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INNOVATION HERITAGE MUST NOT LOST: PRESERVING MEDIEVAL SCIENCE AND TECHNOLOGY THROUGH THE ARABIC LANGUAGE

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Abstract
This study investigated the imperative of safeguarding innovation heritage by focusing on the preservation of medieval science and technology conveyed through the Arabic language. Recognizing the pivotal role of Arabic as a carrier of scientific knowledge during the medieval period, the research shed light on the potential loss of invaluable insights if not adequately preserved. The methodology involves a qualitative examination of medieval Arabic manuscripts, employing linguistic and historical analyses to unveil the intricate interplay between language, science, and technology. By elucidating the significance of this linguistic heritage, the study advocates for proactive measures to ensure the sustained conservation and accessibility of medieval scientific and technological contributions embedded in the Arabic language.

Introduction

The Arabic language, originating from the Semitic root, stands as the sole dynamic survivor within its linguistic group. Its predominant speakers are distributed across the Middle East and Northern Africa. Significantly, Arabic has not only preserved but also elevated the potentialities of the Semitic family of languages to a level surpassing its mostly extinct or moribund counterparts. This accomplishment is underscored by the observation in The New Encyclopaedia Americana (vol. 2, p. 123; Al-Razouki, 2023).

In essence, Arabic, like any language, serves as a medium for communication and self-expression, playing a pivotal role in reflecting the cultural identity of the Arab people (Al-Razouki, 2023). Understanding that discussions on technological advancement are intricately linked to education, and education, in turn, is intricately tied to language, underscores the paramount importance of language in the educational context. Advocating for the education of Nigerian students in Arabic becomes imperative, as it would empower them to make meaningful contributions to the scientific and technological progress of their nation. Moreover, historical insights reveal that when the

Arabs, renowned for their commitment to fact-finding, established their empire and gained access to the accumulated knowledge of the then-civilized world, they prioritized practical sciences that immediately benefitted them and humanity at large (Al-Razouki, 2023). This strategic emphasis prompted them to cultivate various branches of science with utmost urgency.

Conceptual Framework

Before delving into a substantive exploration of the central theme of this paper, it is imperative to establish a comprehensive comprehension of fundamental concepts to ensure clarity in the ensuing discussion. To facilitate this, it becomes essential to initiate the discourse by scrutinizing the definitions and nuances associated with the concepts of science and technology.

The Concept of Science

Science represents a distinct realm of knowledge, as succinctly defined in the Concise Oxford Dictionary of Current English, which characterizes it as systematic and formulated knowledge. Within its purview, science encompasses various branches, spanning the social, political, and natural sciences. The Oxford Advanced Learner's Dictionary, 6th Edition, refines this definition, framing science as the understanding of the structure and behaviour of the natural and physical world, grounded in verifiable facts, often established through experimentation. Ogunniyi (1986) contributes the perspective that science constitutes a human attempt to systematize experiential insights about nature into coherent explanatory frameworks.

Woodbury and Oborn (1965) conceptualize science as a human endeavour driven by the pursuit of describing, with increasing precision, the events and circumstances within our natural environment. Crucially, science is not dogmatic; rather, its principles exhibit universality and reproducibility under consistent conditions, as elucidated by its special characteristics. Etymologically, the term "science" traces its origin to the Latin word "Scientia," denoting knowledge. This linguistic insight reinforces the pervasive influence of science on our lives. Science serves as the foundational framework for much of modern technology, encompassing tools, materials, techniques, and sources of power that contribute to the facilitation of our daily lives and work.

The Concept of Technology

As per the definition provided in the World Book Dictionary Volume 2, technology is characterised as the science encompassing mechanical and industrial arts. It represents the

collective domain of tools, machines, materials, techniques, and processes employed in the production of goods and services, aimed at fulfilling human needs. Alternatively, technology can be understood as a specific application of technical knowledge and methods directed towards accomplishing a particular objective. The dictionary additionally underscores technology's role as the systematic application of knowledge to practical tasks.

Gilbraith (1977) aligns with this perspective, emphasising technology's essence as the organised implementation of knowledge in the practical endeavour. The integration of science and technology is portrayed as an intricate and nearly inseparable alliance. While science primarily concerns itself with the generation of knowledge, technology assumes the crucial role of its practical application. Linguistically, the term "technology" derives from the Greek word 'tecture,' signifying "art" or "craft." Its usage, however, is nuanced and can be broadly interpreted to encompass all processes related to materials. In a more specific sense, technology pertains to industrial processes that have superseded traditional craft operations. This evolution has enabled humanity to explore space and planets, exemplifying how technology, often synonymous with applied science, has propelled significant advancements in human capabilities.

Science and Technology in the Modern World.

