featuring 4 Omani universities in the top 500.

(Oman Vision 2040 Implementation Follow up unit, 2021)

Addition of AI related inputs in the educational system of Oman will make the students equipped with critical knowledge and expertise to be a part of modern-day businesses which are technology driven. AI will also help institutions to take a huge leap in terms of their reach and ability to curate content to match requirement of their students. (Jawarneh, 2024)

3 Discussion

The surge in big data and the exponential expansion in processing power are the reasons behind the popularity of AI. According to Miao et al. (2021), the term artificial intelligence (AI) today encompasses robots that mimic certain aspects of human intellect, including verbal interaction, perception, learning, reasoning, problem-solving, and creative activity.

In the literature review, there is adequate evidence to prove the benefits of the inclusion of AI in teaching, at all levels and mostly so at the higher education segment. AI is capable of reducing the workload of teachers and professors by taking over the mundane administrative tasks and allowing them the opportunity to utilize the time thus saved in preparing to teach with creativity and innovation. AI is proving to be resourceful in providing insights about students, their learning styles, bridging the gap between developed curriculum, what the students actually want to study and what skills the industry expects in graduates making the process holistic. Simulators to train students and teachers to improve the quality of education is proving to be an ideal training mechanism (Al Matari et al., 2023).

In Oman, the use of Artificial Intelligence has received tremendous impetus due to the emphasis of the role of ICT, AI as expressed in the Vision 2040 document. Higher

Education in Oman has multiple streams akin to the rest of the world like – Engineering, Technology, Healthcare, Management, Humanities, Arts & Culture, Tourism etc. All these are educational avenues which are also important for the Vision 2040's target achievement. Since a large part of the country's economic and developmental activity is anchored to Crude Oil & Gas extraction, infrastructure building, public utility capacity enhancement, real estate, and tourism; one common aspect which is important for all these sectors is Health, Safety and Environment (HSE). Development and implementation of AI based techniques and tools in Oman's HEI will help educate students in the sphere on HSE workflow. AI techniques will be used to analyse large data to identify potential risks, recommend risk management path and protect aligned infrastructure and equipment through timely isolation, all done in a time sensitive manner not possible in normal human monitoring (Ghafri et al., 2022). Being an oil-based economy, Oman has many engineering and heavy engineering businesses to support this eco-system. The need and opportunity to implement latest technology like AI is ideal at the Engineering related HEI of the country.

Oman being a fast-developing country, with a major spurt in construction and infrastructure has been undergoing an active phase of technology being continuously being updated in sectors of Building design, thermal comfort and energy efficiency. Due to its geographical location high factors of heat load, humidity, salinity, dust etc are some of the adverse factors to be dealt with while planning any building. Deployment of AI curricula in diverse applications such as building design, heat load calculation, HVAC systems, energy efficiency management, and thermal comfort etc are bound to have success in the industry (Albadi et al., 2021).

Technology develops fastest when it is put on a fast-track practical usage. This is very true for healthcare sector which is one sector where the emphasis on introduction of latest technology like, IoT, AI, Robotics, and diagnostics etc are equally important in the sphere of higher education as it is for real-time usage. There are many examples of Oman having introduced best-in-class technology in their health-care ecosystem with a large share of these efforts being initiated by the government departments or institutions. A study conducted amongst 368 students of Sultan Qaboos University, Oman, indicates that students in their perception of AI assisting physicians and replacing their tasks was very progressive and the respondents marked high scores for high competence tasks for AI and the only low scores were those pertaining to humane angles such as emotional support, personalized treatment schedules and psychiatric counselling support (Hadithy et al., 2023).

Oman has policies in place wherein teachers are expected to include AI supported solutions to enhance learning efficiencies. Summarized discussions of classes (Zawacki-Richter et al., 2019), simulations in classrooms, inclusion of e-learning content are some of the current best practices. At the International Maritime Collage Oman, AI interventions are in place to provide real life experiences for students in areas such as stevedoring, warehousing, incoterms, freight-forwarding, and shipping agent scenarios. Students are taken through the entire process, and they receive the opportunity to monitor and experience the transport of goods from one port to another and learn all the documentations required by creating them in a virtual scenario (Khalfan et al., 2022).

4 Conclusion

The emergence of artificial intelligence in teaching and learning is a significant phenomenon in higher education. It has the potential to revolutionize how students learn and how institutions evolve in their teaching methods. Rising number of students in higher education institutions, coupled with the limited resources available to meet their needs, necessitates innovative solutions to enhance teaching and learning experiences. AI technologies can address various challenges in higher education, such as increasing enrolment, self-paced learning, differentiated instruction, and high costs. By leveraging AI technologies, higher educational institutions can enhance various areas of operations, including student admissions, library services, student personal learning guides, and classroom interactions. Furthermore, AI can also support faculty members in administrative tasks, grading, and data analysis, allowing them to focus more on instruction and personal interactions with students. These advancements in AI will contribute to the realization of Oman's Vision 2040, which aims to establish a knowledge-based economy. Using AI technology in higher education has the potential to revolutionize learning experiences and transform teaching methods. The integration of artificial intelligence into educational curricula, redefining the roles and responsibilities of educators, promoting lifelong learning, and fostering international collaboration are crucial components for preparing individuals for an AI-dominated future in Oman.

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