Undoubtedly, the contemporary era is unequivocally characterized as the age of science and technology, as asserted by Orukotan (1995). In recent years, the global landscape has witnessed remarkable strides in the realms of scientific and technological advancements. These achievements manifested through a plethora of modern inventions and discoveries, collectively contribute to enhancing progress in areas such as health, business, and productivity.

An illustrative example of the transformative impact of science and technology is evident in the realm of communication. Presently, the seamless exchange of information between the state capital and the remotest village in Nigeria is achievable within a matter of seconds. Satellites play a pivotal role in providing real-time visual and auditory access to events, facilitating the instantaneous transmission or broadcast of information across entire hemispheres of the Earth. The advent of computers, available in various brands and sizes, empowers the processing of vast amounts of information with remarkable efficiency and ease of retrieval. These instances, among numerous others, stand as tangible outcomes of the pervasive influence of science and technology in shaping the contours of the modern world.

The Role of Arabic Language as Basis for Creativity and Development of Technical Know-How

The Arabic language, much like any other linguistic system, serves as a fundamental tool for communication and self-expression (Khalifa, Zalmout, and Habash, 2020). It not only facilitates the conveyance of cultural nuances but is also an integral component of the broader cultural identity. In the context of Arabic, the language plays a pivotal role in encoding meaning, shaping thoughts, and expressing emotions derived from personal experiences (Khalifa, Zalmout, and Habash, 2020). Through Arabic, we possess the capability to articulate, describe, and communicate our perceptions of objects and aspirations.

Moreover, the fabric of everyday life, with its diverse sensory impressions, finds expression through the vehicle of the Arabic language. Recognizing the intricate connection between language, education, and technological development becomes imperative (Pupic, 2020). Language, being a cornerstone of education, holds a paramount position in discussions about technological progress. A proposition is advanced for the Nigerian government to impart education through the Arabic language, envisaging that such an approach would enable citizens to proficiently engage with and advance in the realm of technology. An additional layer to this argument suggests that introducing the basics of modern technology, science, and mathematics through the Arabic language in early education could be transformative (Pupic, 2020). This educational strategy is likened to sowing the seeds of technological knowledge in fertile ground, anticipating a swift and robust germination process. Drawing on the insights of Gilbraith (1977), it becomes evident that language is not merely a tool for communication but a prerequisite for formulating and analyzing developmental policies. Development, construed as a creative process, finds its most expressive manifestation through language, and the Arabic language, with its flexibility and adaptability, accommodates the creative intentions and capabilities of artists.

Arabic as a Medium of Intellectual Expression

Arabic emerges as a highly sophisticated medium for expressing the scientific, technological, and philosophical ideas of the Arab-Islamic empires. Beyond its linguistic utility, Arabic serves as a conduit for the transmission of cultural and political concepts within Arab societies (Flanagan, 2019). The Encyclopedia Britannica highlights the adaptability of the Arabic script, noting its application to diverse languages such as Persian, Turkish, Spanish, and Swahili. Kamera (1986) further emphasises the significance of Arabic characters in the documentation of crucial histories

along the Eastern coast, particularly in Swahili. Despite its multifaceted applications, a notable facet of Arabic's historical role is evident in its pivotal role as the primary medium for recording original and authentic primary sources of information about Africa and its people. According to Malik (199), during approximately three centuries between the 17th and 19th centuries, Arabic documents stood as the exclusive source of information for European writers keenly interested in the history of Western and Central Sudan.

Moreover, Arabic scripts found application in various African languages, such as Wolof, Fulfulde, and Hausa, a phenomenon known as 'Ajami.' The Nigerian currency, prominently featuring the boldly written Hausa language in Arabic script, serves as tangible evidence of 'Ajami' being employed by African languages both before and after European penetration into the continent. This historical context underscores the significant and enduring impact of Arabic as a vehicle for knowledge dissemination and cultural expression in diverse regions and linguistic contexts within Africa.

Arabic Science and Technology in the Medieval World.

The term Arabic science and technology (according to Encyclopedia Americana Vol. 2 1981 pp. 144-145), refers to the scientific achievement of men of various ethnic groups who in the medieval Islamic world wrote scientific treatises in the Arabic language. This important phase in the history of science began seriously in the middle of the 8th century CE. Arabic science and technology are continuous with Western science at both ends of medieval life and the names of Jabir Ibn Hayyah, al-Khawarizmi, Ar-Ras, Ibn Sina etc., are as much part of the Western intellectual tradition as they are of Islamic culture. Their Arabic scientific works enjoyed great prestige in Europe down to the 17th century.

The above assertion historically proves that the world today has a great indebtedness to the Arabic language for the preservation of science and technology. The Arab civilization that emerged and showed brightly in the medieval period after the collapse of Greco-Roman civilization helped tremendously in passing the twin knowledge of science and technology to the modern world, (Joseph Hell 1978) The seed of modern science planted in Arabic language during this period by a fair number of original men of science with independent and critical minds of Arabs and non-Arabs alike germinated and expanded in many other languages of the world. According to Chejne

(1969), Arabic is the medium through which Greco-Arabic Scientific lores were transmitted to the West. This was made possible via the translation of Arabic books into Latin and Spanish.

Arab Scientific Contributions and Inventions

Mathematics, as a scientific discipline, encompasses a broad array of topics including Arithmetic, Geometry, Astronomy, Music, Trigonometry, and Mechanics. In the pre-Islamic Arab era, an oral tradition and cultural practice involved using stars as guides in their desert environment (Markiewicz, 2017). However, the integration of Astronomy, Arithmetic, and Mathematics into Arab knowledge systems is traced back to 771 CE when an Indian scholar introduced these subjects in the court of Al-Mansur (Hitti, 1971, p. 373) following the rise of Islam (Markiewicz, 2017).

A pivotal development occurred during the eighth century CE under the reign of Mu'amum, one of the great Abbasid rulers. He established a translation bureau, assembling scholars from diverse regions, to translate scientific knowledge into Arabic (Flanagan, 2019). This concerted effort resulted in the translation of significant works, including Ptolemy's Almagest, Siddhanta's writings, and Greek elements of astronomical works. These translated texts contributed to the burgeoning interest in Astronomy among Arabs, marking a significant shift in their intellectual landscape.

Over several centuries, the translation movement, coupled with genuine contributions from Arab scholars, led to the further exploration of scientific theories, both in Mathematics and Medicine. The cumulative outcome of these extensive translations and scholarly endeavours was the transmission of Arabic sciences to Europe through regions such as Syria, Spain, and Sicily (Hitti, 1971; Abattouy, 2012).). This laid the foundation for a comprehensive body of knowledge that came to dominate medieval European thought, shaping the intellectual landscape of the time (Abattouy, 2012).

Chemist and Chemical Sciences

The term "chemistry" finds its etymological roots in alchemy, which, in turn, traces back to the Arabic term al-Kimiya. The foundational concepts of modern chemistry, as understood today, experienced significant advancements during the medieval period through the collaborative efforts of individuals, both Arabs and non-Arabs with a command of the Arabic language. The development of this body of knowledge primarily unfolded within the linguistic and cultural milieu of the Arabic language.

Alchemy

Jabril Ibn Hayyan, acknowledged as the progenitor of alchemy, has earned recognition in Western civilization with the term "algebra" being christened after him. Renowned as a chemist, he laid the foundational groundwork for modern chemistry, notably making groundbreaking discoveries in the realm of acids. Operating from his laboratory in Kufa, Jabir conducted numerous experiments, achieving notable success in the distillation of sulphuric acid. Furthermore, he systematically classified minerals into three distinct groups: spirit, metals, and non-malleable substances. Jabir's contributions extended beyond experimentation, as he authored several pharmacological treatises, solidifying his status as a globally acclaimed chemist.

As elucidated by Hitti (1971), Jabir played a pivotal role in modifying the Aristotelian theory regarding the constituents of metals. This modified theory endured, with slight modifications, until the advent of modern chemistry in the eighteenth century. Jabir's enduring influence on the trajectory of chemical thought underscores the enduring legacy of his contributions to the evolution of chemistry.

Ttrigonometry

In the field of trigonometry, the Arab contribution was so significant that this branch of mathematics came to be recognized as an Arab science. While both the Greeks and the Indians were familiar with this science, it remained in a preliminary form, often studied as a subsidiary branch of astronomy. However, the Arabs not only elevated it into a separate and independent science but also emerged as pioneers in both plane and spherical trigonometry, areas that were absent in Greek mathematical exploration.

Nasir Din Al-Jusi (1201-1274) played a pivotal role in the substantial progress of trigonometry and planetary astronomy. His efforts were instrumental in establishing trigonometry as an independent branch of pure mathematics. His seminal work, "Kitab Shakl Al-Qatta," focused on the principle of transversal, deducing relations of fundamental importance in spherical trigonometry. The impact of this work was profound, with translations into Latin, French, and English serving as key references for European scholars for an extended period.

Tables and Logarithms: Arab Innovations

In trigonometry's realm, Sinan Al-Hasib, in the ninth century, was the first Arab mathematician to conceive the idea of logarithms. Ibn Yunus (d. 1009) went further by composing the first table of

logarithms, a significant achievement predating John Napier, who, incorrectly credited by Western historians, is often associated with logarithm invention. These Arab contributions demonstrated a pioneering spirit in numerical calculations.

Astronomy: A Pure Mathematical Science

Arab astronomers, paying particular attention to astronomy through the Arabic language, encountered the degeneration of the field into astrology from the Babylonians, Indians, Greeks, and Chinese practices. Unlike their predecessors, the Arabs cultivated astronomy as a purely mathematical science, divorcing it from astrological associations. Abu Abdullah Muhammad Bin Jabir Al-Battani (850-925) emerged as a stellar figure in Arab mathematics and astronomy. He rectified Ptolemy's astronomical calculations, replacing geometrical methods with trigonometry, and conducted highly accurate astronomical observations. The Arab contributions to trigonometry, logarithms, and astronomy marked a transformative era in the development of these mathematical sciences, leaving an indelible legacy that influenced the course of mathematical thought in both the Arab world and beyond.

Physics

Although a considerable portion of the literature crafted by Muslim scientists in the realm of physics and related disciplines has been lost over time, the surviving body of work provides sufficient insights into the advancements achieved in this scientific domain. Eminent Arab physicists have significantly contributed to the progress of science and technology. Notable figures among them include Abu Yusuf Ibn Ishaq, Al-Kindi (d. 873 CE), Ibn Sina (d. 1037 CE), Ibn Al-Haytham (d. 1039 CE), Al-Biruni (d. 1050 CE), and Abu al-Fath Abdul Rahman Al-Mansur Al-Khazini (early 12th century).

Particularly noteworthy is the outstanding contribution of Ibn Al-Haytham in the field of optics. He challenged the prevailing Greek theory of vision, presenting a correct theory of visual perception. According to his theory, vision occurs when light emanates from the observed object and enters the eye, reaching the object—an idea contrasting with the views of Euclid and Ptolemy. Ibn Al-Haytham's research extended to other important aspects of light, with far-reaching implications for science and technology. Notably, he was the first to propose the theory that light travels at a tremendous but fixed speed, a concept initially met with criticism in the West until Romer hinted at its possibility in the late seventeenth century after observing two lunar eclipses.

Abdul Hassan Ali Ibn Yunus (d. 1009) played a significant role at the Muqattam Observatory, where he oversaw practical work. His notable work, "Al-Zij Al-Hakim" (the Hakimi Astronomical Table), named after his patron Caliph Hakim, demonstrated original observations that validated the tables of his predecessors. Additionally, Ibn Yunus is credited with the invention of the pendulum for measuring time, an accomplishment predating Galileo by about six centuries. Galileo later thoroughly studied the subject and laid down most of the laws regarding its arithmetical implications. The contributions of these Arab physicists stand as a testament to the rich heritage of scientific thought and innovation in the Islamic world during this period.

Conclusion

The clarity of the brief topic and introduction underscores how individuals, both Muslim and non-Muslim, who communicated in Arabic, played a pivotal role in preserving medieval science and technology. In this process, they not only safeguarded this knowledge but also became instrumental in ushering in the modern scientific era. Their contribution to the West involved imparting a highly enriched form of the acquired and learned ancient wisdom, enriched with valuable additions of their own. Despite the unfortunate loss of numerous valuable manuscripts, these individuals played a crucial role in shaping the trajectory of scientific thought.

However, it remains disheartening that a substantial amount of literature still exists on various topics, including natural sciences, yet the contents and details of many scientific works remain largely undiscovered. These insights are entombed within manuscripts scattered across libraries worldwide, particularly in Europe, America, and the Muslim world.

Furthermore, it is noteworthy that a significant body of manuscripts was produced by Indian Muslim scientists during the periods of the Sultanate and Mughal rule. These manuscripts cover various sciences, notably mathematics, astronomy, time-measuring devices, music, and medicine. Regrettably, the legacy of these Indian Muslim scientists has not received the attention it deserves from contemporary scholars. There exists a wealth of untapped knowledge within these manuscripts, waiting to contribute to our understanding of the historical development of science and technology.

Recommendations

There is an imperative to delve into the largely unexplored body of works by Arab scientists, as the current research represents only a fraction of the extensive available literature. It is crucial,

therefore, to undertake a comprehensive study and editorial review of manuscripts, employing critical and comparative methodologies. This undertaking would be significantly facilitated through the preparation and dissemination of subject-wise descriptive catalogues, which would serve as valuable resources for researchers.

Emphasizing the importance of acquiring microfilm copies of rare manuscripts cannot be overstated. Additionally, efforts should be directed towards integrating these manuscripts into the Internet system, thereby providing scholars with broader access to these otherwise scarcely accessible treasures. Leveraging the expertise of Arabic translators becomes especially advantageous when manuscripts are presented in their raw form or Arabic their original language. This approach ensures a more thorough exploration and understanding of the wealth of knowledge encapsulated in these manuscripts.

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